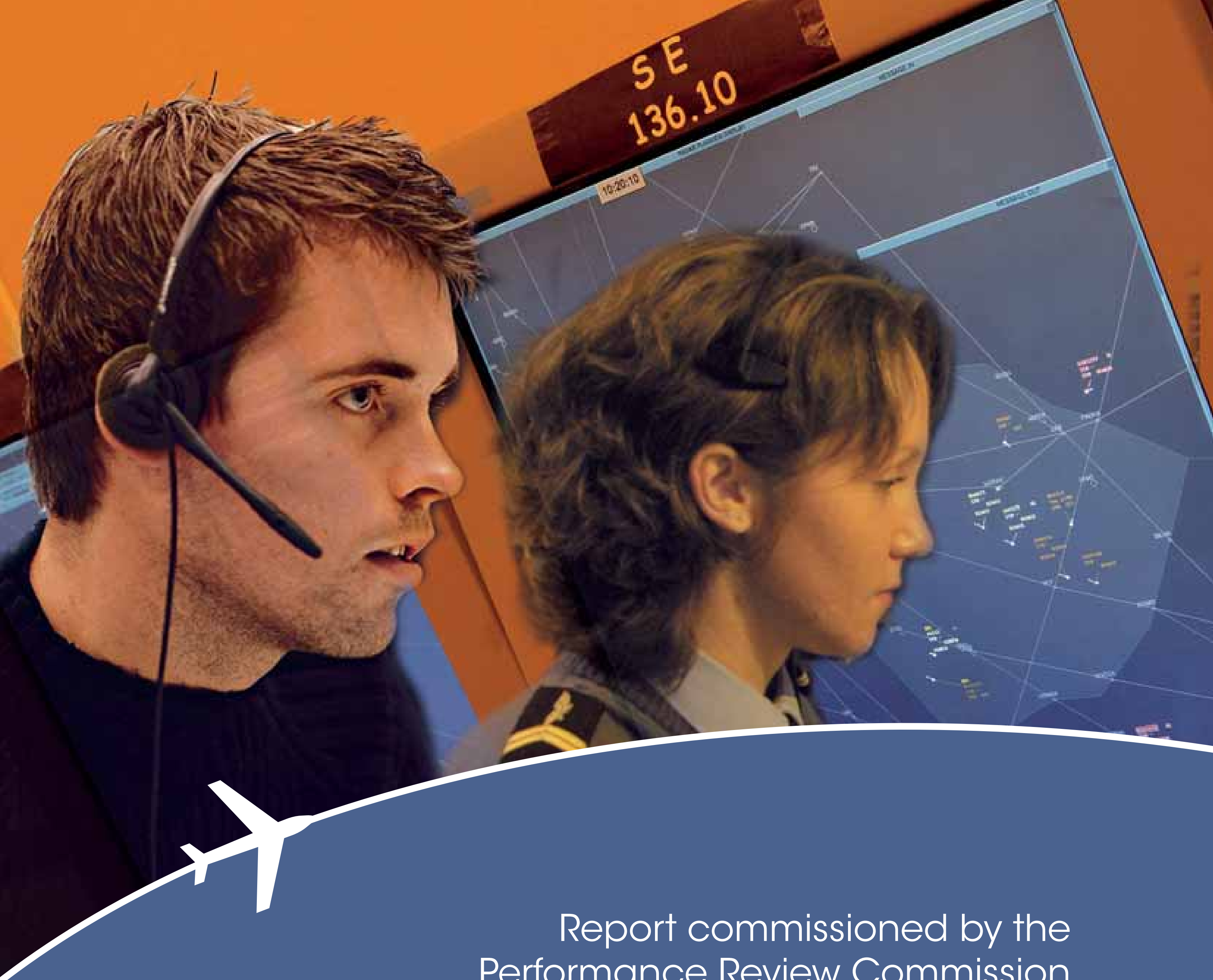

Report commissioned by the
Performance Review Commission

Evaluation of Civil/Military Airspace Utilisation

November 2007

EUROCONTROL

BACKGROUND

This Report has been commissioned by the Performance Review Commission (PRC).

The PRC was established in 1998 by the Commission of EUROCONTROL, in accordance with the ECAC Institutional Strategy (1997).

One objective in this Strategy is *"to introduce strong, transparent and independent performance review and target setting to facilitate more effective management of the European ATM system, encourage mutual accountability for system performance and provide a better basis for investment analyses and, with reference to existing practice, provide guidelines to States on economic regulation to assist them in carrying out their responsibilities."*

The PRC's website address is http://www.eurocontrol.int/prc

NOTICE

The Performance Review Unit (PRU) has made every effort to ensure that the information and analysis contained in this document are as accurate and complete as possible. 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@eurocontrol.int

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DOCUMENT DESCRIPTION

Document Title

Evaluation of civil-military airspace utilisation

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ABSTRACT

This report reviews the sharing of European airspace above FL195 and use of shared airspace for civil traffic and military activities in 2005. It identifies best practices and enablers to maximise the usage of airspace. It addresses airspace in seven States, namely Belgium, France, Germany, Italy, Netherlands, Switzerland and the United Kingdom, focusing on European core airspace.

Keywords

Air Traffic Management	Performance Measurement	
Civil/Military	FUA	ANS
Performance Indicators	ATM	

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1 Airspace is a finite resource, which must be used in an optimal way to satisfy both civil and military requirements.

2 In order to best satisfy both civil and military demand for airspace, EUROCONTROL has developed rules and standards[1] for the sharing of airspace known as "Flexible Use of Airspace (FUA)" since 1994. With FUA, airspace should no longer be designated as either military or civil airspace but should be considered as one continuum and used flexibly on a day-to-day basis.

3 The adoption of Single European Sky regulations in 2004 and of Commission Regulation (EC) No 2150/2005 laying down common rules for the flexible use of airspace reinforced the legal status of FUA.

4 This report commissioned by EUROCONTROL's Performance Review Commission (PRC) presents an evaluation of the civil/military use of airspace in seven European States. It responds to a request from EUROCONTROL's Provisional Council in July 2004 concerning airspace utilisation and the implementation of the FUA Concept.

5 In its report to EC Vice-President Barrot (July 2007), the High Level Group recommends inter alia *"that the EUROCONTROL Performance Review Commission is asked to report annually on the actual usage of FUA"*. This report may therefore be the first in a series of periodic reviews of FUA by the PRC.

6 This evaluation has been produced with the support of civil and military experts from States and EUROCONTROL, so as to provide a comprehensive and balanced appraisal. Their contributions are gratefully acknowledged.

7 This report builds on an earlier report published in 2001, which assessed the status of Civil/Military coordination in air traffic management and made nine recommendations. The extent to which these nine recommendations have been addressed is presented in Annex.

Objective and Scope of this report

8 The objective of this report is to review the sharing of airspace and use of shared airspace for civil traffic and military activities in European airspace above FL195, and to identify best practices and enablers to maximise the usage of airspace.

9 For the purpose of this report, the term "shared airspace[2]" refers to all types of airspace which can be used by civil traffic (i.e. GAT) and military traffic (i.e. OAT), where some form of restrictions could be applied either to civil or to military traffic. This report also identifies which airspace is not available to civil traffic.

10 The report addresses airspace in seven States, namely Belgium, France, Germany, Italy, Netherlands, Switzerland and the United Kingdom (UK), and focuses on European core airspace where the density of civil and military traffic is highest. Future reports would need

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[1] The FUA concept is described in the following EUROCONTROL documents: ASM Handbook, European Airspace Planning Manual, Advanced Airspace Scheme Concept Document, ARNV5 Report, DMEAN documentation and ATFCM Strategy and Evolution Plan;

[2] The shared airspace is reported in parts ENR 5.2 and 5.3 of the Aeronautical Information Publication of each State.

to examine FUA in all European States.

11 The report also contains a high-level review of programmes currently being undertaken by EUROCONTROL, with emphasis on their potential to address shortcomings in implementing FUA.

12 This report analyses the situation in 2005. It is acknowledged that improvements may have taken place since the reference year. Reference to such improvements to-date is made where possible[3].

13 The report does not take into account the ongoing feasibility study of the FAB Europe Central, which may generate major improvements of FUA at levels 1, 2 and 3 in the core area of Europe.

FUA strategies, ASM levels and impact on airspace utilisation

14 Flexible Use of Airspace is composed of three Airspace Management Levels, as illustrated in Figure 1:

- The strategic phase (years, months, days before operations) during which airspace structures (routes, training areas and ATC sectors) are designed, as well as options for using these structures consistently and coherently (i.e. several airspace configurations).
- The pre-tactical phase (from one day to a few hours before operations) during which an option is selected among the ones made available during the strategic phase. After the selection of the airspace configuration, airline flight dispatchers can use routes made available for flight planning.
- The tactical phase (real time operations) during which the options selected in the pre-tactical phase are operated.

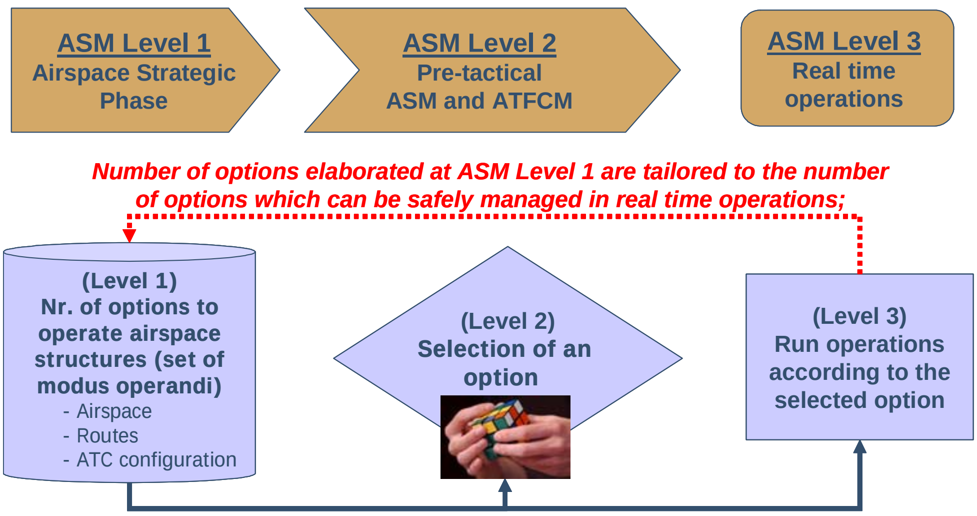


Figure 1: The three interrelated Airspace Management Levels

[3] For instance in France, a new concept of enhanced FUA level 3 is currently implemented with the co-implantation of military operational units in the civil ACCs (so called CMCC for Centre Militaire de Coordination et de Contrôle), commencing with Brest, Bordeaux and Aix-Marseilles ACC, which will manage directly 95% of en-route military flights.

Key findings

15 In the European core area, 32% of the airspace volume above FL195 is shared between civil traffic and military activities. On average, over a 12-month period, the shared airspace is assigned 74% of the time to civil traffic and 26% to military operations. Note: the percentage of time and the percentage of concerned flights can be different.

16 In the European core area, although shared airspace is fully available for civil traffic one third of the year (i.e. weekends), airspace utilisation by civil traffic does not improve significantly compared to weekdays.

17 During weekdays, in the European core area, the airspace booked by military is actually not used half of the time (13% of the daytime period on a yearly basis), although it is progressively released to civil traffic during the day of operations. There are also a few military training areas which are not yet shared with civil traffic.

18 When assigned to civil use, on average less than 50% of the civil traffic which would potentially be interested to use the shared airspace actually uses it.

19 Amongst the analysed States, the utilisation of shared airspace by civil and military airspace users during weekdays varies considerably.

20 In areas where airspace utilisation is the highest (South UK, West Germany, West Belgium), the following factors appear to be a prerequisite for good performance:

- the development of routes and ATC sector configuration options for using the shared airspace when assigned to civil traffic (FUA/ASM level 1);
- ATS operational arrangements and efficient co-ordination between military and ATC units during real time operations (FUA/ASM level 3).
- Pre-tactical ASM plays a vital role in maintaining a consistent and harmonised configuration between ATC sectors and shared airspace (FUA/ASM level 2).

21 The main responsibility to improve the implementation of FUA rests with States, although inefficient FUA applications at State level in the core area have a negative impact on the overall European network. The strategic coordination of national airspace plans is ensured by EUROCONTROL.

22 Pre-tactical ASM is of vital importance for selecting the most efficient option in weekdays. Depending on the characteristics and number of suitable options available, it may be necessary to put in place complex procedures and sophisticated "what-if" tools to assist the selection. When there are only a limited number of suitable options available, pre-tactical ASM is rather static and therefore loses much potential to deliver benefits.

23 There are two important requirements - ATC and military- which must be taken into account when organising pre-tactical ASM:

- In order to deliver ATC capacity, it is fundamental that airspace is assigned to ATC with some hours of advance notice and that it is not revoked unless the same ATC unit has been consulted sufficiently in advance.
- An ATC unit should have enough ATC capacity to accommodate both civil traffic and military activity. The need to operate a trade off between civil and military requirements should be occasional and limited in time and space.

24 Overall, weaknesses in the pre-tactical phase (level 2) are properly addressed by DMEAN and CFMU plans. It is crucial that these plans are implemented. However, only marginal benefits can be expected if the strategic and tactical phases (FUA/ASM levels 1 and 3) are

insufficiently developed.

25 During weekdays, the role of airlines and CFMU in exploiting routes available for flight planning is also fundamental. Clearly, the lack of route density and decisions made in the pre-tactical ASM phase condition the ability of airlines and CFMU in using routes through shared airspace. During weekdays, an enhanced ability of airlines and CFMU in exploiting routes available for flight planning will not deliver substantial benefits unless route density is augmented and route availability in the pre-tactical phase is dynamic.

26 During weekends, airlines do not make the most efficient use of routes through shared airspace, although routes are permanently available for civil traffic.

27 In summary, the main drivers for an efficient use of airspace for both civil and military purposes can be grouped in order of priority as shown in Figure 2.

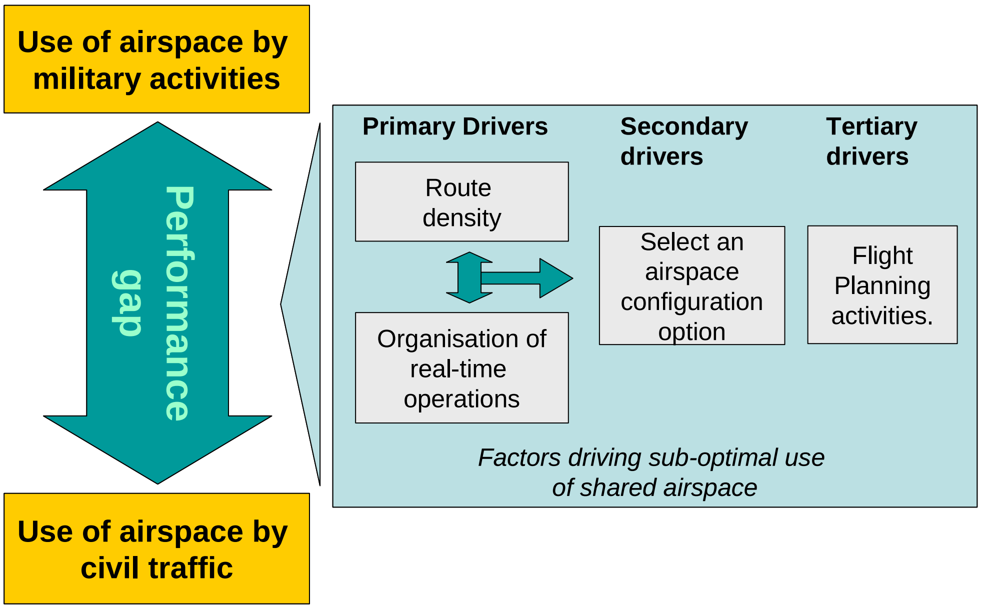


Figure 2: Relative importance of the three ASM Levels

28 The primary drivers of low airspace utilisation are:

- lack of suitable options available in the European core area (low route density and lack of synergy between ATC sector configurations and military zones);
- Insufficient operational arrangements to sustain a high-level of transactions between military and ATC units during real-time operations (specifically in France at the time of review, i.e. 2005);
- The heterogeneity of the FUA applications across the 7 States (e.g. the heterogeneity in the use of the CDR route categorisation during week days).

29 The secondary drivers are related to the pre-tactical ASM, which applies to weekdays only. Overall, it would appear that airspace management one day in advance of operations is rather rigid and predictable. This is likely to be related to the limited number of options designed in the strategic phase and to the high amount of airspace booked but not used by the military.

30 There is also scope to enhance the accuracy of the traffic load monitoring function ensured by CFMU systems for supporting an increased route density through shared airspace.

31 The tertiary drivers are related to the use of routes made available for flight planning. Not enough consideration is given by airlines to carefully identifying the shortest route available

for flight planning. This is especially valid in weekends when many CDRs become permanently available for flight planning.

Main conclusions and suggested actions

FUA/ASM level 1 (Strategic)

32 More options for civil and military traffic to use shared airspace (routes, airspace and sector configurations) are needed to improve flight-efficiency and ATM environmental impact. However, it is recognised that safety and capacity requirements may have to take precedence in the highest density airspace.

33 Initiatives should come from EUROCONTROL (e.g. Advanced Airspace Scheme Concept, plans in response to PRC findings), Functional Airspace Blocks and/or States as appropriate, but need to be coordinated at European level. Action is critically needed at the boundary between France, Germany and Benelux for an improved route, airspace and ATC sectors organisation to be applied by 2009-2010.

34 States, and more specifically the national joint civil-military high level bodies, have a major role to play in ensuring an efficient use of airspace for both civil and military needs.

- High level bodies should be fully aware of the fact that an improvement of airspace utilisation depends on a close relationship and synergy between the design of routes, shared airspace and ATC sector configuration.
- Where military activity is high, the national high level bodies should support the efforts of defence units and ANSPs to develop a sufficient number of suitable options to enhance the synergy of ATC sector and shared airspace configurations.
- The high level bodies should also be fully aware of the fact that ASM Level 1 efforts could be wasted by an organisation of real-time operations (ASM Level 3) which cannot sustain a high level of transactions between military and ATC units.

35 Consideration should be given to having a review of the European airspace structure and national ASM level 1 processes.

FUA/ASM level 3 (Real-time coordination)

36 Civil-military coordination for tactical ATC and ASM needs to be raised to best practice levels, especially in European core area. Best practices include collocation/ integration of civil and military ATC units, use of identical/highly interoperable civil and military systems.

37 EUROCONTROL should identify best practices in civil-military real-time operations and promote their application. Functional Airspace Block initiatives should seek a convergence in ASM level-1 functions and civil-military real-time procedures and practices in their area within limited timescales.

FUA/ASM level 2 (Pre-tactical)

38 Overall, weaknesses in the pre-tactical phase (level 2) are properly addressed by DMEAN and CFMU plans. It is crucial that these plans are implemented. However, only marginal benefits can be expected if the strategic and tactical phases (FUA/ASM levels 1 and 3) are insufficiently developed.

39 The commitment of all concerned parties to deliver the DMEAN and CFMU programmes on time should be reinforced, including:

- Creation of the European Airspace Data Repository
- Consistency in the application of the Conditional Route categories and definitions contained within the FUA Handbook
- Dissemination of airspace status data at European level;
- Introduction in the FUA handbook of improved Conditional Route categories and definitions;
- Improvement of the traffic load monitoring function available through CFMU tools;
- Approach the pre-tactical ASM closer to real-time operations;
- Approach the ATFCM decision making closer to real-time operations;
- Reduce as far as practical airspace booked but not used by military;
- Develop and implement what-if tools for supporting the pre-tactical ASM and ATFCM decision making.

Civil users

40 Civil users must be encouraged to improve their flight planning with CFMU assistance where needed.

41 The role of the CFMU in assisting airspace users in flight planning should be enhanced.

Military users

42 Military users should be encouraged to book segregated airspace only where required, and to release it as early as possible when it is no longer required.

43 Performance indicators are needed to this effect. These indicators should be defined and measured at EUROCONTROL initiative, and made available for performance review purposes. SES implementing rules may be needed in due course.

Civil-military systems interoperability

44 Already now, and even more under the new concepts envisaged in SESAR, it is essential to ensure a high level of interoperability between civil and military air and ground systems. Ensuring this interoperability should be specifically addressed in the SESAR definition phase.

1 Introduction

1.1 Introduction

1.1.1 Airspace is a scarce resource. Therefore, it is vital that its usage be maximised in the interests of all airspace users.

1.1.2 In order to best satisfy both civil and military demands for airspace, EUROCONTROL has developed rules and standards[4] for the sharing of airspace known as "Flexible Use of Airspace" (FUA) since 1994. The application of FUA principles and practices has been a major enabler for ATC capacity increases and flight efficiency improvements in Europe.

1.1.3 Under FUA, "Shared airspace" can be used alternatively for civil traffic and military activities. It should no longer be designated as either military or civil airspace, but considered as one continuum and used flexibly on a day-to-day basis.

1.1.4 The ATM 2000+ Strategy states that "t*he 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"* [Ref. 1].

1.1.5 In order to best satisfy civil and military demand for scarce airspace, the FUA concept is being addressed in a number of initiatives:

Single European Sky
Regulation No 2150/2005 of 23 December 2005 lays down common rules for the flexible use of airspace. It defines operational and technical requirements for civil military coordination regarding the use of airspace. As the Interoperability Regulation defines the support of the progressive implementation of civil military coordination as an essential requirement for systems and constituents, Community Specifications should be established to enable compliance with the essential requirements stemming either from the FUA regulation or the Interoperability regulation. The FUA regulation includes detailed operational requirements for each level of airspace management and in particular for cross border operations. It also includes detailed operational requirements for the EATMN to ensure the timely sharing of information on airspace availability between all users and to permit direct communication between civil and military controllers when they are providing services in the same airspace.
DMEAN
The Dynamic Management of the European Airspace Network (DMEAN) Framework Programme is a short term initiative which aims to deliver additional capacity, release latent ATM system capacity, improve flight efficiency and introduce a new concept for the operational planning and management of the European ATM network. DMEAN brings together a number of important EUROCONTROL initiatives in airspace design, collaborative decision making, Flexible Use of Airspace and Air Traffic Flow & Capacity Management. It will improve information exchange processes to cope with demand and capacity situations in a more dynamic manner. It relies on maximum co-

4 The FUA concept is described in the following EUROCONTROL documents: ASM Handbook, European Airspace Planning Manual, Advanced Airspace Scheme Concept Document, ARNV5 Report, DMEAN documentation and ATFCM Strategy and Evolution Plan (see Annex III: Bibliography).

operation between the European ATM partners.
SESAR
It will be important for the next generation ATM being defined and developed under the SESAR (Single European Sky ATM Research) programme, to build on and further enhance the Flexible Use of Airspace (FUA).

1.1.6 At its 20th Session (July 2004) the Provisional Council of EUROCONTROL:

a. noted the military concerns about the inadequate implementation of the Concept of the Flexible Use of Airspace;
b. noted the impression of the military that overall efforts to implement the Concept of the Flexible Use of Airspace are not as determined as they ought to be;
c. noted the intention of the military to continue their efforts to increase the capacity of airspace and its utilization flexibility with the proviso that AOs and national ANSPs equal these efforts for the benefit of both civil and military users;
d. noted the wish of the military that all the partners of the ATM process to be involved in an efficient collaborative decision making enabling the flights to be dynamically optimised in order to be more reactive in the use of vacant training airspace;
e. agreed to forward this report to the EUROCONTROL Performance Review Commission to initiate an evaluation of FUA enablers like, for example, the utilization intensity of CDRs and of airspace given back to ACC with relative short notice.

1.1.7 The 22nd meeting of CMIC (February 2005) and the 22nd Session of the Provisional Council (April 2005) further encouraged the Performance Review Commission (PRC) to begin the work described in e. above.

1.2 Objectives and scope of this report

1.2.1 This report reviews the level of sharing of airspace for civil traffic[5] and military activity[6] above FL195 during daytime (0400-2200) and the current level of utilisation of the shared airspace. It identifies best practices and enablers to maximise the usage of airspace.

1.2.2 The report addresses airspace in seven States, namely Belgium, France, Germany, Italy, Netherlands, Switzerland and the United Kingdom (UK), focusing on European core airspace. They have been selected as there is high civil and military demand for airspace in these States, where 32% of airspace above FL195 is shared airspace, as shown in Figure **3**.

1.2.3 The majority of European airspace volume is allocated to civil traffic. "Shared airspace" is a generic term used in this report to refer to Flexible Use of Airspace (FUA) structures, such as Temporary Reserved Areas, Temporary Segregated Areas, and Danger Areas. Little airspace is allocated to military traffic only. This is also analysed to some extent. Training areas / shared airspace is the generic term, which will be used to indicate both shared and non-shared training areas used by military activity.

1.2.4 This report analyses the situation in 2005. It is acknowledged that improvements may have taken place since then, and reference to such improvements to-date is made where

5 For the purpose of this report, civil traffic is defined as IFR general air traffic (GAT).

6 Military activities conducted according to Operational Air Traffic (OAT) rules as defined by relevant authorities. The term "military activities" include some special civil activities like test flights.

possible.

1.2.5 In its report to EC Vice-President Barrot (July 2007), the High Level Group recommends inter alia "that the EUROCONTROL Performance Review Commission is asked to report annually on the actual usage of FUA". The PRC will consider reviewing FUA on a regular basis in the light of this recommendations and further decisions.

1.2.6 The report also contains a high-level review of programmes currently being undertaken by EUROCONTROL DMEAN and CFMU, with emphasis on their potential to address existing FUA inefficiencies.

