European Route Network Improvement Plan – Part 1
European Airspace Design Methodology - Guidelines
European Network Operations Plan 2019-2024
## DOCUMENT CONTROL

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## APPROVAL TABLE

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# TABLE OF CONTENT

**DOCUMENT CONTROL** ........................................................................................................... I

**APPROVAL TABLE** .................................................................................................................. I

**EDITION HISTORY** .................................................................................................................. II

**CHECKLIST** ............................................................................................................................. IV

1  **INTRODUCTION** .................................................................................................................. 1

1.1  **Presentation of the document** .......................................................................................... 1

1.1.1  **About the document** .................................................................................................. 1

1.1.2  **Structure of the document** ....................................................................................... 2

1.2  **Purpose** .......................................................................................................................... 3

1.2.1  **European Regulation** ............................................................................................... 3

1.2.2  **Relationship with ICAO** ......................................................................................... 3

1.3  **Scope** ................................................................................................................................ 3

2  **COMMON GENERAL PRINCIPLES** ............................................................................... 5

2.1  **European Route Network Design Function - General principles for airspace design** .... 5

2.1.1  **General Principles - European Regulation** ................................................................ 5

2.1.2  **Principles for the Design of the European Airspace Structures** ............................... 6

2.2  **Components of Airspace Configurations** ....................................................................... 8

2.2.2  **Components in En-Route Airspace** .......................................................................... 8

2.2.3  **Components in Terminal Airspace** ........................................................................... 9

2.2.4  **Airspace Network Management Component** ........................................................... 10

2.3  **Airspace classification** .................................................................................................. 11

2.3.1  **Introduction** ............................................................................................................. 11

2.3.2  **Classification of the European Airspace above FL195** ............................................ 11

2.3.3  **Classification of the European Airspace below FL195** .......................................... 12

3  **EUROPEAN NETWORK COORDINATION AND CONCEPT** ...................................... 17

3.1  **European coordination process** ..................................................................................... 17

3.1.1  **Objective** .................................................................................................................. 17

3.1.2  **Demanding Performance Targets** ........................................................................... 17

3.1.3  **A European Network Cooperative Decision Making Process** ................................ 19

3.2  **European Airspace Basic Concept** ................................................................................. 20

3.2.1  **Introduction** ............................................................................................................. 20

3.2.2  **Basic Concept** .......................................................................................................... 20

3.2.3  **European Network Consistency** .............................................................................. 21

3.2.4  **Airspace Continuum** ................................................................................................ 21

3.2.5  **Airspace Structures Components** ............................................................................ 21

3.2.6  **Airspace Organisation** ............................................................................................... 22

3.2.7  **Airspace Development Approach** ............................................................................. 22

3.2.8  **Operating the ARN Versions** .................................................................................... 25
4.1 Implementation of Performance Based Navigation .............................................. 31
4.2 The PBN Airspace Concept .................................................................................... 32
4.3 PBN Implementation ............................................................................................... 33
4.4 PBN Airspace Implementation Steps ....................................................................... 34
  4.4.1 Activity 1 - Agree on Operational Requirements .................................................. 35
  4.4.2 Activity 2 - Create the Airspace Design Team ...................................................... 35
  4.4.3 Activity 3 - Decide Project Objectives, Scope and Timescales ............................. 36
  4.4.4 Activity 4 - Analyse the Reference Scenario - Collect Data ............................. 37
  4.4.5 Activity 5 - Safety Policy, safety Plan and Selection of Safety and Performance Criteria 37
  4.4.6 Activity 6 - Agree on Enablers, Constraints and ATM/CNS Assumptions ........... 38
  4.4.7 Activity 7 - Airspace Design - Routes and Holds ................................................ 46
  4.4.8 Activity 8 - Initial Procedure Design .................................................................. 52
  4.4.9 Activity 9 - Airspace Design - Structures and Sectors ........................................ 53
  4.4.10 Activity 10 - Confirming the selected Navigation Specification ...................... 54
  4.4.11 Activity 11 - Airspace Concept Validation ....................................................... 55
  4.4.12 Activity 12 - Finalisation of Procedure Design ................................................ 58
  4.4.13 Activity 13a - Instrument Flight Procedure Validation ..................................... 59
  4.4.14 Activity 13b - Flight Inspection ......................................................................... 59
  4.4.15 Activity 14 - ATC System Integration Considerations ....................................... 61
  4.4.16 Activity 15 - Awareness and Training Material ................................................ 62
  4.4.17 Activity 16 - Implementation ......................................................................... 62
  4.4.18 Activity 17 - Post-Implementation Review ....................................................... 62
4.5 PBN Check List of Implementation Actions ............................................................. 63
5 TA DESIGN METHODOLOGY .................................................................................. 64
  5.1 Reference Scenario ............................................................................................... 64
    5.1.1 What is the Reference Scenario? ...................................................................... 64
    5.1.2 Creating the Reference Scenario ..................................................................... 65
    5.1.3 Critical Review of the Reference Scenario ...................................................... 66
    5.1.4 Refining Design Objective(s) .......................................................................... 66
    5.1.5 Comparing Scenarios ..................................................................................... 66
5.2 Safety & Performance Criteria ................................................................................ 68
    5.2.1 Qualitative and Quantitative Assessment .......................................................... 68
    5.2.2 Evaluating Safety .............................................................................................. 69
    5.2.3 The Safety Case Approach ............................................................................... 70
    5.2.4 Other Performance Criteria ............................................................................. 71
Comparing Scenarios

Creating the Reference ('Pseudo' Reference) Scenario

What is the 'Pseudo' Reference Scenario?

Introduction

Reference Scenario

Phased Design Approach

Terminal Airspace Structures

RNAV Routes & Holds

Navigation Specification

Flight Procedures

Holding Areas

Enablers

Area Navigation as an Enabler

When to Identify Assumptions, Constraints & Enablers

Assumptions

Constraints

Enablers

Similarities and Differences

Point Merge

Striking the Balance

Guidelines

Phased Design Approach

Terminal Routes

Arrival & Departure Routes

CDO

CCO

Closed STARs

Open STARs

Trombones

Evaluating Capacity and Environmental Impact

Safety, Performance and Project Planning

Network Management Directorate

Classification: White
7   ASM AND AIRSPACE DESIGN ................................................................................. 193
7.1  General ................................................................................................................. 193
7.1.1 Flexible Use of Airspace (FUA) Concept ..................................................... 193
7.1.2 Flexible Airspace Structures ........................................................................... 193
7.1.3 Strategic ASM Level 1 - National High-Level Policy Body Functions ............. 193
7.1.4 Need for National Airspace Planning Arrangements for Change Process .......... 194
7.1.5 Temporary Airspace Reservation and Restriction Design Principles ................ 194
7.1.6 Validation of Activities Requiring Airspace Reservation/Restriction ............... 197
7.2   Guidelines for Establishment of Airspace Reservation and Restriction .......... 198
7.2.1 Modularity ........................................................................................................ 198
7.2.2 Relationship between Airspace Reservation/Restriction and the FUA Concept .... 199
7.2.3 Guidelines for Establishment of Airspace Reservation ..................................... 199
7.2.4 Guidelines for Establishment of Airspace Restriction ..................................... 203
7.2.5 Establishment of Airspace Restriction/Reservation over the High Seas .............. 204
7.2.6 Guidelines for Spacing ..................................................................................... 204
7.2.7 Guidelines for Establishment of Conditional Routes (CDR) .............................. 207
7.2.8 Guidelines for Flexible Airspace Structures Publication ................................. 212
7.2.9 CDRs Routing Scenarios ................................................................................ 214
8   ROUTE NETWORK AND FREE ROUTE AIRSPACE UTILISATION RULES AND
     AVAILABILITY ........................................................................................................... 218
8.1  Introduction .......................................................................................................... 218
8.2  Basic Principles .................................................................................................... 218
8.3  Structure .............................................................................................................. 219
8.3.1 Document structure ......................................................................................... 219
8.3.2 Restriction Structure ........................................................................................ 224
8.4  Period of Validity ................................................................................................. 233
8.5  Application ........................................................................................................... 234
8.6  CDM Process ....................................................................................................... 235
8.7  Temporary changes ............................................................................................. 236
8.8  Flight Planning ...................................................................................................... 237
8.9  Routeing Scenarios ............................................................................................. 238
8.10 Publication ........................................................................................................... 239
8.11 Tactical Operations ............................................................................................. 240
8.12 RAD Review ....................................................................................................... 241
8.13 Additional airspace utilisation rules and availability ......................................... 242
APPENDIX ..................................................................................................................... 1
A.  ANT AIRSPACE CLASSIFICATION TOOLBOX ..................................................... 1
B.  HARMONIZED CDR AIP PUBLICATION ........................................................... 1
C.  ANNEX C ............................................................................................................... 1
D.  NO PLANNING ZONE (NPZ) - AIP PUBLICATION ........................................... 1
E.  IDENTIFICATION OF CONTROL SECTOR ........................................................... 1
1 Introduction

1.1 Presentation of the document

1.1.1 About the document


(2) The guidelines contained in this document have been developed to support the European airspace design process in that overall performance is improved and airspace structures1 are developed in a harmonised manner. The document will be reviewed periodically so it remains valid in light of the progress made and experience gained, and to reflect the actual changes that take place in aviation.

(3) The European Airspace Design Methodology is mainly focused on providing general guidance and technical specifications for airspace designers.

(4) Where necessary, further reference pertaining to airspace design matters is made to appropriate ICAO documentation.

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1 In the context of this manual, "Airspace Structure" includes Control Area (CTA), Terminal Control Area (TMA), Control Zone (CTR), ATS Route, ATC Sector, Conditional Route (CDR), Danger Area (D), Restricted Area (R), Prohibited Area (P), Temporary Segregated Area (TSA), Temporary Reserved Area (TRA), Cross-Border Area (CBA), Reduced Co-ordination Airspace (RCA), Prior Co-ordination Airspace (PCA)
1.1.2 Structure of the document

The European Route Network Improvement Plan has four Parts. Part 1 (this document) contains general guidelines and technical specifications for airspace design.

Section 1 - Introduction - provides the structure, scope and purpose of the present document

Section 2 - Common general principles - identifies general principles for the establishment and use of airspace structures and provides guidance for the harmonisation of European airspace classification

Section 3 - European coordination process - presents the European processes that govern the production, amendment and approval of the airspace planning and design elements included in the document

Section 4 - Deployment of PBN - identifies the main elements an airspace designer needs to consider with regard to the operational deployment of PBN (Performance Based Navigation)

Section 5 - Terminal Airspace design methodology - provides a methodology with respect to Terminal Airspace design.

Section 6 - En-route Airspace design methodology - provides a methodology with respect to En-Route Airspace design.

Section 7 - ASM and Airspace Design - presents the main Airspace Management elements that European airspace designers need to take into in the airspace design process.

Section 8 - Route network and free route airspace utilisation rules and availability - provides the way in which route network and free route airspace utilisation and availability is done.

Annex A - Airspace classification toolbox

Annex B - Harmonized CDR AIP publication

Annex C - RAD promulgation in National AIP

Annex D - No Planning Zone (NPZ) - AIP Publication

Annex E - Identification of Control Sector
1.2 Purpose

1.2.1 European Regulation

(1) The present document addresses the requirements expressed in the EC Regulation No. 677/2011 Annex I part B article 5 (a).

(2) The EC Regulation No 677/2011 of 7 July 2011 lays down detailed rules for the implementation of air traffic management (ATM) network functions and amends Regulation (EU) No 691/2010. The regulation establishes several ATM network functions to be performed by a Network Manager; EUROCONTROL has been nominated as the Network Manager entrusted to perform these network functions.

(3) The EC Regulation No 677/2011 lists in Chapter II Article 3 paragraph 4, the ATM network functions to be performed by the Network Manager; amongst them, the design of the European Route Network is identified (para (a) refers).

(4) The design of the European Route Network, as described in Annex 1 of EC Regulation No 677/2011 calls for the establishment of the European Route Network Improvement Plan that shall include, inter alia, common general principles complemented by technical specifications for airspace design (Annex I, Part B, art. 5 (a) refers)

1.2.2 Relationship with ICAO

(1) The material contained in this document should be used in conjunction with the provisions specified in ICAO. For any other detailed technical aspects related to airspace design reference is to be made to appropriate ICAO documentation.

1.3 Scope

(1) In order to reconcile competing requirements in airspace utilisation between Commercial Aviation (highest possible protection from other airspace users), General Aviation & Aerial Work (maximum freedom in all airspace) and Military Aviation (highest possible flexibility, freedom of access to all airspace, protection for special activity and low altitude flying), airspace design and allocation is often a compromise between all expressed requirements and lead usually to lengthy discussions between the parties concerned. Therefore, in order to ensure more transparency and predictability of airspace management measures, it is necessary to establish objective criteria for the design of airspace.

(2) The scope of the European Airspace Design Methodology Guidelines - General Principles and Technical Specification for Airspace Design - is the one defined by the EC Regulation No 677/2011 Annex I Part B article 5 paragraph (a). It is concerned with the needs of all airspace user groups on a basis of equity. Consequently, an important goal of the common guidelines for airspace design in Europe is to enable equal access to the airspace providing maximum freedom for all users consistent with the required level of safety in the provision of ATM services, while making due allowance for the security and defence needs of individual States.

2 For full reference the reader is invited to consult the Official Journal of the European Union L185/1 from 7 July 2011.
(3) The evolution of the European airspace structure will follow closely the common general principles and objectives of the European Route Network Improvement Plan. Due account will be taken of the increasing need for the provision of a seamless ATM service and the associated requirements for the interoperability between civil and military systems.
2 Common General Principles

2.1 European Route Network Design Function - General principles for airspace design

2.1.1 General Principles - European Regulation

The EC Regulation No 677/2011 of 7 July 2011 lays down, in Annex I, Part C, the following airspace design principles:

With the development of the European Route Network Improvement Plan the Network Manager, Member States, third countries, functional airspace blocks and air navigation service providers as part of functional airspace blocks or individually, shall within the cooperative decision-making process, adhere to the following airspace design principles:

(a) the establishment and configuration of airspace structures shall be based on operational requirements, irrespective of national or functional airspace block borders or FIR boundaries, and shall not necessarily be bound by the division level between upper and lower airspace;

(b) the design of airspace structures shall be a transparent process showing decisions made and their justification through taking into account the requirements of all users whilst reconciling safety, capacity, environmental aspects and with due regard to military and national security needs;

(c) the present and forecast traffic demand, at network and local level, and the performance targets shall be the input for the European Route Network Improvement Plan with a view to satisfying the needs of the main traffic flows and airports;

(d) ensure vertical and horizontal connectivity, including terminal airspace and the airspace structure at the interface;

(e) the possibility for flights to operate along, or as near as possible to, user required routes and flight profiles in the en-route phase of flight;

(f) the acceptance for assessment and possible development of all airspace structures proposals, including Free Route Airspace, multiple route options and CDRs, received from stakeholders having an operational requirement in that area;

(g) the design of airspace structures including Free Route Airspace and ATC sectors shall take into account existing or proposed airspace structures designated for activities which require airspace reservation or restriction. To that end, only such structures that are in accordance with the application of FUA shall be established. Such structures shall be harmonised and made consistent to the largest possible extent across the entire European network;

(h) ATC sector design development shall commence with the required route or traffic flow alignments within an iterative process that will ensure compatibility between routes or flows and sectors;
(i) ATC sectors shall be designed to enable the construction of sector configurations that satisfy traffic flows and are adaptable and commensurate with variable traffic demand;

(j) agreements on service provision shall be established in cases where ATC sectors require, for operational reasons, to be designed across national or functional airspace block borders or FIR boundaries.

The Network Manager, Member States, functional airspace blocks and air navigation service providers as part of functional airspace blocks or individually, through the cooperative decision-making process, shall ensure that the following principles apply in relation to airspace utilisation and capacity management:

(a) airspace structures shall be planned to facilitate flexible and timely airspace use and management with regard to routing options, traffic flows, sector configuration schemes and the configuration of other airspace structures;

(b) airspace structures should accommodate the establishment of additional route options while ensuring their compatibility (capacity considerations and sector design limitations).

2.1.2 Principles for the Design of the European Airspace Structures

Principle 1 - Safety

Safety shall be enhanced or at least maintained by the design of any airspace structure.

(1) This includes requirements to comply with ICAO SARPs and procedures and with SES regulations. Airspace structures shall be subject to a safety assessment.

Principle 2 - Operational Performance

The European Airspace Design shall be based on network-wide operational performance indicators and targets.

(2) The European Airspace Design will use as an input, network-wide operational performance indicators and targets addressing mainly capacity and environment. The need to accommodate increasing traffic demand will be addressed through more innovative airspace design solutions. Increasingly, environmental considerations have a greater effect on the design and management of the airspace as well as operations within it. Capacity requirements and environmental impact are to be mitigated through design and use of airspace configurations, without prejudice to Safety. In developing and applying Airspace Configurations, trade-offs may be required between capacity, flight efficiency and environmental mitigation without compromising safety. In order to improve the environmental performance of the climb and descent phases, airspace design should enable optimised continuous climb operations.

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3 Standards and Recommended Practices
(CCO) and continuous descent operations (CDO), to top of climb and from top of descent respectively, to the extent possible.

**Principle 3 - Airspace Continuum**

The European Airspace Structure shall be designed as a continuum.

(3) An airspace continuum is envisaged for the European airspace design. This means that there is no intended division within en-route airspace or between en-route and terminal airspace. However, the different attributes of en-route and terminal airspace will drive specific system and tools development needed to improve efficiency thus resulting in changes to the existing interfaces. A lateral airspace continuum is envisaged through appropriate connectivity between regional airspace structures in both En-route and Terminal Airspace (e.g. Functional Airspace Blocks, groupings of Terminal Airspace areas into Terminal Airspace Systems), where application of the rules associated with airspace classes will be uniform.

**Principle 4 - Airspace Configurations**

The European Airspace Structure shall be based on Airspace Configurations.

(4) In en-route and terminal airspace, an **Airspace Configuration** refers to the pre-defined and co-ordinated organisation of ATS Routes of the European ATS Route Network (ARN), Free Route Airspace and/or Terminal Routes and their associated airspace structures (including temporary airspace reservations) and ATC sectorisation.

- In en-route airspace, airspace configurations include pre-defined fixed and flexible routing options, free route airspace and optimum ATC sectorisation capable of being adapted to traffic demand. Airspace configurations will be activated, following the main Strategic Objective(s) for a particular geographic area and/or time period through a CDM (Cooperative Decision Making) process Flexible routeings may still be provided by tactical ATC intervention when appropriate.

- In terminal airspace, airspace configurations will be contained primarily within terminal airspace structures. Airspace configurations may be activated in accordance with the runway configuration in use at one or more airports and the main Strategic Objective(s) for a particular time period. Flexible routeings may still be provided by tactical ATC intervention when appropriate.

(5) Airspace configurations offer a level of adaptability matching the demands of airspace users to the extent possible whilst maintaining cost effectiveness and optimising overall efficiency. This allows for the most effective balance between capacity, mission effectiveness and flight efficiency, whilst reducing environmental impact, where possible.
Principle 5 - Advanced Airspace Scheme and ATS Route Network Versions

The Airspace Configurations shall be part of a European Airspace Structure developed on the basis of a long-term vision of the airspace (Advanced Airspace Scheme Route Network) and deployed implementation of through successive ARN versions.

(6) Consistency is assured across the ATS Route network of the ARN system as a whole through the development of a long-term vision (the Advanced Airspace Scheme) deployed through implementation of successive ARN versions. Coordination and consolidation of airspace design, planning and implementation is achieved through the cooperative decision making process of the Network Manager at European network level.

Principle 6 - Ensure close relationship between airspace design, airspace management and air traffic flow and capacity management

The European Airspace Structure shall be developed through a close relationship between airspace design, airspace management and air traffic flow and capacity management.

(7) There is to be closer co-operation between Airspace Design, ATFCM and ASM with respect to the design and use of the airspace. In route design, main traffic flows are to be given priority over minor flows whether in en-route or terminal airspace and efficient connectivity must be assured between ATS routes of the ARN and terminal routes.

Principle 7 - Development of Airspace Configurations

Airspace Configurations shall be developed, through a Cooperative Decision Making Process, in close coordination with all operational stakeholders.

(8) Airspace configurations are to be developed in consultation with all operational stakeholders. Appropriate co-ordination with ASM, ATFCM, ATS, airspace users and Airports is required.

2.2 Components of Airspace Configurations

(1) The following paragraphs describe the components of airspace configurations. Although they are grouped into en-route and terminal airspace, an airspace continuum is envisaged.

2.2.2 Components in En-Route Airspace

(1) ATS routes in the ARN and in Free Route Airspace will characterise the European airspace. The main feature of ATS routes in the ARN is the ability to offer more routeing options to airspace users. These ATS routes will be based on the principles of ATS route network design and sectorisation, independent from national boundaries and adapted to main traffic flows.

(2) An ATS route network and Free Route Airspace capable of being managed more flexibly allows operators to choose from several strategically designed ATS routes of the ARN. Improvements in the strategic design, planning and management of ATS routes and Free Route Airspace increase the predictability
of the route options and reduce the need for tactical re-routering by Air Traffic Controllers. This flexibility is based on the Flexible Use of Airspace Concept principles.

(3) GAT and OAT requirements have to be accommodated by integrating them in the strategic ARN developments’ process. As a consequence, deviations from ARN developments shall be kept to a minimum.

(4) While, ATS routes and Free Route Airspace of the ARN are to be based, initially, upon RNAV 5, a progression to a more advanced navigation application is envisaged at a later stage.

(5) As regards temporary reserved and segregated airspace, it is envisaged, under certain Airspace Configurations, to have them activated and de-activated closer to real time. Such airspace may vary in size, geographic location and time (to accommodate airspace user requirements). This includes requirements for modular design and standardised rules for separation.

(6) To increase efficiency, it is recommended that due consideration is given to increasing the number of cross-border areas and operations associated with them. In this context the shared use of both cross-border areas and temporary reserved segregated airspaces is expected to become more frequent. To improve vertical flight efficiency and environmental performance in the climb and descent phases, it is recommended that due consideration is given to enabling optimised CCO and CDO in the airspace design process, to the extent possible.

(7) ATC sectors must be adapted to main traffic flows and an optimum route network, and, independent from national boundaries, when required by operational needs. More ATC sectors will be developed and made available, where required (including vertical divisions). Using modular design techniques, sectors must be adaptable in shape and size (pre-defined) in response to demand and airspace availability variations. One should expect an increasing number of cross border ATC sectors to emerge in order to support operations within Free Route Airspace.

(8) Increasingly, traffic into Terminal airspace is managed along ATS routes and metered in time. It is expected that outer and inner terminal holding facilities continue be used and may be redefined both in size and location, based on RNAV.