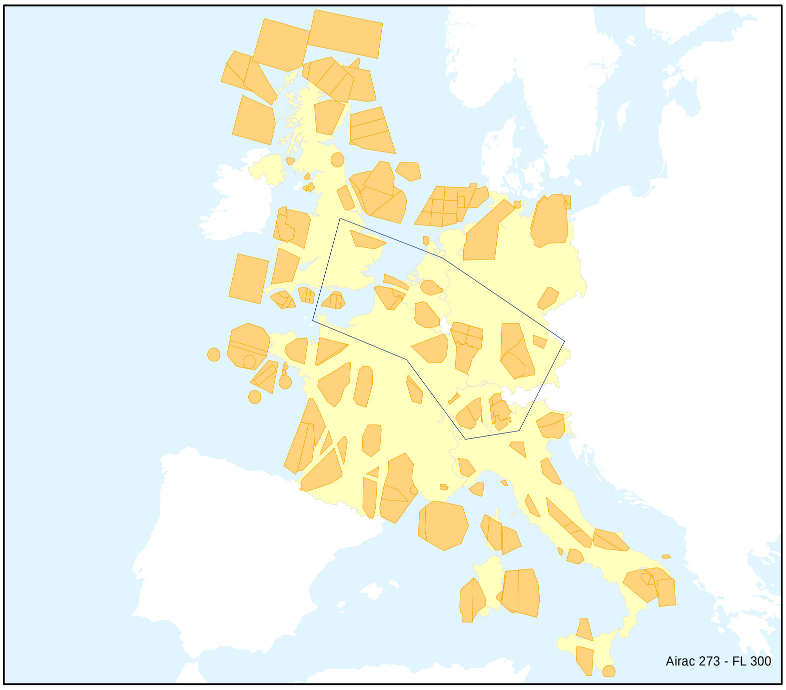


Figure 3: Focus area of the civil-military report

1.2.7 Whereas the findings remain valid for all shared airspace, the focus of the analysis is predominantly on the "core area" outlined in blue in Figure **3**, where demand for airspace is highest for civil traffic, and high for military activities.

1.3 Working method

1.3.1 The PRC and its supporting unit - the Performance Review Unit (PRU) asked the States to provide national military expertise to complement the military expertise provided by the EUROCONTROL Military Unit. Three senior serving military officers were seconded part-time to the PRU - two from France and one from Italy. Their excellent contribution to a balanced understanding of civil and military aspects is gratefully acknowledged.

1.3.2 This report is based on an extensive review of documents addressing the Flexible Use of Airspace in Europe. Data analyses have been conducted using CFMU, AIS and national airspace data. The data quality is considered to be adequate for European high-level analysis.

1.3.3 Interviews and meetings have been conducted with various stakeholders (ANSPs, airlines, military authorities). Presentations of intermediate results were made to CMIC and to expert groups (ANT/RNDSG and ANT / ASMG).

1.3.4 Although it is acknowledged that each shared airspace has specific characteristics and issues, the overall findings remain an important source of information for the further improvement of the use of flexible airspace across Europe.

1.4 Organisation of the report

1.4.1 The report is organised as follows:

- Chapter 2 gives an overview of the FUA concept and interaction with ATFCM and ATC operations within the current mode of operation in Europe. It aims at providing the necessary background information which is necessary to understand the analysis and the subsequent description of enablers for exploiting the capacity of shared airspace for the benefit of civil and military users.
- Chapter 3 illustrates the shared airspace offer in the seven analysed States and analyses the level of potential civil and military demand, the actual allocation and the use of shared airspace by civil and military users in order to identify factors contribution to the sub-optimum utilisation of shared airspace.
- Chapters 4, 5, and 6 evaluate how the seven analysed States apply the different FUA levels.
- Building on the observations contained in the previous chapters, Chapter 7 brings utilisation levels and applications of the FUA concept together in order to identify focus areas and to make some proposals for improved utilisation of shared airspace.
- Chapter 8 summarises the main conclusions of the report and formulates recommendations for the improvement of the use of shared airspace.

2 The FUA concept and its interactions with ATFCM and ATC

2.1 Introduction

2.1.1 This chapter provides an overview of the Flexible Use of Airspace (FUA) concept and interaction with ATFCM and ATC operations. It aims at providing the necessary background information for the analysis part and the successive evaluation of performance enablers for the use of training/shared areas.

2.1.2 Where applicable, the chapter also illustrates areas where the FUA concept leaves scope for interpretation and future European initiatives to further improve the FUA concept.

2.1.3 The main documents which were reviewed for the description of the FUA concept in this chapter are:

- Eurocontrol ASM Handbook [Ref. 2];
- EUROCONTROL Manual for Airspace Planning [Ref. 3];
- Concept of Operations for Enhancing the ASM/ATFM/ATC Processes (FUA 2008 Scenario) [Ref. 4];
- Air Traffic Flow & Capacity Management Evolution Plan for the ECAC States [Ref. 5];
- DMEAN Concept of Operations [Ref. 6];
- ARN-Version 5 Report [Ref. 7]; and,
- EUROCONTROL Advanced Airspace Scheme Concept Document [Ref. 8].

2.1.4 In order to best satisfy both civil and military demand for airspace, EUROCONTROL has developed rules and standards[7] for the sharing of airspace known as “Flexible Use of Airspace (FUA)” since 1994. Airspace should no longer be designated as either military or civil airspace but should be considered as one continuum and used flexibly on a day-to-day basis.

2.1.5 The adoption of Single European Sky regulations in 2004 and of Commission Regulation (EC) No 2150/2005 laying down common rules for the flexible use of airspace reinforced the legal status of FUA.

2.1.6 The FUA concept has increased the flexibility of airspace use and has provided ATM with the potential to increase the capacity of the European air traffic system. The FUA concept allows the maximum joint use of airspace by appropriate civil/military co-ordination. The application of the FUA concept also ensures, through the daily allocation of flexible airspace structures, that any necessary segregation of airspace is based on real usage within a specific time.

2.1.7 The FUA concept addresses the following areas:[8]

- 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.

2.1.8 The concept is based on three interrelated levels of airspace management (ASM) which fulfil different functions:

- <u>ASM Level 1 - Strategic Airspace Management:</u> The design of airspace structures

[7] The FUA concept is described in the following EUROCONTROL documents: ASM Handbook, European Airspace Planning Manual, Advanced Airspace Scheme Concept Document, ARNV5 Report, DMEAN documentation and ATFCM Strategy and Evolution Plan;

[8] A more detailed description of the issues addressed by the FUA Concept can be found in Annex 1.

(training areas, routes and ATC sectors) and the definition of suitable options how they could be used together (modus operandi).

- ASM Level 2 - Pre-tactical Airspace Management: The selection of a modus operandi between the options explicitly or implicitly defined at Level 1.
- ASM Level 3 - Real-time operations: Deploying and operating the selected option in real-time.

2.1.9 The number of suitable options (airspace, routes, ATC configuration) developed in ASM Level 1 provide the basis for the two subsequent ASM levels. The options developed in ASM Level 1 take into account what can realistically be managed in real-time operations (see Figure 4).

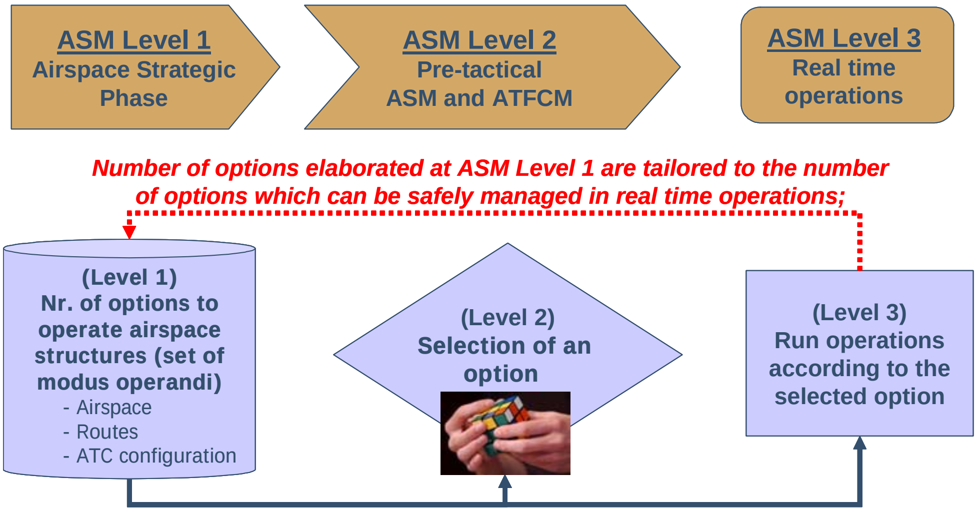


Figure 4: The three interrelated FUA levels of airspace management

2.1.10 Whereas a functional differentiation between the three ASM levels is relatively easy, a clear distinction in terms of time is difficult as there is no commonly agreed timeline. Especially the distinction between ASM level 2 and 3 is difficult as the timing depends on many factors which can differ from one State to another.

2.1.11 According to the FUA 2008 Scenario CONOPS, there is no agreed precise time boundary between the three ASM Levels[9]. In particular, the time boundary between Level 2 and 3 is linked to the local ability to select and to apply an option for the real time operations in ASM Level 3[10].

2.1.12 For ASM Level 2 and 3, the availability and dissemination of airspace and traffic data play an essential role. Currently, most pre-tactical activities (ASM level 2) end on the day before the operations.

2.1.13 The status of shared airspace is sent via the Airspace Use Plan (AUP) message to ATC and military units at State level one day in advance. The AUP message also contains the availability of CDR routes for flight planning. This part of the AUP message is sent to CFMU which then relays the route availability to all Aircraft Operators via the CRAM message. ATC sector configurations are not contained in the AUP message, but are sent to the CFMU by the Flow Management Position (FMP) at the respective ACCs.

2.1.14 Once disseminated, the CRAM message is never updated, while the AUP is updated via Update Airspace Use Plan messages (UUPs). In practice, the UUP does not play a significant role as procedures do not allow the CFMU to react to changes included in the UUP.

2.1.15 In order to promulgate the Airspace Use Plan (AUP) at the agreed time, the planning of

[9] Given the difficulty in making a clear time distinction between the three ASM Levels, the focus of this report is more on the functional elements of each FUA level (defining options, selecting an option, operating an option).

[10] It is one of the main objectives of the DMEAN program to extend the pre-tactical activities until the day of operation (instead of ending one day before the operations).

military activity (e.g. wing squadrons, naval shooting units, etc.) must be prepared in advance. Equally, the organisation and technical systems of the ATFM, ATC, AIS and AO flight planning units should be adequate in order to make use of any airspace released for civil operations (i.e. Conditional Routes).

	ASM Level 1 Strategic Airspace Management	ASM Level 2 Pre-tactical Airspace Management	ASM Level 3 Real time Operations
Tasks	• Design of airspace structures (routes, training areas, ATC sectors). • Definition of explicit or implicit options (route utilisation, sector opening schemes, etc.)	• The selection of a modus operandi for matching the demand	• The usage of airspace structures in real-time operations.
Timeline of processes	• ASM Level 1 ends several days in advance of the day of operations (FUA 2008 CONOPS Scenario)	• Publication of routes available for flight planning **1-day before the day of operation or not later than 05h00 on the day of operations** (see ASM Handbook). DMEAN CONOPS and ATFCM Evolution plan foresee to move the publication of route availability closer to real time operations. • Planning the opening / closure of ATC sector configurations and military training areas **until few hours before operations**. • Adjusting the opening / closure of ATC sector configurations and military training areas (including the updates of ATC sector capacity values) until **approximately one hour** before real time operations. • Run real time operations once airspace is configured • **Continuously** refresh and communication of airspace and traffic data	

Figure 5: The three FUA ASM levels

2.2 Strategic Airspace Management (ASM Level 1)

2.2.1 According to the FUA concept, a permanent high-level policy body should be responsible for formulating a national policy and framework for airspace management matters. ASM Level 1 spans from the collection of airspace requirements to the publication of airspace design (see Figure 6).

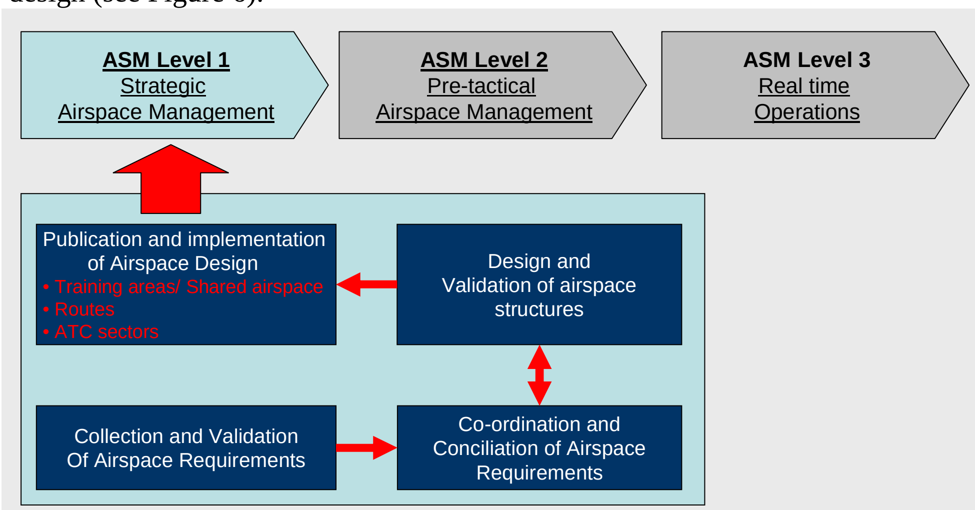


Figure 6: ASM level 1 – Strategic Airspace Management

2.2.2 Based on the airspace requirements, the airspace is designed[11] to accommodate civil and military demand. The ability to tailor airspace to civil and military demand is already strongly influenced during ASM level 1. The flexibility to adjust airspace to varying demand levels is manifested in three main elements defining airspace structures:

- the definition of airspace for shared use/ training areas and associated priorities for use;
- the route design and its usage rules to enable safe and orderly movements through

[11] Airspace Design is a State responsibility. The collaboration at European level is ensured by the Eurocontrol Air Navigation Team.

airspace; and,

- the definition of ATC sectors for the deployment of ATC resources.

2.2.3 Given the high level of interdependence between the three airspace structures (routes, sectors, military zones), the permanent high-level policy body should be involved in the definition of all of them as foreseen in the ASM Handbook. In reality, the level of involvement differs slightly from State to State:

- in the UK, the high-level policy body (UK-DAP) is involved in the definition of the three airspace structures;
- in France, the high-level policy body (Directoire de l'espace aérien) is mainly involved in the definition of routes and military zones, while the ATC sector definition remains at ANSP Level (DSNA); and,
- in Germany, the ASM Level 1 decision making mainly remains at ANSP Level (DFS) in coordination with the military authority (AFSBw).

SHARED AIRSPACE/ TRAINING AREAS

2.2.4 As illustrated in Figure 7, shared areas are a complex system of airspace volumes which are adaptable to meet various military training needs. A training/shared area can be partitioned in many sub-volumes (blocks) to meet different military training mission profiles from simple ones (e.g. a basic training flight) to very complex ones (e.g. a multiple aircraft exercise simulating a combined strike mission with fighter coverage).

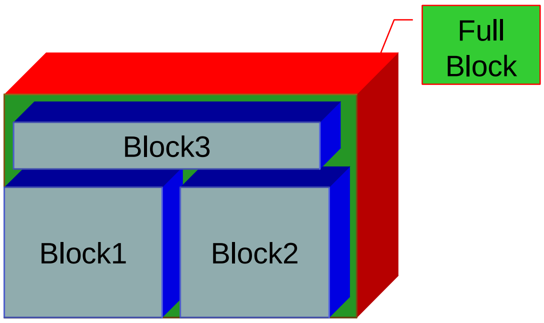


Figure 7: Partitioning of a training/shared areas in sub-blocks

2.2.5 When designing the volumes of a shared area and ATC sector configuration there are two elements of flexibility which are necessary for ensuring a good compatibility between military activities and the management of civil traffic (during weekdays):

1) there is more than one training/shared area which can accommodate similar mission profiles within the same range from the air base. This allows shifting military activities outside more heavily loaded ATC sectors.
2) the training/shared area can be divided in several ways, in order to ensure compatibility with more than one ATC sector configuration (see Figure 8).

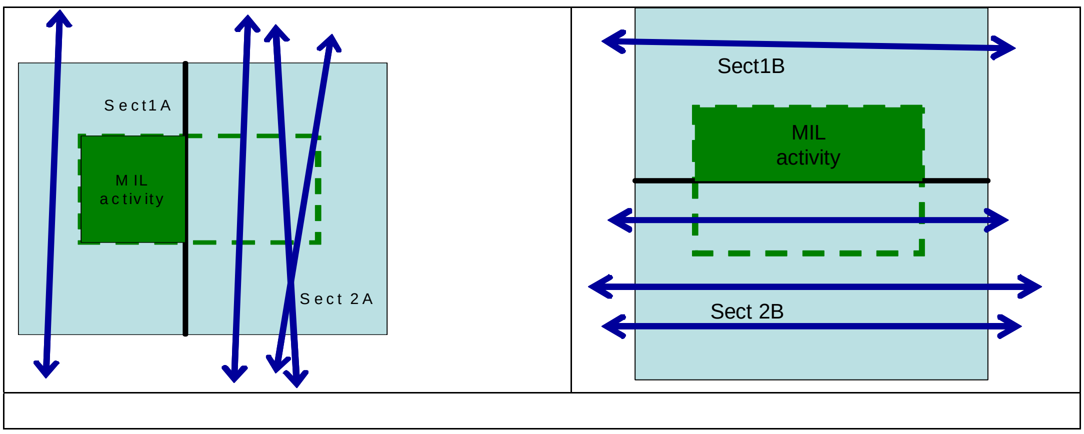


Figure 8: Matching training/shared areas sub-volumes and ATC sector configuration

2.2.6 The example in Figure 8 illustrates how a training/shared area is divided in order to accommodate traffic flows changing from a North/South to an East/West direction. Due to the flexibility to adjust the training/shared area, a more suitable ATC sector configuration can be deployed.

2.2.7 Shared/training areas can be classified according to the degree of sharing (manageability) which is foreseen between civil traffic and military activities. According to their level of manageability, training/shared areas can be grouped into three main categories:

- Airspace Management Cell (AMC) Manageable Areas: Shared areas which are available for pre-tactical management on a daily basis; therefore 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 areas: Areas subject to tactical management for which real-time activity is well known 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 in the pre-tactical ASM does not benefit of the availability of this airspace,.
- Areas not manageable at all or permanently prohibited (P) and 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.[12]

2.2.8 Training/shared areas have different names depending on the type of activity exercised in the area and the level of ATM manageability. The latter can only be identified by reading the area characteristics which are published in the Aeronautical Information Publication (AIP) of the States concerned. An inventory of the different names of training/shared areas is contained in Figure 9.

Code of the training/shared area	Simplified definition	Potential classes of manageability
Temporary Reserved Area (TRA)	Defined volume of airspace **temporarily reserved** for specific activities, 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 **temporarily segregated** for specific activities, through which civil and other traffic will not be allowed to transit.	AMC-manageable
Cross-Border Area (CBA)	TSA established over international boundaries.	AMC-manageable
Restricted Area (R)	Airspace volume of defined dimensions within which the flight is restricted in accordance with specific conditions.	AMC-manageable Non-AMC manageable Non-manageable
Danger Area (D)	Airspace volume of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times. (ICAO definition which is mainly used over international waters,	AMC-manageable Non-AMC manageable Non-manageable
Prohibited Area (P)	Airspace volume of defined dimensions within which the flight of aircraft is prohibited.	Non manageable

Figure 9: Categories of shared airspace

12 The case of non-manageability for lack of potential civil traffic interested to cross the training area is a very remote case in the 7 States.

2.2.9 The “off/on route airspace” can be generally defined as specific airspace structure which constrains IFR controlled traffic on-route (ATS route network) unless there has been prior coordination before instructing a flight to go off-route. In this case the training/shared area may not be published in AIP but military training could occur in airspace outside the ATS route network. For a precise description of the on/off route concept see the ASM Handbook.

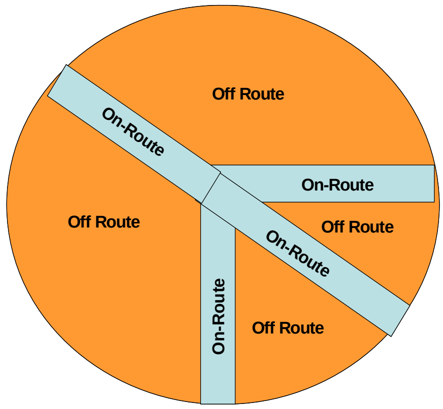


Figure 10: Off -route and On-route airspace

ROUTES

2.2.10 The route network is a fundamental component of the European ATM system. The production of safe ATC capacity requires the systematisation of traffic flows which are conveyed well inside ATC sector boundaries through a route network and trough a number of rules that govern the utilisation of routes.

2.2.11 Broadly, there is a distinction between permanent routes in controlled airspace which are available unconditionally and conditional routes (CDRs) which are ranked according to their level of availability for airline flight planning or use by ATC (dependent on the level of military activities).

2.2.12 Conditional routes are used for managing training/shared areas.[13] The ASM Handbook [Ref. 2] defines criteria for classifying CDRs (see Figure 11).

CDR CODE	Availability for flight planning AND ATC purposes	Availability to ATC ONLY (e.g. airborne rerouting)
CDR-1	Always available during published times in the national AIP, unless closed during the pre-tactical phase.	Available when closed for flight planning - subject to coordination with the military controlling unit.
CDR-2	NOT available for planning unless it is opened during the pre-tactical phase. The route is available for flight planning during the CDR-2 periods when published in CRAM messages issued by CFMU one day in advance.	
CDR-3	Never available for flight planning.	

Figure 11: Conditional route categories (CDR segments)

2.2.13 Even when CDR-1 routes are available for flight planning, the flight might be subject to airborne rerouting when there is military activity in the associated shared area. The rerouting instruction may require slight changes in the horizontal or vertical flight profile resulting in a lower level of flight efficiency than envisaged during the flight planning phase. An alternative route to circumnavigate the shared airspace is published. The fuel loading of civil traffic shall be based on the hypothesis that the alternative route is flown.

2.2.14 Since CDR 2 does not foresee alternative rerouting when the shared area is used by military (CDR-1), CDR-2 cannot be closed once made available for flight planning[14].

13 CDRs can also be used to regulate civil traffic flow, but in practice there are only few CDRs related to this task.

14 In Germany the CDR-2 could be closed even after the publication of AUP, The update is reported in the UUP message,

Therefore the fuel load should be based on the assumption that there will be no airborne rerouting.

2.2.15 CDR-3 routes are never available for flight planning, but may be used by ATC for rerouting (subject to coordination with the military controlling unit). The rerouting instruction generally results in a shorter route than planned.

ATC SECTORS

2.2.16 An ATC sector is a block of airspace usually controlled by a team of two air traffic controllers (ATCOs): one executive and one planner. All GAT traffic passing through the ATC sector is controlled by the ATCOs assigned to the respective sector.

2.2.17 There is an exception to the above working arrangement. Instead of assigning a block of airspace to an ATCO team, a traffic flow can be assigned to one ATCO. In this case the ATCO controlling the flow will maintain the coordination with the ATCO teams which are responsible to control the ATC sectors. This ATC position can be called “ATCO overflow position”.

2.2.18 The airspace volume assigned to an ATC unit (i.e. an ACC) can be divided into many ATC sectors and/or ATC overflow positions. The combination of ATC sectors and positions which are simultaneously opened in an ACC in a given time is called “ATC sector configuration”. ACCs have more than one ATC sector configuration in order to better accommodate variations in demand. The ATC sector configuration which is planned to cope with traffic at peak hours usually referred to as the “standard ATC sector configuration”.

2.2.19 The ability to match variations in traffic demand to variations in airspace availability at peak hours with the adequate level of ATC resources depends on the flexibility of the “standard ATC sector configurations” available in an ATC unit. The larger the variation in demand and airspace availability, the more flexibility is necessary. The typical features which could be deployed by ACCs in order to match available airspace to traffic demand are outlined in Figure 12.

	Flexibility feature at the standard configuration	Relationship with military activity (examples)	Staff management challenges
CASE 1	Various options to combine elementary sectors at the standard configuration - e.g. 4 elementary sectors (A, B, C, D) can be combined in different way for deploying 3 ATC sectors (AB, C, D or A, B, CD). See Figure 13 Left-side.	When airspace is assigned to military activity in a particular area rather than in others.	ATCO rating ATCO training
CASE 2	Increase the number of opened ATC sectors beyond the number of the standard configuration.	When airspace is assigned to military activity in a particular area rather than in others.	ATCO rating ATCO training Overtime practices
CASE 3	Change geographical boundary at the standard configuration. See Figure 13 Right-side.	When airspace assigned to military activity insists on an ATC sector rather than on another, the traffic load between the two sectors can be rebalanced by changing the geographical boundary.	ATCO rating ATCO training

	Flexibility feature at the standard configuration	Relationship with military activity (examples)	Staff management challenges
CASE 4	Multiple options for choosing the vertical boundary between two sectors;	When airspace assigned to military activity insists on an ATC sector rather than on another, the traffic load between the two sectors can be rebalanced by changing the vertical boundary.	ATCO training
CASE 5	Overflow position. An ATC position controls a traffic flow passing trough one or more ATC sectors controlled by other ATCO teams.	When specific actions (e.g. a rerouting of a flow) are requested to avoid a segregated airspace. Such position may remain closed in weekends.	ATCO rating ATCO training Staff rostering

Figure 12: Flexibility features at ACCs to match variations at peak hours

2.2.20 Some examples of ATC sector configuration features are shown in Figure 13, Figure 14, and Figure 15.

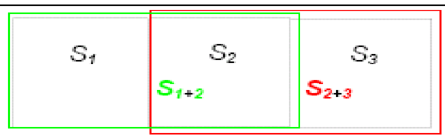
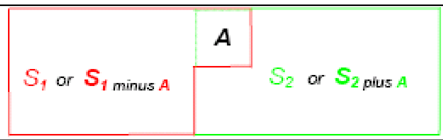
	
Elementary sectors S1, S2, S3 can be opened alone in an ATC sector configuration composed of 3 sectors or S2 can be combined either with S1 or S3 in 2 different ATC sector configurations with 2 sectors .	Flexible horizontal boundaries: Depending on traffic demand and the activation of military areas, the airspace block A can be assigned either to the sector S1 or to the sector S2.

Figure 13: Examples of ATC sector configuration features[15]

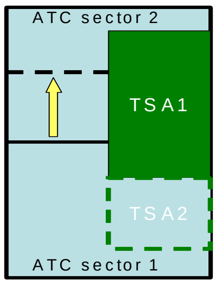
Vertical View		**CASE 4:** The block of airspace TSA1 is segregated due to military activity. The ATC sector 2 would face with an excessive traffic load, while the ATC sector 1 may have been under-loaded. In this situation the vertical boundary is shifted up in order to rebalance the load between the 2 ATC sectors.

Figure 14: Example of multiple options for vertical boundary between sectors

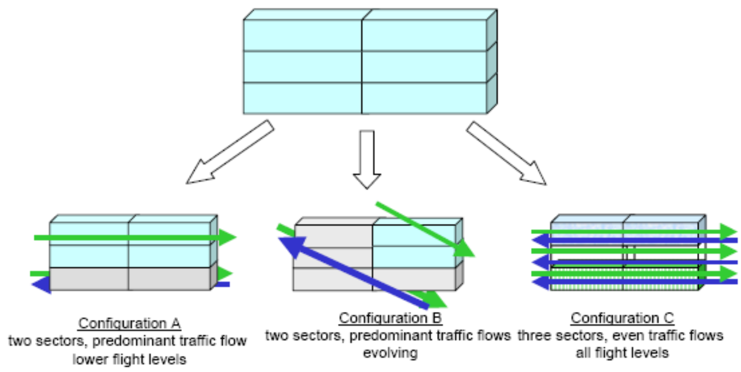


Figure 15: Examples of ATC sector configuration features[16]

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15 Source: European airspace planning manual, EUROCONTROL

2.2.21 Based on this three elements defined during ASM level 1 (areas, routes, ATC sectors), the airspace can be reconfigured through the application of different operational modes (modus operandi), depending on the civil and military demand.

2.2.22 The modus operandi is the way that the three elements of airspace structure are used together.

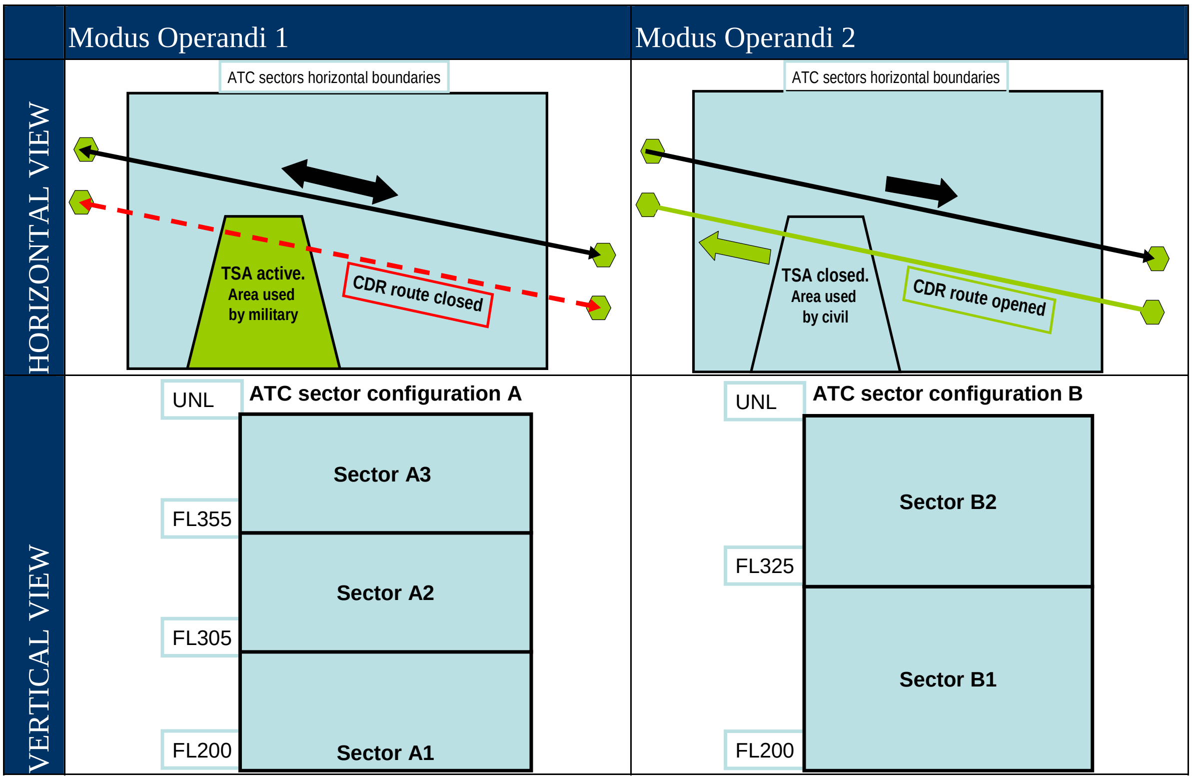

Figure 16: Illustration of two different modus operandi[17]

2.2.23 Figure 16 shows this concept with two different modus operandi, which are applied on the same airspace block. Each modus is composed of three basic elements:

- Shared airspace/ training area (a TSA in the example);
- Routes (in the example there is a permanent and a conditional route); and,
- ATC configuration (in the example there are two ATC configurations: one composed of three sectors and the other of two).

2.2.24 Both modus operandi ensure the same level of civil traffic throughput, but the amount of airspace available to ATC is different: in "modus 1" traffic complexity is higher as shared airspace (TSA) is used for military activities and all civil traffic uses a bi-directional route. Consequently, the level of ATC resources to handle the traffic is higher than in modus 2 (the ATC sector configuration is composed of 3 sectors in Modus 1 and 2 sectors in Modus 2). There is a high level of consistency and synergy between the three elements (shared airspace, routes, ATC configuration option).

2.2.25 There are two concepts when designing shared airspace/training areas which potentially reduce the level of flexibility which an ACC could deploy:

1) The "off/on route concept" is by definition a static airspace volume which does not allow to combine dynamically the ATC sector and training area configuration (see Figure 8).

2) The ACC configuration is decided in the pre-tactical phase. Hence, the shared

16 Source: Advanced Airspace Scheme Concept Document, EUROCONTROL

17 This is a simplified model of real cases. See for instance Case D at page 39 of the ARN Version-5 Report.

airspace/training areas should be "AMC-manageable" in order to allow a combination between the configuration of the training area and of the ACC. Training areas which are non-AMC manageable consequently constrain the modus operandi.

2.2.26 A set of modus operandi is pre-defined in the airspace design phase (ASM Level 1) by designing, classifying and regulating the usage of routes, shared areas/training areas and ATC sectors. The more traffic and airspace variations are expected, the more the set of modus operandi should increase the number of suitable options.

2.2.27 A modus operandi is selected in the pre-tactical phase (ASM Level 2) and then deployed in real time (ASM Level 3). The efficiency of ASM Level 2 and Level 3 depends on the number of suitable options that will be developed at ASM Level 1.

2.2.28 Essentially, the European airspace is defined by a large number of modus operandi consisting of:

- thousands of permanent and conditional routes with different 3D profiles and different time availability profiles;
- hundreds of shared airspace (TRAs, TSAs, etc.) with different 3D profiles, many of them can be used in different airspace blocks combinations;
- more than sixty Area Control Centres (ACCs), each consisting of airspace blocks which are configurable in a number of different ATC sector configurations.

Figure 17: The complexity of configuring airspace

2.3 Pre-tactical ASM (FUA Level 2) and pre-tactical ATFCM

2.3.1 Pre-tactical ASM plays a vital role in preparing the deployment of resources during the day of operations. Given the complexity of airline, ATC and military operations, the pre-tactical must start few days in advance although some flexibility is necessary the day of operations to deal with unplanned events.

2.3.2 Pre-tactical ASM operations are carried out for the preparation of the real time operations. They are generally under the responsibility of the Airspace Management Cell (AMC), a joint civil-military ASM unit in charge for assigning airspace to military units and ACCs. Essentially, the pre-tactical operations are relevant for shared airspace areas which are classified "AMC manageable" as they are the ones where the opening and closing times shall be planned and communicated in advance. The vast majority of training areas above FL 200 in Europe are classified as "AMC manageable".

2.3.3 At State level, there is currently no standardised approach to conduct pre-tactical ASM in Europe. The ASM handbook [Ref. 2] leaves States ample scope of decision on:

- whether to conduct pre-tactical ASM or not;[18]
- how to organise the ASM pre-tactical; and,
- how to integrate ATFCM and ASM pre-tactical.

2.3.4 Pre-tactical ASM deals with the selection of an option for configuring routes, ATC sectors and shared areas in a consistent way (modus operandi) according to priority rules and negotiation procedures defined at ASM level 1. If there is an insufficient number of suitable options available (ASM Level 1 issue), the enhancement of pre-tactical processes will not deliver substantial benefits. However, as soon as options are available, deficiencies in pre-tactical processes could reduce the effectiveness of selecting the best option.

2.3.5 Pre-tactical ATFCM involves the preparation of ATC sector configuration in order to accommodate the civil traffic demand with a minimum level of penalties (delays and

[18] This possibility should only refer to peculiar situations such as, for instance, the very low military activity in some States.

flight efficiency). It also relies on scenario management with the coordination of ATFCM measures like re-routing of flights, flows, flight level capping, etc. Once all the ATFCM solutions for capacity shortfalls resolution have been considered and if demand does still exceed available ATC capacity, an ATFM flow management regulation is issued. Pre-tactical ATFCM is made by the Flow Management Position (FMP) at the ACC in coordination with the Central Flow Management Unit (CFMU) at Brussels.

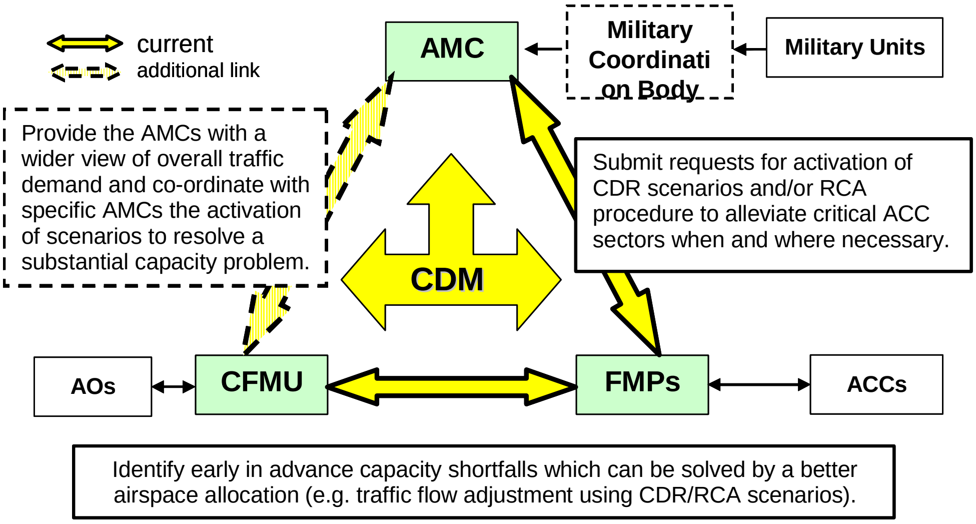

Figure 18: Actual and planned links between AMC, FMP and CFMU [19]

2.3.6 Pre-tactical ASM and ATFCM are coordinated at State level. Whereas pre-tactical ASM is only carried out at State level, pre-tactical ATFCM is coordinated at European level by the CFMU (see Figure 18). At European level, the ASM Handbook foresees limited pre-tactical ASM functions. Today, the route availability for flight planning is the only coordinated function at European level[20].

2.3.7 In many States across Europe, the pre-tactical operations are considered to end one day before the operations. Depending on local agreements and the flexibility to dynamically adjust to demand at short notice, the pre-tactical operations can extent until a few hours before the operations (see ANNEX II).

2.3.8 According to the DMEAN programme and ATFCM Evolution plan, a uniform application of ASM and ATFCM pre-tactical processes at European level few hours before operations is a fundamental enabler to improve airspace utilisation. However, an important point to note is that the enhancement of the synergy of ASM/ATC/ATFM processes should not serve the purpose to provide more airspace to routinely congested ATC units. According to the ATM 2000+ Strategy[21] and SESAR performance targets, the ATC units should be able to deliver the ATC capacity at peak hours at different type of airspace availability.

2.3.9 Today, the pre-tactical processes are relatively standard across Europe one day before the operations. They consist of three activities in sequence:

1) In a first step, military and ATC capacity needs are evaluated in order to decide the ATC sector configuration and the assignment of training areas to military activities. At this stage, there is an interaction between the AMC (ASM pre-tactical unit) and FMPs (ATFCM pre-tactical) for evaluating the available options. However the extent to which the ATC sector configuration is discussed at AMC level is subject to State

19 FUA 2008 Scenario, Figure 2 page 5.

20 See the “lead AMC concept” in the ASM Handbook

21 The ATM 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.

variations. The details of the ATC sector configurations are then finalised at ACC/FMP level. The output of the process can be influenced by the negotiation procedures and priority rules especially when the number of suitable options to choose from is limited.

2) In a second step, 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 the day of operations.

3) Lastly, in the third step, the status of shared areas and CDR routes are disseminated to ATC and military controlling units inside each State through the AUP (Airspace Use Plan) message. CDRs available for flight planning are disseminated to the CFMU in a reduced AUP format.[22] The CFMU in turn disseminates the information to all airspace users through the CRAM. The FMP in parallel communicates ATC sector configurations and ATC sector capacity values to the CFMU.

2.3.10 Figure 19 shows the data available during the pre-tactical phase (ASM Level 2) one day before operations for the selection of the most suitable options to be applied on the day of operation (ASM Level 3).

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

Figure 19: Available data supporting the pre-tactical decision-making 1-day before OPS

2.3.11 Once the options are selected for the day of operation, the information needs to be shared with all relevant parties and it needs to be updated continuously (see Figure 20).

<table>
<tr><th colspan="6">Dissemination of the status of pre-tactical operations
between 1 day and few hours before OPS</th></tr>
<tr><th>Type of data</th><th>Type of message</th><th>ATC and military units in the shared airspace.</th><th>Other military and ATC units inside the State.</th><th>Cross-border units</th><th>CFMU</th></tr>
<tr><td>ATC sector configuration and ATC sector capacity values.</td><td>State format</td><td>Yes</td><td>Yes if necessary</td><td>No</td><td>Yes</td></tr>
<tr><td rowspan="2">CDR route availability for flight planning</td><td>AUP</td><td>Yes</td><td>Yes</td><td rowspan="2">No</td><td>Yes</td></tr>
<tr><td>UUP</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td rowspan="2">Shared airspace opening / closure</td><td>AUP</td><td rowspan="2">Yes</td><td rowspan="2">No</td><td rowspan="2">No</td><td>Yes</td></tr>
<tr><td>UUP</td><td>No</td></tr>
<tr><td>CDR route availability for ATC only</td><td>State format</td><td>Yes</td><td>Yes</td><td>No</td><td>No</td></tr>
</table>

Figure 20: Data dissemination of the status of pre-tactical operations

2.3.12 Figure 20 shows the output of the pre-tactical process and how the information is disseminated to the relevant parties. The output of the pre-tactical process is presently

22 The only exception is France which communicates to CFMU both the status of shared airspace and CDR routes.

not automatically shared at network level (cross-border units). On the day before the operation, the CFMU has got a good visibility of the applied ATC sector configurations and route availability for flight planning. However there is no visibility of activation/de-activation of shared airspace at European level.

2.3.13 The CFMU is currently working on receiving and processing data on the status of shared airspace in order to make States aware of potential synergies at network level. Similarly, cross-border units could benefit from the information on the airspace configurations of adjacent AMC/ATC units in order to enable bilateral discussions for harmonising efforts at the best. This information is currently not shared automatically.

2.3.14 Depending on local arrangements, updates in airspace status (UUP) messages are possible up to a few hours before the operation. However, due to the lack of sharing updates in airspace status (UUP messages) at network level (see Figure 20), the awareness a few hours before the real time operations at network level is reduced. Furthermore, the CFMU does not use the UUP messages which are sent by a small number of AMCs.

2.3.15 CDR route availability for flight planning has been frozen one day in advance, CDR route availability to ATC only (e.g. CDR3 or CDR2) as well as real-time activation of shared airspace in use by military units are unknown outside the ATC and military units directly managing the area.

2.3.16 There may be value in communicating the planned utilisation of CDR routes only available to ATC (e.g. CDR3 or CDR2 closed to flight planning). If downstream cross border units know this information in advance, they may adapt the ATC sector configuration for receiving traffic outside plan able routes (e.g. CDR-3).

2.4 Real-time operations (ASM Level 3)

2.4.1 FUA rules and procedures for real-time operations are contained in the ASM Handbook [Ref. 2] and further complemented by the high-level policy body at ASM level 1.

2.4.2 Many activities have to be conducted in accordance with rules and procedures but the ASM Handbook only covers common aspects applicable at ASM Level 3, leaving ample scope for defining State-specific procedures for the real time coordination between civil traffic and military activities.

2.4.3 Real time operations mainly deal with two types of situations:

- Minimising airspace segregation in real-time; many military mission profiles need airspace segregation in order to avoid potentially hazardous situations for civil traffic. As it was seen in previous paragraphs, the strategic ASM and the pre-tactical ASM have got the potential to minimise the impact of segregation on civil traffic. However continuous changes in airspace configuration request the ability to handle a high level of transactions between ATC and military units.
- Integration of civil-military operations in real time which refers to the organisation of an almost simultaneous usage of airspace structure by civil traffic and military activity, i.e. any form of segregation is absent or very narrow in time and space. However the integration of operations is a feasible option only for few types of military mission profiles. It appears feasible for sea/ground to air operations, for air refuelling, for airborne surveillance missions.

2.4.4 The basis for real time operations is the awareness of the exact status of the shared airspace at all times between all military and ATC units involved. The sharing of information has a direct impact on the utilisation of shared airspace. Inefficient real time ATM procedures and insufficient sharing of information may lead to an underutilisation of airspace (extensive time buffers between civil and military operations).

2.4.5 Broadly, efficient real time operations rely on the following basic elements:

- There is a clear assignment of responsibility to the unit in charge in a given timeframe. This means that the unit in charge is responsible to instruct clearances and it has got the power to instruct all aircraft as the traffic situation requires.
- Common availability and use of ATM technical elements between the ATC and military controlling units which are involved in the management of a given training/shared area (common display visualisation, direct communication between ATC and military positions, etc.);
- Adequate interface between ATM systems and Air Defence systems (national and NATO)
- A sufficient overlap of staff competences: military staff should be rated for ATC-military coordination and ad-hoc GAT traffic handling as well as ATC staff should be rated for military-ATC coordination and ad-hoc OAT traffic handling.
- The sharing of airspace status data.
- The sharing of traffic data and ATC/military intentions data (e.g. the decision to move flights outside the initial FPL profile).

2.4.6 Rules and procedures for real-time operations have a deep impact on airspace utilisation especially in the occurrence of the following events:

- Activation of training/shared areas: ATC units should continue using the airspace until a few minutes before the military controlling unit notifies the start of military activities.
- Deactivation of training/shared areas: ATC units should be immediately informed when an area is usable by civil traffic.
- Extension of the scheduled opening time of training/shared areas and new airspace activations (out of AUP/UUP): military controlling units should be confident that extensions are rarely refused. If ATC units frequently refuse an extension, there may be an increase of airspace booked.
- Notification of cancelled airspace reservations as early as possible: when a squadron fails to notify the cancellation of a mission, there are back-up procedures to identify the failure in order to notify ATC units about the availability of airspace as early as possible.

2.4.7 As the FUA concept strives to avoid any form of segregation, integration of military activity and civil traffic when they use the same airspace in real-time operations is usually the best option.

2.4.8 There is no common criterion to follow when addressing the integration between military activity and civil traffic in real time. The possibility to find an efficient solution depends on:

- The nature of the military activity;
- The level of integration of the ATM civil-military system; and,
- The responsibility to provide the ATC service is not pre-determined by regulation, but it is assigned to the unit (either ATC or military) which is best in place to ensure it at a given time.

2.4.9 It should be noted that when shared airspace is assigned to a military unit, it does not necessarily mean that the airspace cannot be penetrated by civil traffic. The military unit in charge may be in a position to allow the civil traffic to cross the training area either in direct contact with it or leaving the traffic in contact with the ATC unit.

2.4.10 The civil penetrability of shared airspace when a military unit is in charge also depends on the interface between ATM systems and Air Defence systems. There should be an adequate ASM interface between national air defence systems; NATO ACCS, CFMU, EAD, National ATM systems. At the moment this interface has not been devised yet.

2.4.11 The ability to organise efficient real-time procedures also depends on the type of en-route ATC organisational arrangements which are in place. All over Europe there are broadly four types of arrangements[23]:

[23] See Report "Status of Civil-Military coordination in ATM", EUROCONTROL PRU-Agency (2001).

- MODEL 1: Segregated ATC systems and units: in this model there are two ATC systems with poor data exchange between them and with different functions. The military ATC unit is co-located with the Air Defence Unit and the civil ATC is located remotely. The displayed radar data differs between the military and the civil ATC unit. There is no direct communication between military and civil ATC positions. Coordination is ensured through a third party.
- MODEL 2: Integrated ATC systems, but segregated ATC units: the military ATC unit is stand alone unit located remotely from the civil ATC unit. The military and civil ATC systems have similar functions and the level of data exchange is good. The displayed radar data is the same between the military and the civil ATC unit.
- MODEL 3: Single ATC system and co-located units: there is one ATC system. Military and civil ATC sectors are co-located in the same OPS room or at least in the same building.
- MODEL 4: Single ATC system and single ATC sector: The ATC service to civil traffic and military activity is provided by the same ATC sector.

2.4.12 The last two operational models can be equally managed by a single civil-military integrated service provider or by two civil and military service providers which share the same ATC system and OPS rooms.

2.4.13 For MODEL 1 (segregated ATC system and units), it is more difficult to put all the basic elements in place (data flows, rules and procedures for handling efficient real-time operations). This may lead to an underutilisation of airspace due to the application of extensive time buffers between military and civil operations.

2.4.14 The other three models provide a good basis for efficient real-time operations without any particular difficulties, even if the cost of implementation could differ. The common denominators of the three models are same core ATM systems, same HMI software and same HMI settings. Nowadays the easiest way to get to all these features is to co-locate the civil and military ATC units.

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3 The use of shared airspace

3.1 General

3.1.1 Airspace is a scarce resource. Especially where there is a high level of civil and military demand, it is crucial to maximise the utilisation of shared airspace. Willingness to co-operate, and transparency are fundamental enablers for improving the utilisation of shared airspace.

3.1.2 This chapter illustrates the shared airspace offer in the seven analysed States and analyses the level of potential civil and military demand, the actual allocation and the use of shared airspace by civil and military users in order to identify factors contribution to the sub-optimum utilisation of shared airspace.

3.2 Demand for shared airspace

3.2.1 Figure 21provides an overview[24] of the military fleet which operates above FL 195 for training exercises and the fleet of the main commercial Aircraft Operator (AO).