### 2.2.3 Components in Terminal Airspace

(1) Terminal route structures cannot be as flexible as their en-route equivalents. RNAV and RNP Terminal (Arrival and Departure) Routes will be increasingly used. At airports, where RNAV Terminal Routes are used, a number of conventional SIDs/STARs or Vectoring may be retained. In a limited number of cases, only conventional SIDs/STARs, with or without vectoring, may be used. RNAV and RNP Terminal Arrival Routes will feed onto a variety of instrument approaches.

(2) It will be an increased need for RNP-based instrument approach procedures, particularly for those that are newly designed or for those replacing conventional non-precision approaches (e.g. VOR, NDB). In addition, RNP-based instrument procedures with vertical guidance should be introduced to increase safety through the provision of stabilised approaches, and therefore reduce the potential for Controlled Flight Into Terrain (CFIT).
(3) Precision approaches, using ILS and MLS and in the future, GBAS and SBAS are required to accommodate specific operational needs stemming from the main strategic objective(s) pursued. RNP-based curved/segmented approaches may be needed to respond to local operating requirements e.g. terrain or environmental reasons.

(4) Terminal Arrival routes, that accommodate the use of Continuous Descent/Climb techniques and noise preferential departure routes, will be designed to reduce environmental impact wherever possible, whilst observing capacity demands. Terminal Departure routes dedicated to particular aircraft performance may also be designed. Terminal Departure and Arrival routes should also interface with en-route / FRA structures to enable full CCO / CDO to top of climb / from top of descent, where possible.

(5) To improve the design and management of terminal routes and ATC sectorisation servicing several airports in close proximity, the fusion of two or more terminal airspace structures should be considered. This amalgam constitutes a Terminal Airspace System (TAS). TASs could extend across national borders if necessitated by operational requirements. Operations within a TAS should be systemized and characterized by system of entry (arrival) and exit gates that accommodate flows of arrivals and departures to and from various runways/airports. Generally, these entry and exit gates are to remain fixed even when the airspace configuration changes.

(6) Operation within terminal airspace structures is likely to become less flexible yet the use of airspace configurations may determine different dimensions for the airspace structures (depending on the routeing configuration servicing multiple runways at different airports and/or military requirements). New or temporary terminal airspace structures or those with variable dimensions may be developed to accommodate low-density operations. This creates requirements for co-ordination with the military and for VFR aircraft to be informed in real time regarding the status of the relevant terminal airspace structure.

(7) By design, there must be coherence between adjacent terminal airspace structures.

(8) Within Terminal Airspace, use of both geographical and functional sectorisation is needed. To accommodate traffic growth, increasing the use of a dedicated sequencing function for final approach should be considered.

(9) Airports are an integral part of airspace configurations within Terminal Airspace. Runway throughput, selection of the runway in use and the airport capacity in general affect the choice of airspace configuration.

2.2.4 Airspace Network Management Component

(1) Airspace Network Management is a generic term that refers to the gate-to-gate management processes associated with Airspace Management (ASM), Air Traffic Flow and Capacity Management (ATFCM), ATS, Flight Planning and synchronisation with Airports.

(2) Airspace Network Management is achieved through a Cooperative Decision Making (CDM) process involving all participants and will be performed, as appropriate, at European, regional (e.g. FAB/TAS) and national level.

(3) As a result of Airspace Network Management, airspace configurations based on pre-defined airspace structures will be defined. These maximise efficiency of airspace allocation commensurate with the needs of civil and military users.
2.3 Airspace classification

2.3.1 Introduction

Current ICAO Requirements for Classification of ATS Airspace

(1) According to ICAO Annex 11 - 2.5, once it has been determined that air traffic services are to be provided in a particular portion of airspace or in airspace associated with particular aerodromes; those portions of the airspace shall be designated in relation to the air traffic services that are to be provided.

(2) Airspace shall be classified and designated in accordance with the seven classes - A to G, defined in ICAO Annex 11 - 2.6. The requirements for flights within each class of airspace are defined in ICAO Annex 11, Appendix 4, in terms of the type of flight allowed, the separation provided, the services provided, meteorological conditions, speed limitations, radio communication requirements and the ATC clearance required.

(3) States shall select those airspace classes appropriate to their needs from the least restrictive Class G to the most restrictive Class A.

Standardised European Rules of the Air (SERA)

(4) There is a definite requirement for transparency of the rules pertaining to the application of airspace classification, in that this is fundamental to the freedom and ability for aircraft to operate in a seamless manner across the EU. The aim is to increase safety through harmonisation and consistency since the rationalisation of the airspace rules is a significant enabler for FABs.

(5) Against these needs, European wide agreement on harmonisation and simplification of the airspace classification within the framework of Single Sky has been advanced. At the time of writing this document, SERA is still in the process of being developed and approved through agreed European mechanisms.

2.3.2 Classification of the European Airspace above FL195

(1) Within the European Airspace, the type and density of traffic above FL195 require the provision of common procedures by ATC.

(2) According to EU regulations, airspace above FL195 is classified as Class C airspace.

(3) Area control arrangements in place for most of the European States have the advantage that whenever traffic conditions and military activities permit, ATC may authorise specific flights under its control to deviate from the established route structure and to follow a more direct flight path or to fly parallel with other flights, without the aircraft leaving controlled airspace and thus losing the benefit of ATC.

- Common Conditions for VFR Access to Class C Airspace above FL 195

Article 4 of EU regulation No 730/2006 requires states the following:

"In airspace above flight level 195 Member States may establish an airspace reservation, where practical, in which VFR flights may be allowed. In airspace above flight level 195, up to and including flight level 285, VFR flights may also be authorised by the responsible air traffic

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services unit in accordance with the authorisation procedures established and published by Member States in the relevant aeronautical information publication.”

Building on article 4, in addition to establishing Class C airspace as the ATS Airspace Class to be applied throughout European airspace above FL195, it is necessary to introduce harmonised rules for access to this airspace by GAT traffic that may seek to fly en-route under VFR. Having regards to safety and airspace capacity considerations, and to the fact that there is almost no requirement for en-route GAT VFR flight above FL195, the following general rule has been formulated:

- En-route GAT VFR flights above FL195 are not allowed.

However, there are various types of "special" GAT flight that will have to be accommodated; accordingly the general rule is amplified thus:

- GAT VFR flights above FL195 and up to and including FL285 are authorised only in:
  - An airspace reservation [Temporary Segregated Airspace or its equivalent]; or
  - In accordance with specific arrangements agreed by the appropriate ATS authority;

- GAT VFR flights above FL285, within RVSM airspace, must be contained within:
  - An airspace reservation (Temporary Segregated Airspace or its equivalent).

2.3.3 Classification of the European Airspace below FL195

Below FL195, all ICAO airspace classes can be used.

- **Airspace Classification Toolbox**

(1) EUROCONTROL has developed through consultation with its stakeholders an airspace classification toolbox with the aim of ensuring that a common set of solutions is applied Europe wide to achieve maximum transparency for airspace classification rules, thus improving safety and efficiency. Airspace designers are encouraged to use the airspace toolbox within the legal framework agreed at global and European level. The full content of the Airspace Toolbox for airspace classification is contained in Annex A of the present document.

*Note: Below FL195, a mixture of airspaces with different classification may coexist to account for the airspace users’ needs specific to particular areas. The issue of interfaces between airspaces of different classes, both vertically and horizontally, is ensured through application of ICAO Annex 2 and Annex 11 provisions. The local regulator retains full freedom to express specific requirements should particular conditions call for them, in accordance with the legal framework governing ICAO Annexes and European regulations relevant to the matter.*

The following elements should be taken into account when establishing airspace classes below FL195:

- Requirements for Civil ATS Provision;
• Requirements for Military ATS Provision;

• Commercial air transport requirements:
  o to have seamless services within airspace considered as a continuum;
  o to have simple and unambiguous rules, easy to implement and to follow;
  o to have freedom of movement to follow preferred and flexible flight profiles with minimum constraints;
  o to benefit from pan-European harmonisation of airspace classification;
  o to have Upper/Lower Airspace classification harmonised as soon as possible in order to enable the traffic to be operated within the airspace of a European network;
  o Requirement for a Clear Notification of Separation Responsibility.

• Military operations requirements:
  o to have freedom to operate in IMC/VMC at any time in all areas of European airspace;
  o to benefit from special handling - in particular for priority flights and for time-critical missions, but also for military aircraft not fully equipped to the civil standard;
  o to retain the possibility of operating uncontrolled VFR flights, including in "Controlled" airspace;
  o to have temporary airspace reservations, to contain activities which are incompatible with the normal application of the Rules of the Air;
  o to have airspace restrictions for non-flight-related activities such as protection of areas of national interest, gunnery, missile firing, etc..

• General Aviation and Aerial Work requirements:
  o to achieve maximum freedom of movement in all categories/classes of airspace;
  o to have sufficient "Uncontrolled" airspace for its operations and VFR access to "Controlled" airspace;
  o to maintain the right to change flight rules from IFR to VFR and vice-versa in the air, as well as before take-off or, at least, to receive special handling;
  o to have the possibility of operating under VFR as long as weather conditions permit the application of the "see and avoid" rule.

• Test Flights and UAS requirements:
  o To accommodate operations, based on shared use of airspace, with sometimes a need for special handling, rather than on strict segregation;
  o To have defined standards for additional equipment capabilities so that UASs can be designed to achieve compatibility with the airspace requirements they are expected to operate in.
List of Potential Criteria to Establish Classification below FL195

- Level of Air Traffic Services to be provided;
- Air safety-relevant incidents;
- IFR traffic volume;
- Mixed environment (IFR/VFR flights, different speeds and/or types of aircraft, ...);
- Traffic concentration - Environmental Constraints;
- Particular operations (Military, General Aviation, Test Flights, Aerial Work, Gliders, UAS, ...);
- Meteorological conditions - Daylight/Night Operations;
- Flight Planning Issues;
- Cost-Benefit Analysis (Staff training, mandatory equipment, user charges, ...);
- Principles or criteria already established for harmonised airspace.
Level of Air Traffic Services To Be Provided

(2) Essentially, the provision of ATC is required when the number and frequency of IFR flights have reached a level that no longer allows for individual pilots to be responsible for maintaining a safe and expeditious flow of traffic. This should apply in particular when IFR operations of a commercial nature are conducted.

(3) The planning for, and the execution of, ATC is essentially a national responsibility. However situations may arise whereby States are required to improve their services, not because there is an urgent national requirement to do so, but in order to ensure that the efforts of adjacent States to improve their ATS are not compromised.

(4) It is, therefore, of prime importance that both the planning and execution of ATC is conducted in a manner that ensures optimum uniformity is maintained to the greatest degree possible. Thus, the delineation of airspace, wherein ATC is to be provided, should be related to the nature of the route structure and/or the containment of IFR flight paths and the need for an efficient service rather than observing national boundaries.

Air Safety-Relevant Incidents

(5) Although airspace classification should be established mainly to facilitate the separation of aircraft by ATC, when a high number of Air Safety-Relevant Incidents is reported, an immediate overall situational analysis is required; this might lead to the need of changing the classification of the airspace concerned.

IFR Traffic Volume

(6) Categorisation of airspace surrounding aerodromes is mainly influenced by the volume of IFR traffic to be handled. As the number of IFR movements at an aerodrome increases, the necessity to protect IFR operations from other traffic, through implementation of a more restrictive ATS Class, may be appropriate.

(7) Change of airspace classification would therefore be considered primarily on the basis of IFR traffic figures and trends recorded over previous years and forecasted increases (or decreases) at a given aerodrome. To that end, in order to simplify airspace organisation, modular airspace structures with a limited number of ATS Classes, compliant with the Airspace Strategy, should be assigned to different categories of aerodromes in accordance with their annual IFR traffic volume.

Mixed Environment

(8) A mixture of different types of air traffic (IFR/VFR) with aircraft of various speeds (light, conventional, jet, etc...) necessitates the provision of more advanced air traffic services and the establishment of a more restrictive class of airspace than, for example, the handling of a relatively greater density of traffic where only one type of operation is concerned.

(9) Therefore, qualitative data on issues related to the handling of a mixture of traffic should be gathered to assess the best classification for a given block of airspace. The following parameters should be considered:

- the proportion of jet and/or heavy aircraft;
- the amount and type of VFR operations;
- training activities.

Traffic Concentration - Environmental Constraints
Areas of intense activity, flight paths of both IFR and VFR traffic, traffic flows (uni-, bi- or multi-directional), the relative situation of aerodromes in the vicinity, the proximity of big cities, etc. are other qualitative criteria which may influence the choice of an ATS Class in order to ensure the degree of control required to manage the situation.

**Particular Operations**

In determining an ATS Class appropriate to the main user of a block of airspace, care should be taken that unnecessary restrictions are not imposed on other traffic such as Military, General Aviation, Test Flights, Aerial Work, Gliders and/or UAS that wish to operate in this airspace.

**Meteorological Conditions - Daylight/Night Operations**

In areas where regular flows of IFR traffic exist, meteorological conditions and/or Daylight/Night operations might have a substantial effect on the airspace classification. Similar or worse conditions might be less important for the classification of an area where such conditions would suspend the normal VFR traffic.

Therefore, most of the European States have adapted VMC minima to their prevailing national weather conditions. However, in view of the simplification and harmonisation of ATS Classification in Europe, adoption of common VMC minima should be sought to the largest extent practicable.

**Flight Planning Issues**

The flight plan is currently the only way by which pilots/operators inform ATSU about their intended operations and formally request air traffic services. From the flight plan ATSU derives all the information of operational significance such as equipment carried, route to be flown, requested flight level(s), departure/destination aerodrome, etc..

When it becomes necessary for ATC to have at its disposal such information about each aircraft operating within a given volume of airspace, a change in airspace classification may be required in order that filing of flight plans becomes mandatory.

**Cost-Benefit Analysis**

Changes of airspace classification may have an impact on the numbers and training of qualified personnel (pilots & controllers); this requires advanced planning and therefore due consideration during the decision-making process.

Changes of airspace classification may also require the provision of additional facilities, especially for communication, navigation and surveillance.

Therefore, any change of airspace classification that impacts the business aspects related to the provision of ATS requires a comprehensive Cost-Benefit Analysis.
3 European Network Coordination and Concept

3.1 European coordination process

3.1.1 Objective

(1) In response to COMMISSION REGULATION (EU) No 677/2011 of 7 July 2011 (laying down the detailed rules for the implementation of air traffic management (ATM) network functions and amending Regulation (EU) No 691/2010), the objective of this document is to provide a harmonised process and methodology for European airspace design thus improving European ATM capacity, flight efficiency and environmental performance. This is to be achieved through the development and implementation of an enhanced European ATS route network, Free Route Airspace and TMA systems structures supported by corresponding improvements to the airspace structure and by the optimal utilisation rules of both in the ECAC area.

(2) This harmonised process and methodology also ensures regional interconnectivity and interoperability of the European route network within the ICAO EUR Region and with adjacent ICAO Regions.

3.1.2 Demanding Performance Targets

(1) In response to the COMMISSION REGULATION (EU) No 390/2013 of 3rd May 2013 (laying down a performance scheme for air navigation services and network functions), a new set of Key Performance Indicators and associated targets have been set for the 2nd Reference Period (RP2).

(2) It includes two important key performance areas and associated indicators, related to the operational performance of the European ATM network for the period 2015 - 2019.

Environment

- **average horizontal en-route flight efficiency of the actual trajectory**, defined as follows:
  - the indicator is the comparison between the length of the en-route part of the actual trajectory derived from surveillance data and the corresponding portion of the great circle distance, summed over all IFR flights within or traversing the European airspace;
  - “en-route” refers to the distance flown outside a circle of 40 NM around the airports;
  - where a flight departs from or arrives at a place outside the European airspace, only the part inside the European airspace is considered;

  This KPI is applicable at both network and Functional Airspace Block level.

- **average horizontal en-route flight efficiency of the last filed flight plan trajectory**, defined as follows:
  - the difference between the length of the en-route part of the last filed flight plan trajectory and the corresponding portion
of the great circle distance, summed over all IFR flights within or traversing the European airspace;
- "en-route" refers to the distance flown outside a circle of 40 NM around the airports;
- where a flight departs from or arrives at a place outside the European airspace, only the part inside the European airspace is considered;

This KPI is only applicable at network level.

- **Capacity**
  - *minutes of en-route ATFM delay per flight*, calculated for the full year and including all IFR flights within European airspace and all ATFM delay causes, excluding exceptional events.

(3) In February 2019, COMMISSION REGULATION (EU) No 317/2019 was published which details an updated set of KPIs that have been set for the 3rd Reference Period (RP3). For the third performance Reference Period starting on 1st January 2020 and ending on 31st December 2024, the European Union-wide performance indicators will be as follows:

**Environment**

- average horizontal en-route flight efficiency of the actual trajectory, calculated as follows:
  - the indicator is the comparison between the length of the en route part of the actual trajectory derived from surveillance data and the achieved distance, summed over IFR flights within or traversing the airspace as defined in Article 1, hereinafter referred to as 'European airspace';
  - 'en route part' refers to the distance flown outside a circle of 40 NM around the airports;
  - where a flight departs from or arrives at an airport outside the European airspace, the entry or exit points of the European airspace are used for the calculation of this indicator as the origin or destination respectively, rather than the departure or destination airport;
  - where a flight departs from and arrives at an airport inside the European airspace and crosses a non-European airspace, only the part inside the European airspace is used for the calculation of this indicator;
  - 'achieved distance' is a function of the position of the entry and exit points of the flight into and out of each portion of airspace for all parts of the trajectory. Achieved distance represents the contribution that those points make to the great circle distance between origin and destination of the flight; and,
  - the indicator is calculated for the whole calendar year and for each year of the reference period, as an average. When calculating this average, the ten highest daily values and the ten lowest daily values are excluded from the calculation.

This KPI is applicable at both network and Functional Airspace Block level.

The Regulation also introduces a new environmental indicator for monitoring:

- the share of arrivals applying Continuous Descent Operation (CDO), calculated at local level as follows:
  - this indicator is the ratio between the total number of arrivals performing a CDO from a reference point at a height above ground, defined by the national supervisory authority, and the total number of arrival operations; and,
This indicator is expressed as a percentage, calculated for the whole calendar year and for each year of the reference period. **This indicator is applicable at the local level.**

It should be noted that this indicator may be used to measure the performance of the part of the descent profile where noise is the principal environmental impact. Whilst the altitude of the reference point to be defined by the national supervisory authority may depend upon local factors such as airspace particularities or the extent of the area of responsibility, the majority of emissions savings can be gained from enabling CDO from top of descent or from higher levels wherever possible. Whilst reference points may be defined according to local requirements, airspace design should still aim to enable CDO from top of descent or from as high a level as possible.

**Capacity:**

- The average minutes of en route ATFM delay per flight attributable to air navigation services, calculated as follows:
  - the en route ATFM delay is the delay calculated by the Network Manager, expressed as the difference between the estimated take-off time and the calculated take-off time allocated by the Network Manager;
  - for the purposes of this indicator:
    - ‘estimated take-off time’ means the forecast of time when the aircraft will become airborne calculated by the Network Manager and based on the last estimated off-block time, or target off-block time for those airports covered by airport collaborative decision-making procedures, plus the estimated taxi-out time calculated by the Network Manager;
    - ‘calculated take-off time’ means the time allocated by the Network Manager on the day of operation, as a result of tactical slot allocation, at which a flight is expected to become airborne;
    - ‘estimated taxi-out time’ means the estimated time between off-block and take off. This estimate includes any delay buffer time at the holding point or remote de-icing prior to take off;
  - this indicator covers all IFR flights and all ATFM delay causes, excluding exceptional events; and,
  - this indicator is calculated for the whole calendar year and for each year of the reference period.

### 3.1.3 A European Network Cooperative Decision Making Process

At European network level, the Route Network Development Sub-Group (RNDSG) is the co-ordination forum for European rolling airspace design and development, planning and implementation of improved European ATS route network, optimised civil and military airspace structures and ATC sectors. The members of the RNDSG work in a partnership approach and are civil and military experts in airspace design from NM, the ECAC member States, ANS providers, Functional Airspace Blocks, airspace users international organisations, flight planner organisations and other relevant international organisations. Its work is supplemented by other activities that, depending on their nature or complexity, may be either under the auspices of the RNDSG or independent, but bring their results into the overall network picture through RNDSG processes. Examples are:

- Sub-Regional RNDSG Meetings;
- Regional co-ordination meetings between States;
- Working groups proposing various solutions for specific problem areas;
Special projects (FABs, national re-organisation projects, sub-regional agreements, etc.).

(2) Appropriate links are ensured with the Airspace Management Sub-Group to cover civil-military related aspects and with other specific ATFCM groups.

(3) The consolidation of the entire development process is ensured through the Network Operations Team.

(4) This cooperative planning process responds to the emerging requirements related to the establishment of cooperative planning and decision making processes for the development of the European route network.

(5) At local, sub-regional or Functional Airspace Blocks level, other working arrangements are set to deal with detailed airspace design and utilisation aspects. Those groups ensure a close coordination with the European network level.

3.2 European Airspace Basic Concept

3.2.1 Introduction

(1) The strategic planning and design of “packages” of ATS routes of the ARN, Free Route Airspace, Terminal Routes, airspace reservations and ATC sectors—responding to requirements stemming from different strategic objectives—represents one of the solutions for meeting the safety, capacity, flight efficiency, cost effectiveness and environmental requirements of the European airspace network. These packages are called Airspace Configurations.

(2) To meet the diversity of user requirements, there is a need for an effective and dynamic management of airspace configurations through a highly flexible and integrated Cooperative Decision Making (CDM) process at network, regional, national and local level.

3.2.2 Basic Concept

(1) In both en-route and terminal airspace, an Airspace Configuration refers to the pre-defined and co-ordinated organisation of ATS routes of the ARN and/or Terminal Routes, Free Route Airspace and their associated airspace structures (including temporary airspace reservations, if appropriate) and ATC sectorisation.

(2) In en-route airspace, airspace configurations include pre-defined fixed and flexible routing options or optimised trajectories and optimum ATC sectorisation capable dynamically adaptation to traffic demand. Airspace configurations become active, through a CDM process, depending upon the driving Strategic Objective(s) for a particular geographic area and/or time period.

(3) In terminal airspace, airspace configurations are contained primarily within terminal airspace structures. Airspace configurations may be activated depending upon the runway configuration in use at one or more airports and the driving Strategic Objective(s) for a particular time period.

(4) The above is based on a coordinated and systematic approach to selecting and changing airspace configurations across the European ATM System.
The European airspace must be built through close co-operation between airspace design, ATFCM, airspace users and ASM. It supports a close link between airspace design and airspace utilisation.

### 3.2.3 European Network Consistency

(1) Overall European Network Consistency is assured through a consolidated development of European airspace through ARN Versions. Co-ordination and consolidation of airspace design, planning and implementation is achieved through Cooperative Decision Making (CDM) at European network level.

(2) European ARN Versions are based on the result of a European wide collaborative process whereby major traffic flows, combined with major airspace constraints (airports, military areas etc.) are translated into a basic route structure. Built upon agreed planning principles, the resultant structure provides the basis for more detailed development by States and ANSPs at national or regional/FAB level. The scheme considers the ECAC airspace in its totality, independent of FIR boundaries.

### 3.2.4 Airspace Continuum

(1) An airspace continuum is envisaged in the development of the ARN Versions. As such, there is no intended division within en-route airspace or between en-route and terminal airspace. However, the different attributes of en-route and terminal airspace have determined specific requirements resulting in changes to various interfaces to improve efficiency.

(2) A lateral and vertical airspace continuum is ensured through regional airspace configurations in both en-route and Terminal Airspace (e.g. FAB or TAS), where application of various rules associated with airspace utilisation will be harmonised.

(3) A network continuum is ensured through the development of the ARN Versions where all aspects related to lateral and vertical interconnectivity, including interconnectivity within and between regional airspace configurations, are thoroughly addressed.

### 3.2.5 Airspace Structures Components

(1) ATS routes continue to characterise the European airspace for the most part in the context of the future ARN Versions, while Free Route Airspace will be used in selected airspaces and/or at selected times.

(2) The main characteristic of the ATS routes of the ARN Versions is to offer more routeing options to airspace users. These routes are based on principles of route network design and sectorisation independent from national boundaries, adapted to main traffic flows.

(3) An airspace structure built on the basis of an ATS route network and Free Route Airspace offers more flexibility to operators to choose from several strategically designed airspace structures (ATS routes and Free Route Airspace) of the ARN Versions.

(4) Improvements in the strategic design, planning and management of these two components improve the predictability of the route options. GAT and OAT requirements are accommodated by integrating them into the strategic ARN
developments through the application of Flexible Use of Airspace Concept principles.

(5) ATC sectors of the ARN Versions are adapted to main traffic flows and to an optimum route network and are, when required, independent from national boundaries. More ATC sectors are developed and made available, where required (including vertical divisions), in response to variations in demand and airspace availability. This work is conducted with the full involvement of States and ANSPs as it is their direct responsibility for the final design of ATC sectors supporting the route network structure and Free Route Airspace.

(6) To improve the design and management of terminal routes and ATC sectorisation servicing several airports in close proximity, a forward looking option will be the fusion of two or more terminal airspace structures, where required. This amalgam is described as a Terminal Airspace System (TAS) and could extend across national borders if operational requirements demand it.

3.2.6 Airspace Organisation

(1) The practical airspace organisation features of the ARN Versions are:

- **Multi-option route choice**: New route segments and Free Route Airspace will be added to the network. These additional airspace structures are compatible with the overall airspace structure. They include 24 hours choices, but also time limited choices. In the event of airspace restrictions caused by traffic density and/or ACCs/sector configuration or activation of segregated airspace, alternative re-routing options are available, through the design itself. The dynamic capacity/route use will be brought about by collaborative decision-making based on the pre-determined set of routing options.

- **Modular sectorisation**: To the largest possible extent and where required, sectors are established across national borders and in accordance with main traffic flows. They support the pre-defined airspace structures. Reconfiguration of pre-defined modules of airspace (sector modularity) helps adapting sector configurations to specific traffic flows.

- **Efficient Terminal/En-route interface**: Efficient structures based on segregated arrival/departure routes extending beyond the Terminal Airspace are part of the ARN Versions. Where incompatibilities arise, priorities are discussed and assigned depending on operational requirements to the en-route part or to the terminal structure.

3.2.7 Airspace Development Approach

(1) The process for developing an airspace structure is based, in most of the cases on the following sequence:

- **Determine the ATS Route Network or the Free Route Airspace** - improvement of the ATS route network or implementation of Free Route Airspace take into account users’ preferred routes and the inclusion of direct route segments to the largest possible extent whilst meeting military requirements;

- **Define the Sector Families** - areas containing specific air traffic flows and conflict areas which will consist of strongly interdependent sectors;

- **Define Sectors** - definition of the minimum operational elementary volume;
• **Define Sector configurations** - a combination of sectors best placed to satisfy the operational requirements (traffic demand, traffic pattern, staff) and airspace availability;

• **Define the Modus Operandi**

  **ATS Route Network**

The objective of ARN Versions is to provide Aircraft Operators with their preferred trajectories selected from within the route network, whilst ensuring that the capacity and safety targets defined by the sectorisation are met.

ARN Versions offer more route choices to aircraft operators when planning a flight. This involves improved access to the existing route network and the creation of new routes, including predefined direct routes available subject to time limitations or ASM conditions.

The ATS Route Network design criteria takes into account the need to create additional routes that did not exist in the previous network as they caused capacity problems during certain time periods. The ARN Versions introduce these new routes and make them available for use under specific pre-defined conditions that all airspace users are informed about. As a result, the most direct of the routes choices could be planned at certain times.

In other cases, choices need to be made by aircraft operators between the shortest route but with capacity constraints, a slightly longer route involving ASM solutions with no capacity constraints, or a longer route available with no airspace constraint.

Airspace users will, at a pre-determined time, make the decision on the choice of route based on up to date data as regards sector constraints and segregated airspace availability.

The creation of pre-defined direct routes subject to ASM conditions should provide benefit to military users since those could better respond to their requirements when a preferred route is available. This in turn leads to the implementation of a larger number of CDRs.

**Free Route Airspace**

ARN Versions provide an enabling framework for the harmonised implementation of Free Route Airspace in Europe. It is based on the FRA Concept developed in the context of the ARN Version-7.
Sectorisation

The development of ARN Versions takes into account the need to gradually implement Sector Families of interdependent sectors that can be clustered into logical Family Groups. In all the development projects, aspects related to areas of weak and strong interaction, were considered through the utilisation of supporting airspace design tools.

The criteria for determining Sector Families, Family Groups and elementary sectors were based on:

- an optimised ATS route network, integrating direct routes, Free Route Airspace, multiple route options, associated alternatives and military operational requirements;
- efficient connectivity with terminal airspace;
- design of elementary sectors with strong/complex interaction that require close co-ordination between controllers enabling continuous climb and descent operations, from ToD for CDO and to ToC for CCO, where possible;
- traffic density, conflict density and repartition, traffic profiles, nature of traffic (climbing/descending), crossing flows, close crossing points, etc.;
- operational considerations for lateral and vertical delineation;
- determining variable sizes of sectors with small/specialised low level sectors, deep medium sectors (for evolving traffic) and wider upper sectors;
- usage of modular techniques;
- time of flying within a sector family;
- several combinations of flexible sectors configuration were defined, depending on traffic flows;
- enabling sufficient distance for conflict resolution in all routeing options;
- maintaining route options, on the largest possible extent within the same sector family;
- iterative process for sectorisation considering route network modifications to enable the best possible sectorisation;
- the identification of zones of lesser complexity.
Modus Operandi

The Modus Operandi of the ARN Versions includes:

- The availability, in terms of time and FL, of route segments (including the direct route segments) or Free Route Airspace in line with constraints imposed by segregated airspace or by the need to better balance capacity and demand;

- The links between-route network, Free Route Airspace and sectorisation including conditions for availability of certain route segments or Free Route Airspace and their dependence on ATC sectors configurations to match traffic demand;

- Routing scenarios - including all pre-planned alternate routeings to compensate for the temporary unavailability or constraints imposed on the use of certain airspace structures;

- Structural constraints - notified constraints, such as, the activation of segregated airspace, sector capacity restrictions, specialised routes for specific traffic flows, profile constraints to skip sectors in a given configuration and modifying capacity depending on the sector configuration;

- Recommended practices - proposals derived from operational experience including the process for selecting sector configurations.

In the scope of development of airspace structure and its subsequent adaptations as major airspace changes are considered extensive changes to procedures or services which will impact international air transport. The examples of major airspace changes are:

- the introduction of new arrival and/or departure and/or instrument approach procedures at international aerodromes;

- the introduction of new ATS routes;

- the introduction of new sectorisation;

- the complete re-sectorisation vertically and/or laterally;

- the introduction of new Free Route Airspace with associated procedures;

- the significant changes (vertically and/or laterally and/or timely) in existing Free Route Airspace impacting the associated procedures.

3.2.8 Operating the ARN Versions

The rationale for the ARN Versions is to ensure that the ATS route network, Free Route Airspace and ATC sector planning allow for an improved balance between:

- freedom for GAT to choose between-route options, and select their preferred one;

- offering greater flexibility for OAT users through more efficient allocation of airspace;

- capacity management - relying on fine tuning of route adaptation to optimise the use of available capacity where limitations of capacity occur.
Local and Network documentation need to be amended, as required, to include, *inter alia*, the updated airspace structures, rules and procedures. Amongst these are:

- National AIPs;
- National ATC Regulations;
- LOAs;
- National ATM Military Documents;
- Airspace Management Handbook;
- IFPS Users Manual;

Flight planning procedures are continuously improved to account for the flexibility of route selections offered by ARN Versions. Further initiatives are under way to facilitate improved flight planning and route selection. Airspace users should expect more flexibility in the FPL handling based on planned IFPS system enhancements supporting a dynamic choice of route and/or the re-routeing process. ARN Versions support the use of DCT in the FPL within a consolidated concept and approach.

It is expected that operations within the ARN Versions will be facilitated through the deployment of the ADR that will ensure gradually an automated distribution of airspace availability information in order to provide all interested parties with a clear and accurate picture of the airspace structure situation.

ARN Versions enable a more flexible ATFCM system and will ensure the gradual transition towards a system responsive to capacity management. The addition of an optimisation process able to provide routeing alternatives to solve capacity and flight efficiency constraints, while maintaining the balance with airspace user costs, will enhance the current method of managing airspace capacity.

### 3.2.9 Military Operations

ARN Versions recognise and support the responsibilities and requirements of Military airspace users. In order that all airspace users gain benefit from ARN Versions, military airspace planners are part of the planning process. An organised collection of military airspace requirements is one of the specific elements that ARN Versions take into consideration.

Through the solutions proposed in ARN Versions, the military should be able to have:

- freedom to operate in all weather conditions in all areas of the European airspace;
- special handling in particular for priority flights and for time-critical missions, but also for military aircraft not fully equipped to the civil standard;
- the possibility of operating uncontrolled VFR flights;
- temporary airspace reservations, situated as close as practicable to the appropriate operating airfield;
- airspace restrictions for non-flight-related activities;
- a more dynamic airspace allocation system with enhanced FUA application.

ARN Versions support these requirements through greater flexibility in airspace use, efficient allocation of segregated airspace and associated re-routeing of
GAT. With a route network and sectorisation adaptable to traffic flow variations, there is scope for better application of the Flexible Use of Airspace.

3.2.10 Airspace Management Solutions

- General Principles

(1) The identification and development of ASM Solutions is a part of the ASM Improvements Initiative. ASM solutions form an integral part of ARN Versions. They include:

- Reviewing the different application of CDR categories at the different stages;
- Addressing the potential incompatibility of different CDR categories on segments of the same route with the stakeholders concerned;
- Reviewing and improving the design of CDRs in combination with modular TRA/TSA design;
- Improving the definition of ASM Solutions to be used at ASM level 2 and 3.

(2) The main objective of the ASM Solutions development is to identify hidden airspace capacity or flight efficiency directly related to the area of Airspace Management, i.e. civil-military requirement to use the same portion of airspace at the same time. This aims to improve existing practices in order to overcome capacity constraints and provide efficient flight operations of both, civil and military airspace users; as such it identifies airspace use scenarios that bring benefits to both civil and military airspace users. In the end, it provides for a credible process that balances the needs and requirements of all partners in airspace use and its management.

(3) To deliver extra capacity and flight efficiency, the current ASM processes and procedures related to a particular TRA/TSA are reconsidered, both in their design and associated airspace planning as well as allocation processes and procedures. The enhanced ASM processes will consider various levels of flexibility, either in time or in spatial location (vertical/horizontal), that are allowed by planned civil or military flight operations.

(4) Civil aircraft operators can have more efficient, less costly and delay-free operations even in some portions of airspace where today there is a capacity constraint. This is to be achieved through use of different CDR options associated with each modular configuration of a particular temporary reserved or restricted airspace portion.

(5) The military might need to request an enlarged airspace volume to meet the requirements of specific missions. To respond to this request a set of well-planned airspace scenarios adapted to different mission requirements concerning the airspace size (lateral and vertical) and timing will be available, thus eliminating any need for airspace overbooking.

(6) Air Navigation Service Providers’ participation in collaborative decision making on the implementation of a particular scenario related to a specific TRA/TSA will ensure that their needs to accommodate traffic demand are properly addressed.

(7) The final objective of the ASM Solutions development is to identify concrete and consistent solutions for identified hot-spots, i.e. an interactive civil-military solution. Next step is to extend the activity at sub-regional level by coordinating interaction between adjacent local options. The process of final ASM Solutions
development is expected to be carried out by civil and military partners responsible for a particular TSA/TRA.

(8) Subsequently, the coordination for definition and decision on the choice of different scenarios is planned to be extended to all those concerned, resulting in the most suitable sub-regional ASM Scenario.

(9) Last but not least, with this optimised local and sub-regional network response, the task of the Network Manager Operations Centre (NMOC) should be focused on the global network solutions that can lead, by judicious selection, to less ATFCM measures.

- **ASM Solutions Methodology**

(10) The traffic samples to be used in the initial scoping and identification of potential hot-spots, but equally later - when developing concrete ASM Scenario(s) - will be based on the Network Manager historical traffic data. Data on TRA/TSA booking will be derived from AUP/UUP/e-AMI information available; data on the actual TRA/TSA use will be acquired from various sources like CIAM and PRISMIL, or from national ASM tools.

- **Future Data Collection and Planning**

(11) The objective of this particular activity is to continually collect information and data on planned introduction and/or change in ASM-related airspace structures and arrangements, i.e. TRAs, TSAs, CBAs, manageability of D and R areas, cross-border airspace sharing arrangements. The information and data collected will enable the assessment and coordination of any planned introduction or change in collaborative manner, enabling consistent solutions planned by neighbouring States, but also at sub-regional (FABs) and European Regional level, thus enhancing the European Network performance. This approach was already agreed and put in place between the parties concerned.

- **Identification of areas of interest**

(12) Identification of Hot-Spots that have potential for capacity and/or flight efficiency improvements through an interactive civil-military solution will be constantly pursued in order to make use of the options made available through the ARN Versions.

(13) For the purpose of initial scoping and identification of potential benefits, the available ATS route traffic sample closest to the optimum will be considered as the reference, i.e. the least constrained by military activity or other events. It will then be compared against the traffic sample of the most intense day of civil and military activity. Choices of such traffic samples are dependent on the operational characteristics of the area studied.

(14) Aircraft Operators that may benefit from ASM/ATFCM scenarios will be involved in these processes at an early stage (through the appropriate cooperative decision making processes and working arrangements of the Network Manager), to ensure that benefits are realistic and ensure AO utilisation of the scenarios. Once the selected Hot-Spots are identified, the expected benefits will be analysed against potential solutions based on variation and combination of different parameters:

- **Vertical**

  A number of vertical configurations will be examined in the context of the cooperative decision making processes to identify any potential benefits
should the TSA/TRA concerned be dynamically managed. The main criterion will be to assess if a vertical move of the military activity contributes to the airspace capacity in a particular area.

- **Lateral**

  A number of lateral configurations, based on current and possible future airspace sub-modular design, will be investigated through the cooperative decision making processes. The solution calls for larger portions of airspace to be allocated (as appropriate) through activation of different sub-modules suitable to accommodate military requirements. Through this assessment one confirms whether solutions to (potentially) organise differently the airspace, in particular TSA/TRA, do exist.

- **Time-related**

  This refers to the possibility of increasing airspace capacity by accommodating both military and civil demand as close as possible to the planned time to use the airspace.

- **Conditional Routes**

  More conditional routes in a particular TSA/TRA will be investigated through the cooperative decision making processes as a function of different lateral TSA/TRA configurations to increase capacity and accommodate both military and civil requirements. The main principle will be that, except when the military requires using the whole TSA/TRA, different sub-module scenarios should accommodate both - the planned military activity and the civil traffic demand cross the TSA/TRA concerned. In theory, must provide for at least one CDR along the main traffic flow and within a particular TSA/TRA that can accommodate civil traffic.

(15) Following the steps described above a comprehensive initial impact assessment will be performed per each identified Hot-Spot candidate. This assessment is to facilitate the decision that the Hot-Spot identified qualifies to be proposed to potential partners for further work on future ASM Solutions in the particular TSA/TRA.

### 3.2.11 Network Enablers

(1) The main enablers for the efficient implementation of the ARN Versions are:

- System Support - Enhancement for the purposes of flight planning and ATFCM;
- Procedures - Enhanced procedures when necessary for operations within Free Route airspace and at its interfaces;
- Adaptations to airspace structures;
- Adaptations to airspace management procedures.

(2) Additional equipment requirements, if required, should be identified for aircraft operators.

(3) All these are developed in the context of the cooperative decision making processes of the Network Manager.

### 3.2.12 Connectivity with Adjacent Areas

(1) Through the RNDSG, the interfaces with adjacent areas are studied so they remain coherent and compatible. Liaison with adjacent States is constantly
made through relevant ICAO groups where the work undertaken by the RNDSG is presented through working and information papers. Similarly, States, ANSPs and the ICAO secretariat present updates to the RNDSG on airspace evolutions in adjacent areas. This good cooperation ensures a consistent airspace structure based on the continuum principle.

3.2.13 High Seas

(1) Flight Information Regions (FIRs) in the ICAO European Region extend over the sovereign territory of each State. Some States also have FIRs covering high sea areas, within the ICAO European Region, where the responsibility for the provision of Air Traffic Service has been delegated to them by ICAO.

*Note:* The status of the airspace over the high seas and the responsibilities towards it by the relevant States are clearly defined by Chicago Convention and its Annexes.

(2) Any changes of ATS routes or Free Route Airspace over the High Seas need to be coordinated through ICAO.
4 Deployment of PBN

4.1 Implementation of Performance Based Navigation

(1) ICAO’s Performance-based Navigation (PBN) Concept has replaced the RNP Concept; it was introduced through publication of the ICAO Doc 9613 PBN Manual in 2008. The PBN Concept is geared to respond to airspace requirements.

(2) To these ends, ICAO’s PBN concept identifies a component known as the **Navigation Application** which is enabled by two sub components: the **NAVAID Infrastructure** and the **Navigation Specification**:

- The **Navigation Application** identifies the navigation requirements resulting from the Airspace Concept such as ATS routes and Instrument Flight Procedures;
- The **NAVAID Infrastructure** refers to ground- and space-based navigation aids.
- The **Navigation Specification** is a technical and operational specification that identifies the required functionality of the area navigation equipment. It also identifies how the navigation equipment is expected to operate in the NAVAID Infrastructure to meet the operational needs identified in the Airspace Concept. The Navigation specification provides material which States can use as a basis for developing their certification and operational approval documentation.

(3) The updated 2012 edition of the PBN Manual contains eleven navigation specifications: four of these are RNAV specifications (see below, left) and seven of these are RNP specifications (see below, right).
4.2 The PBN Airspace Concept

The PBN Manual introduces the Airspace Concept as a formal way to set out and respond to airspace requirements. As such, the development of the Airspace Concept is a key step in PBN implementation. From an ANSP’s perspective, PBN is one of several enablers of the Airspace Concept. From an aircraft and air crew perspective, PBN clarifies and provides a uniform structure to requirements for airworthiness certification and operational approval for use of area navigation systems in airspace implementations.

An Airspace Concept describes the intended operations within an airspace. Airspace Concepts are developed to satisfy strategic objectives such as safety, capacity, flight efficiency or to mitigate environmental impact. Airspace Concepts include details of the practical organisation of the airspace and its operations as well as the CNS/ATM assumptions on which it is based. Practical organisation of the airspace includes the ATS route structure, separation minima, route spacing and obstacle clearance. Thus the Airspace Concept hinges on the airspace design. Once fully developed, an Airspace Concept provides a detailed description of the target airspace organisation and operations within that airspace and can, when complete, be anything from five pages in length (for extremely simple airspace changes) to a document of several hundred pages.
4.3 PBN Implementation

(1) The ICAO Resolution at the 36th Assembly and the publication of ICAO’s PBN Concept in 2008 effectively triggered the launch of PBN. The ICAO Resolution was a significant step in that it reflects international concordance as to high-level goals and ambitions for global uptake of PBN. It reads as follows:

- where RNAV operations are required, en-route (oceanic and continental) and terminal ATS routes should be implemented according to PBN by 2016, with intermediate milestones as follows:
  - en-route oceanic and remote airspace (RNAV 10 or RNP 4): 100 per cent implementation by 2010;
  - en-route continental airspace (RNAV 5, 2 and 1): 70 per cent by 2010, 100 per cent by 2014; and
  - terminal area (RNAV 1 and 2, and basic RNP1): 30 per cent by 2010, 60 per cent by 2014, 100 per cent by 2016; and
  - all instrument runway ends should have an approach procedure with vertical guidance (APV), either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014.

(2) The ICAO Resolution was updated at the 37th Assembly and marks a significant step in that it reflects international concordance as to high-level goals and ambitions for global uptake of PBN. Text from Resolution 37-11 is replicated in italics below.

The Assembly:

1. Urges all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the Performance-Based Navigation (PBN) Manual (Doc 9613);

2. Resolves that:
   a) States complete a PBN implementation plan as a matter of urgency to achieve:
      1) implementation of RNAV and RNP operations (where required) for en-route and terminal areas according to established timelines and intermediate milestones; and
      2) implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS), including LNAV only minima for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014; and
      3) implementation of straight-in LNAV only procedures, as an exception to 2) above, for instrument runways at aerodromes where there is no local altimeter setting available and where there are no aircraft suitably equipped for APV operations with a maximum certificated take-off mass of 5 700 kg or more;
   b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs, Procedures for Air Navigation Services (PANS) and guidance material including a global harmonized safety assessment methodology to keep pace with operational demands;

3. Urges that States include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway end serving aircraft with a maximum certificated take-off mass of 5 700 kg or more, according to established timelines and intermediate milestones;

4. Instructs the Council to provide a progress report on PBN implementation to the next ordinary session of the Assembly, as necessary;
5. Requests the Planning and Implementation Regional Groups (PIRGs) to include in their work programme the review of status of implementation of PBN by States according to the defined implementation plans and report annually to ICAO any deficiencies that may occur; and

6. Declares that this resolution supersedes Resolution A36-23.

4.4 PBN Airspace Implementation Steps

(1) This section provides guidance in the form of Activities for Airspace Concept development and implementation. **These activities are required to be performed, depending on the phase of development, at network, sub-regional/FAB or local level or by a combination of those levels.**

(2) There are **17 such activities**, clustered under the broad headings of Planning, Design, Validation and Implementation. Given that Airspace Concept development is driven by strategic objectives, it follows that the first Activity is triggered by operational requirements. These triggers are usually formalised in a Strategic Objective such as Safety, Capacity, Flight Efficiency, Environmental mitigation and Access. While some strategic objectives may be explicitly identified, others will remain implicit. Trade-offs and prioritisation of strategic objectives may be needed where there are conflicts between these objectives. Nevertheless, the maintenance of safety remains paramount and cannot be diluted by compromise.