State	Air Power	Combat aircraft	Main AO	No. of aircraft
Belgium	BAF NATO-TLP*	72 100	TNT AIRWAYS BRUSSELS AIRLINES EUROPEAN AIR TRANSPORT	43 37 29
France	FAF, FN	320	AIR FRANCE REGIONAL AIRLINES BRIT AIR	272 69 47
Germany	GAF, GNY US Fleet**	356 60	LUFTHANSA LUFTHANSA CITYLINE AIR BERLIN	256 82 73
Italy	IAF, IN US Fleet**	160 21	ALITALIA AIR ONE ALITALIA EXPRESS	158 56 32
Netherlands	RNAF, RNN	107	KLM Royal Dutch Airlines KLM CITYHOPPER TRANSAVIA AIRLINES	107 33 32
Switzerland	SAF	90	SWISS INTERNATIONAL JET AVIATION BUSINESS JETS JET CLUB	88 16 13
UK	RAF, RN US Fleet**	312 50	BRITISH AIRWAYS EASYJET FLYBE	240 136 84
Mediterranean Sea	VIth US Fleet**	130	N/A	N/A

*114 weekdays of activity a year ** Permanent based aircraft only
Data source Civil carriers: Eurocontrol PRISME Fleet as of 25/4/2007
Data source military: Eurocontrol DG-CMAC

Figure 21: Military fleet compared with the main AO operating in the 7 States

24 The figures shown in the table were compiled from various sources.

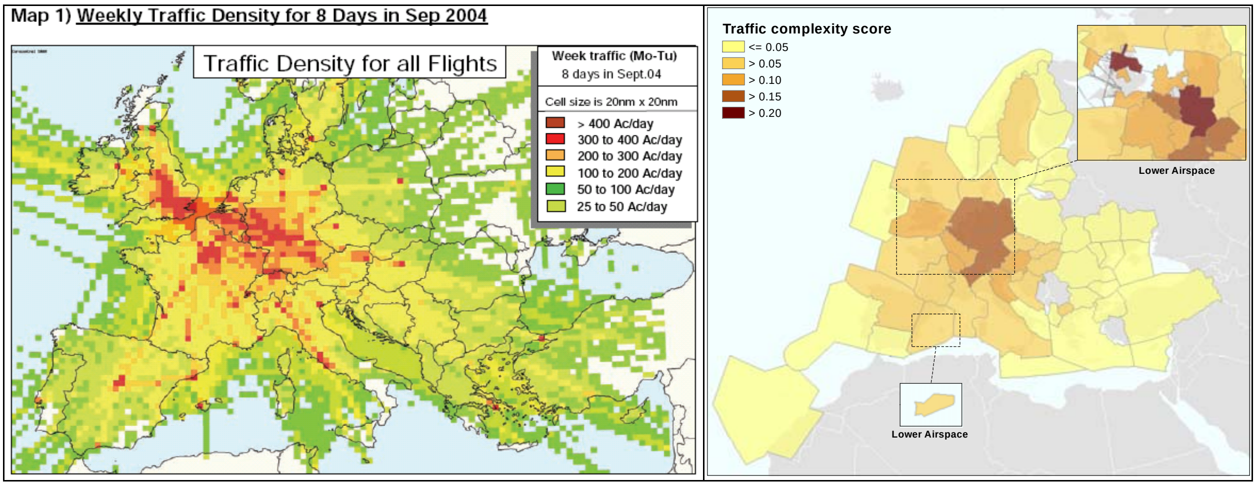


Figure 22: Characteristics of civil demand in the core area

3.2.2 Figure 22 provides an indication of the traffic density and the complexity of the civil traffic demand in European airspace.

3.2.3 The civil demand in terms of density and complexity shows broadly the same geographical distribution most notably in South UK, Belgium, the Netherlands, Switzerland, Northern Italy, and at the boundary between France and Germany.

3.2.4 It should be noted that the traffic density is lower on weekends but the geographical distribution of civil demand remains largely the same.

3.2.5 As illustrated in Figure 23, there are a high number of military airbases in the areas with high civil demand creating a high level of civil and military demand for airspace.

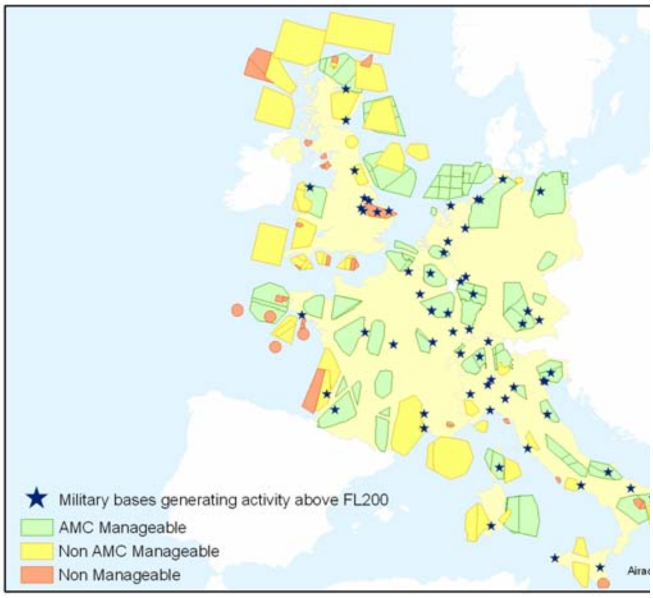


Figure 23: Location of military airbases

3.3 Shared airspace offer

3.3.1 In the seven analysed States, the shared airspace offer covers approximately 32% of the total airspace volume. Figure 24 shows the geographical location of the shared airspace in the States and the level of manageability.

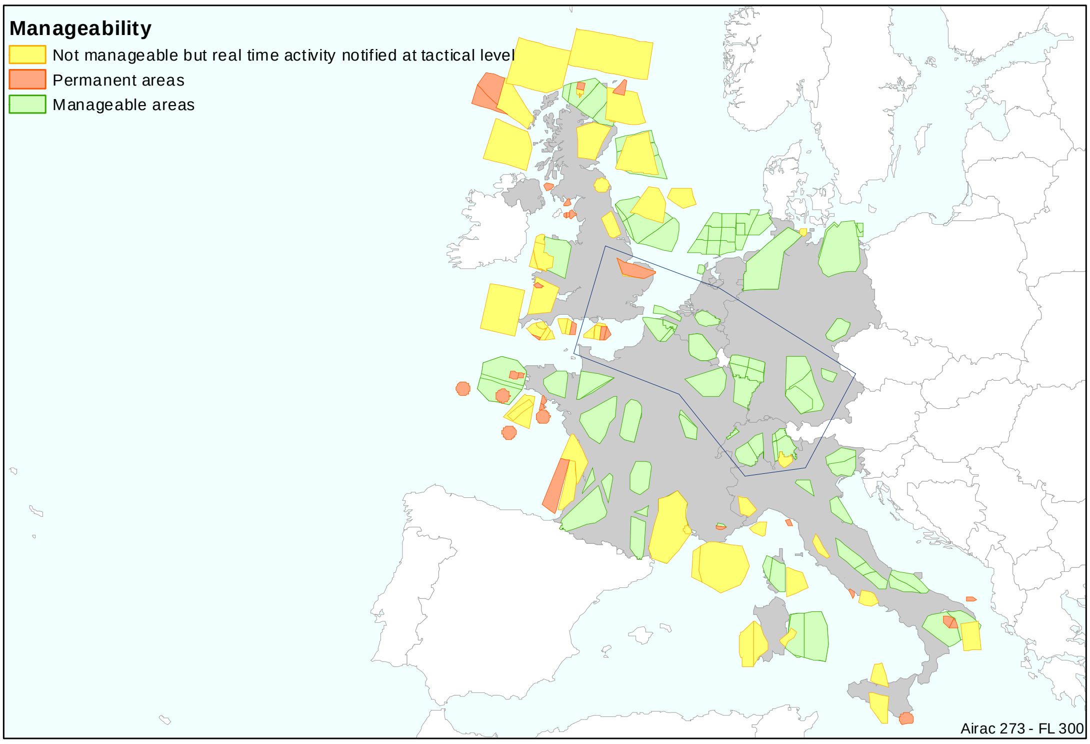


Figure 24: Shared airspace offer in the 7 States

3.3.2 The following sections of the analysis focus predominantly on the "core area" outlined in blue in Figure 24, where demand for airspace is highest for civil traffic, and high for military activities. With the exception of two areas in the UK (East Anglia, Portsmouth) and one area in Northern Italy, most of the shared airspace in the core area is manageable.

3.4 Allocation of shared airspace between civil and military users

3.4.1 Most areas[25] affected by military activities are shared between civil traffic and military activities during the busy period of weekdays (04h00-22h00 UTC, i.e. 18 hours), hereinafter called "day period".

[25] There are exceptions, e.g. the East Anglia MTRA area (North East of London TMA), which is used solely for military activities during weekdays, i.e. not shared with civil traffic.

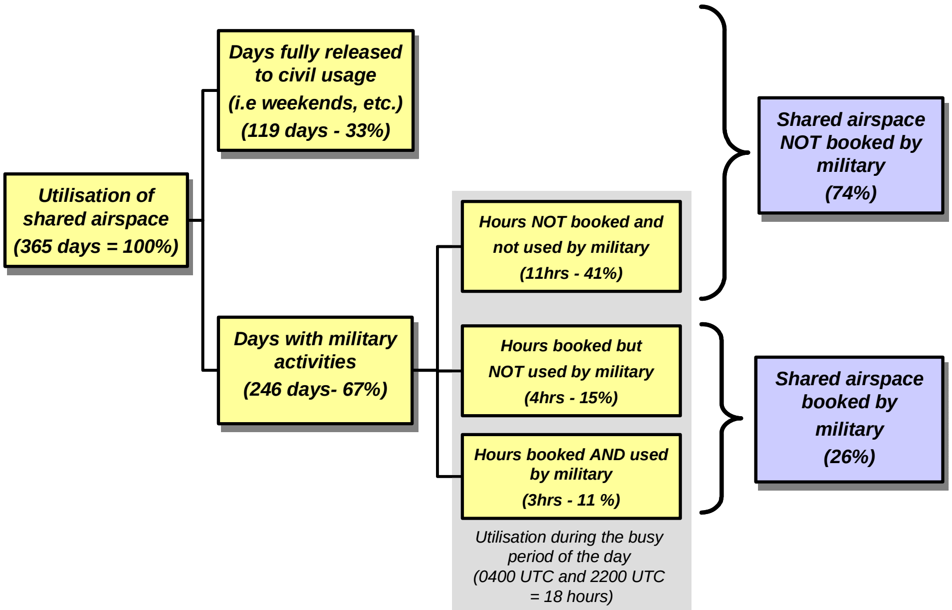


Figure 25: Approximate repartition of the day period between civil and military

3.4.2 Figure 25 provides an approximate breakdown for the repartition of shared airspace in the European Core area during the day period of the day:

- On average, military activities are conducted 246 days a year. Airspace is therefore fully available for civil use for the remaining 119 days.
- On the 246 days with military activity, the shared airspace is reserved for military usage[26] on average for 7 hours, of which 3 hours are actually used.
- The remaining 11 hours in the 246 days is available for civil traffic with one day advance notice.

3.4.3 On average, shared airspace is therefore available for civil traffic approximately 74% of the day period in the "core area". Airspace is generally even more available to civil traffic outside the core area.

3.4.4 It should be noted that ATC units can exploit the airspace booked but not used by the military on the day of operations, provided that airspace availability is notified a few hours in advance, and that airspace users and ATC are sufficiently flexible to adapt their operations.

3.5 Usage of shared airspace

3.5.1 Figure 26 shows differences between potential demand[27] and actual usage by civil traffic on weekdays when 41% of the day period is available to civil traffic (see Figure 25). The areas of high civil interest are outlined in blue and represent the areas where the need for an efficient utilisation of the shared airspace is highest.

26 Booked time by military is the time allocated to military activities as published in the initial AUP (e.g. TSA, CBA). See also KPI 4, "Efficient booking procedures in the Military KPI", Pilot Project Final Report (2005).

27 Civil traffic flying a theoretical profile based on the great circle route.

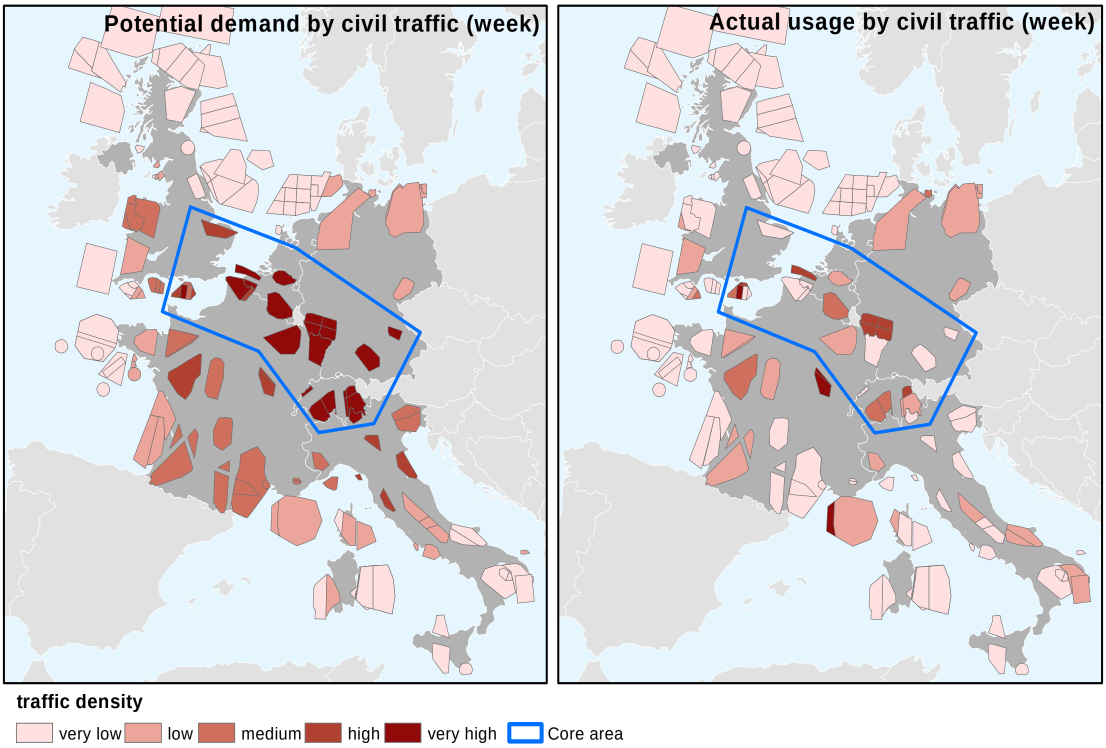


Figure 26: Potential and accommodated civil demand (weekdays)

3.5.2 Whereas on the left side of Figure 26, the potential demand by civil traffic is high for almost all shared areas within the area outlined in blue, the actual utilisation by civil traffic varies considerably between the shared areas.

3.5.3 Since the potential demand is based on the shortest possible route (great circle), a high level of unsatisfied demand is an indirect indicator for a sub-optimal level of flight efficiency.

3.5.4 On average, 26% of the day period is booked for military activities (see Figure 25). Figure 27 compares the allocation of shared airspace to military users one day in advance to the actual use[28] on the day of operation.

[28] The actual level of utilisation by the military was provided by the military authority of each State analysed in this report

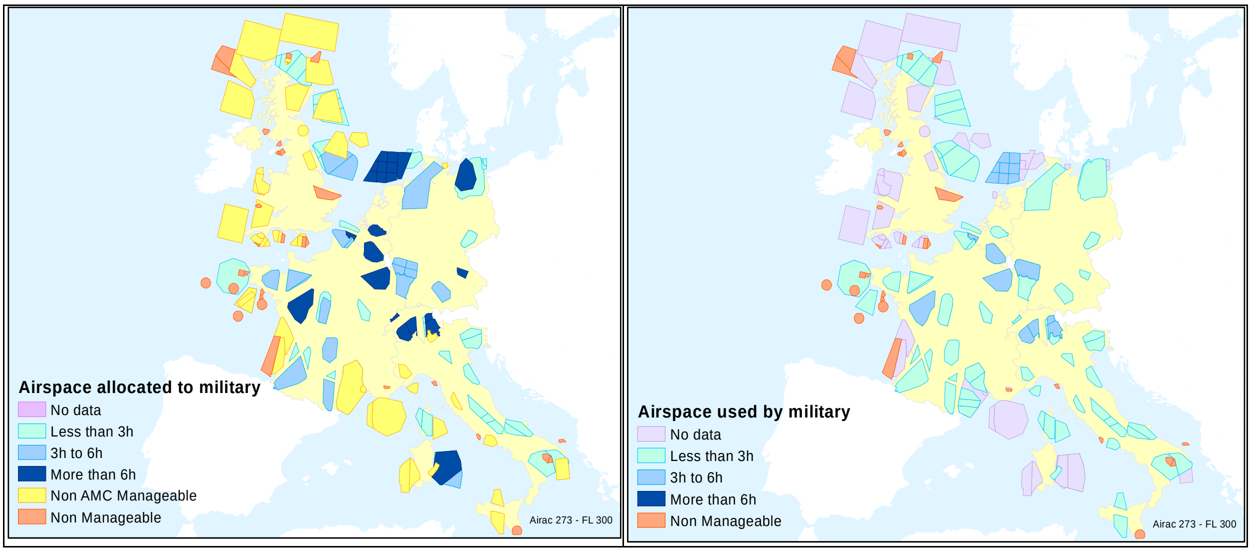


Figure 27: Allocation (AUP D-1) and actual use of shared airspace by the military

3.5.5 Figure 27 suggests that, on average, the shared airspace in the core area is allocated longer to military users than it is actually used for military activities on the day of operations. The analysis reveals that, on average, seven hours are booked for military activities, but only three hours are actually used on the day of operation. In other words, more than 50% of the time booked for military activities one day in advance is not used on the day of operation but – due to the short notice period – cannot be fully availed of by civil users.

3.5.6 Under certain conditions, this cancelled airspace can still be used efficiently by ATC operations; therefore it is necessary to determine how much of the airspace booked by the military is cancelled only a few hours before the time of operations.

3.5.7 It should be noted that airspace booked but not used by the military (see Figure 25) is progressively released to ATC during the day of operation.

3.5.8 Figure 28 suggests that, on average, 20% of the day period booked but not used by the military is cancelled three hours or more before the operations. 60% of the day period is cancelled between 3 and 1 hour before the operations and the remaining 20% is cancelled less than one hour before the operations.

	Release before scheduled start of shared airspace booked but not used (4 hours on average, 15% of the daily time on yearly basis)			
	24 hours in advance	Between 24 hrs and 3 hrs in advance	Between 3 hrs and 1hr	Less than 1 hr
European Average	0%	20%	60%	20%

Figure 28: Cancellation of booked but not used airspace during the day of operation

3.6 ATM ability to exploit the capacity of shared airspace

3.6.1 This section aims at analysing the ability to accommodate civil demand in shared airspace when military activities are present (i.e. weekdays) and when the shared airspace is fully available for civil use (i.e. weekends).

3.6.2 Figure 29 measures the ability to accommodate civil traffic[29] and military activities during weekdays (i.e. actual airspace utilisation).

3.6.3 As shown on the left side of Figure 29, the actual level of utilisation varies among the shared airspace booked by the military. TSA-20, LAUTER and TRA-SOUTH are extensively booked and used by the military, while CBA-1 and TSA-22 show a lower level of utilisation. Only limited comparable data on the actual level of military utilisation of the Portsmouth and Anglia areas in the United Kingdom were available, but the level of utilisation was indicated to be high during weekdays.

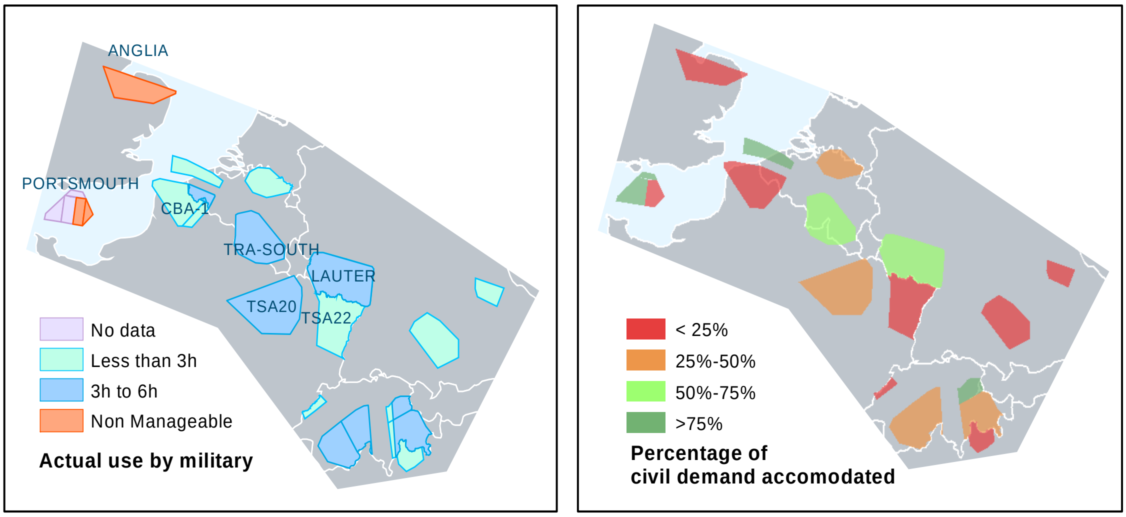


Figure 29: Actual usage of shared airspace by civil and military on weekdays (2005)

3.6.4 The right side of Figure 29 provides an indication of the extent to which civil traffic can be accommodated on weekdays with potential military activity. It is interesting to note that some areas with a high military utilisation show a high percentage of accommodated civil demand (LAUTER, TRA-SOUTH), which is clearly not the case for other areas less used by the military (CBA-1, TSA-22).

3.6.5 Complementary to the analysis of the ability to accommodate civil and military demand on weekdays, Figure 30 examines to what extent civil demand is accommodated at weekends, when the shared airspace is fully released for civil use.

3.6.6 However, whereas only a moderate increase is expected in areas which accommodate already a considerable level of civil demand on weekdays (TRA-LAUTER, TRA-SOUTH), there is little or no change in the level of civil utilisation of shared airspace in CBA-1 and TSA-22, even when it is fully released for civil use at weekends. During weekends, there is considerable scope for improving civil use in all areas as the shared airspace is fully available to civil traffic.

29 Comparison of actual observed routes with theoretical great circle routes between city-pairs.

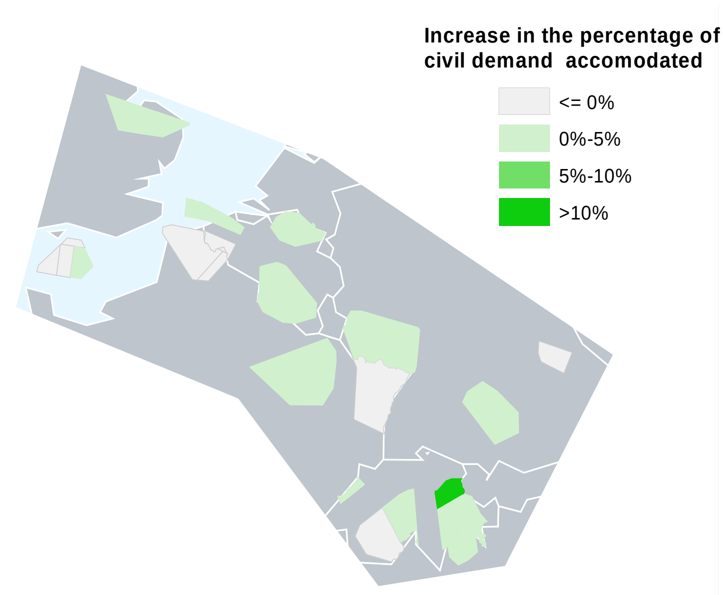


Figure 30: Changes in civil utilisation of shared airspace between weekdays and weekends

3.6.7 The analysis of ATFM delays on weekends in Figure 31 also suggests that the additional capacity of the shared airspace is not exploited to the maximum possible extent. The average ATFM delay per flight of ACCs operating close to capacity is in fact sometimes higher during weekends when shared airspace is fully released for civil use.

	En route ATFM delay per flight					
	2004		2005		2006	
	W	W.E	W	W.E	W	W.E
Geneva	0.3	0.5	0.9	1.2	0.6	0.7
London ACC	0.5	0.6	0.4	0.5	0.6	0.7
Maastricht	0.6	0.5	0.1	0.1	0.3	0.2
Munchen	0.1	0.1	0.1	0.2	0.2	0.2
Reims	0.7	0.9	0.5	0.6	0.3	0.4
Rhein	0.0	0.0	0.2	0.2	0.2	0.1
Zurich	0.7	1.1	0.4	0.7	1.3	1.2

Figure 31: ATFM delays in upper centres in the European core area

3.6.8 The next chapters provide an overview on how the FUA concept is applied in the seven analysed States. It aims at illustrating that the national ATM civil-military arrangements vary even though they are all based on the FUA concept.

4 Applications of FUA Level 1 – Strategic ASM

4.1 General

4.1.1 The following chapter provides an evaluation of how FUA level 1 is applied in all airspace of the various countries analysed in this report. The background information for the analysis in this chapter is provided in Chapter 2.2.

4.2 Training/shared areas

4.2.1 Airspace design of shared airspace is a State responsibility carried out by the Joint National High Level Policy body.

4.2.2 The main characteristics of training/shared areas which impact on airspace utilisation are:

- the ability to adjust training/shared areas to different mission profiles through a division of the area into sub-volumes (modularity);
- potential synergies of training/shared areas with ATC sector configuration (multiple options for similar mission profiles); and,
- the regular application of the "off/on route concept".

4.2.3 The higher the modularity (i.e. possibility to divide the training/ shared area into sub-blocks) the better the ability to exploit synergies during the pre-tactical ASM until a few hours before operations:

- The portion of the shared airspace to be used for the military activity can be synchronised with the ATC sector configuration and the route network. The portion to be selected for the daily military training will be the one with the least impact on the ATC capacity and the expected traffic load.
- More missions can be assigned to different portions of the TRA during the same time period while selecting it between the periods of low civil traffic.

4.2.4 A comparison of the airspace design in Figure 32 shows that TRA-SOUTH and TRA-LAUTER are divided into many parts which accommodate up to 2/4 simple mission profiles at a time, while TSA20 and TSA22 do not have this level of flexibility.

4.2.5 The analysis of the level of utilisation in Section 3.6 of Chapter 1 suggests that TRA-SOUTH and TRA-LAUTER have higher levels of civil airspace utilisation than TSA20 and TSA22. TRA-SOUTH is used by Belgian Air Force. TRA-LAUTER is used by US-Air Force and by the GAF aircraft, TSA20 and TSA22 by French Air Force.

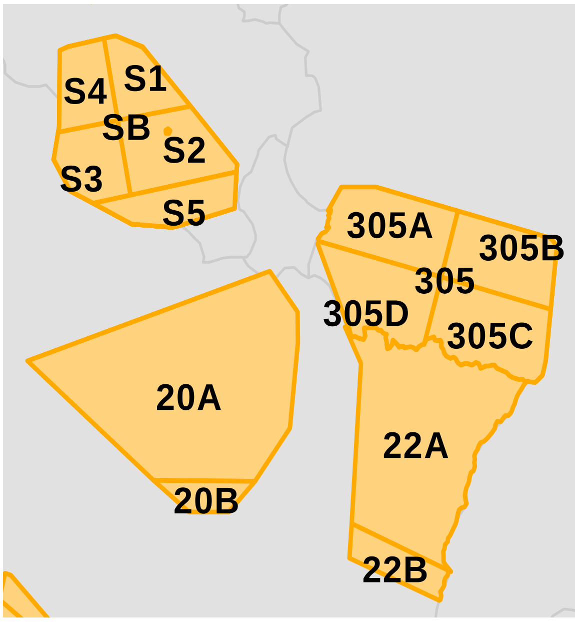


Figure 32: Airspace Design in training/shared areas (AIRAC 283)

4.2.6 When a military mission profile (e.g. one aircraft versus one) requires a limited amount of airspace, the Belgian and the US-Air Force may require - depending on the mission profile - just a portion of the TRA, leaving the remaining airspace volume to civil traffic. Similarly, two or three missions can operate simultaneously in separated portions of the TRA and hence reduce the overall time required for the military exercise.

4.2.7 A quite promising application for minimising airspace segregation is the Military Variable Profile Area (MVPA concept) under development by DFS. In 2007, the MVPA concept is applied in some German areas at the boundary with Poland where the civil traffic is less dense than in the European core area.

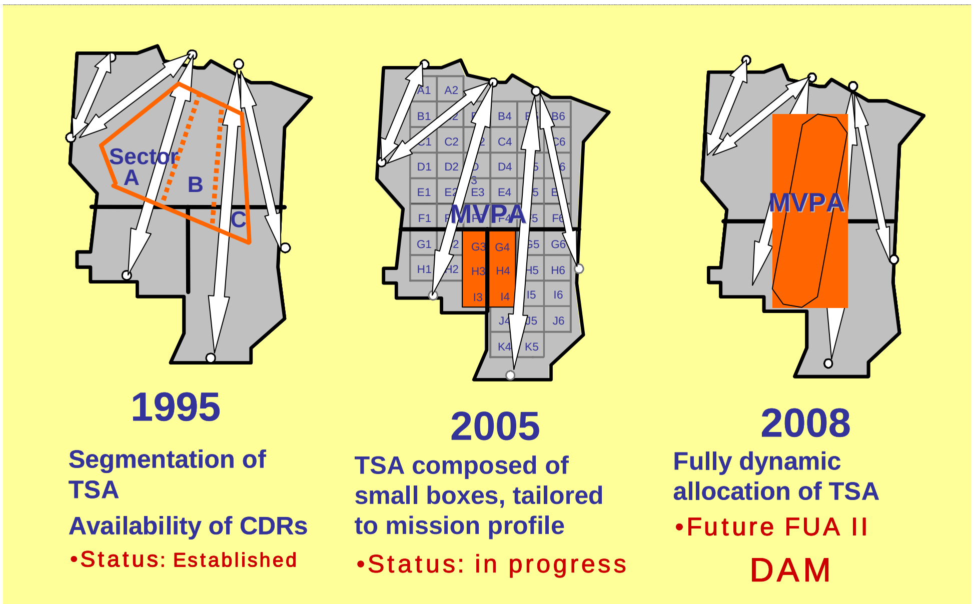


Figure 33: Military Variable Profile Area Concept developed by DFS[30]

4.2.8 The MVPA concept provides for training areas which are divided in many airspace sub-volumes (see Figure 33, central picture); they can be combined depending on military needs. The selection of the geographical location where to activate the sub-volumes could be done some hours in advance avoiding the areas where the civil traffic is mostly concentrated. Further allocation / re-location of sub-volumes could be done even later. The MVPA concept requests a high level of flexibility by the ATC sector configuration. This is likely to be a critical point for implementing the MVPA Concept in the European core area.

4.2.9 Figure 34 shows the flexibility features in shared/training areas by State. A higher modularity allows to better tailor the airspace to military mission profiles (see par.2.2.5). Furthermore, training areas can have different sub-volume configurations in order to adapt them to ATC sector configuration changes (see Figure 7 on page 8). This is the case in Germany, Belgium and Italy.

30 DFS presentation at MILHAG 20 (Colonel Herbert Schramm)

State	Ability to accommodate training/shared areas to different mission profiles (division of areas into sub-volumes)	Potential synergy of training/shared areas with ATC sector configurations and route network	Regular application of the “off/on-route” concept (see Figure 10)
Belgium	Yes	Yes	No
France	No in many areas	No in many areas	No
Germany	Yes	Yes	No[31]
Italy	Yes	Yes	No
Netherlands	Yes	Yes	Yes
Switzerland	Yes	Yes	No
UK	Yes in AMC manageable areas	Yes in AMC manageable areas	Yes

Figure 34: Modularity of training/shared areas in States (2005)

4.2.10 Figure 35 provides an overview of the level of manageability of the training/shared areas in the seven analysed States. There is a clear difference in terms of manageability of training/shared areas between the analysed States.

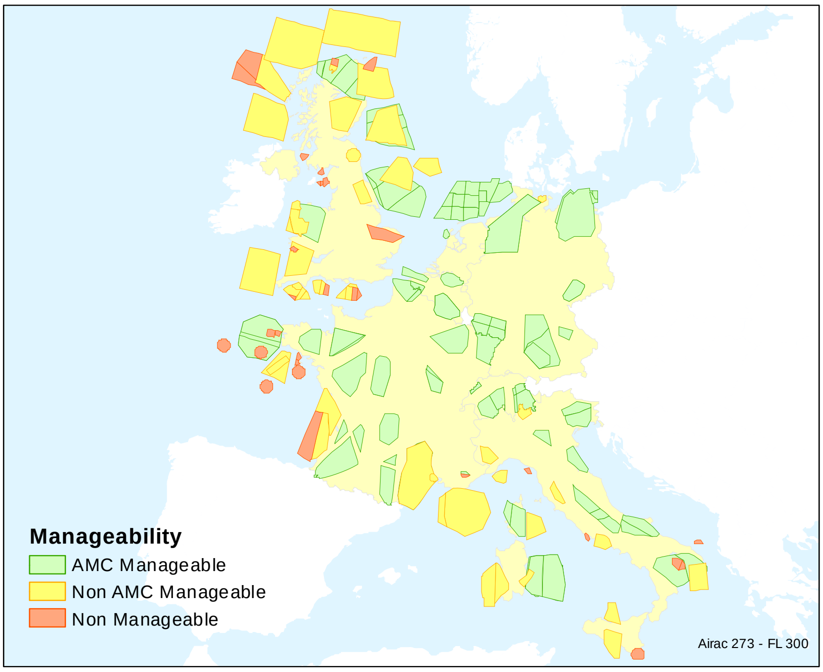


Figure 35: Manageability of training/shared areas

4.2.11 It is important to reiterate the meaning of “AMC-manageable” (compare 2.2): When an AMC manageable area is released to ATC it cannot be revoked unless the same ATC unit had been consulted sufficiently in advance (say up to 2 or 3 hours before revoking the area). A training area which can be revoked without prior notice cannot be used to formulate the ATC sector configuration in the pre-tactical ATFCM phase.

[31] In the Maastricht airspace the off/on route concept is still applied, but rarely.

4.3 Conditional route density

4.3.1 The route network is a primary enabler for airspace utilisation. A good integration of the shared airspace in the route network is consequently a prerequisite for the accommodation of civil demand in shared airspace when it is available.[32]

4.3.2 Route density and ATC sectorisation are highly interdependent; routes can only be efficiently operated if the ATC sector design supports a given route network design. When shared airspace is made available to civil traffic, the route network should convey traffic demand inside the shared airspace, while the ATC sectorisation enables the deployment of ATC resources to manage the traffic.

4.3.3 The range of options for airspace designers is between an approach which privileges the stability of “conflict points”, but traffic density could be higher than what airspace availability could allow (i.e. the route network conveys traffic always in the same position; the repetitiveness of tasks makes the ATCO job less difficult) and an approach which privileges the maintaining of traffic density at the minimum, but “conflict points” move dynamically (i.e. the traffic is the least complex because the traffic is spread all over available airspace so that the ATCO job is less difficult). The former approach requests few CDRs inside shared airspace; the result could be high ATC capacity, but low airspace utilisation of shared airspace. The latter approach requests many CDRs inside shared airspace; the result could be high ATC capacity as well as high airspace utilisation. The right mix between the two approaches depends on ATCO training, ATC procedures, HMI software (e.g. MTCD), etc.

4.3.4 Route density and ATC sectorisation are highly interdependent; routes can only be efficiently operated if the ATC sector design supports a given route network design. When shared airspace is made available to civil traffic, the route network should convey traffic demand inside the shared airspace, while the ATC sectorisation enables the deployment of ATC resources to manage the traffic.

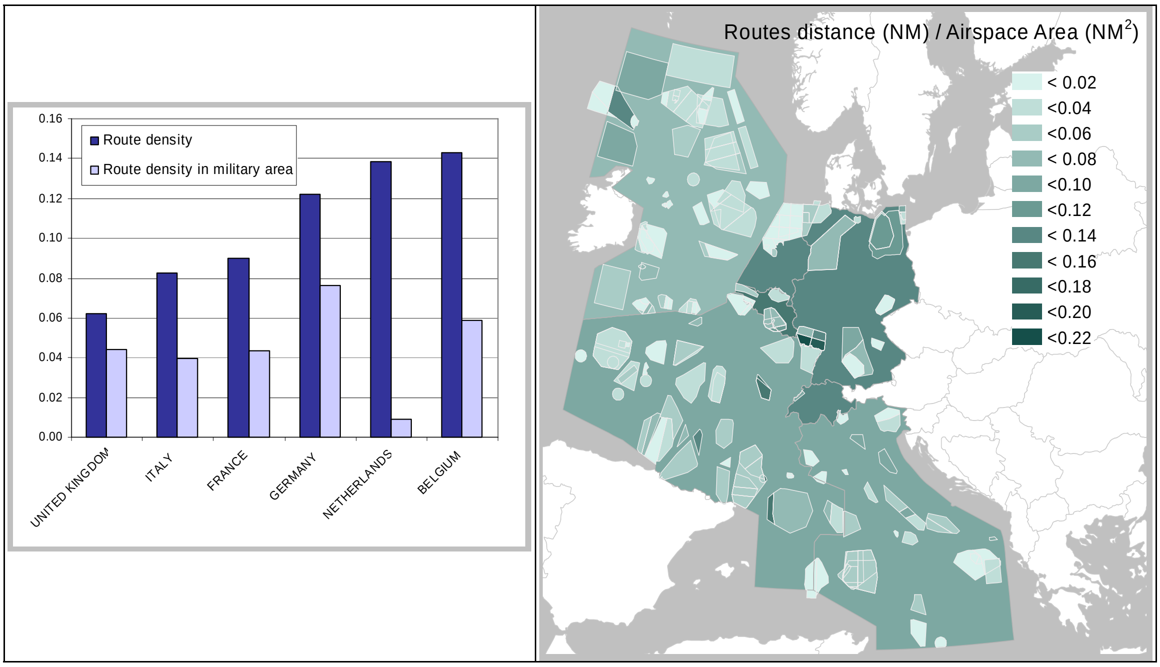


Figure 36: Route density inside and outside shared airspace (2005)

32 However when traffic is conveyed through shared airspace via the activation of routes, then ATC sector configuration shall be compatible to the activated route scheme.

4.3.5 Figure 36 compares the route density inside and outside of shared airspace for the analysed States. The comparison provides an indication on how efficiently the shared airspace can be integrated in civil operations when it is available for civil use. The analysis on route density shows whether the selected modus operandi (i.e. the synergy between route network and sectorisation) is efficient in using shared airspace.

4.3.6 Across all analysed States, the route density in shared airspace is significantly lower than in controlled airspace which may lead to a sub-optimal utilisation of the shared airspace when it is available for civil use. The analysis of route density suggests that the applied modus operandi may not always be suitable in exploiting the availability of shared airspace.

4.4 Conditional route offer in the seven analysed States

4.4.1 For data analysis purposes, the route offer is divided in the following high-level categories:

- Permanent routes in controlled airspace;
- CDRs permanently available for flight planning (CDR1-H24); and,
- CDRs not permanently available for flight planning (CDR 1 / 2, CDR 1 / 3, CDR2, CDR3).

4.4.2 Permanent means that the availability of the route for flight planning is known when the AIRAC cycle is published, i.e. 56 days before the start of the AIRAC cycle which lasts 28 days.

4.4.3 The study also tried to evaluate the availability of routes to ATC when not available for flight planning (e.g. a CDR2 closed for flight planning, but released to ATC from the military unit). Unfortunately, there was no systematic data collection to support this type of analysis.

4.4.4 The total route offer (NM*FLs) in the 7 States[33] is the same during week and weekends, but the permanent route offer (for flight planning) increases from 80.6% up to 84.5% on weekends. Similarly the CDR1-H24 increases from 7.3% to 13.5% on weekends. Overall, 98% of routes are permanently available for flight planning on weekends compared to 87.9% of routes permanently available for flight planning on weekdays.

4.4.5 Overall, it can be observed that the route offer is higher on weekends and that the CDR1-H24 is the only route type which is used in all seven States on weekends. This makes the European route network more consistent on weekends than on weekdays (see also next section).

4.5 Application of Conditional Routes in the 7 States on weekdays

4.5.1 The application of Conditional Routes in the 7 States evaluates the following aspects of the FUA concept:

- The existence of a harmonisation of the CDR route classification which allows an easy interconnectivity of routes across borders;
- The ability of different applications of CDR classification and management to deliver route availability for flight planning; and,
- The potential of CDR classifications to create synergies with the use of

[33] The route offer is measured in term of Nautical Miles times Flight Levels (between FL200 and FL400). The route availability for flight planning is measured as a percentage of the 18-hours day period (between 0400 and 2200 UTC).

training/shared areas and the ATC sector configuration (modus operandi).

4.5.2 Figure 37 provides an overview of the application of the different CDR classification (see also Chapter 2.2) during the day period on weekdays in the seven analysed States.

CDR Route combination in the day period	How the route is managed	States applying the CDR route combination
CDR1 available H24	The route is available for flight planning for most of the time. The associated training area is closed on real-time and airborne rerouting is required for flights which planned to use the route.	All 7 States
CDR1/2 or CDR2	The route is always available for flight planning during the CDR1 periods, generally early morning and late afternoon. The route is available for flight planning during the CDR2 periods when published in CRAM messages.	Belgium, Germany, Netherlands.
CDR13 or CDR3	The route is always available for flight planning during the CDR1 periods, generally early morning and late afternoon. During the CDR3 periods the route is not available for flight planning.	France, Italy, Belgium
AMC-Manageable CDR1 and CDR1/3	These routes are managed in the pre-tactical phase. Routes are often closed to flight planning via NOTAM or via the CRAM. Airborne rerouting may be required when the route is closed but some flights are already airborne.	UK

Figure 37: Application of the CDR classification in the 7 States

4.5.3 The CDR1-H24 is the only category which is used by all seven States. This category ensures the highest CDR availability for flight planning. However the amount of CDR1-H24 during weekdays varies significantly from State to State (see Figure 38).

4.5.4 When looking at the other CDR categories, the seven States fall into three groups (Belgium being part of two groups):

- Those States that use CDR2 route types which are managed during the pre-tactical phase one day in advance (Belgium, Germany, Netherlands and Switzerland);
- Those States that use CDR3 route types which are never managed in pre-tactical ASM (Belgium, France, Italy); and,
- The UK which is the only State regularly managing CDR1 and CDR1/3 during the pre-tactical phase.

4.5.5 The existence of three groups raises concerns about the compatibility of CDRs for the planning of cross border flights passing through different States. The DMEAN programme is expected to address the problem as it attempts to review the CDR classification in order to ensure harmonisation among States.

4.5.6 The analysis of route availability (see Figure 38), does not suggest that one of the three applications (CDR12, CDR13 and AMC-Managed CDR-1) is superior to the others.

State	Percentage of CDR1-H24 over the total of CDRs	Prevalent CDR model for non permanent CDRs	Level of availability to Flight Planning (excluding CDR1-H24)
Belgium	28%	CDR12 and CDR13	Low (<50%)
Germany	23%	CDR12	Medium (>50%)
France	44%	CDR13	Low (<50%)
Italy	54%	CDR13	Medium (>50%)
Netherlands	9%	CDR12	Low (<50%)
Switzerland	30%	CDR12 and CDR3	Medium (>50%)
UK	24%	Managed CDR1 and Managed CDR13	Medium (>50%)

Figure 38: Prevalent State CDR models during weekdays (2005)

4.5.7 Although the UK application of AMC-Manageable CDR1 may not be completely aligned with the FUA rules as published in the ASM Handbook[34], it reveals that the closure of CDR1 can be applied for the same purpose as a CDR2 opening, but also that CDR1 closure has got some advantages for flight planning compared to the CDR-2 type:

- The AMC-Manageable CDR1 and CDR1/3 could be closed via NOTAM a few hours before using the associated training areas, while CDR-2 shall be opened 1 day in advance.[35] CDR-1 is manageable closer to real-time operations than CDR-2. Furthermore, one could decide to close the CDR1 without NOTAM if the traffic that needs to be rerouted is low. In summary, CDR1 allows a higher level of flexibility than CDR-2. (see also 2.2.13 and 2.2.14).
- Whereas in the AMC-Managed CDR1 case, aircraft operators may become aware of the CDR1 closure because the FPL is rejected by IFPS, there is no process to make aircraft operators aware that a CDR2 is opened. Therefore, the opening may remain unnoticed, resulting in a loss of potential flight efficiency gains.

4.5.8 For the CDR3 category, it was noted that in particular circumstances it can be upgraded to a CDR2 status (i.e. available for flight planning). That is another clear signal that the CDR1, CDR2 and CDR3 categories should be better used.

4.5.9 In summary, the main issue during weekdays is the heterogeneous application of CDR categories throughout Europe.

4.6 Relationship between CDRs and the utilisation of shared areas on weekdays

4.6.1 The purpose of this section is to establish whether there is a relationship between the level of military airspace utilisation and the different types of CDR category. This analysis also helps in understanding how CDR routes and training area classifications are combined within the same modus operandi.

4.6.2 Although there are exceptions, Figure 39 suggests that there is a relationship between low military airspace utilisation and the use of CDR1-H24. Similarly, there appears to be a relationship between high military airspace utilisation and the use of other CDRs either manageable at Level 2 (CDR1/2 and CDR1 UK style) or non-manageable (CDR13).

[34] The ASM Handbook states that a CDR 1 route should be rarely closed, while the British AMC-manageable CDR1 are closed quite a significant number of times.

[35] This is an option foreseen by the ASM Handbook. Actually the UK never closes a CDR1 on the day of operation; the UK always closes CDR1 and opens CDR2 at Day -1

4.6.3 The reasons for using CDR1-H24 when military airspace utilisation is low could be that ATC clearances for avoiding active training areas may be rare and/or easy to implement. There may also be an overflow ATC position at the ACC which can be opened on an ad-hoc basis to handle the civil traffic to be routed outside the active area.

4.6.4 When military utilisation is high, it is not possible to use tactical ATC instructions to keep flights outside the training area as it would happen too frequent and for complex traffic situations. Therefore the most used CDR categories are Manageable CDR1, CDR2 and CDR3.

4.6.5 There are important exceptions: for instance in continental Italy the CDR1-H24 is used for low military airspace utilisation, while in North-Sea, East of UK, the AMC-managed CDR1 is used for the same level of military airspace utilisation as in Italy.

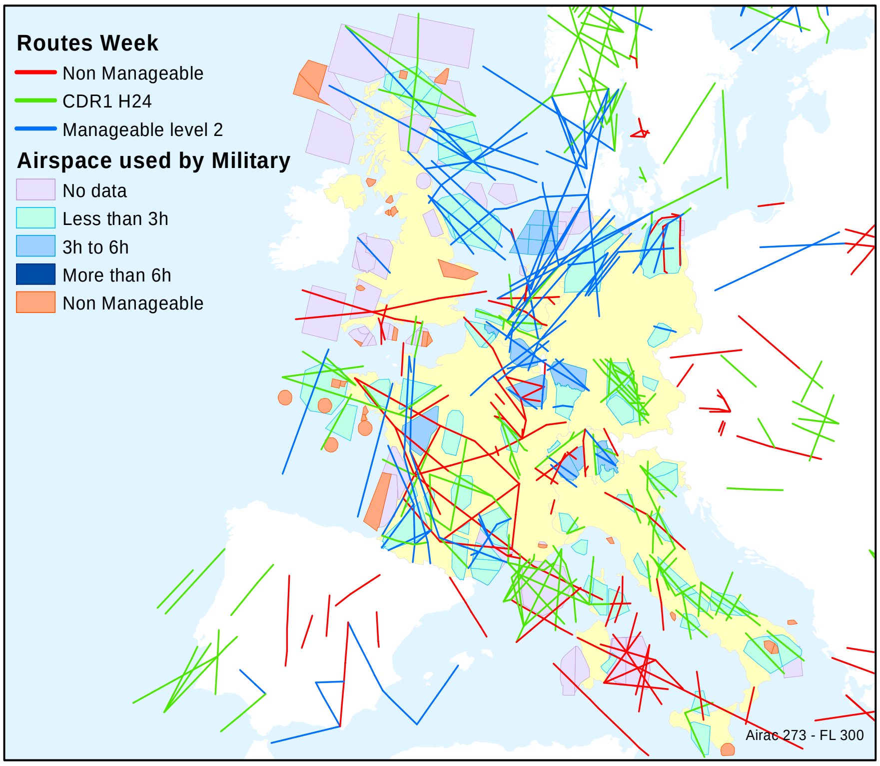


Figure 39: Relationship between CDR category and military airspace utilisation (2005)

4.6.6 All in all, the situation observed in Figure 39 is in line with the criterions defined in the ASM Handbook on how to choose CDR categories when classifying CDR routes.

4.7 Relationship between CDR categories and ATC sector configuration

4.7.1 This section aims at providing an understanding how CDR routes and ATC sector configuration are used within the same modus operandi.

4.7.2 Broadly three different types of situations which apply to all seven States can be identified. Variations are less relevant as they can be grouped into one of the situations described below:

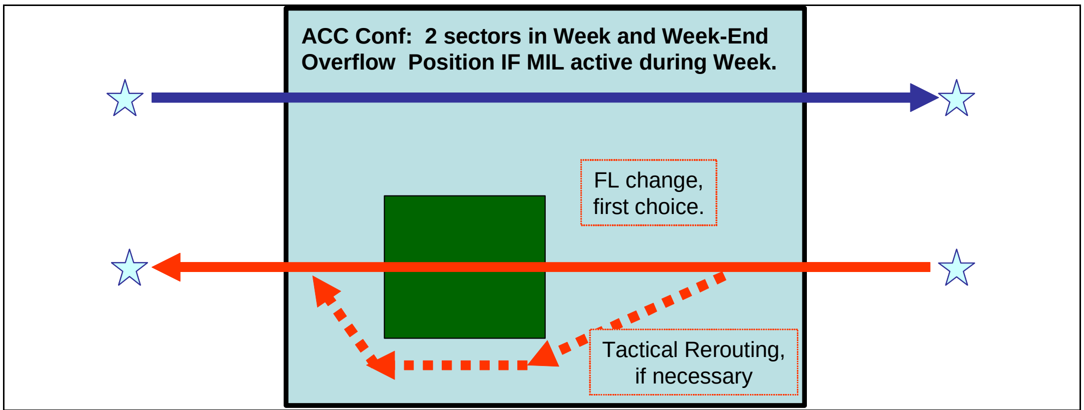
1) when low military airspace utilisation and/or specific ATM working arrangements allows the application of a CDR1-H24;
2) when military utilisation is high and the ACC is close to ATC capacity limits;
3) when the CDR2 or CDR3 route swap into a CDR1-H24 from week-days to weekend.

SITUATION 1) Low military airspace utilisation (or real-time integration between civil traffic and military activities) + CDR1-H24 application

4.7.3 Whenever a CDR1-H24 is applied, the main advantage is that the ATC sector configuration can be treated almost independently from the existence of military activities. This could happen when there are ATM working arrangements to integrate the military activity and the civil traffic (see Portsmouth area) or when the low military airspace utilisation allows for "easy" ATC solutions in tactical rerouting the traffic.

4.7.4 The main advantage for the ATC sector configuration is that the traffic flow orientation remains the same between week and weekend; therefore the ACC configuration will only vary depending on civil traffic orientation.

4.7.5 When the training area is active, the tactical rerouting can be instructed by the ATC sector when the traffic load is relatively low (see Figure 40) or an ATC overflow position could be opened in case there is the need to alleviate the ATC sector from complex traffic.



In this example there is a route structure which is composed of two main routes both on weekdays and weekends. The blue line represents a permanent route, while the red line illustrates a CDR1-H24. There is an alternative route which may be used when the military area is active. If necessary, an overflow position reroutes traffic via the alternative routing. During weekends the overflow position is not staffed, but the ATC sector configuration remains essentially the same.

Figure 40: Example of a modus operandi involving a CDR1-H24 in weekdays

4.7.6 Overflow positions can be opened in German centres. In Italy, the number of options in term of available training areas usually allows to accommodate activities outside heavily loaded ATC sectors.