(3) Airspace Concept development relies on sound planning prior to starting the Airspace Design, Validation and Implementation. Planning needs to be an in-depth (and therefore, quite a lengthy) process because sound preparation is one of the pre-requisites to successful Airspace Concept development. The other is iteration: development of the Airspace Concept is **not** a linear process but relies on several iterations and refinement.
Planning Phase

4.4.1 Activity 1 - Agree on Operational Requirements

Airspace changes are triggered by operational requirements. Examples of operational requirements include: the addition of a new runway in a terminal area (here the corresponding strategic objective may be to increase capacity at an airport); pressure to reduce aircraft noise over a residential area (this strategic objective is to reduce environmental impact over a particular area) or need to allow operations at an airport during low visibility conditions (i.e. improved access). Operational requirements tend to be reasonably high level and are often decided at a high managerial level.

<table>
<thead>
<tr>
<th>Strategic Objective</th>
<th>Operational Requirement</th>
<th>PBN Project Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase capacity</td>
<td>Addition of new runway</td>
<td>Design new RNP SIDs/STARs for new runway and adapt existing ATS Route network to PBN</td>
</tr>
<tr>
<td>Reduce environmental impact</td>
<td>Avoid noise sensitive areas at night and enable CDO from ToD and CCO to ToC (where possible)</td>
<td>Design of RNP SIDs/STARs and PBN procedures that specifically enable CCO and CDO</td>
</tr>
<tr>
<td>Increase flight efficiency</td>
<td>Use airspace users on-board capability</td>
<td>Develop ATS Route network based on Advanced RNP</td>
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<tr>
<td>Increase safety on Approach</td>
<td>Improve vertical profile enabling stabilised approaches</td>
<td>Introduce RNP APCH</td>
</tr>
<tr>
<td>Increase flight efficiency</td>
<td>Improve vertical interaction between flights to avoid unnecessary levelling off.</td>
<td>Redesign RNP SID/STAR interactions and move SIDs clear of holding areas.</td>
</tr>
<tr>
<td>Increase access</td>
<td>Provide alternative to conventional NPA</td>
<td>Develop RNP APCH Procedures</td>
</tr>
</tbody>
</table>

4.4.2 Activity 2 - Create the Airspace Design Team

In order to tackle the operational requirements an Airspace Concept will need to be developed, validated and implemented. Such an Airspace Concept, addressing all of the requirements, cannot be developed by a single individual working in isolation. Airspace Concepts, from inception to implementation, are the product of an integrated team of people working together: the Airspace Design Team (nonexclusive example shown below). Commonly, this team is led by an ATM specialist with an in depth operational knowledge of the specific airspace under review. This specialist will need to be supported by Air Traffic Controllers familiar with the airspace in question, ATM and CNS System specialists and Technical pilots from lead carriers operating in the airspace. Instrument flight procedure designers play an integral role in this team. The Airspace Design Team should also include environmental experts that are familiar with airspace design principles that enable optimised CDO from higher levels, and with tools that assess the potential environmental savings to be associated with different airspace / procedure designs.
4.4.3 Activity 3 - Decide Project Objectives, Scope and Timescales

(1) One of the first tasks of the airspace design team is to decide what the objectives of the airspace project are. **Project objectives** are easily derived from the operational requirements which have triggered the project. For example, if the project is triggered by need to reduce noise impact over a residential area, the (airspace) project objectives would be linked to noise reduction (reduce the noise footprint over Village X, by designing new SIDs/STARs, for example).

(2) Deciding **project scope** can be much more challenging. Experience has shown that the definition of a project’s scope and remaining within the limits of that scope can be extremely difficult. As such, scope ‘creep’ is a project risk in almost every project and it often causes the failure of projects. Once the scope of the project has been decided, it is important to avoid extending the project objectives (if at all possible) as this invariably results in a need to increase the scope which causes cost overruns and delays. For this reason it is critical to decide what needs to be done to achieve the project objectives and to agree - and stick to - a specific body of work to reach those objectives. The project’s **scope** is very much a function of how much **time** and **resources** are available to complete the project.

(3) Two possibilities exist as regards available time: either the team decides its implementation date based on all the work that needs to be completed or the implementation date is fixed beforehand and the team’s challenge is to fit the work into the available time available. **Resources, Time and Scope** are the three sides of the project planning “triangle”.

(4) Whilst in their daily lives controllers are accustomed to having a very short interval between planning and execution, the timing element on airspace projects can be the trickiest to manage. Take, for example, a case where an aircraft concept has unexpectedly identified the need for a new DME to provide coverage throughout a terminal airspace.

(5) The installation and commissioning for use of an additional DME could take up to two years to achieve given if one considers the need to find an available frequency and that it may be necessary to find a location (and perhaps build an access road and provide a power supply); procurement processes for the equipment can be lengthy, as can the delivery time, civil works needed to build the site, installation, calibration both ground and flight check until final commissioning for use by the CAA.
(6) Enablers to support this phase may be available in the form of impact assessment guidelines e.g. those contained in the SESAR Environmental Assessment Process document - SESAR Deliverable D4.0.080.

4.4.4 Activity 4 - Analyse the Reference Scenario - Collect Data

(1) Before starting the design of the new Airspace Concept, it is important to understand and analyse existing operations in the airspace. These existing operations may be called the Reference Scenario. The Reference Scenario includes all existing ATS Routes, SIDs/STARs, airspace volumes (e.g. TMA), ATC sectorisation, the air traffic data and as well as all the inter-centre and inter-unit coordination agreements. Description and analysis of the Reference Scenario is a crucial exercise - a step not to be missed. This is because analysis of the Reference Scenario in terms of the project’s performance indicators, (1) makes it possible to gauge how the airspace is performing today; (2) allows the airspace design team to know with certainty what works well in an airspace, and hence should be kept, and what does not work well and could be improved; (3) by fixing the performance of the Reference Scenario, a benchmark is created against which the new Airspace Concept can be compared. Use of this benchmark makes it possible to measure the performance of the proposed Airspace Concept. It also becomes possible to establish whether the Safety and Performance criteria of the new Airspace Concept have been achieved.

![Diagram](Image)

(2) In some (rare) instances, the targeted Airspace Concept may be so different from the Reference Scenario that a comparison is not possible. This would be the case, for example, where a new airport is to be built with a new terminal airspace surrounding it. If, in such a case this new airport were intended to replace or complement existing operations at another terminal area, it could prove useful to compare the performance of the existing versus the new terminal area.

4.4.5 Activity 5 - Safety Policy, safety Plan and Selection of Safety and Performance Criteria

(1) A regulator’s Safety Policy drives a service provider’s Safety Plan and enables Safety Criteria to be identified. For the Airspace Design team, the crucial question speaks to the criteria to be used to determine the adequate safety of the PBN-based Airspace Concept. As such, the Airspace Design team must decide upon the safety criteria to be used, as determined by the Safety Policy. This Safety Policy will normally be set externally to the project but if it does have to be established by the project team it is vital that it is agreed at highest level early in the developments. Safety criteria may be qualitative or quantitative (often a mix of both is used). The Safety Policy has to be known at the outset of the project. Safety Policy concerns itself with questions like:

- Which Safety Management System?
• Which Safety Assessment Methodology?
• What evidence is needed that the design is safe?

(2) Support and guidance from the regulatory authorities at this stage is extremely beneficial and therefore they are recommended to be involved in the Implementation team. The in-depth analysis of the Reference Scenario in Activity 4 provides direct input to the new Airspace Concept of the project being undertaken. In deciding the project’s objectives and scope, it is necessary to know how a project’s success can be measured in terms of performance.

(3) For example, the project may be considered to be a success when its strategic objectives are satisfied. So - if the strategic objectives are to double the throughput on runway X, if this is demonstrated in a real-time simulation of the (new) Airspace Concept, this is a strong indication that the project will satisfy this performance criterion.

4.4.6 Activity 6 - Agree on Enablers, Constraints and ATM/CNS Assumptions

(1) For the Airspace Concept to be realised, the technical operating environment needs to be agreed. This requires knowledge, as regards the ground infrastructure and airborne capability, as to which CNS/ATM enablers are already ‘available’, the limitations or constraints which exist and what the future environment will be when the Airspace Concept is implemented: the assumptions. Whilst enablers and constraints are usually not difficult to establish, agreeing assumptions can be challenging. Their 'realism' is important because the airspace concept which is designed and the PBN specification(s) used as a basis for that design relies on these assumptions being correct.

(2) ATM/CNS assumptions cover a wide field and need to take account of the expected environment applicable for the time when the new airspace operation is intended to be implemented (e.g. in 20XX).
(3) General assumptions include, for example: the predominant runway in use within a particular TMA; the percentage of the operations which take place during LVP; the location of the main traffic flows; (in 20XX, are these likely to be the same as today? If not how will they change?); the ATS Surveillance and Communication to be used in 20XX. (Should any specific ATC System aspects be considered e.g. a maximum of four sectors are possible for the en-route airspace because of software limitations in the ATM system.

- **PBN Assumptions & Enablers 1/2: Fleet Mix and airborne Navigation Capability**

Traffic assumptions are of crucial importance to the new Airspace. First, the traffic mix must be known: what proportion is there of jets, twin turboprops, VFR single-engine trainers etc., and what are their ranges of speeds, climb and descent performance. Understanding the fleet mix and aircraft performance is important to any airspace concept development, but in a PBN Implementation context, traffic assumptions related to **fleets navigation capability are the most significant**. This is because the predominant navigation capability in the fleet provides the main indicator as to which ICAO navigation specifications can be used as the basis for designing the airspace concept to make the PBN Implementation **cost effective**.

A **Cost Benefit Analysis (CBA)** is an effective way of determining whether the design of PBN ATS routes (incl. SIDs/STARs and instrument approach procedures) will be cost effective. (The NAVAID Infrastructure costs are also integral to a Cost Benefit Analysis and are discussed below). Particularly when an airspace mandate is envisaged, the higher the number of aircraft
already qualified for the intended navigation specification, the lower the retrofit costs and benefits can be realised more quickly. But high fleet equipage with a particular functionality is only helpful if ALL the functionalities associated with the targeted navigation specification are also widely available in the fleet. This means that for PBN implementation to be cost effective, the majority of the fleet should have all the capability required in the navigation specification intended for implementation. Partial qualification for a navigation specification is not possible. An equipage questionnaire culminating in a graph such as the one below (a 2010 European Avionics Survey) is a useful tool for analysing fleet capability.

In undertaking such an analysis it is equally important to determine what area navigation system upgrades are expected in the period up to implementation; these may affect the implementation date and significantly impact the Cost Benefit Analysis. The certification of a specific RNAV capability and maintaining pilot currency in the operation of that capability is costly for the operator. As a result, especially with regional operations, operators will only seek approval sufficient to meet the existing navigation requirements for the airspace. The (new) Airspace Concept may require functionality present in the software but not specified in the existing certification. While it will cost operators to gain approval and undertake the pilot training for this new functionality, the cost is likely to be significantly less than if the aircraft required retrofitting with new equipment or software as well as having an adverse effect on implementation timescales.

**Focusing the fleet analysis for selection of a potential Navigation Specification**

The PBN Manual makes it clear that the ICAO navigation specifications cover certain flight phases. For Terminal operations, for example, there are essentially three available navigation specifications i.e. RNAV 1, RNP 1 and Advanced RNP.
The PBN Manual also explains that certain RNP specifications can be 'augmented' by additional functionalities such as Radius to Fix (RF). So if the airspace concept is for a complex, high-density airspace where routes are to be placed in close proximity, an RNP specification with some extra functionalities are more likely to provide that extra design capability. So in such a case, the fleet analysis could, from the outset, be probing for fleet equipage related to functionalities associated with either/both the Advanced RNP or RNP 1 functionalities thereby focusing the fleet analysis. The Table below shows the ICAO navigation specifications (with equivalent European specifications) and permitted additional functionalities.

<table>
<thead>
<tr>
<th>Navigation Specification</th>
<th>Additional Functionalities (Required or Optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>En-route Oceanic/Remote</strong></td>
<td><strong>Flight phase</strong></td>
</tr>
<tr>
<td>RNAV 10</td>
<td>15 5 5</td>
</tr>
<tr>
<td>RNAV 5</td>
<td>2 2</td>
</tr>
<tr>
<td>RNAV 2</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>RNAV 1</td>
<td>2 2</td>
</tr>
<tr>
<td>RNP 4</td>
<td>2 2</td>
</tr>
<tr>
<td>RNP 5</td>
<td>2 2</td>
</tr>
<tr>
<td>Advanced RNP</td>
<td>2 2</td>
</tr>
<tr>
<td>RNP APCH</td>
<td>2 2</td>
</tr>
<tr>
<td>RNP APCH AMC 20/26/27</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>RNP 0.3</td>
<td>0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3</td>
</tr>
</tbody>
</table>

Notes:
1. Only applies once 50m (160ft Cat H) obstacle clearance has been achieved after the start of climb.
2. RNAV 5 is an en-route navigation specification which may be used for the initial part of a STAR outside 30 NM and above MSA.
3. The RNP 1 specification is limited to use on STARs, SIDs, the initial and intermediate segments of instrument approach procedures and the missed approaches after the initial climb phase; beyond 30 NM from the airport reference point (ARP), the accuracy value foralerting becomes 2 NM.
4. Advanced RNP also permits a range of scalable RNP lateral navigation accuracies – see Part C, Chapter 4, para 4.3.2.3.3.4.
5. Optional – requires higher continuity.
6. There are two sections to the RNP APCH specification; Part A is enabled by GNSS and Baro VNAV, Part B is enabled by SBAS.
7. RNP 0.3 is applicable to RNP APCH Part A. Different angular performance requirements are applicable to RNP APCH Part B only.
8. The RNP 0.3 specification is primarily intended for helicopter operations.

- **PBN Assumptions & Enablers 2/2: NAVAID Infrastructure availability**

The NAVAID Infrastructure is comprised of all navigation aids permitted by PBN, be they ground or space based. NAVAIDs transmit positioning information which is received by the appropriate on-board sensor providing input to the RNAV or flight management system/navigation computer. The aircrew in combination with the Flight Management System (FMS)/RNAV or RNP system enables path steering to be maintained along a route within a required level of accuracy.

**Ground-Based (or terrestrial NAVAIDs)** permitted for use with navigation specifications include DME, and to a more limited extent VOR. NDB is not a PBN positioning source.

**Space spaced NAVAIDs** are synonymous with GNSS (including augmentation systems). Existing operational GNSS constellations include GPS (USA), GLONASS (Russia) with the following under development: Galileo (EU), Compass / Beidou (China) and QZSS (Japan). Augmentation systems include wide-area and local area augmentations (termed Space
Based Augmentation System or Ground Based Augmentation System, SBAS and GBAS, respectively). Wide-area augmentations are included in PBN; operational GNSS augmentations in use today include EGNOS (Europe) and WAAS (US). Gagan (India), MSAS (Japan) and SDCM (Russia) are under development.

One of the original aims of PBN is to permit aircraft to use any available sensor (e.g., navigation aid and/or aircraft integration with IRU, inertial reference unit). In practice however, this freedom of choice is increasingly limited by the performance requirements for a particular navigation specification, e.g., only a specified set of sensor combinations has been determined suitable to achieve the performance requirements of a specific navigation specification. On the NAVAID infrastructure side, this means that for each aircraft sensor choice offered, suitable navigation facilities need to be available in the desired coverage volume.

Each navigation specification stipulates which positioning sensor may be used for a particular navigation application, as can be seen from the table on the next page. The table shows that the only navigation specification with full sensor flexibility is RNAV5. The flexibility gets reduced the more demanding the navigation specification becomes. The table also shows that only GNSS is able to meet the requirements of any navigation specification. Because GNSS is available globally, it is essential to make GNSS available for aviation use. The steps required to do this are described in detail in the ICAO GNSS Manual (ICAO Doc 9849). However, as is shown in the figure above listing avionics capabilities, not all airspace users are currently equipped with GNSS.

Consequently, matching up the local fleet avionics capability with a particular navigation specification requires that infrastructure is available to support all potential airspace users. Specifically, Air Navigation Service Providers should provide VOR/DME infrastructure for RNAV 5, and DME/DME infrastructure for RNAV 5, RNAV 1 and potentially also RNP specifications. However, if it was cost prohibitive or impractical (terrain limitations etc.) to provide a specific type of infrastructure coverage, then this limitation of sensor choice will need to be declared in the AIP, with the consequence that airspace users which do not have the required sensor combination could not use those routes or procedures. Aligning airspace requirements with aircraft PBN equipage and available NAVAID infrastructure is the interactive process implied by the PBN triangle. Normally it is the navigation aid engineering department which performs the assessment of available infrastructure, in cooperation with procedure designers and flight inspection services. If facility changes are required to enable a certain application, such as the installation of a new DME or the relocation of an existing facility, sufficient lead time is required. Consequently, this interaction should take place as early as possible to determine the initial feasibility of the infrastructure to meet airspace requirements. The input that is needed for this activity from airspace planners is which type of coverage is needed in which geographic area (horizontal and vertical dimensions). In setting those requirements, it should be remembered that providing terrestrial NAVAIDs coverage is increasingly difficult at lower altitudes.
Traffic Assumptions (1) - The Traffic Sample

The traffic sample for the new Airspace Concept is of critical importance as is the knowledge of the fleet itself. This is because the placement of routes (be they ATS routes, SIDs/STARs or Instrument Approach Procedures) is decided with a view to ensuring maximum flight efficiency, maximum capacity and minimum environmental impact. In a terminal area, for example, SIDs and STARs/Approaches provide the link between the major en-route ATS routes with the active runway (hence the importance of knowing the primary and secondary runway in use).

A traffic sample for a new Airspace Concept is usually a future traffic sample i.e. one where certain assumptions are made about the fleet mix, the timing of flights, and the evolution of demand with respect to both volume and traffic pattern. Various models are used to determine air traffic forecasts, e.g. the econometric model, and it is not surprising to note that the success of an airspace design can stand or fall on its traffic assumptions. Despite ATC’s intimate knowledge of existing air traffic movements, the future traffic sample for 20XX must be thoroughly analysed (in very futuristic cases, it may even be necessary to create a traffic sample). Invariably, certain

<table>
<thead>
<tr>
<th>NAVAID → /NAV SPEC↓</th>
<th>GNSS</th>
<th>IRU</th>
<th>DME/ DME</th>
<th>DME/ DME/ IRU</th>
<th>VOR/ DME</th>
</tr>
</thead>
<tbody>
<tr>
<td>RNAV 10</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNAV 5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RNAV 2 &amp; 1</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNP 4</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNP 2</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RNP 1</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Advanced RNP</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>RNP APCH/ APV Baro</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNP APCH/LPV</td>
<td>✓</td>
<td></td>
<td>+</td>
<td>SBAS</td>
<td></td>
</tr>
<tr>
<td>RNP AR APCH</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNP 0.3</td>
<td>✓</td>
<td></td>
<td></td>
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</tbody>
</table>

The above table has been formulated from the ICAO Navigation Specifications in the PBN Manual (though naturally a local implementation would specify acceptable sensors). Tick (Pink Background), sensor mandatory; Tick (Green Background), Sensor use subject to ANSP requirement & aircraft capability; Tick (clear background), Sensor optional.
characteristics will be identified in the traffic sample e.g. seasonal, weekly or
daily variations in demand changes to peak hours and relationship between
arrival and departure flows (see diagram below).

Once the main assumptions are known, it is time to design the airspace. For
both en-route and terminal airspace, the design of airspace is an iterative
process which places significant reliance on qualitative assessment and
operational judgement of controllers and procedure designers involved from
the outset in the design.
Airspace Design Phase

(1) For both en-route and terminal airspace, the design of airspace is an iterative process which places significant reliance on qualitative assessment and operational judgement of controllers and airspace/procedure designers.

(2) Once Activity 6 is complete, it is time to design the airspace which, in ECAC has extensive surveillance and communication coverage. The availability of independent surveillance (i.e. Radar as opposed to ADS-B only) across most of the European continent means that the airspace design benefits more from PBN than would be the case in an airspace without radar surveillance. PBN allows, particularly in the terminal areas repeatedly used radar vectoring paths to be replicated with RNAV or RNP SIDs/STARs thereby reducing the need for controller intervention.

(3) The reliance on navigation performance through a navigation specification as the basis of ATS route placement is important. Whilst airspace planners know that connectivity between en-route and terminal routes must be assured, if a different navigation specification is required in en-route airspace to the one used for SIDs/STARs, the route spacing possibilities in en-route and terminal can be different requiring a transition area where the route spacing is adjusted. Consequently, PBN-based ATS routes whether in the en-route or terminal need to be fully integrated and an understanding of plans/strategies in the connecting airspace is required.

(4) For terminal airspace changes the procedure designer shall participate in the conceptual design led by the operational controllers. Whilst the operational controllers seek the best route placement from an efficient ATM perspective, procedure designers provide input as regards obstacles and aircraft performance.

(5) Airspace design usually follows this order for PBN implementation:

- First the SIDs/STARs and ATS Routes are designed conceptually; (Activity 7)
- Second, an initial procedure design is made of the proposed traffic flows (Activity 8) [this paves the way for finalising the Procedure design in Activity 12].
- Third, an overall airspace volume is defined to protect the IFR flight paths (e.g. a CTA or TMA) and then this airspace volume is sectorised (Activity 9);

(6) As suggested by the diagram below, Activities 7 to 9 do not follow a linear progression. Iteration is the key to the success of these three activities; the moving forwards and backwards between the activities until finally the airspace design is sufficiently mature to make it possible to move on to Activity 10 onward.
4.4.7 Activity 7 - Airspace Design - Routes and Holds

(1) The conceptual design of traffic flows (which ultimately become the future the SIDs/STARs and ATS Routes) is the starting point of this exercise. This is an analytical & iterative process (which can be done with paper and pencil). Route placement is usually determined by the traffic demand, runways in use and strategic objectives - and, to a greater or lesser extent, the airspace reservations and their flexibility. Route spacing is determined by the operational requirements and the navigation approvals of the aircraft fleet determined in Activity 6. For example: if a 10 - 15 NM route spacing is intended in an en-route airspace where Radar surveillance is provided (as in European airspace) there is a requirements for the fleet to be approved to RNAV 5 as determined during Activity 6. As such, the intended route spacing and CNS infrastructure indicate that PBN (in this case an RNAV 5 specification) is needed. If RNAV 5 equipage is needed but the fleet does not have this capability, then it becomes necessary to decide whether to mandate RNAV carriage or whether to widen the route spacing associated with a less demanding navigation specification.

**Note 1:** Airspace Concepts and their generic route spacing (determined by ICAO’s Separation and Airspace Safety Panel (SASP)) are published in an Appendix to Volume II of the PBN Manual as well as Chapter 5 of the ICAO Doc 4444 PANS-ATM.