SITUATION 2: Military utilisation is high and the ACC is close to capacity limit

4.7.7 When military utilisation is high, the best option appears to be a CDR2 or CDR3 type route. During interviews, it emerged that when the ACC capacity depends on the availability of airspace and the ACC is close to capacity limits, CDR2 or CDR3 routes are better suitable for a flexible ATC sector configuration. When flexibility is fundamental to deliver ATC capacity, the ACC may prefer delaying the choice of the sector configuration up to a time when it is clear what the best option is. At this time it may be far too late to allow the use of the route for flight planning. Therefore, ACCs may prefer to maintain the route not available for flight planning.

SITUATION 3: Swapping a CDR2 or CDR3 in CDR1-H24 during weekend

4.7.8 Shared/training areas which are heavily used by military activities on weekdays are generally released to civil traffic on weekends. The conversion of CDR2 or CDR3 routes into CDR1-H24 routes is the standard situation in all 7 States.

4.7.9 A low route density within the shared/training area may be a symptom of a lack of ATC sector configurations to handle a significant traffic increase inside shared airspace.

4.8 ATC sector configuration in the 7 States

4.8.1 In recent years, ACCs have increased both the number of ATC sectors and the flexibility to respond to variations in traffic demand. The introduction of RVSM in ECAC States in 2002 has contributed to increase the ATC capacity in European ACCs. Overall, the performance of European ACCs has increased significantly since 1999. This can also be observed by the continuous reduction of en-route ATFM delays.

4.8.2 From a civil-military point of view, the most important ACC feature for further development is the flexibility to cope with different situations which vary from two extremes: (1) the reduction of airspace when it is segregated to civil traffic and (2) the increase of airspace when it is released to civil traffic.

4.8.3 Figure 41 outlines the various options to increase the level of flexibility and Figure 42 illustrates the level of flexibility currently observed at European ACCs in the core area.

TYPE 1	Various options to combine elementary sectors at the standard configuration.
TYPE 2	Increase the number of opened ATC sectors beyond the number of the standard configuration.
TYPE 3	Change geographical boundary at the standard configuration.
TYPE 4	There are multiple options among which the vertical boundary between two sectors can be chosen.
TYPE 5	Overflow position. An ATC position controls a specific traffic flow passing inside one or more ATC sectors controlled by another ATCO teams.

Figure 41: Options to increase flexibility of ATC sector configurations in ACCs

ACC	Type of options available / Flexibility at the standard configuration (peak hours)
Reims	1, 2
London	1,2
Rhine / Munchen	1,2, 3, 4, 5
Maastricht	1, 2
Zurich / Geneva	1, 2
Rome / Milan	1, 2

Figure 42: Flexibility in upper ACCs of the core area (2005)

4.8.4 As can be seen in Figure 42, the level of flexibility in German centres is higher than in other ACCs in the core area, although their sectorisation options are much higher in the vertical axis than in the horizontal axis (i.e. flexibility Type 2 is much more developed in the vertical axis).

4.8.5 The different levels and types of ACC flexibility represent a constraint for configuring the European airspace in a seamless way in the pre-tactical and real-time phases.

4.9 Relationship between ATC sector configuration and shared areas

4.9.1 The effectiveness of the various modus operandi depends on the flexibility of the ATC sector configuration to match the modularity of the military training areas. Furthermore it depends on how the ATC sector configuration can cope with the contrast in high military utilisation on weekdays and the absence of military activity on weekends.

4.9.2 Figure 43 provides an overview of the different strengths and weaknesses of the various modus operandi used by the seven analysed States. Due to the heterogeneous nature of the European network, the problems which need to be addressed differ in each State. There is considerable work which needs to be done in order to upgrade the European network to an optimum level.

ACC	Matching between the flexibility of ATC sector configuration and training/shared areas.	Potential and actual response to the contrast week – weekend operations.
Maastricht UAC over Belgium and Germany	The flexibility of the ATC sector configuration well combines with the modularity of training/shared areas.	The type of ATC sector flexibility is suitable to increase airspace utilisation on weekends. However improvements are still possible.
Maastricht UAC over Netherlands	The regular application of the "off/on route concept" constraints the flexibility of ATC sector configuration during weekdays.	
Reims	Lack of integration between ATC sectorisation and modularity of training areas. However the ATC sector configuration itself has got many options, but only related to civil traffic variations (see ARN V5 Report) and not to increased availability of shared airspace.	The ATC sector configuration does not provide for an increase of airspace utilisation on weekends. The actual ATC sector configuration in North Reims seems to be suitable to handle more traffic on weekends provided there is an increase in route density. The other ATC sector configurations are not adapted.
Munchen, Rhine and Maastricht over Germany	There is a good match between the flexibility of the ATC sector configuration and the modularity of training/shared areas.	The ATC sector configuration provides for a small increase of airspace utilisation on weekend. It is likely that the ACC flexibility in the horizontal axis may be enhanced.
Rome and Milan	There is a good match between the flexibility of the ATC sector configuration and the modularity of training/shared areas.	The relatively low level of military airspace utilisation and the solutions adopted in CDR classification reduces the contrast between week and weekend.
Geneva and Zurich	The flexibility in the ATC sector configuration is limited by the small size of the ACCs .	The ATC sector configuration does not provide for a significant increase of airspace utilisation on weekends.
London	• Very good integration between the Hurn ATC sector suite and the Portsmouth area system. • Lack of integration between the Clacton and Daventry ATC sector suites and the East Anglian area due to the non-AMC manageability of the latter. • Lack of integration between the Lakes and Bristol ATC sector Suites with the North Wales area system. This is likely to be related to a civil ATC rating issue (those ATCOs rated to Lakes suite are not rated to Bristol one and vice versa).	The ATC sector configuration does not provide for an increase of airspace utilisation in weekend. The reasons are two-fold: • Although the East Anglian area is available to civil traffic, the sectorisation is inadequate to accommodate the potential traffic (e.g. arrivals to LHR from Nordic States). • In North Wales area system the ATC rating issue may impede a different re-sectorisation.

Figure 43: Matching between training/shared area and ATC sector configuration flexibility

4.9.3 As already observed for the application of the CDR route classification, Figure 43 shows that there is no consistency across ACCs regarding the relationship between ATC sectorisation and the design of shared airspace.

4.9.4 In order to converge towards a seamless and consistent airspace utilisation in the European core area on weekdays, the surveyed States could make improvements as follows:

- Belgium and Germany appear to be the most mature States with respect to FUA, although improvements are still possible;
- The Italian model is also a positive example of how to manage the civil-military interaction. In Italy, the ATC sector configuration is relatively independent of the activation of training areas. This is due to the relatively low military airspace utilisation, to the substantial number of suitable options to accommodate the military activity and to the application of the CDR1-H24 concept (i.e. no closure of routes for flight planning, but tactical rerouting when necessary).
- France would benefit from a better integration of the ATC sector design (which was only applied to manage civil traffic at the time of review) with military areas. Additionally, the modularity of shared/training areas could be increased to better adjust the airspace to the military mission profiles.
- As the Netherlands apply the off/on route concept, the volumes of airspace remain static. Generally speaking, this type of airspace organisation is not compatible with dynamic ATC sector configurations.
- Switzerland has to orientate the ATC sector design towards and integration with military areas whose airspace volume modularity seems already quite good.
- The UK faces problems of a different nature:
    - Portsmouth area is well integrated with London ATC sectorisation. Recent changes have suppressed ATFM delays originating from the Hurn suite. The situation has just to be monitored.
    - The North Wales area system is not well integrated with the London ATC sectorisation. This is highlighted by the low airspace utilisation of the shared area (see Chapter 3). However, this seems to be mainly a civil issue.
    - The East Anglia area is a civil-military issue of very complex nature. Solutions cannot be expected in the short term.

4.9.5 Similarly the potentiality to address the week/week-end contrast (high military airspace utilisation in week / absence of military activity in week-ends) varies considerably across the European core area.

5 Applications of FUA Level 2 – Pre-tactical ASM and ATFCM

5.1 Introduction

5.1.1 The background information for the analysis in this chapter is provided in Chapter 2.3. The pre-tactical operations can be divided in three successive steps:

1) the configuration of shared airspace and ATC sector configuration (i.e. the selection of options);
2) the activation, de-activation of CDR routes in line with decisions at Step 1; and,
3) the dissemination of decisions (see par. 2.3): periods of activation of training areas, ATC sector configuration schemes and the CDR availability for flight planning.

5.1.2 The configuration of shared airspace and ATC sector configuration is much more important than the CDR availability for flight planning as it relates directly with the production of ATC capacity and the airspace availability for military training.

5.1.3 The following chapter provides an evaluation on how FUA level 2 is applied in the seven States analysed in this report. A particular focus is put on Step 1, the configuration of shared airspace, and on the CDR route availability for flight planning.

5.1.4 Pre-tactical operations should not be required on days when military activity is absent (weekends - 33% of day period, see also Figure 25) as the airspace is fully available for civil use (routes, sector configurations).

5.2 Pre-tactical ASM and ATFCM for the configuration of shared airspace and ATC sectors.

5.2.1 The pre-tactical activities deal with the preparations of resources which will be deployed the day of operations. The planning of military units (wing squadrons, naval shooting units, etc.), airlines and ATC centres must be prepared well in advance (i.e. few days before the day of operations)[36], although some flexibility is necessary during the day of operations to deal with unplanned events.

5.2.2 In few instances (e.g. the Portsmouth area before 2007) the pre-tactical ASM is not operated due to the peculiarity of the mission profile and of working arrangements.

5.2.3 Pre-tactical operations don't have the same purpose for all shared airspace. It depends on the military airspace utilisation and the organisation of Level 1 and Level 3. Figure 44 illustrates the pre-tactical operations of some areas with a good utilisation of shared airspace.

[36] See also Figure 2-1 of the "Report on Punctuality Drivers at Major European airports" and §.4.3 of the report "Status of civil-military coordination" both available at www.eurocontrol.int/prc

Shared airspace	Intensity of military airspace utilisation.	ASM Level 1 airspace structures	Purpose of Pre-tactical operations	Civil-military Real-time procedures
TRA-Lauter (Germany)	High	• CDR12 routes, • Modular training area • Flexible ATC sector configurations in the vertical axis.	Maintain a consistent and harmonised configuration between ATC sectors and opened shared airspace modules.	Focus on Activation / De-activation of shared airspace and airborne rerouting.
Portsmouth (UK)	High	• CDR1-H24, • Sector configuration adapted to the shared airspace modules.	No pre-tactical ASM[37], but ATFM regulations if necessary in the day of operations.	Focus on integrating military activities and civil traffic in shared airspace (military slots defined in real time, airborne rerouting, etc.)
Training areas in Continental Italy	Low	• CDR1-H24, • Modular training area • Sector configuration adapted to the training area modules.	Select areas where civil traffic is lower in order to position military activity there without impacting on the ATC sector configuration.	Focus on Activation / De-activation of shared airspace and airborne rerouting.

Figure 44: Different pre-tactical organisations

5.2.4 The pre-tactical operations vary considerably between the analysed areas. When the pre-tactical ASM focuses on the harmonisation between ATC sector configuration and training areas activation (TRA-Lauter, but also in some parts of the TRA-SOUTH in Belgium), great care is given to ensure the stability of airspace which has been assigned to ATC units.

5.2.5 In TRA-Lauter, the military booking of TRA is possible more than 3 hours in advance without restrictions for military flights (published in UUP message). Booking of the TRA is possible 2 to 3 hours in advance with restrictions for military flights concerning activated CDR (published in UUP message), and booking of the TRA is possible less than 2 hours in advance with restrictions for military flights concerning activated CDR and additional restrictions related to ATC needs (not published in UUP). Similar procedures are applied for some parts of the TRA-South in Belgium (FUA Level 3+ initiative).

5.2.6 The above procedures ensure stability of airspace assigned to ATC. The airspace stability delivers significant benefits during the ATFCM pre-tactical process (i.e. ATFM regulations can be avoided). The increased stability of airspace for ATC in the TRA-SOUTH was one of the main reasons of the good Maastricht performance in 2005. [38]

5.2.7 Another perspective for analysing the pre-tactical operations looks at the sequencing of processes for the configuration of airspace.

37 It is recognised that pre-tactical ASM for Portsmouth area has been introduced since March 2007.

38 See Performance Review Report 2005

5.2.8 In many analysed States, the pre-tactical ASM and ATFCM aim at accommodating the military demand first before the ATC sector configuration is decided. However, the civil traffic needs are considered in the negotiation phase.

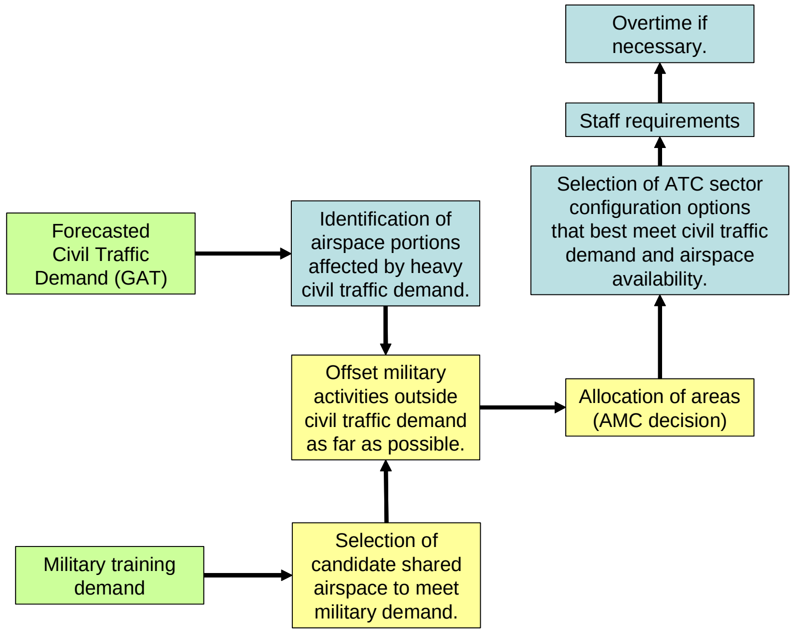


Figure 45: Main thread of the pre-tactical ASM and ATFCM in many analysed States

5.2.9 In France and in some UK airspace, it appears that the pre-tactical processes aim at putting the ATC sector configuration in place first before the military demand is shifted outside the critical ATC sectors[39].

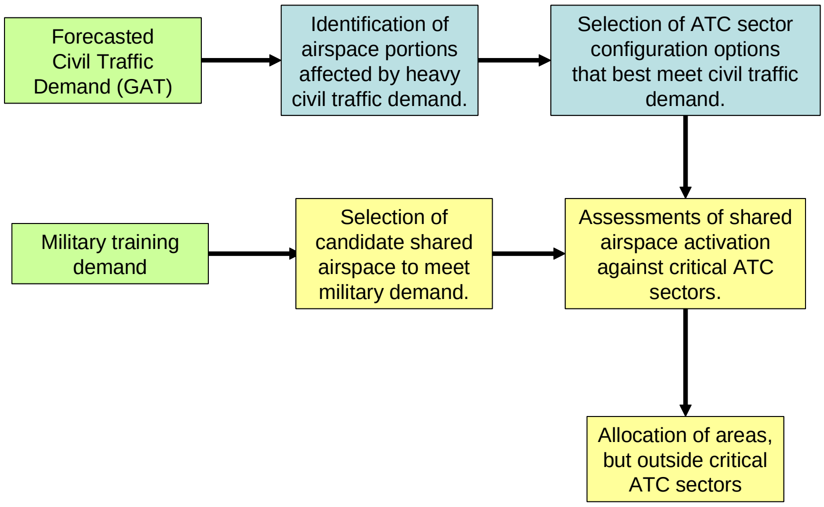


Figure 46: Main thread of the pre-tactical ASM and ATFCM in France

5.2.10 Whatever process is applied to assign airspace to military activity or to ATC for configuring sectors, it should be noted that an ATC unit should have enough ATC capacity to accommodate both civil traffic and military activity at different levels of airspace availability. The need to operate a trade-off between civil and military requirements should be occasional and limited in time and space. This is the sense of the ATM2000+ objective with regard to ATC capacity:

- *The objective is to provide sufficient capacity to accommodate the demand **of all users***

[39] However there are safeguard rules which avoid potential abuses.

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.*

5.3 Pre-tactical ASM for releasing routes for flight planning

5.3.1 Whenever the airspace configuration of ATC sectors and training zone allows, it is worth releasing CDR routes for flight planning. This is not the main objective of pre-tactical ASM, but it could deliver benefits to Aircraft Operators .

5.3.2 Some 20% of CDR routes are currently subject to pre-tactical ASM (flight planning availability is published one day in advance via the CRAM message issued by the CFMU).

5.3.3 The pre-tactical ASM for flight planning should be applied any time that the route availability is unpredictable many days in advance (i.e. at the AIRAC cycle dates). As a matter of fact it should be expected that the dynamicity of pre-tactical ASM makes the CDR route availability unpredictable. Conversely, if route availability is static, then it is better to advice about opening and closing times at the AIRAC cycle date.

5.3.4 In summary, if the route availability is predictable from an AIRAC point of view, the pre-tactical ASM has little added value as the route availability could be published only once at the beginning of each new AIRAC cycle.

5.3.5 Figure 47 illustrates the predictability of the vertical availability of negotiated routes. During the AIRAC cycle (28 days), the vertical availability of CDR routes which are published at pre-tactical ASM level 2 (1 day before operations) is highly predictable. Some 83% of the time the starting FL is the same and some 84% of the time the number of available FLs (range) is the same.

CDR Segments	FL Start options in 28 days
642	1
98	2
28	3
5	4
1	6
2	7
CDR Segments	**FL range options in 28 days**
655	1
86	2
28	3
7	4

Figure 47: Vertical predictability of negotiated routes

5.3.6 Figure 48 outlines to which extent the time availability of negotiated routes is predictable. The analysis was done on many CDR segments for all AIRAC cycles in 2005 and shows the hourly availability (Y-Axis) per day (X-Axis). The analysis suggests that only very few CDR segments are unpredictable, while the large majority of the CDR segments are highly predictable (i.e. little changes in the profile shown in Figure 48).

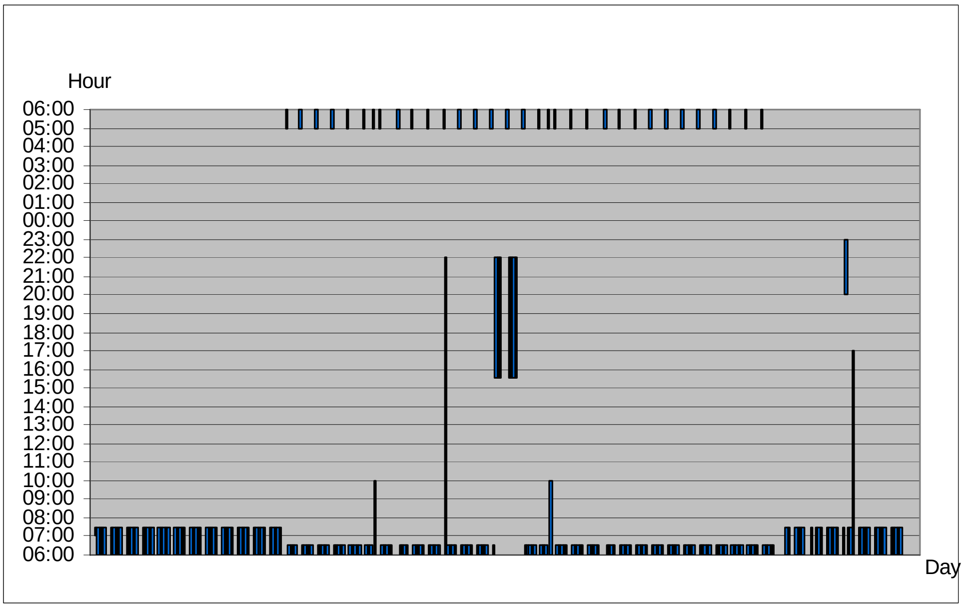


Figure 48: Time availability of LNO-FAMEN (CDR-2 segment) in 2005

5.3.7 Overall, it can be concluded that the availability of CDR negotiated routes is highly predictable.

5.3.8 The predictability of CDR availability for flight planning is a symptom of the actual FUA inefficiencies and it could suggest that:

- At ASM Level 1, an insufficient number of suitable options are developed; therefore the pre-tactical processes are rigid and predictable due to the lack of options to choose from.
- During the day of operations, the ASM procedures to satisfy changes in military requirements are inadequate; therefore the military airspace booking becomes rather conservative the day before operations.

5.3.9 Whatever are the reasons behind the predictability of CDRs, it seems that an upgrade of AO flight planning systems could only deliver substantial benefits when the route availability in pre-tactical becomes more dynamic than nowadays.

5.4 Airline Operator's ability to exploit available routes

5.4.1 Whereas the existence of routes through shared airspace (i.e. route density) is, of course, the most critical factor (see Chapter 2.2), this section focuses on factors affecting the ability and willingness of aircraft operators to consider CDR routes in their flight planning.

5.4.2 The flight dispatching activities affecting CDR usage can essentially be divided into three subsequent phases:

Route selection	Usually based on a company route catalogue which consists of routes used in the past. The route catalogue is a reactive database which is updated over time. In addition to the reactive database, the path finder generator is an additional tool which can be bought by airlines at extra costs. The cost model for route selection can be sophisticated (a complex methodology and a software) or simple (human expertise with a main focus on fuel costs).
FPL submission	Once the route is selected, a FPL is submitted to IFPS for acceptance. The CFMU is equipped with a path finder generator used by flow managers. If a better route is identified (less ATFM delays along the route or a more direct route), the CFMU may send a rerouting proposal for acceptance by the airline.
Aircraft preparation	Fuel is loaded according to the selected route. With regard to CDR segments there are two considerations to take into account: on the one hand, the availability of a CDR segment may shorten the route, on the other hand, the use of CDR segments in flight planning shall take into account that the route could be closed with a very short time notice; therefore fuel computation shall take into account the possibility to be rerouted in a longer route than the FPL one;

Figure 49: Flight dispatching activities related to CDR usage

5.4.3 For the flight planning process, route structure (density), route activation (availability) and the dissemination of information (aircraft operators' awareness) are the most important factors which determine CDR utilisation for flight planning.

5.4.4 The aim of aircraft operators is to minimise overall costs (fuel burn, route charges, and time)[40]. Surprisingly, CDR utilisation which can potentially reduce operational costs does not increase significantly during weekends when most routes become CDR-1 and hence permanently available for flight planning. [41]

5.4.5 Two reasons, explaining the low level of CDR-1 utilisation on weekends, were identified in discussions with aircraft operators:

1) Some CDR routes are de-facto not available, because their usage is impeded by external restrictions (e.g. RAD constraints). This is a symptom that CDR routes are not well integrated in the modus operandi of the European network; and,
2) The route catalogue of a significant number of airlines only contains route options which are valid from Monday to Sunday, and Repetitive Flight Plans submitted to IFPS have the same route profile all over the week (Monday to Sunday).

5.4.6 It can be concluded that not enough consideration is given by airlines to carefully identifying the shortest route available for flight planning. This is especially valid on Saturdays and Sundays when many CDRs become permanently available for flight planning.

5.4.7 It would be beneficial for airspace utilisation if the CFMU gave assistance to airlines in updating the company route catalogue before the AIRAC cycle starts in order to:

– - Select the best route option to be applied on weekend operations; and,

40 Evaluating the true cost to airlines of one minute of airborne or ground delay, Edition 4, 17 February 2004, Transport Studies Group – University of Westminster

41 The FATE study concluded that CDR1 route utilisation increases by 8% during weekends, but a similar increase occurs in the CDR1-H24 route offer. The route utilisation of CDRs may deserve further analysis: for instance, it was never made a comparison between the route utilisation of permanent routes and CDR routes. There is no baseline against which the level of CDR route utilisation could be benchmarked.

– - Select a pre-planned number of options which are useful on weekday operations when CDR route types are released for flight planning.

5.5 Dissemination of airspace status information on weekdays

5.5.1 The ATC and military awareness of the exact airspace status has a direct impact on the efficiency of real-time operations (i.e. when the airspace status is not known precisely, the airspace is not used).

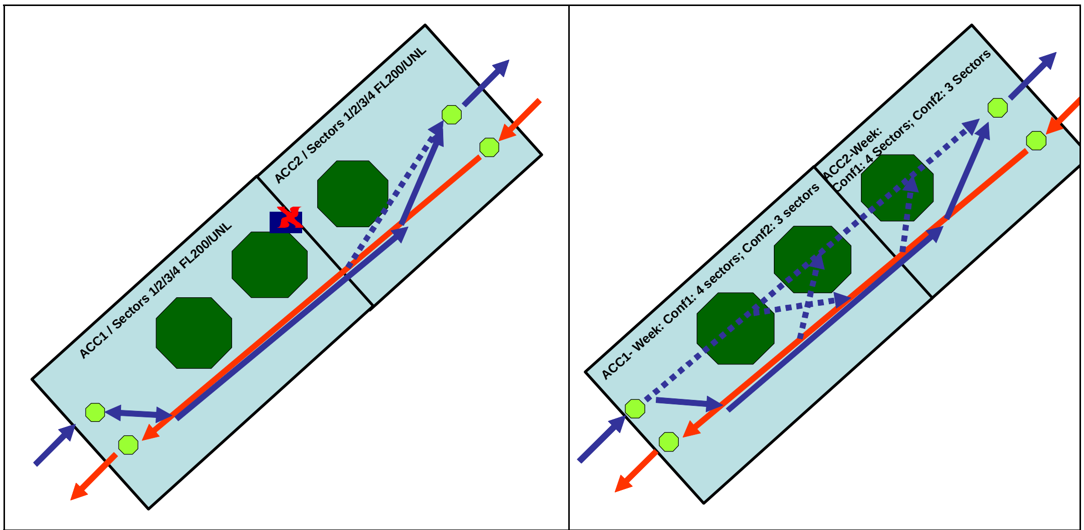
5.5.2 The situation of airspace status data dissemination remains largely unchanged since the first PRU report on civil/military use of airspace, published in 2001 [Ref. 9]. The DMEAN programme recognises the need to improve the dissemination of airspace status information, but improvements are not expected before 2009.