**Note 2:** the role of the procedure designer in the terminal airspace route description and placement is of crucial importance. This specialist advises the team whether the intended routes match the navigation assumptions and can be designed in accordance with obstacle clearance criteria (Activity 6).

(2) One of the greatest advantages of PBN is that ATS Routes, SIDs/STARs and instrument approach procedures do not have to pass directly over ground-based NAVAIDs. PBN makes it possible to place routes in the most optimum locations provided the necessary coverage is provided by the ground or space-based NAVAIDs. It means that routes can be placed where they give flight efficiency benefits by, for example, avoiding conflicts between flows of traffic. Similarly, routes can be designed to provide shorter route length or vertical windows supporting continuous descent or climb operations enabling more fuel efficient profiles with reduced environmental impact (noise CO2 emissions, etc.). It also means that parallel routes can be designed to avoid having bi-directional traffic on the same route and to provide various route options between same origin and destination airports. Most significantly, perhaps, this placement benefit provided
by PBN makes it possible to ensure efficient connectivity between en-route and terminal routes so as to provide a seamless (vertical) continuum of routes.

Key to obtaining these advantages (particularly in a terminal airspace) is the need for arrival and departure routes (STARs(IFPs and SIDs) to be designed as a function of the interaction between them as well as servicing the traffic's desired track and ensuring obstacle clearance. Route placement for PBN does not negate best practices in route design developed over decades.

**Note:** In the text which follows, ATS routes refer to those routes usually designated as per Annex 11, Appendix 1 (e.g. UL611), whilst the undefined expression ‘terminal routes’ generally refers to instrument approach procedures (IAPs) and arrival/departure routes (SIDs/STARs) designated in accordance with Annex 11, Appendix 3 (e.g. KODAP 2A).

- **Free Route Airspace**

  Increasing use is being made of Free Route Airspace in some part of the European airspace. From a PBN perspective, the main difference between Free Routes Airspace and fixed ATS route network is that fixed ATS routes are published in the AIP as they are predetermined in advance. Publication of an ATS route means that an ‘airway record’ can be created for loading in the RNAV or RNP system database by the (aeronautical) data houses. Airway records have particular attributes associated with them, such a specific navigation accuracy required along a flight segment e.g. RNP 1, or a particular way of executing a turn at a waypoint along the route (e.g. using Fixed Radius Transition). Without the airway record such attributes cannot necessarily be associated with a flight segment so ‘reliance’ on a ‘prescribed’ navigation specification in free route airspace is not necessary.

- **Continental ATS Route planning**

  ATS routes should form a network that is planned at continental, regional or area level as appropriate. This invariably results in a more efficient route network and avoids the potential conflicts between traffic flows i.e. a regional or continental approach to ATS route planning ensures that route in one direction from one area to a waypoint do not meet a route coming in the opposite direction from another area to that same waypoint. As a general rule, uni-directional routes are better than bi-directional routes,
from an ATM perspective. A parallel system of routes across a continent can provide great benefits in that it is possible to segregate traffic or balance traffic loads on different routes. When creating a parallel route system, care must be taken where the ATC sector lines are drawn when it comes to balancing the ATC workload. In most route spacing studies, the assumption is made that the parallel routes will be contained in the sector of a single controller i.e. the ATC sector line is not drawn between the two routes. This means that if it became necessary to draw a sector line between the parallel routes in order to control ATC workload, the implementation safety assessment would have to address this reality and it may prove necessary to increase the spacing between the two routes.

- **Terminal routes leaving/joining Free Route Airspace or ATS Route Network**

Continental traffic flows which service multiple origin and destination airports are best segregated where possible from the terminal routes to/from airports. This is to avoid mixing overflying traffic with climbing and descending traffic, fixed en-route ATS routes and/or free route trajectories. Such segregation may result in a potential reduction in the vertical flight efficiency of the climb and descent profiles. In such cases, simulations evaluating the effect of random variations of input variables are useful in evaluating likely trajectories and can therefore be used to assess trade-offs of various options based on specific cases and locations.

- **Climb and Descent profiles of Terminal Routes**

Whilst operators, environmental managers and procedure designers consider the placement of each SID/STAR and IAP in terms of flight efficiency, environmental mitigation and safety (obstacle clearance/flyability), ATC has to manage all traffic along the routes as a package. As such, the airspace design from an ATC perspective, needs to address the interaction between arrival and departure flows of STARs/IAPs and SIDs. Different objectives such as flight efficiency, environmental mitigation, safety and air traffic management are not mutually exclusive. It is possible to design terminal routes and achieve most of the (apparently conflicting) objectives. However, care must be taken in choosing the crossing points between departure and arrival routes. The crossing point of SIDs and STARs should not constrain arriving or departing aircraft (hence, knowledge of aircraft performance is essential).

As fleet mixes may change, the crossing points of departure and arrival routes should be regularly assessed to ensure that any restrictions are kept to a minimum and do not have an adverse impact upon vertical flight efficiency. The procedure designer along with operational pilots provides most of the aircraft performance data to the airspace design team. With
PBN, some navigation specifications provide extra confidence in the vertical as well as the lateral planes and the use of these additional requirements can be of benefit in the airspace design.

When designing airspace, consideration should be given to designing a sectorisation that enables an adherence to good practice principles of procedure design, inter alia:

- Procedure design should include the design of approach and departure routes together - simulations evaluating the effect of random variations of input variables are useful in evaluating likely trajectories and can therefore be used to optimize crossing points / levels as well as the trade-offs of various choices based on specific cases and locations. Where level flight is required for crossing tracks, this should be as high as practicable;

- Whilst each case may be considered different, where aircraft types are similar, in a conflict situation, priority should be given to maintaining a continuous descent for the arriving aircraft as opposed to continuous climbing climb for a departing aircraft which is contrary to current guidance material. This is because fuel penalties at lower FLs are higher when the aircraft is lighter, i.e. when landing. Fuel penalties for flying at non-optimal FLs are much less when aircraft are heavy so levelling off a climbing aircraft has less fuel burn impact on that aircraft than when the aircraft is lighter. In addition, the climbing aircraft will travel the rest of the flight with less weight (hence less fuel burned due to the lower weight), due to the extra fuel burned, so the effect is minimised on the climbing aircraft;

- Approach routes should follow the optimum idle descent path of the most common aircraft profiles for each individual runway bearing in mind aircraft weights, prevalent winds, temperatures, speed schedules and optimum descent angles etc. Rule of thumb are available for supporting descent route creation;

- Optimum profile calculators may be used during procedure design to indicate minimum / maximum average FLs over certain points based on the descent profiles of different aircraft types;

- There is a need to be flexible when designing an approach procedure - airspace and procedure design usually takes into account a workable solution for traffic peaks but may hamper optimised profiles during non-peak periods;

- When such peak / non-peak periods are determinable, solutions may be found to make available optimised descent profiles during specific times / days / seasons or under specified conditions;

- The FMS logic of all manufacturers, especially Airbus and Boeing, should be taken into account when creating altitude windows in approach procedures - some FMSs may delete ‘unnecessary constraints above, at and even below CFL’. This is because any constraints above the cruising level are deleted whilst the upper limit of a constraint window will also be deleted if it is located above the cruising level.
The sample graph below shows that for particular (blue) climb gradients - 3%, 7% and 10% - and particular (red) arrival profiles - with specific speed assumptions - unconstrained arrival and departure profiles would seek to occupy the same level at various distances from the runway.

For example: if a departure on a 7% climb gradient (marked on graph) had travelled 24 track miles from the departure end of the runway (read on lower X axis) when it crossed the arrival on a 3° slope which was at 36 track miles from the runway (read on upper X axis), both aircraft would be in the region of 11,000 feet AMSL. So choosing this crossing point would not be efficient because it would restrict the departure's continuous climb and the arrival's continuous descent.

- **Pressure cooker (with holds) vs. extended routeings (without holds)**

There tend to be two predominant ‘models’ used in the design of busy terminal airspaces with ATS surveillance. The first can be compared to a pressure cooker where a number of holding patterns are spread geographically at a similar distance from the landing runway (nominally, at four ‘entry points’ to the terminal area). These holding patterns keep the pressure on the terminal airspace by feeding a continuous stream of arriving traffic from the holding stacks to the arrival/approach system with departures threaded through the arriving traffic.

The second model is more ‘elastic’ in that, in order to avoid holding aircraft, (sometimes extensively) longer terminal arrival routes are designed to the landing runway.

Sometimes a third model is used which is a hybrid of these two.

The advantages and disadvantages of each system can be extensively debated. Some contend that in the end the track miles flown by arriving aircraft are more or less the same irrespective of the model used, which may be true in given circumstances. However, when aiming to facilitate continuous descent, linear extensions on extended routing may provide the pilot with greater ability to plan the descent profile and hence provide benefits over holding, especially at lower altitudes.
- **Open vs. Closed procedures**

PBN makes it possible to design closed or open procedures. Although ‘Open’ or “Closed” procedures are not ICAO expressions, they are increasingly in common use. The choice of open or closed procedure needs to take account of the actual operating environment and must take into account ATC procedures.

Open procedures provide track guidance (usually) to a downwind track position from which the aircraft is tactically guided by ATC to intercept the final approach track. An open procedure will require tactical routeing instructions to align the aircraft with the final approach track. This results in the area navigation system to being able to descend only to the final point on the procedure and, where path stretching is applied by ATC, will impact the ability of the area navigation system to ensure a continuous descent profile.

Radar vectored open-path STARs give great flexibility in keeping a high runway throughput which is typically required in high density traffic environments therefore they will provide more ATC capacity than closed-path STARs however they also require more tactical ATC interventions. For more information see paragraph 5.4.4.

Closed-path procedures provide track guidance right up to the final approach track whereupon the aircraft usually intercepts the ILS. Closed STAR procedures can be pre-programmed into the FMS and published in the AIP. The closed STAR procedure therefore provides the pilot with a defined distance to touchdown thus supporting the area navigation’s systems execution of the vertical profile. Where multiple arrival routes are operated onto a single runway using closed STARs, a strategic and tactical sequence of aircraft is required to ensure that safety is maintained in the case of aircraft automatically making a final approach turn into the direction of other arriving aircraft on different routes. Closed procedures however, can be designed and published in a manner that anticipates alternative routeing to be given by ATC on a tactical basis. These tactical changes may be facilitated by the provision of additional waypoints allowing ATC to provide path stretching or reduction by the use of instructions ‘direct to a waypoint’. However, these tactical changes, needed to maximise runway capacity, may impact on the vertical profile planned by the area navigation system.

The ideal closed path design is one with the minimum amount of distance flown, with no speed or altitude restrictions so that each aircraft can fly its optimum descent profile and is therefore the optimum procedure for enabling CDO.

In the case that tactical changes are instructed by ATC, the provision of regular and accurate distance to go (DTG) information from ATC to the pilot is essential to enable the pilot to optimise the descent profile. For more information on closed STARs, see paragraph 5.4.3.
Specific Techniques

Continuous Descent and Climb Operations are pilot techniques, facilitated by airspace design and procedure design and enabled by ATC. They can provide significant fuel burn savings for aircraft, a reduced environmental impact together with enhanced flight efficiency. CCO and CDO may be directly enabled by PBN and the ability to design an ATS route structure and procedures that enable CCO / CDO to / from a high level, to the optimum extent possible.

Road maps for the implementation of CCO and CDO are available in the ICAO manuals on CDO and CCO (ICAO Doc 9931 and Doc 9993, respectively). These roadmaps, when aligned with into the airspace design process, will support the integration of CCO and CDO implementation into the airspace change.

4.4.8 Activity 8 - Initial Procedure Design

(1) During the design of the arrival and departure traffic flows, the procedure designer begins the initial procedure design based on PANS-OPS (ICAO Doc 8168) criteria. This preliminary design considers various perspectives:

- It is necessary to determine whether the placement of the proposed routes is feasible in terms of turns and obstacle clearance, for example. For this analysis, local Instrument Flight Procedure design expertise is crucial because only he or she has the local knowledge of terrain and obstacles as well as the training to determine whether the intended procedures can be coded using ARINC 424 path terminators (applicable to RNAV SIDs and STARs). If these routes are not feasible from a procedure design perspective, they need to be modified (this is an example of an iteration between Activity 8 and Activity 7);

- Another analysis which must take place is to see whether the fleet capability identified in Activity 6 actually meets the requirements of the intended design of Routes and Holds completed in Activity 7. Here again, great reliance is placed on the procedure designer and technical pilots included in the team, because if there is no match, the routes and holds will have to be modified with aircraft capability in mind;

- Consideration must also be given to the NAVAID Infrastructure: if the navigation specification identified in Activity 6 requires GNSS and/or DME/DME and the identified fleet capability identified suggests that most aircraft have DME/DME without GNSS, the intended design may generate a requirement for an additional DME. In such a case, the need for an additional DME could cause a delay to the project implementation date (because procurement of the necessary land and installation/calibration of a DME can take time). Alternatively, the conceptual routes and holds may
have to be re-designed so as to exclude the need for an additional DME; this could mean a significant change to the airspace concept.

**Consultation with Airspace Users**

At this point of the design process, before designing the structures and sectors, is an opportune - and very necessary - moment to undertake a formal consultation with a wider audience of airspace users. Such consultations can either take place bilaterally between the team and different users, but it is often more beneficial to organise an event where several users are present and the route design is discussed with them as well as the work done on the Cost Benefit Analysis (activity 6), the fleet analysis and the actual placement of the route from activity 7 and 8. Such consultations are integral to the partnership approach advocated by PBN. *Every stakeholder* needs to be included and to be on-board in order to ensure buy-in and the success of the implementation.

### 4.4.9 Activity 9 - Airspace Design - Structures and Sectors

1. For completeness, mention is made of the non-PBN aspects of airspace design which occur after the routes have been designed and the navigation analysis of the design is complete: first, the design of the airspace volumes followed by the sectorisation of the airspace volume. Significantly, both of these design activities occur after the ATS and Terminal routes have been completed.

2. It is generally undesirable to design the routes so as to fit them in a predetermined airspace volume or sector shape. Traffic demand and the operational requirements determine route placement, then the airspace volumes are built to protect the IFR flight paths and finally the airspace volume is sectorised in order to manage ATC workload.

3. The airspace volume is created to protect IFR flight paths - both vertically and horizontally. As such it can be of any shape or size. In developing the airspace volume it may be necessary to go back and modify the routes to ensure that they fit within the airspace volume.

4. Once the airspace volume is completed, then the airspace is sectorised for purposes of air traffic management. Sectorisation is done as a function of the traffic sample and traffic assignment (see Activity 6) and may be functional or geographical (or a mixture of both). Whilst en-route airspace tends to be geographical, terminal airspaces tend to use either one or the other or a mix.
   - Geographical Sectorisation is where the airspace volume is divided into ‘blocks’ and a single controller is responsible for all the traffic in a single block i.e. sector; or
   - Functional “Sectorisation” is characterised by dividing the workload in the airspace volume as a function of the aircraft’s phase of flight. The most common type of Functional Sectorisation is where one controller is responsible for arriving flights in the Airspace whilst another is responsible for departing flights in the same Airspace volume.

5. Once the sectors are designed, it may be necessary to go back and revisit the route placement as determined by the controller workload generated by a given ATC sector design. The design of ATS routes, terminal routes, airspace volumes and ATC sectorisation is an iterative process. From a purely airspace design point-of-view, neither the airspace volume nor sectors need to follow national borders. It is possible, and even desirable for reasons of flight efficiency and
capacity, to design cross-border airspace volumes or sectors. In such cases, the delegation of ATS will need to be considered.

4.4.10 Activity 10 - Confirming the selected Navigation Specification

(1) Once the airspace design activity is complete, it is important to step back and verify that the design can indeed be supported by the navigation specification identified in Activity 6.

(2) This activity is a relatively simple step if Activities 6 - 9 have been done in an integrated manner and if Activity 6 has definitively identified one particular specification as the basis for the design. In such cases, this step can be used to refine the choice between two navigation specifications and to decide on one of the two. Alternatively, it may be viable to have provided for two sets of design each based on different navigation specifications. Both could then be subjected to an in-depth feasibility assessment to establish the final choice.

(3) The confirmation of chosen Navigation Specification can be quite complex - even once the airspace concept has been completed and the validation phase looms. A specific example of this can be seen in the ECAC area of Europe where the initial intent of implementing RNAV 1 foreseen for the 1990s had to be scaled ‘back’ to an RNAV 5 implementation when it became clear nearly three years before the 1998 implementation date that the expected natural replacement of the older equipment meeting RNAV 5 with systems compatible with RNAV 1 was much slower than expected. This example serves to emphasise, again, the importance of fixing realistic assumptions in Activity 6.
Validation Phase

4.4.11 Activity 11 - Airspace Concept Validation

(1) By the time the airspace design is complete, the Airspace Concept has become a comprehensive body of work that needs to be validated and checked. Validation takes place in various phases: the airspace design is usually validated first; once this has been done the Instrument Flight Procedures are designed and validated. In fact, during the design phase, many of the iterations can be considered as part of the validation process.

(2) This section of the brochure first discusses the airspace design and ATM validation and then the validation of instrument flight procedures.

(3) The main objectives of airspace design and ATM validation are:

- To prove that the airspace design has successfully enabled efficient ATM operations in the airspace;
- To assess if the project objectives can be achieved by implementation of the airspace design and the Airspace Concept in general;
- To identify potential weak points in the concept and develop mitigation measures;
- To provide evidence and proof that the design is safe i.e. to support the Safety Assessment.

(4) Two kinds of assessment/validation can be distinguished: Quantitative and Qualitative. Both are needed and they are undertaken at the same time as they each need information produced by the other method. As a result it is essential that the results are viewed as a single entity even if they are significantly different approaches.

(5) In general terms, Quantitative Assessment refers to validation methods that are numerical and rely on the quantification of data. Validation by Quantitative Assessment often relies on tools which are primarily - but not exclusively - computer based simulators.

(6) Qualitative Assessment is different in that it is not reliant on data but more on reasoning, argument and justification. These three pointers indicate why Quantitative and Qualitative cannot be separated. Data from a quantitative assessment cannot be accepted as such: it needs to be analysed, reasoned through and checked for validity: these are the very tools of Qualitative Assessment.
There are several ways in which to undertake airspace design and ATM validation. These are:

- Airspace Modelling;
- FTS/RTS;
- Live ATC Trials;
- Environmental assessment tools e.g. IMPACT;
- Flight Simulator;
- Data Analytical Tools;
- Statistical Analysis;
- Collision risk modelling.

Each of these differ in terms of Cost, Realism (and complexity), Time and the number of Traffic Samples and Test Cases used. Generally, the more complex the simulation method used, the greater the cost, preparation/run time required and the closer to reality the results become. In contrast, and normally for reasons related to cost/time - the number of traffic samples/test cases tend to decrease as the complexity of the simulation method used increases.

**PROJECT CHECKPOINT**

**Deciding Factors**

During the validation process, it becomes evident whether the proposed PBN implementation is possible, and this is the most likely place to make the decision as to whether to go ahead with implementation. This decision is based on certain deciding factors i.e. not the least of which are whether Safety and Performance Criteria have been satisfied. Other factors can prevent a ‘go’ decision, e.g.:

a) A change to the ATM system (see below), needed to support the implementation, may prove impossible to realise despite careful identification of this enabler and a go-ahead being given by ATM systems engineers; Or, for example...
b) Dramatic political events which have nothing to do with the Airspace design and which could never have been foreseen when the Traffic Assumptions were chosen, could nullify the entire airspace concept. This could occur, for example, if the entire design concept rested on the (traffic) assumption that 80% of the traffic would enter an Airspace from the west and unforeseen political events change the geographic distribution of traffic completely;

c) Unforeseen change by the lead operator concerning aircraft equipment upgrades causes the collapse of the Business Case or, for example, Navigation assumptions.

(10) An aware and fully integrated PBN Implementation team should not be caught out by last minute surprises described in bullets a) and c), above. One thing is certain, however, the possibility of unexpected events is one of the reasons why it is necessary to fix a go/no-go date for implementation.

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**Regional and State Considerations**

A PBN implementation for oceanic, remote continental and continental en-route operations generally requires regional or multi-regional agreement in order that connectivity and continuity with operations in adjoining airspace can ensure maximum benefits. For terminal and approach operations, the PBN implementation is more likely to occur on a single-State basis although TMAs adjacent to national borders are likely to require multinational coordination.

Note: For instance, in the European Union the obligation to implement PBN in defined volumes of airspace could be established in the framework of the Single European Sky, Where compliance with an ICAO navigation specification is prescribed for operation in airspace or on ATS routes, these requirements shall be indicated in the State’s aeronautical information publication.

**Implementation Options: Is there a need to mandate a navigation specification?**

One of the toughest decisions to be made by the PBN Implementation team is whether or not to propose a mandatory requirement for a particular navigation specification for operation within airspace. There are usually three options implementation options to consider which can be considered:

No mandate but phased implementation leading to mixed mode navigation capability

Generally, phased implementation of a navigation specification is more popular with airspace users (no costs are involved to retrofit). That said, without a mandate, there may be little incentive for aircraft to obtain operational approval and the fleet’s navigation performance remains mixed. Consequently, NAVAID infrastructure evolution may also be slowed as all the permitted navigation specifications (or even conventional navigation) must be supported.
Mandate navigation enabler

This option is usually popular with ANSPs because the homogenous nature of the traffic reduces the need for ATM system changes compared to the mixed environment. ATC prefer this option because all aircraft are treated the same way. The airspace design and operations within the airspace are simpler for reasons of uniformity. From the users’ perspective, this decision is often not popular, however, because it usually involves retrofits, which can be costly. For this reason, a favourable business case is essential to supporting a mandate. It is not possible to persuade airspace users without a positive benefits case.

Two mandate scenarios can be envisaged: an equipment mandate (where all aircraft above a certain mass are required to be approved against a particular navigation specification) or an airspace mandate (requiring all aircraft operating within an airspace volume to be approved against a particular navigation specification). Whilst equipment mandates seem more palatable, their net effect is that a mixed navigation environment can in fact exist if, for example, high-end business jets were to be below the cut off mass. Mandate considerations include:

a) Business case; and
b) The lead-time to be given to airspace users and, depending on the nature of the mandate, various service providers such as ANSPs; and
c) The extent of the mandate (local, regional or multi-regional); and
d) Safety cases; and
e) Implementation Plans. This option involves an investment for the airspace user (including a 7 year lead time) with less costs being incurred by the ANSPs. This option will ensure that capacity is maintained or increased. However, this option may result in slowing the pace of change (to more advanced navigation capability) if the lowest common denominator is selected as a mandate for the airborne navigation enabler.

Mixed Mandate.

A “mixed-mandate” can be used within an airspace volume where, for example, it is mandatory to be approved to an RNAV 1 specification for operation along one set of routes, and RNAV 5 along another set of routes within the same airspace. The issues raised under the mixed environment also pertain to such a variant.