5.5.3 In particular, the sharing of airspace status data between cross-border military and ATC units could be beneficial for the use of shared airspace. There are some bilateral agreements (e.g. the status of TRA-LAUTER is communicated to Maastricht ACC), but there is no systematic distribution to all ACCs which may be affected by the status of the shared airspace.

5.5.4 In some parts of Europe, TSA or CBA status may be of interest to many ATC and military units at the same time. It is a challenge to disseminate the correct information to all relevant parties within the appropriate timeframe. In addition, since military areas often consist of 3 or 4 subsets which may be activated separately, the risk of errors and discrepancies is high.

5.5.5 Accurate and updated airspace status information should circulate between all systems which support the operations of ASM, ATFM, ATC and military units, including EAD, CFMU and national air defence systems and NATO ACCS. Currently there is a poor data circulation at European level which tends to explain the difficulty to use airspace when cross-border operations are involved.

5.5.6 Poor information on the exact airspace status may even have an impact on the design of routes through shared airspace (ASM Level 1). Figure 50 illustrates the importance of the sharing of airspace status information for the airspace design phase.



At the boundary between 2 ACCs (blue boxes), there are three military areas (green) which are heavily used both in terms of time and FLs.	
The two ACCs at the boundary do not exchange airspace status information. Therefore, the two parallel routes become unidirectional so increasing traffic complexity.	The two ACCs at the boundary exchanges airspace status information. During weekdays the main route across shared airspace is not made available for flight planning, but it remains available for ATC to reduce traffic complexity when there is no military activity (CDR3 routes).

Figure 50: Relevance of airspace status dissemination

5.5.7 The lack of accurate airspace status dissemination may lead to a sub-optimal route design which also impacts on the use of shared airspace when military activity is absent (weekends).

5.6 Traffic load monitoring and the use of shared airspace on weekdays

5.6.1 Accurate traffic load monitoring is fundamental for the safety of operations and for the maximised use of available airspace. The selection of ATC sector configurations are usually based on traffic load information from the ETFMS (Enhanced Tactical Flow Management System). The ETFMS is based on flight plans (FPLs) and updated according to data availability in order to draw a realistic picture of the estimated traffic load. The system brings three different data sources together: FPL messages, FSA messages and radar data.

5.6.2 When an ACC decides to use a CDR-3 route three hours or more before the operation, most of the flights have not yet left the departure gate. There would be the option to update their flight plans before take off so improving the accuracy of the ETFMS traffic load monitoring. The increase of accuracy would improve the selection of the ATC sector configuration of downstream ACCs. However this is not done nowadays.

5.6.3 The use of shared airspace at short notice[42] (e.g. CDR-3 routes) potentially generates unexpected over-deliveries for adjacent ACCs. As ATC intentions to use shared airspace

[42] 80% of airspace is deactivated with less than 3 hours of prior notice

at short notice are not considered in the ETFMS system, flights already airborne get only updated in the system (via AFP message) when the pilots receive an ATC instruction to reroute via the CDR-3 routes.

5.6.4 The use of CDRs generates a level of flexibility (see also Chapter 2.2 on page 7) which is important for enhancing the utilisation of shared airspace. However, it also generates a certain level of inaccuracy in the traffic load monitoring system (ETFMS). Given the low density of CDR routes this impact is not high nowadays.

5.6.5 This inaccuracy in the traffic load monitoring system can make the lead time to adjust resources to this unexpected level of traffic demand too short for adjacent ACCs. As a consequence, it may be decided not to use shared airspace at short notice in order not to jeopardise safety in adjacent ATC sectors where an accurate traffic load monitoring is fundamental for the safety of operations.

5.6.6 A solution to traffic load monitoring issues is urgently required for improving airspace utilisation.

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6 Application of FUA Level 3 - Real-time operations

6.1 General

6.1.1 The following chapter provides an evaluation of how FUA level 3 is applied in the various States analysed in this report. The background information for the analysis in this chapter is provided in Chapter 2.4.

6.1.2 The analysis of real-time operations is divided in the following areas:

- Organisational arrangements between civil and military service providers;
- Integration of civil traffic and military activity in real time
- Minimising airspace segregation in real time.

6.2 Organisational arrangements between civil and military service providers

6.2.1 The efficiency of real time operations can be affected by the organisational arrangements between civil and military service provider. Figure 51 outlines the most prevalent models applied in the 7 States.

En-route ATC organizational arrangements[43]	The most prevalent model in States
MODEL 1: Segregated ATC systems and units	France
MODEL 2: Integrated ATC systems, but segregated ATC units	Netherlands, Belgium
MODEL 3: Single ATC system and unit	Italy, UK
MODEL 4: Single ATC system and ATC sector	Germany, Switzerland

Figure 51: En-route ATC organisational arrangements in the 7 States

6.2.2 There are some obstacles which are difficult to overcome when using segregated ATC systems and units (Model 1). Some of the issues associated with this model are:

- The non-optimal permeability of training areas to civil traffic due to lack of direct coordination between ATC and military positions.
- A slight time lag between the deactivation of a training area and the time when the civil ATC position starts using the shared/training area for civil purposes. This is related to the long communication line between the military and the civil ATC position.
- Rigidities in accommodating military airspace request in real time operations. This increases the need to foresee all possible scenarios when booking airspace for military activities.
- Difficulty in applying flexible solutions for the separation between military activity and civil traffic (e.g. mobile airspace reservations).

6.2.3 Due to the higher level of integration between civil and military service provider, the other three models (2, 3, and 4) provide a better basis for efficient real-time operations (good communication and coordination, shorter lead times, etc.).

6.3 Minimising airspace segregation in real-time

6.3.1 Many military mission profiles request airspace segregation by civil traffic in order to avoid potentially hazardous situations for civil traffic. As it was seen in previous chapters

[43] See first Joint PRU-Agency report published in 2001

(see §4.2 and Figure 45 in Chapter 5) the strategic ASM and the pre-tactical ASM have got the potential to minimise the impact of segregation on civil traffic.

6.3.2 However, when the strategic ASM provides for many options, the airspace configuration during real time operations could be subject to continuous changes to adapt to any slight variation of the demand. Only a real time organisation which can support high level of transactions between ATC and military units can cope with such continuous changes.

6.4 Integration of civil traffic and military activity in real time

6.4.1 Integration of civil-military operations in real time refers to the organisation of an almost simultaneous usage of airspace structure by civil traffic and military activity, i.e. any form of segregation is absent or very narrow in time and space.

6.4.2 However the integration of operations is a feasible option only for few types of military mission profiles. It appears feasible for sea/ground to air operations, for air refuelling, for airborne surveillance missions.

6.4.3 The possibility to apply integrated civil-military operations depends on the nature of the military mission profile (some are more potentially hazardous than others) and on the ATM ability to identify safe solutions for managing the interaction between civil traffic and military activity.

6.4.4 The real-time integration of civil-military operations avoids and/or minimises any form of segregation and results in a high level of civil and military airspace utilisation. Another advantage is that there is no difference in airspace availability between week and week-end; consequently there is no need to change the allocation of ATC resources (i.e. ATC sector configurations) from weekdays to weekends.

6.4.5 Figure 52 describes four ATM solutions for integrating military activity and civil traffic in real time:

Cases of GAT/OAT separation	Operational advantages
The shared use of Portsmouth Danger Areas (South UK): high technical integration between RAF ATC, NATS and Royal Navy systems, sophisticated procedures of airspace management and the proactive role of Royal Navy in ensuring separation between civil traffic and military exercises.[44]	The civil advantage is that the GAT/OAT separation is offset to the Royal Navy, so ATC efforts can remain concentrated in delivering ATC capacity to civil traffic.
As suggested by the ICAO ATS planning manual, in Germany specific military activities (e.g. air refuelling) are protected by a “mobile” airspace reservation.	The civil advantage is that the airspace segregation is minimised in time and volume.
In Italy, in complex GAT traffic situations an OAT flight transiting the controlled airspace can be transferred in contact with the civil ATC. Equally a GAT flight can be transferred to the military ATC for crossing an active training area.	The advantage is that the traffic is sent in contact with the ATC unit which is in the position to handle the traffic with the least ATC workload.
Penetration of civil traffic in active air defence areas at breaks between one interception and the other. The fighter controller, which is rated to handle specific civil-military interactions, maintains the separation between the civil transit traffic and	The advantage is that civil airspace utilisation is maximised even when the shared airspace is released to the military unit. Even one / two crossing per hour can reduce ATC complexity and save flight

[44] The example refers to the airspace situation in Portsmouth before March 2007. After this date some pre-tactical activity has been introduced. However the civil-military real-time operational model is substantially unchanged.

the military activity. Whenever necessary the fighter controller can get in contact the civil traffic and/or pass instruction to it via the civil ATC. This is done in Nordic States (Sweden, Norway, Finland). [45]	extension.

Figure 52: Good practices in managing GAT/OAT interactions

[45] This ATM solution is geographically out of scope as it refers to Nordic States. However it was decided to include it because it pushes the civil-military integration very far and because it demonstrates that best practices in airspace utilisation could also be found outside the European core area.

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7 Focus areas for improved utilisation of shared airspace

7.1 Introduction

7.1.1 This chapter aims at linking the analysis of the utilisation of shared airspace in Chapter 1 with the application of the FUA concept in the analysed States (Chapters 4, 5, and 6) in order to identify focus areas and some proposals for improved utilisation of shared airspace.

7.1.2 Overall, ATM in the seven States has been able to deliver a good quality of service to civil traffic and the required airspace availability to train military forces since 2001.

7.1.3 The sub-optimal utilisation of shared airspace identified in this report should be seen as an opportunity to further increase ATC capacity and flight efficiency whenever possible while providing the airspace necessary to train military forces.

7.1.4 The practical experience described in previous chapters seems to highlight two possible strategies to enhance airspace utilisation:

1) **Integrating civil traffic and military activity during real-time operations;** this strategy is only applicable to some military operations (sea-air firing, air refuelling, etc.);
2) **Flexible management of airspace**, which implies airspace segregation to civil traffic during week days. Depending on the amount of military operations and civil traffic, this strategy has got two types of applications:
   a. **Minimising airspace segregation** through continuous airspace reconfigurations along the day to adapt to demand variation (opening / closure of routes, ATC sectors, sub-volumes of training areas); This type of flexible management is normally quite effective when military operations and civil traffic are high (e.g. TRA-South in Belgium and TRA-Lauter in Germany).
   b. **Managing military activity by exception** (activation of training areas outside heavily loaded ATC sectors and tactical rerouting of airborne flights), when military airspace utilisation and the amount of civil-traffic to be rerouted are low (e.g. in the training areas above continental Italy). This type of flexible management is normally quite effective when military operations are relatively low and/or the civil traffic demand interested to fly inside the training area is relatively low.

7.1.5 In all three applications described above it was found that:

- There is a sufficient number of options to deal with many foreseeable situations; i.e. there is a close relationship and synergy between the design of routes, shared airspace and ATC sector configuration, and.
- Real time operations are designed to support a high level of transactions between ATC and military units.

7.1.6 Additionally, the two applications of "flexible management of airspace" require pre-tactical operations to select the best option according to the traffic situation as predicted a few hours before the operations.

7.1.7 When segregation is used during week days for long periods (see §7.1.4 2b), there is the potential to create a disparity of airspace availability with weekends. During weekdays flights are requested to submit a Flight Plan along routes outside the shared airspace and then they are rerouted dynamically on CDR2/CDR3 routes as shared airspace is freed by military activity (see Figure 50 right side). During weekends, the CDR2/CDR3 routes become CDR1-H24, i.e. permanently available for flight planning (see § 4.7.8 & § 4.7.9).

Drawing from experience	**Military airspace utilisation**	**The strategy in a nutshell**	**Common supports to the three strategy**	**Specific support to each strategy**
TRA-LAUTER (Germany), TRA-SOUTH (Belgium)	High	Relying on the flexibility of the ATC sector and shared airspace configuration.	There is a sufficient number of options to deal with many foreseeable situations; close relationship between the design of routes, shared airspace and ATC sector configuration. Real time operations are designed to support a high level of transactions between ATC and military units.	Use of CDR2 and CDR3 routes. Intense pre-tactical operations for matching the sector configuration with the shared airspace configuration.
PORTSMOUTH (South of UK)[46]	High	Integrating civil traffic and military activity during real-time operations.		Use of CDR1-H24 routes with airborne reroutings. Enhanced real-time operations, while pre-tactical is nearly absent.
Training areas in continental Italy.	Low	Managing military activity by exception.		Use of CDR1-H24 routes with airborne reroutings. Intense pre-tactical operations for identifying FLs and periods of low civil traffic and then locating military activity there.

Figure 53: Three successful applications for week operations

7.1.8 Looking at EUROCONTROL plans, it can be observed that:

- The “Advanced Airspace Scheme Concept” (AAS)”[47] developed by EUROCONTROL seeks to elaborate a sufficient number of suitable options at ASM Level 1.
- The DMEAN programme and the ATFCM evolution plan support the improvement of pre-tactical operations with plans for the dissemination of airspace status data and for the evolution of the traffic load monitoring function.
- There should be more efforts to search, develop and export applications of of civil-military operations in real-time.

46 It is recognised that the pre-tactical ASM applies for the management of the Portsmouth area since March 2007. However the integration of civil-military operations in real time still applies.

47 The document was published in December 2004.

7.2 Critical factors in ASM Level 1 – Strategic ASM

7.2.1 The analysis of the three successful strategies has highlighted that there should be a close relationship between the design of routes, shared airspace and ATC sector configurations.

7.2.2 The analysis of the application of the FUA concept in the seven States allows conclusions to be drawn on the enablers to support the three applications highlighted in par. 7.1.4.

Type of the operational situation	ATC sector flexibility	Features of the training areas	CDR route type
Flexible Management of airspace: Minimising airspace segregation (par. 7.1.4 2 b)	Flexible vertical and horizontal boundaries between sectors and various options to combine elementary sectors (See Figure 41: Type1, 2, 3, 4)	Many sub-volumes with vertical and horizontal modularity. These sub-volumes should be in synergy with the ATC sector configuration options.	CDR2 and CDR3
Contrast low /high airspace availability to civil traffic in weekdays / weekends (see par. 7.1.7)	Various options to combine elementary sectors (See Figure 41: Type1, 2)	Not applicable: military activity is absent	CDR1-H24
Integration of civil traffic and military activity in real time	Various options to combine elementary sectors (See Figure 41: Type 1,2)	Many sub-volumes with vertical and horizontal modularity. These sub-volumes should be in synergy with the ATC sector configuration options.	CDR1-H24
Flexible Management of airspace: managing military activity by exception (par. 7.1.4 2b)	Overflow positions at ATC units if necessary (See Figure 41: Type 5)	More areas for same mission profile or many sub-volumes to choose between.	CDR1-H24

Figure 54: Airspace design features (ASM Level 1) to deal with operational situations

7.2.3 An analysis of strength and weaknesses could be carried out for each State. Strong points could be used for an early implementation of parts of the AAS concept while weak points should be improved in order to ensure the convergence of the FUA concept towards the best European applications (see Figure 55).

State	Strength on weekdays	Weaknesses on weekday	Potential ability to cope with week / weekend contrast
Belgium and Maastricht UAC	Good synergy of ATC sector configuration, training areas and routes.	Lack of flexibility (flexible and horizontal vertical boundaries).	High
Germany and Maastricht UAC	Good synergy of ATC sector configuration, training areas and routes.	Sub-optimal ATC sector configuration (horizontal flexibility)	High
France	Good ATC sector flexibility to deal with civil traffic.	Lack of integration between ATC sector configuration and shared airspace. Low modularity of training areas.	High
Italy	Good synergy of ATC sector configuration, training areas and routes.	No particular weakness at ASM level 1	Not applicable
Netherlands and Maastricht UAC	Good ATC sector flexibility	Application of the off/on route concept	High
Switzerland	Good modularity of training areas	ATC sector configuration flexibility to be developed	Medium
UK	Good modularity of training areas in West-End. Excellent airspace organisation in Portsmouth area.	ATC sector configuration flexibility in Bristol and Lakes suites. Complex airspace design North-East of London and non-AMC manageability of the East Anglia area. [48]	Medium

Figure 55: Considerations for the implementation of the AAS concept

7.2.4 Among many initiatives, an ASM Level 1 week-end scenario could be applied in France, Germany and Benelux to solve the contrast of high military utilisation on weekdays and absence of military operations on weekends. The expected value is in the order of tens of Millions of euro [49] per annum. The feasibility of implementing a weekend scenario in these States would be based on the following considerations:

- Military activity is absent;
- All shared airspace is available to civil traffic and ATC;
- CDR1-H24 category is applied consistently in these States;
- Off/on route concept is alleviated in Netherlands;
- Pre-tactical ATFCM is made independent of ASM pre-tactical;

48 With regard to the actual configuration of the East Anglia airspace and its surroundings the UK-CAA (UK-DAP) states that : “This region of airspace was designed collaboratively with airspace users; civil, military and recreational groups, as an integral part of two major development projects implemented in 2003 and 2004. In order to accommodate the prime needs of the military (two large over-sea TSAs just to the North of this area) and of civil capacity (straightening and expanding several key corridors between major city-pairs) the overland East Anglia military training area was substantially reduced in size. The criticality of this area for military training was recognised and thus a compromise solution of increasing its vertical height (it had previously existed only up to FL245) was agreed. The arrangement of route confluences (e.g. links to LTMA STARS) and crossovers in this area is deliberated focussed on maximum capacity and safety through a high degree of systemisation. Simply routing more directly through the East Anglia area would fundamentally compromise capacity in the interests of maintaining safety.”

49 See PRR 2006

- Airspace status data dissemination is not an issue; and,
- Traffic load monitoring is not an issue related to CDR route availability.
- Relatively high ATC sector configuration flexibility in all involved ACCs;
- Reduced levels of civil traffic on weekends;
- Opportunity to apply the weekend scenario also on weekdays when the airspace is available for civil use.

7.2.5 An ASM Level 1 week-end scenario would also bring difficulties such as the ATCO challenging task to deal with conflict points at different positions between week and week-end operations.

7.2.6 An early application of a weekend scenario in this region may concern non-participating States, as the traffic could result in different ATC bottlenecks between week and weekends. Although it seems that there is a good opportunity to introduce a weekend scenario in France, Germany and the Benelux, this should be further evaluated in the context of the European network.

7.3 Critical factors in FUA Level 2 – Pre-tactical ASM and ATFCM in week days

7.3.1 FUA Level 1 (airspace design phase) is a critical enabler for the pre-tactical phase. The enablers to increase airspace utilisation in the pre-tactical phase build on FUA Level 1 and apply to weekday operations only (due to the absence of military activity during weekends, pre-tactical ASM is of little value or nugatory during weekends)

Reduce the amount of airspace booked but not used

7.3.2 There appears to be scope to reduce the amount of airspace which is booked but not used by the military (see Chapter 3.5 on page 24). Many military mission cancellations occur late because it is genuinely difficult to predict the aircraft availability and MET conditions some hours before the operations.

7.3.3 Improved booking accuracy can increase the amount of airspace available to civil traffic or to military missions which have not previously booked the airspace. Initiatives should focus on:

- Better understanding the reasons for airspace booked but not used
- On reducing the 60% of unused airspace which is cancelled between 3 hours and 1 hour before operations (see Figure 28), and
- On bringing ATFCM processes closer to real-time operations. This action would reduce the impact of late cancellations on civil operations.

7.3.4 Enablers concentrate around a set of concerted civil and military actions:

- Improving the information flow of cancellations from military squadrons up to ATC/ATFM units. This action would attempt to shift cancellations which are currently communicated 0/3 hours before operations at an earlier stage (before 3 hours of operations).
- Reduce the cancellation rate of military missions by attempting to increase military airspace utilisation when it is booked;
- Review booking and allocation procedures in order to understand whether it is possible to reduce the amount of booked airspace and under which conditions. Particularly the existence of flexible civil-military ASM procedures to modify or to introduce new military airspace requests would appear to be very beneficial.
- Approach the deadline for implementing ground ATFM regulations closer to real time operations. This action would attempt to exploit the availability of cancelled airspace less than three hours before operations in the ATFCM process.

7.3.5 The pre-tactical ATFCM conducted in ACCs would also greatly benefit from a reduction of airspace booked and not used. The DMEAN project to approach route availability for flight planning closer to operations would also benefit from more accurate booking of shared airspace.

7.3.6 An important factor to consider here is that a European ACC should have enough ATC capacity to accommodate both civil traffic and military activity at different levels of airspace availability. The need to operate a trade-off between civil and military requirements should be occasional and limited in time and space.

CDR route utilisation by airlines in the flight planning phase

7.3.7 The availability for flight planning of most routes seems to be highly predictable already 56 days before the AIRAC cycle starts (see Chapter 5.3 on page 44). This is a symptom of the actual rigidity of the pre-tactical ASM caused by the limited number of suitable options designed in the strategic phase and by the relatively high amount of airspace booked but not used by the military.

7.3.8 However, the airline performance in filing the shortest available route is too low, especially during weekends when CDR routes are available all day long.

7.3.9 While it is recognised that more performing flight planning systems and organisations could increase airspace utilisation, it is unlikely that benefits will materialise before the airspace becomes more dynamically available than nowadays (see Figure 47 and Figure 48). While awaiting for a more dynamic airspace management, actions can be taken in co-operation between airlines and the CFMU. The comparison of airline route catalogues with the route options generated by the CFMU-IFPS pathfinder before the AIRAC cycle has the potential to increase the aircraft operators' ability to exploit conditional routes both in weekdays and weekends.

Dissemination of airspace status information and traffic load monitoring

7.3.10 Airspace status dissemination and traffic load monitoring are the basis for selecting the ATC sector configuration during the day of operations.

7.3.11 It is encouraging to observe that the improvement of airspace status data dissemination and of the traffic load monitoring is included both in the DMEAN work programme and in the ATFCM evolution plan as they both actions are fundamental enablers for exploiting an increased number of suitable options –developed during the airspace design phase (ASM Level 1).

7.3.12 Especially the initiative of the "Single Initial Flight Plan" will significantly improve the traffic load monitoring for flight which has not yet left the departure gate. However more improvements should come for addressing those flights which are airborne, ATC have planned them via CDR-3 routes, but they have not yet received an ATC instruction.

7.3.13 It is noted that the DMEAN programme on airspace data dissemination does not yet include the interface between the national air defence systems, NATO ACCS and European ATM systems (CFMU and EAD). This would seem to be a critical point for enhancing airspace utilisation.

7.4 Critical factors in FUA Level 3 – Real time operations

7.4.1 The primary enabler to increase airspace utilisation in shared airspace is to increase the route density (FUA Level 1). Therefore it is necessary to verify whether real time operations are able to support increased utilisation of shared airspace on weekdays.

7.4.2 An increased route density would also require a high integration of civil-military real time operations. The increased use of shared airspace requires a common sharing of the traffic picture and an increased information flow between civil and military ATC positions.

7.4.3 The basic requirement is the interoperability of civil and military ATM systems; obviously the co-location of civil and military ATC units is the easiest way to achieve interoperability.

7.4.4 As illustrated in Chapter 6.2 on page 51, at the time of review in 2005, there appeared to be scope for an improved level of integration between civil and military ATC positions in France in order to support a denser route structure in real time. The situation may have changed in the meantime.

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8 Conclusions

8.1 Objectives and scope of the report

8.1.1 The objective of this report has been to review the level of sharing of airspace between civil traffic and military activity above FL195 and the current level of utilisation of the shared airspace in order to identify best practices and enablers to maximise the usage of airspace.

8.1.2 The report addresses airspace in seven States, namely Belgium, France, Germany, Italy, Netherlands, Switzerland and the United Kingdom (UK), focusing on European core airspace. The report also contains a high-level review of programmes currently being undertaken by EUROCONTROL DMEAN and CFMU, with emphasis on their potential to address any shortcoming in implementing FUA.

8.1.3 This report analyses the situation in 2005. It is acknowledged that improvements may have taken place since then.

8.2 Fact finding on airspace utilisation

8.2.1 The application of FUA principles and practices has been a major enabler for the continuous ATC capacity increase and flight-efficiency improvements in Europe while releasing enough airspace to train military forces. However, allocation and use of airspace could be further improved.

8.2.2 In the seven analysed states, the shared airspace offer covers approximately 32% of the total airspace volume. Civil and military demand for shared airspace above FL 195 is concentrated in the South UK, Belgium, the Netherlands, Switzerland, Northern Italy, and at the boundary between France and Germany.

8.2.3 The utilisation of shared airspace by civil and military airspace users varies considerably among the analysed States.

Shared airspace is fully available for civil traffic one third of the year

8.2.4 On average, shared airspace is available for civil traffic some 74% of the day period in the "core area" of which 33% is due to weekends with no military activities (known months in advance). The remaining 41% of the day period are released to civil traffic at the latest one day before the actual day of operation.

Airspace utilisation by civil traffic does not improve during week-end

8.2.5 Even when shared airspace is known to be available for civil use months in advance (i.e. weekends – 33% of time), there seems to be little or no change in the level of civil utilisation. Especially when the availability of shared airspace is known long in advance, there appears to be considerable scope for improving civil use of shared airspace.

50 % of the airspace booked by military is not actually used

8.2.6 On average the shared airspace is allocated to the military some 7 hours on a weekday in the core area. The actual utilisation of airspace by the military is in reality much lower (3 hours per day). Although airspace booked but not used by the military is progressively released to ATC during the day of operation, the accuracy of booking by the military suggests room for improvement

8.3 Fact finding on airspace utilisation enablers and drivers

8.3.1 There is in fact little relationship between military airspace utilisation and the ability to accommodate civil traffic. The analysis of the use of shared airspace shows that the utilisation of shared airspace is sub-optimal in many parts of Europe. There are however a number of examples where shared/training areas have a high level of civil and military utilisation on weekdays.

8.3.2 The main reasons that support a high level of airspace utilisation are predominantly related to the efficient organisation of airspace design (ASM Level 1) and real time operations (ASM Level 3);

Good airspace utilisation can be achieved where there is efficient civil/military organisation

8.3.3 Experience in Belgium (TRA-SOUTH), in the UK (Portsmouth area) and in Germany (TRA-LAUTER) shows that shared airspace which is intensively used by military activities can also be extensively used by civil traffic where there is good civil/military organisation.

Lack of routes is often the reason for a poor utilisation

8.3.4 Overall, the low route density appears to be the main reason which explains the low utilisation of shared airspace. Under the current operating mode, the route network is a fundamental piece of the European ATM system. The production of safe ATC capacity requires the systematisation of traffic flows through the route network design and associated rules governing the route utilisation.

8.3.5 Across all analysed States, the common factor contributing to a low route density in shared airspace is the sub-optimum level of ATC sector configuration flexibility (ASM Level 1). Other drivers vary from State to State:

- A low modularity of training/shared areas (ASM Level 1) was observed in France in 2005. This impeded the minimisation of airspace utilisation when simple military mission profiles are flown and reduced the opportunity of synergies with the ATC sector configuration options;
- Insufficient operational arrangements to sustain a high-level of transactions between military and ATC units during real-time operations (specifically in France at the time of review, i.e. 2005)
- The Netherlands applies the off/on route concept which reduces the scope for synergies with the ATC sector configuration options; and,
- The UK is the only State with a non-manageable area in the core area (East Anglia training area). However the full airspace design around the area would not allow its exploitation, even if the area was shared.

8.3.6 At network level, factors contributing to a low route density on weekdays appear to be:

- The heterogeneity of CDR classification between States which creates problems of network design consistency during weekdays.

The actual ASM and ATFCM pre-tactical processes at European level are inadequate to sustain an increased route density offer in week days

8.3.7 The configuration of shared airspace and ATC sector configuration is much more important than the CDR availability for flight planning as it relates directly to the production of ATC capacity and the airspace availability for military training.

8.3.8 The main deficiencies are:

- Pre-tactical activity generally stops one day in advance so that a significant amount of airspace is wasted,
- A non-optimal dissemination of airspace status data, especially at the boundary between cross-borders units;
- The inability of the traffic load monitoring functions to incorporate changes in flight planning profiles originating from ASM pre-tactical and ATC tactical decisions.
- ASM and ATFCM procedures do not allow for changing military airspace requests on the day of operations in some States
- Decision supporting tools to select ASM configuration options under time pressure are not in place.

The AO and CFMU commitment in using CDR routes available for flight planning is not yet optimal.

8.3.9 CDR route availability for flight planning is highly predictable during week days. This is a symptom of rigidities in the pre-tactical ASM.

8.3.10 Whatever are the reasons behind the predictability of CDRs, it seems that an upgrade of AO flight planning systems could only deliver substantial benefits when the route availability in pre-tactical becomes more dynamic than nowadays.

8.3.11 CDR utilisation which can potentially reduce airline operational costs does not increase significantly during weekends when most routes become CDR-1 and hence permanently available for flight planning.

8.4 Key issues at ASM Level 1

Increase the commitment to design more CDR routes inside shared airspace

8.4.1 National joint civil-military high level bodies at ASM Level 1 should increase their awareness of the fact that an improvement on airspace utilisation depends on a close relationship and synergy between the design of routes, shared airspace and ATC sector configuration.

8.4.2 Where military activity is high, the national high level bodies should support the efforts of defence units and ANSPs to develop a sufficient number of suitable options to enhance the synergy of ATC sector and shared airspace configurations.

8.4.3 The high level bodies should also increase their awareness of the fact that ASM Level 1 efforts could be wasted by an organisation of real-time operations (ASM Level 3) which cannot sustain a high level of transactions between military and ATC units.

8.5 Key issues at ASM Level 2

8.5.1 Generally, the DMEAN programme and the ATFCM Evolution plan address the rigidities of the present ASM Level 2. They also sustain the application of the AAS concept through:

- The implementation of an efficient airspace status data dissemination conducted by the DMEAN programme;
- The improvement of traffic load monitoring capability conducted by the CFMU through the initiative to update flight plans before the flight has left the departure gate;
- The development of "what-if" tools to assist ASM decision-making (ASMSTD and CIAM initiatives)

How DMEAN and CFMU initiatives could be further enhanced

8.5.2 However, additional initiatives may be taken:

- The DMEAN programme could take into account the need to exchange airspace data between national air defence systems and the NATO ACCS, EAD and CFMU.
- States could develop initiatives for reducing the proportion of shared airspace bookings cancelled between 3 hours and 1 hour before operations (currently 60%), and, in cooperation with CFMU, for bringing ATFCM processes closer to real-time operations.
- The CFMU could take tactical ATC information into account (e.g. the flight will be routed via a CDR-3 route) to update planned profiles of departed flights in order to improve the traffic load monitoring.

8.5.3 These additional initiatives together with existing ones would make the CDR route availability for flight planning more dynamic. This could allow Aircraft Operators and the CFMU to exploit an increased flexibility in route flight planning during week days.

8.6 Key issues at ASM Level 3 (real time operations)

8.6.1 Much greater attention should be given to ASM Level 3. It is important to give high priority to all initiatives which can sustain a high level of transactions between ATC and military units. Each State should ensure that its ATC organisational arrangements for real time operations can sustain a high level of transactions between ATC and military units, especially where there is high demand for civil traffic.

8.6.2 The basic requirement to achieve a high level of transactions between ATC and military units is the interoperability of civil and military ATM systems; obviously the co-location of civil and military ATC units is the easiest way to achieve interoperability.

8.6.3 In the longer term benefits could be delivered by the development of an interface between SESAR and national air defence systems and the NATO ACCS.

8.7 Key issues when using CDR routes made available for flight planning

8.7.1 When routes are made available for flight planning, it is responsibility of CFMU and Aircraft Operators to make the best use of them.

8.7.2 Not enough consideration is given by airlines to carefully identifying the shortest route available for flight planning. This is especially valid on Saturdays and Sundays when many CDRs become permanently available for flight planning.

8.7.3 It would be beneficial for airspace utilisation if CFMU gave assistance to airlines before the AIRAC cycle starts in order to:

- Select the best route option to be applied in weekend operations;
- Select a pre-planned number of options that can be used during week-days when CDR routes are made available for flight planning at the pre-tactical phase.

ANNEXES

ANNEX I - ISSUES ADDRESSED BY THE FUA CONCEPT

Issue 1: Safe use of shared airspace

- FUA rules and procedures shall provide for safe operations both civil and military.
- FUA rules and procedures shall ensure that there is only a unit (either ATS or military) responsible for a given portion of shared airspace in a given timeframe. The unit in charge at a given time shall be responsible to approve operations inside the assigned portion of airspace. There shall also be clear procedures for activating and releasing the area.
- The scheduled, planned and actual status of airspace shall be properly disseminated to all relevant ATS and military units in such a way that only cleared traffic or approved military activity can access shared airspace in the agreed timeframe.
- For avoiding incorrect airspace infringements (i.e. the incorrect presence of traffic or military activity in shared airspace), safety net procedures (e.g. radio failure procedure, check-list before using airspace, etc.) and technology (e.g. Airspace Proximity Warning) shall be put in operations and properly maintained.

Issue 2: Availability of airspace to civil operations during the weekdays [Ref. 6]

- The objective is to use newly available ("gained") airspace to achieve increased benefits by both reducing airspace complexity (i.e., by redirecting flights away from congested airspace) and allowing greater user flight efficiency and flexibility.
- If a block of shared airspace is not going to be utilized by participating military aircraft during a specific time period, the military controlling unit may contact the local civilian controlling agency to release the airspace. This information may or may not be disseminated to users for flight planning purposes.
- The benefits of increased airspace availability are achieved by early attention to the changes. An alert of airspace availability can initiate a process of assessment, collaboration, and resolution. There may be no urgency to use the gained airspace, but the benefits should be identifiable and available to the user and service provider.

Issue 3: Non availability of airspace for civil operations during weekdays [Ref. 6]

- This problem is the effect of changes in European airspace that reduces the available airspace in a specific location and time. The focus is on those civil flights that are to be in the location during the active time.
- The general objective is to mitigate the airspace capacity impact by implementing ATC solutions. These decisions should be generally beneficial to service providers and individually desirable by users.
- It should be noted that the status of airspace shall be planned sufficiently time in advance in order to maintain the management of the increased traffic complexity within safety margins.

Issue 4: Penetrability of shared airspace (mix operations of civil traffic and military activities)

- Under particular circumstances, the military controlling unit and/or the ATS unit could ensure the separation between civil traffic and military activities.
- The conditions to allow mix operations of civil traffic and military activities are as

follows:

- Mix operations can be maintained inside the safety loop
- There are common systems and similar display to visualise the traffic situation
- There are direct communication between the military and ATS positions which are responsible to manage the civil traffic and the military activity
- The ATS and/or the military staff is qualified and rated to manage mix operations
- There are established procedure and training programmes

- Example of mix operations are as follows:
  - A mobile airspace reservation can be ensured to AWACS and refuelling operations which maintain contact and listening watch in the frequency of the ATS unit
  - Radar monitor of civil traffic by the military controlling unit in charge for sea firing operations.
  - Recovery of air defence missions complex airspace in contact with ATS units
  - Civil flights across shared airspace in contact with the responsible military controlling unit.
- The principle is that the unit in charge for ensuring separation between mix operations is always the one with the majority of the traffic picture. For some type of operations, the correct application of the principle requests certain flexibility; depending on the real-time situation, the separation responsibility can be assumed either by the ATS unit or by the military controlling unit. The principle shall only apply to operational circumstances related to the management of mix operations.
- The penetrability of shared airspace is a very interesting feature for many reasons:
  - It allows the coexistence of civil traffic and military activities
  - ATC workload could be offset to the military controlling unit so that the military activity does not generate a reduction of civil traffic throughput.
  - Military missions could cross civil complex airspace so improving flight efficiency
- Although the penetrability of shared airspace could be a fundamental enabler to reduce the impact of military activities on ATC capacity and flight efficiency, there is no general rule to apply it; it depends on the type of the military activity, on local circumstances and, last but not least, on the creativity and willingness to find solutions to complex problems. Therefore, this chapter does not contain any further description on the penetrability of shared airspace and on how to manage mix operations. The subject is further treated in the chapter dealing with current real time operations.

Issue 5: Availability of airspace during weekends

- Shared airspace is permanently available to civil traffic from Friday evening until early Monday morning. Should military activities occur during week end, this is known months in advance unless crisis situations.
- Traffic flows orientation is very similar between week and weekend, but traffic volume is higher in Southern Europe while there is a reduction in the North Europe compared to weekdays.
- The concomitance of traffic reduction with more airspace available in North Europe allows scope for reducing traffic complexity and improving flight efficiency.
- In areas where the additional airspace would dramatically change the traffic flow structure between week and weekend operations, the ATM flexibility requirements to could be very challenging.

ANNEX II - PRE-TACTICAL OPERATIONS

Whereas it is acknowledged that there are no commonly agreed time bands for pre-tactical ASM (Level 2) and real time operations (Level 3), the following sections will distinguish between 1 day before operations and a few hours before the operations in order to illustrate time related differences in the ability to select the best option for adjusting the airspace to balance civil and military demand.

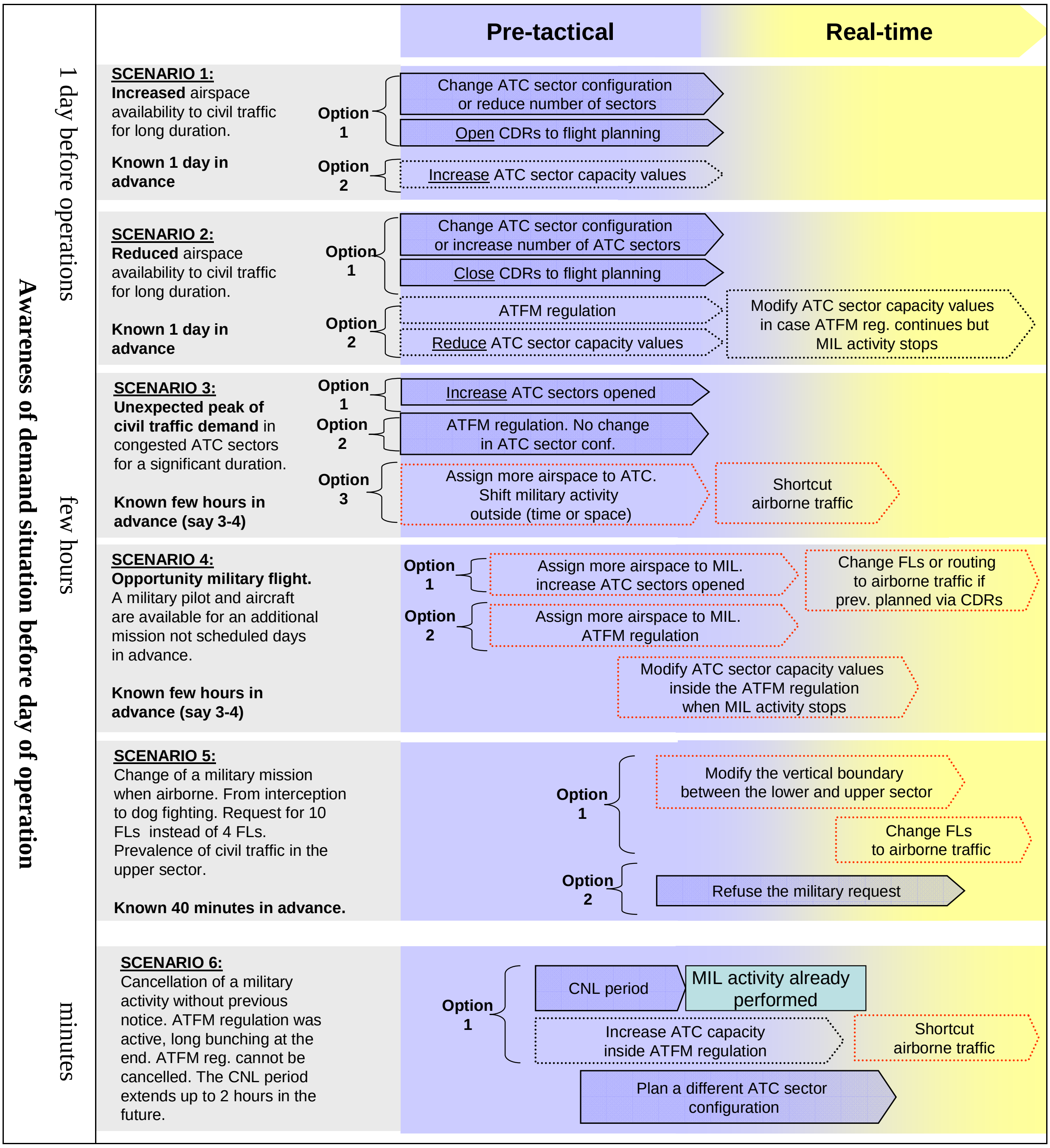

Figure 56 : Actual and future ASM and ATFCM pre-tactical scenarios

Figure 56 shows six different scenarios and possible options to handle the traffic situation during the pre-tactical phase. The ability to maximise the use of shared airspace depends on the number of options available (ASM Level 1) and the ability to select the best option before the real time operation. Nowadays the only options available everywhere are the ones selected one day in advance of operations. In many States the selection of options is not done during the day of operations.

Pre-tactical operations extending until a few hours before the operations

Selection of ASM options few hours before operations is currently not done neither at European level nor in many States.

With regard to data supporting the selection process of options few hours before real time operations, the traffic prediction is often not as precise as it should be. Flight plans and airborne flights are not updated according to the actual availability of airspace or according to the ATC intentions to move flights outside the original FPL profile (e.g. intention to reroute a flight via a CDR-3). This has an impact on the accuracy of the traffic load monitoring which is fundamental to decide the deployment of ATC sector configurations and flow management strategies.

The current limitations of doing pre-tactical a few hours in advance can be divided into the lack of options (ASM Level 1 issue) and lack of processes (ASM Level 2 issues).
Option 3 in Scenario 3 in Figure 56 is applied nowhere, while the options in Scenario 4 and 5 are only applied in Germany.

The more options are available to choose from, the higher is the flexibility but the lower is the awareness at network level and at cross-border due to the data flow limitations described in previous paragraphs. Furthermore, the use of tools for decision making support would be necessary given the fact that options are evaluated and selected under time pressure. However these tools do not exist yet[50].

[50] See Airspace Management, a future concept, NATS LTD 2006

ANNEX III - RECOMMENDATIONS OF THE FIRST EUROCONTROL PRU-AGENCY REPORT ISSUED IN 2001

Recommendation	Addressed through	Comments
Define common principles for effective airspace design and management to be adopted by all Eurocontrol member States	European airspace planning manual issued by Eurocontrol	
Identify mechanisms to ensure international coordination of airspace design and management.	European airspace planning manual issued by Eurocontrol	The following point has not yet been addressed: *there is no international authority that can impose a trade off, when airspace requirements conflict at international level*
Identify which principles, rules and procedures for the conduct of military (OAT) operations and for OAT / GAT compatibility need to be commonly applied within EUROCONTROL member States.	Work in progress by EUROCONTROL MILHAG and DCMAC-Agency	
Investigate methods to improve the usage of Conditional Routes	Work in progress by EUROCONTROL DMEAN and ANT	
Investigate a more effective method for the notification and dissemination of airspace status during pre-tactical (ASM Level 2) and real-time (ASM Level 3) phases,	Work in progress by EUROCONTROL DMEAN.	
Investigate a common content, format and methods for automatic exchange of GAT and OAT flight data, both nationally and internationally, to be adopted by all EUROCONTROL Member States.	The EUROCONTROL Civil-Military action plan	
Identify the most efficient civil/military en-route ATS operational arrangements in the high density airspace of EUROCONTROL member States.	The action is still pending.	
Investigate the need to address formally safety issues within ATM civil-military co-ordination at European level.	The EUROCONTROL SRC and Agency	
Develop both national and international review process to ensure the most effective use and evolution of the FUA concept	EC SES Regulations and HLG proposals,	

The full report is available in PRC website:
http://www.eurocontrol.int/prc/
http://www.eurocontrol.int/prc/gallery/content/public/Docs/civmilcoordrep.pdf

ANNEX IV - GLOSSARY

ACCS	NATO Air Command and Control System
ADEXA	Air Defence EXercise Area
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information Regulation And Control
ASM (Airspace management)	Means a planning function with the preliminary objective of maximizing the utilisation of available airspace by dynamic time-sharing and, at times, the segregation of airspace among various categories of airspace users on the basis of short term needs; [Art. 2. SES Framework Regulation]
Airspace users	Means all aircraft operated as general air traffic; [Art. 2. Framework Regulation]
AMC	Airspace Management Cell
ANS (Air Navigation Services)	Means air traffic services; communication, navigation and surveillance services; meteorological services for air navigation; and aeronautical information services; [Art. 2. Framework Regulation]
ANSP (Air Navigation Service Providers)	Means any public or private entity providing air navigation services for general air traffic; [Art. 2. Framework Regulation]
AO	Airspace Operator
APW	Area Proximity Warning
ASM	Airspace Management
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow & Capacity Management
ATFM (Air traffic flow management)	Means a function established with the objective of contributing to a safe, orderly and expeditious flow of air traffic by ensuring ATC capacity is utilized to the maximum extent possible, and that the traffic volume is compatible with the capacities declared by the appropriate air traffic service providers; [Art. 2. SES Framework Regulation]
ATM (Air Traffic Management)	Means the aggregation of the airborne and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations; [Art. 2. SES Framework

	Regulation]
ATM2000+ Strategy	The EUROCONTROL Air Traffic Management (ATM) Strategy for the years 2000+
ATS	Air Traffic Services
AUP	Airspace Use Plan
CBA	Cross-Border Area
CDR	Conditional Routes
CFMU	Central Flow Management Unit of EUROCONTROL
CMIC	Civil-Military Coordination Group
CPR	Correlated Position Reports
CRAM	Conditional Route Availability Message
DMEAN	Dynamic Management of the European Airspace Network (DMEAN) Framework Programme
EOBT	Estimated Off Block Time
ETFMS	Enhanced Tactical Flow Management System
FDP	Flight Data Processing
FL	Flight level (e.g. FL 195)
FMP	Flow Management Position
FSA	First System Activation messages
FUA	Flexible Use of Airspace
GAT (General air traffic)	Means all movements of civil aircraft, as well as all movements of State aircraft (including military, customs and police aircraft) when these movements are carried out in conformity with the procedures of the ICAO; [Art. 2. SES Framework Regulation]
ICAO	International Civil Aviation Organisation
IFPS	Integrated Initial Flight Plan Processing System
IFR	Instrument Flight Rules
KPA	Key Performance Area
KPI	Key Performance Indicator
MET (Meteorological services)	Means those facilities and services that provide aircraft with meteorological forecasts, briefs and observations as well as any other meteorological information and data provided by States for aeronautical use; [Art. 2. SES Framework Regulation]
MoD	Ministry of Defence

NATO	North Atlantic Treaty Organisation
NOTAMs	Notices to Airmen
OAT	Operational Air Traffic
PC	EUROCONTROL Provisional Council
PRC	Performance Review Commission
PRU	Performance Review Unit
RAD	Route Availability Document
RVSM	Reduced Vertical Separation Minimum
SES	Single European Sky
SESAR	Single European Sky ATM Research
TRA	Temporary Reserved Area
TSA	Temporary Segregated Area
UTC	Coordinated Universal Time
UUP	Updated Airspace Use Plan

ANNEX V - BIBLIOGRAPHY

1. Functional Specifications for System Support to Airspace Data Distribution and Civil/Military Co-ordination; Edition : 1.0, Edition Date : 15 May 96
2. En-Route Constrained Airspace Concept Definition- Final Report ; NASA Contract: RTO-07: NAS2-98005, September 1999; Authors: William Thedford, Ph. D. - Robert A.Vivona, M.S.-Craig Hodgdon
3. EUROCONTROL Guidance Document for the Implementation of the Concept of the Flexible Use of Airspace, Edition 2.0, Edition Date 18 August 2003
4. Enhanced Airspace Management Study: Future Concept of Airspace Management Issued by NATS , Version 1.0 Edition Date: 18th November 2005
5. ECAC endorsed Report on the Organisational Structures and Procedures required for the Application of the FUA Concept, Edition 1.0, Edition Date 01 January 1994.
6. Commission Regulation (EC) No 2150/2005 of 23 December 2005 laying down common rules for the flexible use of airspace Official Journal L 342, 24-Dec-05, p20-25 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:342:0020:0025:EN:PDF
7. Military KPI Handbook, Edition 1.0, EUROCONTROL, 09 February 2006 (Military KPI 1 – Measurement 2 – Percentage Airspace Designated Segregated – Area based)
8. Military Key Performance Indicators Pilot Project – Final Report, Edition 1.0, Edition Date 28 October 2005.
9. Performance Review Commission, Performance Review Report 2005 (PRR 2005). An assessment of Air Traffic Management in Europe during the Calendar Year 2005 (April 2006).
10. Performance Review Commission, Performance Review Report 2006 (PRR 2006). An assessment of Air Traffic Management in Europe during the Calendar Year 2006 (April 2007).
11. FUA ASSESSMENT AND TOOL EVALUATION (FATE) Report
12. EUROCONTROL Determining Future Military Airspace Requirements in Europe, Reviewed Version, 31 July 2004.
13. ECAC Institutional Strategy for Air Traffic Management in Europe, adopted by ECAC Ministers of Transport on 14 February 1997.
14. SESAR Definition Phase - Deliverable 2 “The Performance Target Document”, DLM-0607-001-02-00a, December 2006.
15. ATFCM Evolution Plan for the ECAC States, Edition 1.0 Edition Date: 29/09/04
16. DMEAN Master Plan, Edition P1 - Proposed Issue, 16 September 2004.
17. DMEAN Action Plan 2007/2008, Edition 1.0, Edition Date : 09 November 2006
18. Evaluating the true cost to airlines of one minute of airborne or ground delay, Edition 4, 17 February 2004, Transport Studies Group – University of Westminster.

ANNEX VI - REFERENCES

1 EUROCONTROL, ATM Strategy for 2000+ (November 1998).

2 EUROCONTROL Handbook for Airspace Management; Edition 2.0, Edition Date : 22 October 2003

3 EUROCONTROL Manual for Airspace Planning; Edition 2.0, Edition Date : 22 October 2003

4 Concept of Operations for Enhancing the ASM/ATFM/ATC Processes (FUA 2008 Scenario); Edition 1.0, Edition Date:14 July 2004.

5 Air Traffic Flow & Capacity Management Evolution Plan for the ECAC States; Edition : 1.0, Edition Date: 29.09.04

6 DMEAN Concept of Operations, Edition P1, Edition Date: 16.09.2004

7 ARN-Version 5 Report; Edition: 1.1, Edition Date: 28.11.2006

8 EUROCONTROL Advanced Airspace Scheme Concept Document (AAS), Edition 2.1., Edition Date: 01 December 2004.

9 EUROCONTROL Report “Status of Civil-Military Co-ordination in Air Traffic Management (2001)