In remote continental/oceanic airspace, it is not uncommon to have a mixture with approval against a navigation specification being mandatory along certain routes whilst no such requirements exist on other routes. In such cases, sophisticated ATM systems can determine the required spacing between random tracks or separation minima can be established between aircraft using specific approved conflict probes. This is a truly user-orientated service but difficult to achieve in high density/complex airspace.

4.4.12 Activity 12 - Finalisation of Procedure Design

Only once the airspace design and ATM validation is complete does the Instrument flight procedures specialist set about finalising the design of the IFPs and SIDs/STARs using the criteria in ICAO Doc 8168 PANS-OPS. Being an integral member of the airspace design team from the outset, the IFP designer
is familiar with the procedures to be designed and the Airspace Concept into which they will fit. This activity occurs iteratively with Activity 13. For PBN, procedure designers need to ensure that the procedures can be coded in ARINC 424 format. Currently, this is one of the major challenges facing procedure designers. Many are not familiar with either the path terminators used to code RNAV systems or the functional capabilities of different RNAV systems. Many of the difficulties can be overcome, however, if close cooperation exists between procedure designers and the data houses that compile the coded data for the navigation database. Once these procedures have been validated and flight inspected, they are published in the national AIP along with any changes to routes, holding areas, or airspace volumes.

### 4.4.13 Activity 13a - Instrument Flight Procedure Validation

1. This activity occurs iteratively with Activity 12.
2. The purpose of this validation is to obtain a qualitative assessment of procedure design including obstacle, terrain and navigation data, and provides an assessment of flyability of the procedure. The validation is one of the final quality assurance steps in the procedure design process for instrument flight procedures (IFP) and is essential before the procedure is published.
3. The full validation process includes Ground validation and Flight validation.
4. Ground Validation must always be undertaken. It encompasses a systematic review of the steps and calculations involved in the procedure design as well as the impact on flight operations by the procedure. It must be performed by a person(s) trained in Flight Procedure Design and with appropriate knowledge of Flight Validation issues.
5. Ground Validation consists of an independent IFP design review and a pre-flight validation. Flight validation consists of a flight simulator evaluation and an evaluation flown in an aircraft (though both evaluations are not always necessary). The validation process of IFP(s) must be carried out as part of the initial IFP design as well as an amendment to an existing IFP. (One of the particular challenges at this point is making a pre-production database available to the flight validation aircraft).

### 4.4.14 Activity 13b - Flight Inspection

1. Flight inspection of NAVAIDs involves the use of test aircraft, which are specially equipped to measure compliance of the navigation aid signals-in-space with ICAO standards. Due to the flexibility of PBN to create routes or procedures in areas where a particular ground facility has normally not been flight inspected, it may be necessary to perform dedicated flights. Of primary interest is the actual coverage of the NAVAID infrastructure required to support the flight procedures designed by the flight procedure designer. Depending on the avionics capabilities of the test aircraft, flight inspection and flight validation activities may be combined. The amount of flight inspection required is determined by the infrastructure assessment conducted as part of activity 6, and is part of the validation process.
2. The Manual on Testing of Radio NAVAIDs (ICAO Doc 8071) provides general guidance on the extent of testing and inspection normally carried out to ensure
that radio navigation systems meet the SARPs in Annex 10 - Aeronautical Telecommunications, Volume I. To what extent a Flight Inspection needs to be carried out is normally determined in the validation process.

**IMPLEMENTATION PHASE**

**Go : No-Go Decision**

(3) It is usually during the various validation processes described previously that it becomes evident whether the proposed Airspace Concept can be implemented. The decision whether or not to go ahead with implementation needs to be made at a pre-determined point in the life-cycle of a project. This decision will be based on certain deciding factors, starting with achievement of the goals set for implementation. Other factors could include:

- a) whether the ATS route/procedure design meets air traffic and flight operations needs;
- b) whether safety and navigation performance requirements have been satisfied;
- c) pilot and controller training requirements; and
- d) whether changes to ATC systems such as flight plan processing, automation, as well as AIP publications are needed to support the implementation

(4) If all implementation criteria are satisfied, the project team needs to plan for implementation, not only as regards their ‘own’ airspace and ANSP, but in cooperation with any affected parties which may include ANSPs in an adjacent State.

**Implementation Planning**

**Selecting Implementation Criteria**

It is usually during the validation process that it becomes evident whether the proposed design can be implemented. The decision to go ahead with implementation needs to be decided at a particular date in the life-cycle of a project.

The decision of whether to go ahead or not with implementation is based on certain deciding factors i.e. Implementation Criteria, not the least of which are whether Safety and Performance Criteria have been satisfied, see above. But there is more than satisfying Safety and Performance Criteria when deciding whether or not to go ahead with Implementation. Other factors can prevent a ‘go’ decision, e.g. -

- A change to the ATM system (see below), needed to support the implementation, may prove impossible to realise despite careful identification of this enabler and a go-ahead being given by ATM systems engineers;
- Or, For example -

- Dramatic political events which have nothing to do with the Airspace design and which could never have been foreseen when the Traffic Assumptions were chosen, could nullify the entire Airspace Concept. This could occur, for example, if the entire design concept rested on the (traffic) assumption that 80% of the traffic would enter a Terminal Airspace from the west and unforeseen political events change the geographic distribution of traffic
An aware and fully integrated airspace design team should not be caught out by last minute surprises described in bullets 1 and 3, above. One thing is certain, however, the possibility of unexpected events is one of the reasons why it is necessary to fix a go/no-go date for implementation.

Pre-Implementation Review

At the go/no go date, a Pre-Implementation Review is undertaken, the result of which decides whether implementation goes ahead. During the Pre-Implementation Review, the Airspace design project’s progress is measured against the implementation criteria selected during the planning stage.

Examples of Criteria which an Airspace Design Team may have selected to determine whether to go ahead with implementation include:-

- Collapse of the main assumptions;
- Critical Enablers become void;
- Emergence of a project-critical constraint;
- Performance/Safety Criteria are not satisfied during or by the Validation or Safety Assessment process;
- No regulatory approval;
- ‘NO-GO’ decision.

Although it can be very discouraging to be confronted with a ‘no-go’ decision, it is essential that attempts should not be made to ‘produce’ a quick-fix or workaround so that implementation takes place at any cost. However difficult it might be not to proceed with implementation, a ‘no-go’ decision should be respected.

The route to be followed after a ‘no-go’ decision depends upon the reason for which the no-go decision was reached. In extreme cases, it may be necessary to scrap an entire project and return to the planning stage. In others, it might be appropriate to return to the selection of Assumptions, Constraints and Enablers. And it is also possible, that a new Validation exercises will have to be developed, or a new Safety Assessment completed. What-ever the route, the work needs to be re-organised and re-planned.

‘Go’ Decision - Plan Implementation

If, on the other hand, all the implementation criteria are satisfied the Airspace design team needs to plan for implementation - not only as regards their ‘own’ airspace and ANSP but in co-operation with any affected parties which may include ANSPs in an adjacent State. Amongst items to be covered are ATC system integration and Awareness and Training material.

4.4.15 Activity 14 - ATC System Integration Considerations

(1) The new Airspace Concept may require changes to the ATC system interfaces and displays to ensure controllers have the necessary information on aircraft capabilities. Such changes could include, for example,

a) Modifying the air traffic automation’s Flight Data Processor (FDP);

b) Making changes, if necessary, to the Radar Data Processor (RDP);
c) Required changes to the ATC situation display;
d) Required changes to ATC support tools;
e) There may be a requirement for changes to ANSP methods for issuing NOTAMs.

4.4.16 Activity 15 - Awareness and Training Material

(1) The introduction of PBN can involve considerable investment in terms of training, education and awareness material for flight crew, controllers, AIS staff, engineering etc. In many States, training packages and computer-based training have been effectively used for some aspects of education and training. ICAO provides additional training material and seminars. Each Navigation Specification in the PBN Manual Volume II, Parts B and C addresses the education and training appropriate for flight crew and controllers. Training should be timely and not rushed; it is an excellent vehicle for gaining acceptance of airspace users and controllers. A useful technique is to use members of the PBN Implementation team as training champions.

4.4.17 Activity 16 - Implementation

(1) With proper planning and organisation, the culmination of an Airspace design project is trouble-free Implementation. Nevertheless, the Airspace design team could decide to:

a) Ensure that there is adequate representation from among the members of the team available in the operations hall on a 24-hour basis for at least two days before implementation, during implementation and for at least one week following implementation. This would make it possible for the airspace team to:

- Monitor the implementation process;
- Support the Centre supervisor/Approach Chief or Operational Manager should it become necessary to use redundancy or contingency procedures;
- Provide support and information to operational controllers and pilots;
- Enable a log-keeping system for a period similar to that in [i] above, so that implementation-related difficulties may be noted and used in future project planning.

b) A System Safety Assessment should be conducted after implementation and evidence collected to ensure that the safety of the system is assured - see ICAO Safety Management Manual, Doc 9859.

4.4.18 Activity 17 - Post-Implementation Review

(1) After the implementation of the airspace change which has introduced PBN, the system needs to be monitored to ensure that safety of the system is maintained and determine whether strategic objectives are achieved. If after implementation, unforeseen events do occur, the project team should put mitigation measures in place as soon as possible. In exceptional circumstances, this could require the withdrawal of RNAV or RNP operations while specific problems are addressed.

(2) A System Safety Assessment should be conducted after implementation and evidence collected to ensure that the safety of the system is assured - see ICAO Safety Management Manual, Doc 9859.
4.5 PBN Check List of Implementation Actions

(1) The presented check list of implementation actions refers to the major airspace changes as defined in paragraph 3.2.6.

<table>
<thead>
<tr>
<th>Ref</th>
<th>Topic</th>
<th>Description</th>
<th>Rationale</th>
<th>Responsible / Involved</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Local PBN implementation</td>
<td>• General scope; • 4D description of the PBN volume; • Cross-Border impacts; • Enablers and constraints; • Impact on ATM (ATS / ASM / ATFCM) Procedures; • Impact on flight planning procedures; • Impact on Publication; • Impact on local / AOs / CFSPs / NM systems; • Identification of benefits.</td>
<td>To ensure network harmonised PBN implementation</td>
<td>ANSP(s) / NM</td>
<td>T0 - (24 - 30) months depending on the expected impact of the change; input concerning the implementation plan from ERNIP Part 2.</td>
</tr>
<tr>
<td>2.</td>
<td>Airspace (terminal and/or en-route) Design</td>
<td>• Establish the airspace volume (horizontal and vertical limits); • Horizontal / Vertical connectivity; • RAD restrictions; • Airspace reservations; • Flight Plan Buffer Zones (FBZs); • No Planning Zone (NPZ); • ATS delegation; • Sector design; • Optimised CCO / CDO.</td>
<td>To ensure interconnectivity and interoperability with adjacent horizontal and vertical airspace and to ensure optimised vertical flight efficiency</td>
<td>ANSP(s) / NM / Military / AOs</td>
<td>T0 - 12 months</td>
</tr>
<tr>
<td>3.</td>
<td>Airspace Management Process</td>
<td>• Priority Rules; • CDM requirements; • Utilisation of AUP/UUP; • Information Sharing; • Rerouting; • OAT Handling.</td>
<td>To ensure seamless network application of ASM/FUA procedures</td>
<td>ANSP(s) / NM / Military</td>
<td>T0 - 12 months</td>
</tr>
<tr>
<td>4.</td>
<td>ATC Procedures and Letters of Agreement</td>
<td>• Definition of all required procedures internally and with neighbouring ATC units.</td>
<td>To ensure appropriate interconnectivity</td>
<td>ANSPs</td>
<td>T0 - 6 months</td>
</tr>
<tr>
<td>5.</td>
<td>Air traffic flow and capacity management</td>
<td>• Sector Configuration Management; • Sector and Traffic Volumes (Capacities / Monitoring Values); • Re-routing Proposals; • ATFCM Procedures.</td>
<td>To ensure seamless network application of ATFCM procedures</td>
<td>ANSP(s) / NM</td>
<td>T0 - 6 months</td>
</tr>
<tr>
<td>6.</td>
<td>CAA / NSA Involvement</td>
<td>• Consultation with CAA / NSA / Military; • Safety case; • Mitigating actions (if required).</td>
<td>To ensure safe implementation and fulfilment of all regulatory requirements</td>
<td>ANSPs / CAA / NSAs / Military</td>
<td>T0 - 9 months</td>
</tr>
<tr>
<td>7.</td>
<td>Awareness and consultation</td>
<td>• CONOPS; • Airspace design and airspace management. • ATC Procedures and Letters of Agreement. • Air traffic flow and capacity management.</td>
<td>To ensure network harmonised PBN implementation</td>
<td>ANSPs / NM through the NM CDM process to all operational stakeholders, including NSAs</td>
<td>T0 - 24 months</td>
</tr>
<tr>
<td>8.</td>
<td>AIS / RAD Publication</td>
<td>• AIC Publication. • AIP Publication. • RAD.</td>
<td>To ensure network harmonised PBN implementation</td>
<td>ANSPs / NM</td>
<td>T0 - (6 - 12) months</td>
</tr>
<tr>
<td>9.</td>
<td>NM Integration / Pre-validation Check</td>
<td>• NMOC Validation / Review; • NMOC Integration following successful validation.</td>
<td>To ensure network harmonised PBN implementation</td>
<td>ANSPs / NM / AOs / CFSPs</td>
<td>T0 - 6 months</td>
</tr>
<tr>
<td>10.</td>
<td>Implementation</td>
<td>• PBN Project Implementation.</td>
<td>To ensure network harmonised PBN implementation</td>
<td>ANSPs / NM / AOs / CFSPs / Military</td>
<td>T0</td>
</tr>
<tr>
<td>11.</td>
<td>POST implementation</td>
<td>• Lessons Learnt.</td>
<td>To ensure network harmonised PBN implementation</td>
<td>ANSPs / NM / AOs / CFSPs / Military</td>
<td>T0 + (1 - 2) AIRAC cycles</td>
</tr>
<tr>
<td>12.</td>
<td>Fine-tuning of implementation</td>
<td>• Implementation of further changes depending on lessons learnt.</td>
<td>To ensure network harmonised PBN implementation</td>
<td>ANSPs / NM / AOs / CFSPs / Military</td>
<td>T0 (1 - 6) AIRAC cycles</td>
</tr>
</tbody>
</table>
5 TA Design Methodology

5.1 Reference Scenario

(1) This chapter presents the Reference Scenario, which constitutes the first step of the Design Methodology.

(2) As stated in the previous chapter, the relevance of the Reference Scenario and a Critical Review is four-fold:

- it provides a benchmark against which the design concept can be compared; and
- it is an efficient way of refining the design objectives and ensuring that operational requirements are being addressed (see Part B) given that a design project is usually undertaken as a means of improving upon the existing design; and
- it helps to refine the scope of the existing project; and
- it prevents design ‘weaknesses’ identified in the Reference Scenario being repeated.

(3) Although the process of describing current Terminal Airspace operations is sometimes considered a tiresome exercise, one of its additional advantages is that it provides the opportunity to discover (and correct) inconsistencies related to the existing design. Examples of these inconsistencies may include -

- published SIDs/STARs - that are no longer used;
- out-dated instrument approach procedures;
- publication errors in the AIP;
- abandoned navigation aids; and
- the identification of airspace / procedure design principles that enable / do not enable CCO / CDO from higher levels; and
- the assessment of LoAs to see whether they are optimised in terms of fleet mix, potential flexible applications or could benefit from moving existing points or creating new points.

5.1.1 What is the Reference Scenario?

(1) In general terms, the Reference Scenario is a description of the current Terminal Airspace operations. As such, the Reference Scenario describes the current layout of routes and instrument approach procedures as well as holding patterns, airspace structures, ATC sectorisation and how the traffic is managed within the airspace and in relation to surrounding airspace.

(2) Given that the (main) purpose of the Reference Scenario is to provide a benchmark against which the new/modified design is compared, the assumptions, enablers and constraints which formed the basis of the Reference Scenario should also be identified.

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6 The relevance of this is that a comparative assessment is the most usual way in which safety is assessed in those instances where ‘absolute’ measurement is not required. (See Part C, Chapter 3).
Nevertheless, there are cases when the current Terminal Airspace is not used as the Reference Scenario. This occurs when, for example, previously validated modifications to any aspect of the Terminal Airspace (i.e. routes, or holds or structure or sectorisation) are to be implemented in the short-term i.e. before the implementation of the current project.

The figure below illustrates the ‘Pseudo’ current using an example of a change to airspace dimensions. The yet-to-be-implemented change (i.e. (b)) would thus be used as a ‘Pseudo’ Reference against which new changes are measured. This ‘Pseudo’ Reference could equally be a based upon a new route or routeing structure, holding patterns or the sectorisation.

5.1.2 Creating the Reference Scenario

The Reference Scenario is created from various sources. Ideally, all these sources should be used so as to build the most complete picture as to the current or ‘pseudo’ current Terminal Airspace operations.

Below, an abridged list is provided showing selected items needed in the statement of the Reference Scenario.

<table>
<thead>
<tr>
<th>Information</th>
<th>How obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predominant Runway-in-use at airport(s) within the existing Terminal airspace.</td>
<td>Statistical analysis of existing data over the last few years.</td>
</tr>
<tr>
<td>Current Traffic Demand and its geographic and time distribution.</td>
<td>Traffic samples can be obtained from the NMOC and/or local ATC centre (1).</td>
</tr>
<tr>
<td>Analysis of the Traffic sample e.g. IFR/VFR mix; Fleet Mix; Aircraft performance mix, etc.</td>
<td>Traffic sample obtained above.</td>
</tr>
<tr>
<td>Routes (IFR &amp; VFR), instrument approach procedures and Holding patterns/areas.</td>
<td>AIP and traffic sample;</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Radar Vectoring patterns</td>
<td>Operational controllers</td>
</tr>
<tr>
<td>Airspace dimensions</td>
<td>AIP and Operational controllers</td>
</tr>
<tr>
<td>Sectorisation (Terminal Airspace, adjacent Terminal Airspace and Lower ACC sectors)</td>
<td>Operational Controllers and ATC System specialists</td>
</tr>
<tr>
<td>Traffic Management i.e. Co-ordination agreements between sectors and</td>
<td>Local ATC Instructions and Letters of Agreement.</td>
</tr>
<tr>
<td>Existing constraints (e.g. terrain)</td>
<td>PANS-OPS specialists / environmental specialists; policy makers.</td>
</tr>
<tr>
<td>Barriers to optimize the vertical profile (CCO/CDO)</td>
<td>Local ATC expert / environmental specialist</td>
</tr>
<tr>
<td>Existing ATM/CNS enablers (e.g. 5 DMEs in Terminal Airspace)</td>
<td>Operational controllers/Engineers</td>
</tr>
</tbody>
</table>

Note (1): Part C, Chapter 4 explains how to select and analyse Assumptions. One of the most important assumptions is the Traffic Sample.

5.1.3 Critical Review of the Reference Scenario

(1) Once the Reference (or Pseudo Reference) Scenario has been described, it should be critically reviewed. This critical review is a qualitative exercise which involves operational experts closely scrutinising the existing Terminal Airspace operations i.e. each element of the airspace organisation and how effectively and safely it works with a view to identifying operational problem areas. This is the stage at which existing constraints are identified, and the required mitigation and enablers.

(2) Undertaking the critical review is a relatively straight-forward exercise - although it can be difficult for the design team to examine (what may be their previous efforts) in a critical light. The Critical Review is concerned with establishing what is wrong, or which factors limit the Reference Scenario. On the positive side, aspects that work well should be identified (so that the benefits are not lost).

(3) If, for example, the SIDs are being critically reviewed, the design team may agree that for most of the year, the existing SIDs meet the operational requirements in that they appear to respond to the actual aircraft performance of the current fleet mix. This said, however, controllers may notice that most heavy aircraft bound for the Far-East are unable to make the level restrictions on one of the SIDs when the temperature are high during the summer months. During the critical review process, this situation is identified - and may indeed be used to refine the design objectives.

5.1.4 Refining Design Objective(s)

(1) One of the 'outputs' of the Critical Review process is that current design weaknesses or flaws in the current operation may be 'added' to list of design objectives or used to refine the design objectives. In the example used above, the possibility of designing a discrete SID for use during the summer months by heavy aircraft has arisen and as such, it may be appropriate opportune to add this to the design objectives.

5.1.5 Comparing Scenarios

(1) Although the Reference (or 'Pseudo' Reference) Scenario serves, at a later stage, as the yard-stick against which the success of the new or modified design is
measured, it may be considered logically inconsistent to seek comparisons between the Reference Scenario and new Scenarios based upon different assumptions or enablers (or constraints). The diagram below presents this process.

(2) In the above diagram

A = the Reference Scenario with its particular Assumptions, Enablers and Constraints and its resultant Performance.

C = the new Scenario 1, with, for example, a new set of SIDs/STARs based on a different assumptions (e.g. Navigation means = P-RNAV) and its resultant Performance.

(3) In comparing the Performance of Terminal Airspace C (Scenario 1) with that produced by A (Reference Scenario), it could be argued that A and C are not comparable because the assumptions are different (e.g. navigation) and that the changes made to the SIDs and STARs are therefore substantial. Furthermore, a different sectorisation method has been used. Logically, this argument is correct, and if followed through one would need A to be based on C’s assumptions to obtain performance B and that B should then be compared to C so that the comparison is meaningful.

(4) If this approach was followed, it could be argued that the Reference is no longer the Reference once it is based on different assumptions. E.g. assume the ‘true’ Reference has one runway, and a new assumption is the addition of a parallel runway.

(5) For these - amongst other - reasons, airspace designers seek to compare the performance output of the ’new’ scenarios, in order to establish whether the new scenario(s) meets strategic and/or design objectives.
5.2 Safety & Performance Criteria

(1) This chapter discusses Safety and Performance Criteria whose formulation constitutes the first phase of the design concept.

(2) Safety and performance criteria are important because they provide a yardstick against which the safety and performance of the proposed design can be measured. Identified during initial project planning, these criteria may be translated into project and/or design objectives (see Part B) which accompany the project throughout its life-cycle. These ‘benchmarks’ remain constant throughout the development of the Terminal Airspace design project though the extent to which they can be successfully ‘measured’ may be affected by the project phase. For example, it may not be possible during the concept design phase to measure whether a capacity performance target is met, though this can be determined during the validation phase using the appropriate tool. In order for a proposed and implemented design change to be considered successful in safety and performance terms, the selected criteria need to be satisfied.

(3) Although safety and performance criteria have always been important, their significance has increased since the introduction of mandatory ICAO and European requirements to undertake a safety assessment when making changes to their airspace design.

5.2.1 Qualitative and Quantitative Assessment

(1) The need to assess the safety or other performance of a Terminal Airspace design is one reason for establishing safety and performance criteria. Assessment is an ongoing process: qualitative assessment which begins at conceptualisation and continues through implementation also provides the foundation for quantitative assessment.

(2) Two types of assessment have been distinguished: qualitative and quantitative assessment.

- **Qualitative assessment** is achieved by expert judgement being used to assess the design using ICAO standards, recommended practices and procedures as a benchmark. Qualitative assessment relies upon expert (air traffic control/operational) judgement and effectively forms the basis for the design concept (and the Critical Review of the Reference Scenario and the identification of Assumptions, Constraints and Enablers). Qualitative Assessment is an on-going process: as well as providing the basis for the design concept, this expert judgement is also used to qualitatively assess all phases of the design methodology, and it is integral to quantitative assessment and to safety measurement - even when the emphasis appears to be on measurement against an absolute threshold.

- In contrast, **Quantitative assessment** is concerned with ‘quantified’ results produced in the form of numerical data. E.g. capacity increased by 20%.
• Both qualitative and quantitative assessments are essential to the process of safety evaluation.

5.2.2 Evaluating Safety

(1) ICAO Annex 11 and Doc 4444 PANS-ATM includes requirements for a Safety Assessment to be undertaken when making certain modifications to the Air Traffic Management System. Significantly, ICAO has detailed those instances in which a Safety Assessment is required. Because airspace designers must ensure and demonstrate that an airspace design is safe (i.e. provide evidence of safety through a safety assessment process), this section provides a broad overview of how safety can be evaluated.

(2) Two methods are commonly used to evaluate safety: one is comparative (or relative), the other absolute. The use of one method does not exclude the other and most frequently, they are combined.

(3) Most airspace designers are familiar with the comparative (or relative) method because it is the most and frequently used. When safety is evaluated using this method, the safety of the proposed Terminal Airspace design is compared in relation to an existing design (called a Reference Scenario). Use of this method could therefore show an increase/decrease or maintenance of safety of a proposed design which has been compared to a Reference Scenario.

(4) In contrast the absolute method involves evaluating safety against an ‘absolute’ threshold. An example of such an absolute threshold could be: that the risk of collision is not to exceed 5 fatal accidents per 1 000 000 000 flight hours. (This would more commonly be expressed as a requirement to meet a target level of safety (TLS) of 5x10^-9). A collision risk analysis using a collision risk model is the usual way in which a determination is made as to whether a TLS is being met.
Whatever the method and/or safety criteria used, a safety evaluation can only be rigorous if qualitative assessment forms the backbone of the evaluation process.

It should be noted that the safety of an airspace design is not only dependent upon the correct application of design criteria when designing routes, holding areas, and airspace structures designed in accordance with the design rules and procedures contained, inter alia, in ICAO Annex 11 and Doc 8168 PANS-OPS (especially Vol. II). Safety factors are considered before and during this design phase, by, for example:

- developing a feasible airspace design concept prior to the application of the PANS-OPS design criteria; and
- ensuring the accuracy of critical aircraft and operational assumptions which are used to form the basis of the PANS-OPS design;

In the ‘greater’ context, the design is also required to satisfy the safety objectives which are included, but not limited to the generic ATC objectives and whether these are met is most often determined by qualitative assessment. Thus whilst Annex 11 and Doc 8168 PANS-OPS provide rules relating to airspace dimensions and obstacle clearance criteria respectively, qualitative assessment criteria are included, but not limited to, Doc 4444 PANS-ATM and various ICAO Annexes.

Comment:

How does the designer know when safety should be evaluated using the absolute method? Typically, the absolute method is to be used when required by ICAO. This usually involves instances when the change envisaged is radical and untried elsewhere. For example:

- reduction of the vertical separation minima (RVSM)
- determination of new spacing between parallel ATS routes for which lateral navigation accuracy is specified with a view to applying the separation minima in Doc 4444 PANS-ATM, Chapter 5, as a basis for route spacing in Terminal Airspace;

It is opportune to add that because most Terminal airspace re-designs rely, for the most part, on existing ICAO provisions and do not involve radical changes such as those introduced with the RVSM example, the comparative/relative method is likely to remain the most frequently used (subject to certain conditions).

The Safety Case Approach

The pre-implementation process involves the development of a safety case comprising a reasoned safety argument based on a Functional Hazard Assessment (FHA) and Preliminary System Safety Assessment (PSSA). After
implementation, the safety case is revised as well as a System Safety Assessment (SSA) - (See diagram below).

![Safety Policy Diagram]

### 5.2.4 Other Performance Criteria

1. The following are examples of performance criteria:
   - an airport capacity increase of 20% is demonstrated; and
   - no increase in noise pollution is experienced by the residents of Suburb Y between 22:00 and 05:00 UTC;
   - track mileage flown by arriving aircraft is not extended by more than 5%;
   - optimisation of vertical flight efficiency for CDO and CCO (to / from cruising levels where possible).

2. Having decided upon the performance criteria (usually embodied in the strategic and design objectives), it is necessary for the Terminal Airspace design team to select the appropriate tool so as to correctly measure these criteria.
5.2.5 Evaluating Capacity and Environmental Impact

Although the comparative and absolute methods are commonly used in a safety context (above), other performance criteria can also be evaluated using in either a comparative or absolute manner.

<table>
<thead>
<tr>
<th></th>
<th>Comparative</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>an airport capacity increase of 20% is demonstrated; and</td>
<td></td>
</tr>
<tr>
<td>2a</td>
<td>no increase in noise pollution is experienced by the residents of Suburb Y between 22:00 and 05:00 UTC;</td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>track mileage flown by arriving aircraft is not extended by more than 5%;</td>
<td></td>
</tr>
<tr>
<td>4a</td>
<td>average time in level flight for arrivals from top of descent is reduced by 10 seconds.</td>
<td></td>
</tr>
</tbody>
</table>

Examples of absolute measurement being required are illustrated by changing the wording of the above criteria to new wording below.

<table>
<thead>
<tr>
<th></th>
<th>Absolute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1b</td>
<td>airport capacity = 129 movements per hour</td>
</tr>
<tr>
<td>2b</td>
<td>noise emitted by each ACFT does not exceed 65dB at the noise monitoring point.</td>
</tr>
<tr>
<td>3b</td>
<td>track mileage flown by arriving aircraft does not exceed 32 NM from Terminal Airspace Entry point.</td>
</tr>
<tr>
<td>4b</td>
<td>average time in level flight for arrivals does not exceed 80 seconds from top of descent</td>
</tr>
</tbody>
</table>

Naturally, normal ATC simulators such as fast- or real-time may not be suitable for measurements relative to noise (e.g. 2a or 2b, above) and noise modelling tools would be required. Appropriate modelling tools e.g. IMPACT, should be used to compare the environmental impact, in terms of noise, fuel burn and CO2 emissions impacts including any potential trade-offs, between the baseline scenario and any future scenario. For more information, support may be found in the SESAR Environmental Assessment Process document - SESAR Deliverable D4.0.080. Further resources to support optimising the environmental performance of climb and descent phases may be found at https://www.eurocontrol.int/concept/continuous-climb-and-descent-operations.

5.2.6 Safety, Performance and Project Planning

Strategic Objectives: Increase existing capacity; reduce environmental impact over Suburb Y; meet the Target Level of Safety.

Design Objectives: Create new Terminal arrival and departure routes to accommodate a new parallel runway.

(ICAO ATC Objectives: Prevention of collision; maintaining a safe and orderly flow of air traffic i.e. creating a design that will be conducive to these objectives).

Safety Criteria: the route spacing of 8NM between parallel Terminal Routes is required to meet a target level of safety of 5 x 10^-9.

Performance criteria: The Terminal Airspace design will be considered a success if, for example:
- (quantitative) Approach West Sector demonstrates a capacity increase of
20% demonstrated; and
- (quantitative) no increase in noise pollution is experienced by the residence of Suburb Y between 22:00 and 05:00 UTC;
- (quantitative) track mileage flown by arriving aircraft is not extended by more than 5%;
- (quantitative) average time in level flight for arrivals from top of descent is reduced by 10 seconds;
- (qualitative) A crossing SID and STAR have been designed in accordance with PANS-OPS criteria complete with profiles. Inadvertently, the profile of both the SID and STAR requires aircraft to be at FL070 at the crossing point. This error would be detected during the qualitative assessment (which is almost an ongoing subconscious process for most designers). As such, this error would be identified and the profiles redesigned so that the SID and STAR profiles are separated by at least 1000 feet at the crossing point.

5.3 Assumptions, Constraints & Enablers

(1) This chapter discusses Assumptions, Enablers and Constraints which constitute the second phase of the design concept.

(2) As suggested in previous chapters, the performance criteria, assumptions, enablers and constraints are established before the Terminal Airspace is designed conceptually or any other design phase is undertaken. Moreover, it is important to note that assumptions, constraints and enablers underpin all phases of the design process and therefore remain constant throughout the design process is to test an assumption (or enabler, or constraint)). This requirement for consistency is illustrated below.
5.3.1 Assumptions

(1) Assumptions refer to elements of ATM/CNS, which are assumed to be ‘true’ for purposes of the design. Assumptions may also have to be made concerning factors beyond direct ATM/CNS e.g. certain weather phenomena.

(2) The incorrect identification of assumptions can be the undoing of a Terminal Airspace design. It is therefore better to err on the side of caution when selecting assumptions. This can be illustrated by way of an example:

(3) Example: Suppose that it is not possible to establish whether an ATS route will be available for traffic from X to Y, and that the absence/presence of the new route is the key to reducing the workload in a particular sector. In this case, it would be better not include the new ATS route as an assumption in the traffic sample. This said, however, it may be worthwhile to have a two-phase design plan where the first excludes the new ATS route and the second includes the ATS route, so that the true value of the new route can be quantified.

(4) The identification and selection of assumptions is likely to provide the greatest challenge to the designer in the case of futuristic design projects e.g. creating a Terminal Airspace model for the year 2025 for a new airport site with eight parallel runways. As most designers can vouch, the closer the implementation date the easier the assumptions are to select. In the case of futuristic projects, the designer may be left no choice but to use educated guesswork - and ensuring that the final report properly reflects this.

Traffic Assumptions

(5) Assumptions made concerning the traffic demand in the Terminal Airspace and those made concerning the predominant and secondary runway(s) in use are of crucial importance to the design of a Terminal Airspace. Traffic demand and runway(s) in use are important because the notion of Terminal Airspace includes the ‘resultant’ airspace created to protect IFR flight paths to and from the runway(s) in use. For this reason, it is imperative that the designer:

- properly analyses the traffic demand;
- the current and estimated fleet mix; and
- the predominant and secondary runway(s) in use, their mode of operation and any conditions attached thereto are established.

(6) In context, traffic demand refers to a traffic sample which the design team considers representative of the traffic servicing the airport(s) within the Terminal Airspace. Thus the representative traffic sample chosen by the design team is
the ‘assumption’ and it is this assumption that requires thorough analysis prior to commencing the design process.

(7) Whilst traffic demand inevitably refers to a traffic sample, a traffic sample may need to be created to cater for futuristic Terminal Airspace design projects e.g. a concept design for the year 2025. In such a case future market analyses are undertaken and a traffic sample created for airspace design purposes.

**Runway in use**

(8) Similarly, identifying the predominant and secondary runway(s) in use requires assumptions to be made as to which runway orientation is used for the greater part of the day (e.g. RWY20 is used 70% of the time as opposed to RWY02). This important relationship between runway in use and traffic flows explains why the addition of a new runway within a Terminal Airspace invariably results in the need for some modifications being made to the Terminal Airspace design.

### 5.3.2 Constraints

(1) Constraints stand in contrast to assumptions in that they suggest the absence of certain elements of ATM/CNS or limitations created by extraneous factors. Typical constraints include high terrain, adverse weather patterns, the requirement to satisfy environmental needs (which dictate, for example, the noise-preferential runway to be used at night time) or the absence of rapid-exit-taxiways which may limit the landing rate and therefore influence route placement. In general terms, constraints can be said to have a negative impact upon the ATC operational requirements of a Terminal Airspace design. At best, it may be possible to mitigate the constraints using enablers. At worst, constraints have to be accepted because there is no alternative ‘solution’.

### 5.3.3 Enablers

(1) Enablers refer to any aspects of ATM/CNS that may be used to mitigate the constraints identified and/or any factors, which may be relied upon to ‘enable’ ATC operations in the airspace designed. Importantly, the identification of enablers may take the form of functional requirements (which are then ‘translated’ into technical requirements) which require follow up work on the part of the ANSP and may be outside the scope of the design project.
<table>
<thead>
<tr>
<th>CONSTRAINTS</th>
<th>MITIGATIONS</th>
<th>ENABLERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High terrain on final approach RWY X</td>
<td>Increase ILS angle by 1°?</td>
<td>Specification change for ILS</td>
</tr>
<tr>
<td>Multiple airports within close proximity with poor coordination agreement</td>
<td>Letter of Agreement</td>
<td>EUROCONTROL Doc The Cross-Border Common Format letter of Agreement</td>
</tr>
<tr>
<td>Aircraft performance mix limits capacity</td>
<td>Design different SIDs for high and low performance aircraft</td>
<td>Airspace Design</td>
</tr>
<tr>
<td>Aircraft navigation performance mix limits capacity by increasing ATC workload</td>
<td>ATC system modification to allow FDPS / RDPS to show aircraft navigation capability</td>
<td>Software application Change</td>
</tr>
<tr>
<td>Inadequate navigation infrastructure</td>
<td>New DME at location A</td>
<td>Enhance NAV Infrastructure</td>
</tr>
<tr>
<td>High mix of IFR-VFR movements limits capacity</td>
<td>Segregated VFR / IFR routes</td>
<td>Airspace Design</td>
</tr>
<tr>
<td>Fixed wing / rotor craft mix increases approach workload and complexity</td>
<td>Separated routes based upon aircraft category</td>
<td>Airspace Design</td>
</tr>
<tr>
<td>TSA which adversely affects traffic patterns</td>
<td>Airspace sharing arrangements</td>
<td>Flexible Use of airspace concept and EUROCONTROL Doc The Cross-Border Common Format letter of Agreement</td>
</tr>
<tr>
<td>Poor radar coverage prevents route placement in part of the terminal airspace</td>
<td>Improve surveillance capability</td>
<td>Enhance Radar Infrastructure</td>
</tr>
<tr>
<td>Poor radio coverage prevents route placement in part of the terminal airspace</td>
<td>Improve radio coverage</td>
<td>Enhance Communications Infrastructure</td>
</tr>
<tr>
<td>Severe weather disrupts traffic especially at peak times</td>
<td>Create ‘contingency’ routes for poor weather operations; re-locate holding patterns</td>
<td>Airspace Design</td>
</tr>
<tr>
<td>No flights permitted over village X</td>
<td>Diverge departure routes as soon as possible after take-off</td>
<td>Airspace Design</td>
</tr>
<tr>
<td>Parallel runway regulations (ICAO-SOIR)</td>
<td>New PBN separation standards</td>
<td>Enhanced navigation technologies</td>
</tr>
<tr>
<td>Environmental requirements to reduce / minimise noise / emissions</td>
<td>Continuous Descent Operations</td>
<td>Airspace design, procedure design, ICAO manuals, EUROCONTROL CCO / CDO tool kit</td>
</tr>
</tbody>
</table>

### 5.3.4 Similarities and Differences

(1)Whilst (design) assumptions can be viewed as ‘uncertainties’ which have been elevated to ‘facts’ to be used as a basis for the design, the role of enablers is to mitigate against constraints which have been identified. An example can be used to illustrate this difference: Suppose that a designer wishes to design RNAV routes up to the final approach fix in a Terminal Airspace. Because Terminal
RNAV Routes with waypoints having a level restriction below MSA or MRVA may only be designed for use by aircraft which are certified for P-RNAV operations, an assumption can be created that aircraft operating within the Terminal Airspace are appropriately certified. In seeking to design the route based upon this assumption, the designer identifies a constraint viz. that the navigation infrastructure is inadequate and therefore does not allow the design of a necessary STAR route. This constraint could be mitigated against by the installation of a new DME pair in the Terminal Airspace and the enabler would be an enhancement of the navigation infrastructure. In view of the costs, which enablers sometimes incur, a Cost Benefit Analysis may be required to determine whether the benefits provided by the enablers outweigh the costs. If this is not the case, it may be necessary to identify alternative mitigation.

5.3.5 Selecting Assumptions, Constraints and Enablers

(1) In order to identify and select assumptions, constraints and enablers, a comprehensive inventory of ATM/CNS elements is needed as well as expert input from, for example, meteorologists and pilots.

(2) Example: A Terminal Airspace contains four DME stations. A fifth, located in an adjoining State, is assumed to be within the range of most aircraft departing from RWY23 at the only airport within the Terminal Airspace. Based on this belief the designers include the availability of this ‘cross-border’ DME in their assumptions when designing a SID (intended to be flown by P-RNAV equipped aircraft) from RWY23. What the designers have not realised, however, is that the co-ordinates of this fifth DME are not WGS84 compliant (which is pre-requisite for SIDs designed for use by P-RNAV equipped aircraft). (Data collection obtained from an official source such as the AIP of the neighbouring State would reveal this shortfall.). Thus the ‘assumptions’ has turned out to be a constraint requiring mitigation.

(3) Example: Having tested various sectorisation options, designers decided upon a combined functional/geographic sectorisation option because (a) it was the most efficient and (b) it did not require extra working positions and allowed them to make use of the existing three. When seeking to implement these new sectors, however, they were informed by ATC system specialists that the current ATC system was incapable of functional sectorisation and that it was no longer possible to modify the system software. (In this instance, the input of an ATC systems expert during the design phase would have prevented this option being chosen).

CHOOSING A TRAFFIC SAMPLE

(4) Selection of a traffic sample that is most representative of the traffic within a Terminal Airspace is best achieved by combining statistical analysis with ATC experience and by looking beyond the information available. Two elements of the traffic sample are to be distinguished, which for convenience, will be described as Traffic Distribution over Time and Geographic Distribution of traffic. An appreciation of both elements is crucial to choosing a representative traffic sample.
Traffic distribution over Time

(5) As regards Time, a feasible starting point is a snapshot analysis of the number of movements through the Terminal Airspace by month so as to determine the regularity of the resultant graph.

(6) Using the sample graphs below (of three fictitious Terminal Airspaces) the following information can be drawn: Where Terminal “A” has a graph that is characteristic of large Terminal Airspaces in the core area, Terminal “B” is typically representative of summer holiday resorts and Terminal “C” typical of winter holiday (ski) resorts.

(7) Whilst in the case of Terminal “A” it is obvious that one day’s traffic (the traffic sample) should be selected from one of the busier months, airspace design planners for Terminals “B” and “C” may wonder whether selecting one day during the busiest month truly constitutes a representative traffic sample. Because two busy months of the year may not be ‘representative’, airspace designers from these two Terminal Airspaces would do well to select two traffic samples i.e. one day from the busy months and one day from the quieter period.

(8) The advantages reasons for this are twofold:
- to enhance the potential to apply the Flexible Use of Airspace concept;
- if the geographic spread of the traffic is significantly different during the ‘quiet’ and ‘busy’ months, it may be necessary to create two sets of Terminal Routes.

(9) Comment: Is it viable to create two (or more) sets of Terminal Routes to accommodate significant changes in traffic density and/or distribution? Opinions diverge as to how significant changes in the operating environment should be accommodated. Whilst one view holds that an ‘unstable’ or ‘changeable’ airspace structure is to be avoided, the opposing view contends that it is not only possible but desirable to use airspace in a flexible manner. Whatever the philosophy followed, designers should ensure that the design fully supports safe and orderly air traffic management.

Geographic distribution of traffic

(10) Having selected a one-day traffic sample from a Time perspective, it is necessary to determine the geographic distribution of this traffic with a view to identifying
the predominant and secondary traffic flow(s). To this end, the traffic sample needs to be analysed using, for example, a spreadsheet.

(11) Because traffic data files contain information on each flight, flights can be sorted in several ways, e.g.:

- Terminal Area entry “point” (in the case of arrivals) and Terminal area exit point (for departures);
- origin (in the case of arrivals) and destination in the case of departures.

(12) Sorting the geographic traffic distribution by origin and destination so as to identify the raw demand is only necessary when (i) doubt exists that the current En-Route ATS route network is not sufficiently refined thus making it lightly that some aircraft are not on the most direct route or, (ii) in the case of futuristic design projects for new airports where part of the exercise is trying to develop an entire airspace organisation on a clean sheet. The diagrammatic representation of raw demand is not nearly as clean as that of entry/exit point.

(13) Given that the thicker lines in the above diagram represent routes of heavier (raw) demand, it is possible to ascertain - by comparing the location of existing Terminal entry/exit point [black circles above] in relation to these lines - whether these points have been placed effectively.

(14) In those instances where En-route airspace designers alter their route network within the greater EUR ARN so as to minimise the differences between the raw demand ‘tracks’ and actual traffic routeings, it is not necessary for Terminal Airspace design planners to undertake the ‘raw demand’ exercise - providing that
En-Route or Terminal Airspace design is undertaken collaboratively as a matter of course.

5.3.6 Determining the Predominant & Secondary Runway(s) In Use

By and large, the predominant and secondary runway(s) in use are usually easier to identify (e.g. either because environmental requirements or weather phenomena dictate runway use). Whilst ‘predominant runway in use’ is a relative term (as is ‘major traffic flow’), a predominant runway is one that is used most of the time. Usually stated as a percentage e.g. 80% (which equals 292 days a year), it may be said that RWY20 is used 80% of the time, and RWY02 20% of the time. At multiple-runway airports, this ‘predominance’ may be stipulated according to the time of day (for environmental considerations) or be distributed among several runways e.g. e.g. RWY20 is used 80% of the time by arriving aircraft, and RWY18 is used 90% of the time by departing aircraft.

5.3.7 When to Identify Assumptions, Constraints & Enablers

As shown in the above diagram, Assumptions, Enablers and Constraints are identified at different stages of the design process. Constraints and Enablers enter the design process during the critical review of the Reference Scenario where the constraints and enablers refer to the Reference Scenario. The Assumptions are identified prior to commencing the conceptual design - and these are verified at different stages of the process. During the design process i.e. the conceptual design of Routes, Holds, Structures and Sectors, constraints, mitigation and enablers are identified. In some cases, a Cost-Benefit analysis may be required.

5.3.8 Area Navigation as an Enabler

Whilst communication, surveillance and navigation are all vital elements to be considered in the design of a Terminal Airspace, the importance of navigation into the design equation has increased through the application of area navigation (RNAV) in Terminal Airspace.
(2) In order to design RNAV Terminal Routes (e.g. SIDs/STARs for use by RNAV-equipped aircraft in Terminal Airspace), coherency is required between:

- the availability of a navigation infrastructure that supports the standard of RNAV to be employed. (NAVAIDs can be ground- or space-based or self-contained on-board the aircraft); and
- Design of the procedure in accordance with Doc 8126 PANS-OPS design criteria stipulations of the PANS-OPS Design Criteria used; and
- the aircraft’s on board RNAV system being certified (or the navigation function included in a flight management system (FMS)) being certified to the RNAV standard required by the Terminal area procedure and/or SID/STAR (and the flight crew having the appropriate operational approval);

(3) For both B-RNAV and P-RNAV, this coherency referred to previously between the navigation infrastructure, PANS-OPS design criteria and the certification standard of the aircraft’s RNAV system is required. Thus different obstacle clearance criteria (PANS-OPS) apply for B-RNAV compared to P-RNAV, different certification standards exist for B-RNAV and P-RNAV, and the navigation sensors (which relate to the navigation infrastructure) that can be used for B-RNAV and P-RNAV are not necessarily the same though similar). The main differences between any RNAV type and another concern:

- RNAV Systems Description
  (E.g. a database needed; positioning sensors to be used etc.)
  - Airworthiness Certification Objectives:
  - Described in terms of accuracy, Integrity & Continuity of service
  - Functional Criteria:
  - (Required; Recommended)
  - (Area of application: where it can be used...and how)

(4) The differences for RNAV System Descriptions are identified in the following table:

<table>
<thead>
<tr>
<th></th>
<th>B-RNAV</th>
<th>P-RNAV</th>
<th>RNP (x) RNAV*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>5 NM Lateral</td>
<td>1 NM Lateral</td>
<td>(x) NM Lateral and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Longitudinal</td>
</tr>
<tr>
<td><strong>Integrity</strong></td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td><strong>Continuity of Function</strong></td>
<td>-</td>
<td>Loss = Remote</td>
<td>Loss = Extremely Remote</td>
</tr>
</tbody>
</table>

* According to MASPS DO236-B
The increasing level of sophistication of the RNAV System (B-RNAV < P-RNAV < RNP(x) RNAV) results in a proportional increase on the Requirements for respectively the RNAV Systems, Accuracy/Integrity/Continuity and Required Functionalities.

The main differences in what is required and what is recommended for Functional Criteria between any RNAV type and another are identified in the following table:

<table>
<thead>
<tr>
<th>Required</th>
<th>B-RNAV</th>
<th>P-RNAV</th>
<th>RNP (x) RNAV*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required</td>
<td>4 Way point storage (manual data entry; Display of distance/bearing to Waypoint)</td>
<td>NAV Data Base; Data Integrity; leg types (e.g. TF; CF; FA)</td>
<td>NAV Data Base; Integrity (RNP alerting); leg types (e.g. RF; FRT) // Off-set</td>
</tr>
</tbody>
</table>

Recommended // Off-set

* According to MASPS DO236-B

Where and how different RNAV types can be used i.e. the Area of Application is described in the following tables:

<table>
<thead>
<tr>
<th>Area of Application</th>
<th>B-RNAV</th>
<th>P-RNAV</th>
<th>RNP* (x) RNAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENR Above MSA/MRVA</td>
<td>ENR TERMINAL AIRSPACE up to Final App WPT Below MSA/MRVA</td>
<td>ENR TERMINAL AIRSPACE depends on Functional Requirements</td>
<td></td>
</tr>
</tbody>
</table>

* According to MASPS DO236-A

Depending on the RNP accuracy the following distinction can be made:

<table>
<thead>
<tr>
<th>RNP1 RNAV</th>
<th>RNP3 RNAV</th>
<th>Functionalities specified by JAA (EASE) determine area of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENR TA up to FA WPT Below MSA/MRVA</td>
<td>ENR TA inside FA WPT Below MSA/MRVA</td>
<td></td>
</tr>
</tbody>
</table>

5.3.9 ATC System

Designers’ attention is drawn to the fact that the need to understand the technical capabilities and limitations of the ATC system should not be underestimated. The same can be said of the requirement to ensure that a proposed Terminal Airspace design can be supported by the ATC system. As a basic rule, it may be stated that the more complex the design of a Terminal Airspace, the greater the demands made on the technical capabilities of the ATC system and controller support tools.

GENERAL TECHNICAL DESCRIPTION OF THE ATC SYSTEM

In simple terms, it may be stated that the basic aim of the technical ATC system is to get the data related to a flight to relevant controllers in a timely and complete manner.

In a technical ATC system, the main data carrier is called a flight plan. It is often referred to as a System Flight Plan or a Current Flight Plan and FPL, SFPL or CPL.
are commonly used abbreviations. In general terms, it can be stated that the technical ATC system generally consists of three main components:

- Flight Data Processing (FDP);
- Surveillance/Radar Data Processing (RDP);
- Display System or Human Machine Interface (HMI).

(4) From a Terminal Airspace Design perspective, the following sub-components of the system are also relevant:

- Environment Data Processing (ENV);
- Flight Plan Distribution (DIS);
- (Flexible) Sectorisation (SEC).

(5) The following diagram provides an overview of the relations between main components and sub-components of the technical ATC system.

![Diagram showing relations between main and sub-systems of the technical ATC system.]

5.3.10 Spacing

Route Spacing

(1) When designing ATS routes, there is a strong connection between aircraft-to-aircraft separation and navigation specification. That translates into route spacing requirements defined in the ICAO documentation. For route spacing below ICAO specifications, a safety case shall be required for individual projects.
5.4 Arrival & Departure Routes

(1) This chapter presents Design Guidelines for Routes. They are intended to support creation of the design concept for Routes for a specific Terminal Airspace. This concept would be based on certain assumptions.

(2) Whilst the generic ICAO definition of ATS Route is broad, ATS routes within Terminal Airspace are usually arrival and departure routes.

(3) These arrival and departure routes may be:

- designated, as is the case with IFR departure and arrival routes which are usually published as SIDs/STARs (based upon RNAV or conventional navigation means), designated VFR routes (promulgated, for example, by visual reporting points) or VFR corridors; and/or

- those which are not designated, as is the case with tactical routeing ‘created’ by ATC in the form of Radar Vectors or instructions to proceed “direct to” an RNAV waypoint.

(4) RNAV has been increasingly used as a basis for the design of RNAV-based instrument approach or departure procedures. Usually, the RNAV-based instrument approach procedure does not include the final approach and/or missed approach segment. In many cases, the tracks depicting these procedures are designed to replicate radar vectoring patterns because these procedures are used as a substitute for radar vectoring by ATC.
Note: Whilst instrument approach procedures based upon conventional navigation are sometimes used as a substitute for Radar Vectoring, this is less common.

(5) Although Radar Vectoring has been used by ATC for traffic separation and sequencing for several decades, the increased use RNAV in Terminal Airspace has resulted in ATC being able to provide tactical instructions to a waypoint. Unlike Radar Vectors, instructions to a waypoint result in aircraft flying a particular track (as opposed to heading). Whilst Radar Vectors and instructions to proceed direct to a waypoint are not considered to be ATS Routes (in the traditional sense), they have been included in the figure above because Terminal Airspace designers are required to consider all routes when designing an airspace, whether these are 'created' in a strategic or tactical manner.

(6) In light of this variety, the generic expression Terminal (Arrival/Departure) Routes is used to describe the sub-set of ATS routes comprised of arrival and departure routes, SIDs/STARs and RNAV-based instrument approach or departure procedures. Naturally, the designer is also required to consider tactical routes shown in the green box in this figure.

Note: When used specifically, expressions such as ATS routes, Arrival or Departure routes, SIDs/STARs and Instrument Approach Procedure (or parts thereof) are to be ascribed their ICAO meaning.

STARs & INSTRUMENT APPROACH PROCEDURES IN AN RNAV ENVIRONMENT

(7) STARs and instrument approach procedures are defined in ICAO Doc 8168 PANS-OPS and explanatory material is provided by ICAO Doc 9426ATS Planning Manual. The identification of STARs (and SIDs) is provided for in Annex 11, Appendix 3.

(8) Over the years, States implemented two quite distinct ‘models’ of STARs in Terminal Airspaces. Whilst in the first the STARs provides the connection between the En-route ATS Route system and the Terminal Airspace, in the second, STARs commence closer to the landing runway. Thus in the first case, the STAR begins in the En-route system and ends (usually) inside the Terminal Airspace, often at a holding fix, whilst in the second, the STARs tends to begin at - approximately - the Terminal Airspace boundary (or the Approach Control Unit area of responsibility).

(9) RNAV is being used in Terminal airspace, not only as the basis for the design of STARs but also to design RNAV-based instrument approach procedures.

(10) As far as ‘Model’ 1 is concerned, the introduction of RNAV as the basis for Terminal Route design envisages replacing or replicating Radar Vectoring patterns with RNAV-based instrument approach procedures (or RNAV STARs, in some cases).
5.4.1 CDO

(1) When designing departure and approach routes, it should be noted that both airspace and procedure design are the key enablers for CCO and CDO; pilot techniques that can provide considerable noise, fuel and emissions savings. Therefore, CCO and CDO should be an integral part of the airspace / procedure design process. Where the local situation permits, airspace / procedure design should enable CCO and CDO to the highest extent possible (ideally, optimum CCO is provided to top of climb, and CDO from top of descent). In general, CDO provides approximately 10x the level of fuel / emissions saving benefits when compared to CCO.

(2) Continuous Descent Operations focus on the vertical profile of incoming traffic. The intention is to allow aircraft to descent without interruption from their cruising or intermediate FL all the way to final approach, intercepting the glide path as required. The descent without interruption allows the aircraft to remain longer at more fuel efficient cruising flight levels as opposed to temporary level-offs at more fuel inefficient lower levels. This can only work if an exact distance to touchdown can be given, either by adhering to a fixed STAR or by receiving accurate DTG from ATC.

(3) The benefits are mainly environmental: fuel saving and less noise. Some ANSPs refer to CDO as CDA (Continuous Descent Approach) or Green Approach.

(4) When an airspace change to enable optimised CDO, there are a number of good practices that should be taken into consideration. These relate to airspace and procedure design, the definition of Letters of Agreement between centres / sectors and the designation of any altitude or speed constraints in the arrival procedure (see also paragraph 4.4.7). These include the following:

- The creation of each approach procedure should be made in close collaboration between the ANSP and the airlines as an optimised design should take into account both the constraints and requirements of each party.

- Departure routes (SIDs) and arrival routes (STARs) should be designed laterally independent as much as possible. When considering between the optimisation of the vertical and lateral profiles of the procedure, each case will have a local solution. However, when designing a procedure, it should be borne in mind that any level segment included in the descent path will increase the fuel burn and emissions of each arrival by an amount that
depends on the aircraft type, the altitude at which the level segment occurs and atmospheric conditions. As a rule of thumb, if level segments are unavoidable, they should take place as high as possible in the procedure.

- LoAs, where required / needed / in place, should enable optimal descent profiles (ideally from top of descent) and be designed on a flexible basis that can be adapted to runway direction, high / low demand periods, seasonal traffic, week / weekend traffic patterns and should be regularly reviewed on an individual restriction basis.

- LoAs may benefit from moving existing points or creating new points to both enable a higher descent point or a more optimum descent profile. Such changes should be promoted during the regular LoA review.

- Bearing in mind the NM “file it, fly it” campaign to ensure predictability for ATCOs, when the traffic situation permits, ATCOs should be encouraged, wherever possible and when the traffic situation permits, to relax RAD restrictions on a tactical basis to allow aircraft to cruise at more optimal higher levels thus enabling CDO from higher levels / top of descent. This optimises the descent profile and may allow tactical handovers at more optimum levels. Coordination with neighbouring sectors may be required to ensure that any such relaxation of RAD restrictions will not influence flow measurements or create overload situations for the remaining route of the flight concerned.

- For optimised CDO, Approach routes should be defined with a minimum amount of constraints and restrictions (FMSs may be unable to handle closely located constraints) whilst a reduced number of waypoints have been shown to increase compliance of lateral and vertical constraints.

- Where altitude restrictions exist, approach routes should take into account the requirement to reduce the descent rate within the last 2000ft to 1500ft/min, and within the last 1000ft to 1000ft/min, to an altitude constraint in order to avoid TCAS RAs.

- Although the implementation of altitude waypoint constraints shall be limited as much as possible, any restrictions should be published exactly on the idle descent path of most aircraft types and ideally be based on altitude windows with the following priority of instructions:
  - “at and above”
  - “at or below”
  - “between” (altitude window)
with “be level at…” instructions to be avoided wherever possible.

- The level and speed windows of STARs and approach procedures must be designed to take account of aircraft performance limits and should be large enough to accommodate idle descent profiles for the specific fleet of aircraft types operating at each aerodrome but not too large as to block too much airspace.

- Speed constraints should be avoided wherever possible although there may still be a need to use trade-offs between speed control and efficiency to maintain throughput in peak time periods.

- If speed constraints / adjustments are required it is preferable to define an
entry speed into the CDO Arrival (e.g. “Maintain last MACH number, 280kts on transition”).

- Published speed constraints may improve predictability for ATC by harmonising traffic, it may also be used to improve energy management for pilots in cases when continuous descent profiles are commonly disrupted and late further descent clearance is commonplace.

5.4.2 CCO

(1) The principle of Continuous Climb Operations is straight forward: in this case, an aircraft should not be required to level off the climb at any stage. The aircraft can climb from take-off to cruising level without any restriction.

(2) Both CDO and CCO may be regarded as the vertical extensions of a published SID or STAR procedures where the published departure / approach procedures are restricted to terminal or lower airspace. Taking into account the normal climb and descent profiles, it is possible to put crossing points of SIDs and STARs at a location where the natural profiles will not interact anyway. By doing so, ATC still has to monitor the crossing points, but an obligatory level off is no longer required.

5.4.3 Closed STARs

(1) Closed-path procedures provide track guidance right up to the final approach track whereupon the aircraft usually intercepts the ILS. Closed STAR procedures can be pre-programmed into the FMS and published in the AIP. The closed STAR procedure therefore provides the pilot with a defined distance to touch-down thus supporting the area navigation’s systems execution of the vertical profile. The ideal closed path design is one with the minimum amount of distance flown, with no speed or altitude restrictions so that each aircraft can fly its optimum descent profile and is therefore the optimum procedure for enabling CDO.

(2) Where multiple arrival routes are operated onto a single runway using closed STARs, a strategic and tactical sequence of aircraft is required to ensure that safety is maintained in the case of aircraft automatically making a final approach turn into the direction of other arriving aircraft on different routes.

(3) Closed procedures however, can be designed and published in a manner that anticipates alternative routeing to be given by ATC on a tactical basis. These tactical changes may be facilitated by the provision of additional waypoints allowing ATC to provide path stretching or reduction by the use of instructions ‘direct to a way-point’. However, these tactical changes, needed to maximise runway capacity, may impact on the vertical profile planned by the area navigation system.

(4) In a closed STAR procedure design, the FMS is able to monitor the total energy of the aircraft versus the planned trajectory to the greatest extent possible. With a closed STAR procedure, if an aircraft is cleared by ATC for a shorter route after passing ToD, this will result in the aircraft having too much energy relative to landing requirements. The corresponding reduction in energy is usually done via various drag devices, such as speed brakes or premature reconfiguration of the aircraft through slats/flaps or extension of the retractable landing gear. This can create adverse noise impacts on the ground.
In the case that tactical changes are instructed by ATC, the provision of regular and accurate distance to go (DTG) information from ATC to the pilot is essential to enable the pilot to optimise the descent profile.

In closed-path STARs, any tactical small speed adjustments should only be considered, preferably before the aircraft is vectored off the procedure, as predictable DTG is still accurate and the excess/lack of energy that the speed adjustment creates is manageable by the crew. Speed control is most effective when a small correction is made early in a procedure and given time to take effect, or, when speeds are a part of the procedure.

### 5.4.4 Open STARs

At airports where the closed path option is not possible or the most appropriate solution, open-path STARs provide track guidance (usually) to a downwind track position from which the aircraft is tactically guided by ATC to intercept the final approach track.

Alternatively, the open-path procedure may terminate at the entry of a TMA sector or at the merge point of two flows. In this case, being further away from the runway, ATC has more freedom to vector aircraft. This can prove beneficial in cases where the runway configuration changes frequently. Radar vectored open-path STARs give great flexibility in keeping a high runway throughput which is typically required in high density traffic environments therefore they will provide more ATC capacity than closed-path STARs however they also require more tactical ATC interventions.

With open-path STARs, the area navigation system plans the optimum descent profile to the final point of the procedure where after appropriate path stretching is applied by ATC.

The FMS assumes that the trajectory to be flown will be almost direct from the intermediate approach fix to the RWY i.e. the FMS does not know what path stretching will be applied by ATC and assumes that distance to touchdown is much shorter than is actually the case. In this case, the vertical profile in the FMS will reflect the assumed lateral trajectory (resulting in a non-optimised vertical profile) unless the flight crew generates their own FMS inputs to reflect the predicted trajectory that is expected to be flown. By generating such FMS inputs, the pilot can optimise the vertical profile of the aircraft to the extent possible, in the absence of full knowledge of the planned ATC instructed trajectory. In such cases, predictability of ATC instructions will provide a level of support to pilot planning and FMS input but for the full picture, it is essential that ATC provides the pilot with DTG.

Therefore, with open path procedures, ATC should enable an optimised vertical profile by providing regular and accurate DTG information to the pilot, wherever
possible, so that a descent profile without inefficient level segments can be executed to the extent possible. Even with no level segments, the open path option will create a non-optimal descent unless the distance to go information is given before the descent is initiated. This is the main reason why, closed-path procedures are preferred over open-path. Where DTG is not provided, it may be requested by the flight crew to ATC.

5.4.5 Trombones

(1) The principle of Open STARs on downwind can be transformed in a more strict procedure by publishing the downwind leg as part of the STAR and extending it. The final approach leg is also extended, with waypoints at fixed intervals. This allows ATC to sequence aircraft by turning them from downwind to final, using a DCT clearance to the desired waypoint taking into account flight energy and avoiding unsuitable turns.

(2) The principle of using DCT clearances to shorten the published procedure can be extended by adding another leg, parallel to downwind. The shape of this procedure now resembles that of a trombone. Every point in the procedure can be used to in a DCT clearance to achieve the desired sequencing of incoming traffic.
These procedures provide ATC with a clear traffic picture, thus achieving relatively high capacity in the TMA sectors. The length of the procedure may present disadvantages in terms of flight efficiency. Similar issues relating to predictability, as with open-path STARs, may exist with trombones. Where trombones are in operation, predictability may be enhanced with several good practices e.g. designing the trombones with a closed path structure whereby they standardize the “down wind-base-final” circuit and offer a high degree of predictability, publishing the procedures (together with average flown arrival distances) in the AIP for planning purposes and the provision of regular and reliable DTG.

5.4.6 Point Merge

The “point merge system” is an operating method to integrate high density arrival flows. Traffic integration is performed by merging inbound flows to a single point. This system enhances situational awareness and reduces workload of flight crews and air traffic controllers.

Before the merge point, a sequencing leg is created as a buffer. While an aircraft is on the sequencing leg, it can be instructed to fly “Direct To” the merge point at any appropriate time. This allows the controller to stretch the trajectory by keeping an aircraft on the leg for a certain amount of time. Alternatively, the controller can send the aircraft “Direct To” the merge point very early as to shorten the trajectory.

A sequencing leg should have approximately the same distance from the merge point over the entire length. This means the sequencing leg will resemble an arc with the merge point at the centre of the arc.
(4) When multiple sequencing legs are created, the distance from the merge point should be approximately equal. An exact overlap should however be avoided. The leg closest to the merge point should be assigned the highest altitude. The leg that is slightly further away should be assigned a lower altitude. This assures vertical separation between aircraft leaving the outer leg to turn to the merge point and aircraft that are over flying on the inner leg.

(5) Additional lines on the radar scope should be created to assist the controller to determine if two consecutive aircraft have established the required separation for sequencing. As one aircraft passes first line on its way towards the merge point, separation is established with all other aircraft that are still on the sequencing leg(s). This means that the next aircraft can be turned “Direct To” the merge point. Part of the procedure is to lock the aircraft on speed. By doing so, longitudinal separation is maintained even after the merge point.

(6) The process of monitoring the aircraft as they pass the iso-distant lines and turning the next aircraft in towards the merge point is constantly repeated. By these means, high density traffic can be safely and efficiently managed. After this merge point, aircraft are established on a common route until the exit of the point merge system. In this phase, separation is maintained by speed control.

(7) In order to optimise the vertical descent profile in a point merge system, predictability is again the key. A pilot may execute a CDO prior to the merge point arc, maintain level flight whilst following the arc and continue with CDO when cleared to the merge point. When traffic levels permit, the aircraft may be cleared direct to the merge point rather than establishing on the arc. Whilst some point merge systems may require a level segment on the arc to separate distinct traffic flows, the only way to avoid the level segment for a single point merge arc is to give accurate DTG information to the pilot before the procedure is initiated. CDO may also be enabled by designing the procedure with an altitude restriction of “at or above” at the beginning of the arc.

5.4.7 Striking the Balance

(1) The diagram below draws attention to the fact that designing Terminal Airspace is rapidly becoming a major challenge due to constraints related to national boundaries, environmental needs and competing user requirements. Frequently, the most appropriate placement of a route for ATC does not necessarily meet the requirements of an adjacent Terminal Airspace and/or environmental or user needs. Thus a trade-off is required.

(2) Mindful that sustaining capacity is already a challenge in some Terminal Airspaces, it is impossible to over-state the need for a collaborative approach between adjacent Terminal Airspaces and between users, ATC and Airport Operators and/or other environmental interest groups when designing terminal routes. Terminal Airspace designers require clear directions as to whether, and to what extent, Environmental and User requirements are to be taken into account and when this consultation should occur.
In view of the above, it is stressed again that a collaborative approach to design is required. Once the routes and holds have been created and are available for use - as agreed collaboratively between all parties - they should be used in accordance with the conditions agreed by all parties.

Mandatory Consultation Process: In some countries where a mandatory consultation process exists, Terminal Airspace development can be discontinued because of a failure to comply with this consultation process.

5.4.8 Guidelines

In this section, Design Guidelines for terminal routes and Holding Areas are described with a view to creating a conceptual design based on certain assumptions, enablers and constraints.

Guidelines related to terminal routes are preceded by an “R” and those to concerning Holding Areas, by an “H”. They are not prioritised.

Whilst, for the most part, the Guidelines for the Design of terminal routes and Holding Areas concentrate upon IFR flights, many of the notions contained in these design guidelines apply equally to terminal routes promulgated for use by VFR flights. This said however, special mention is made of route planning for VFR use where appropriate.

These Design Guidelines are based on three assumptions:

Assumption 1: An air traffic control service is provided and Radar Surveillance is available within the Terminal Airspace;

Assumption 2: Within the context of needing to strike a balance between competing interests referred to above, these Design Guidelines aim primarily for efficient design of Routes and Holds with a view to enhancing safety and maximising ATM capacity.
### 5.4.9 Phased Design Approach

(1) The figure above, suggests a phased approach to the design of routes and identification of constraints and enablers.

**Step 1:** using assumptions only, create a conceptual design either of (‘ideal’) routes and holds or modify existing routes/holds; then

**Step 2:** refine the output of Step 1 by ‘adding-in’ PANS-OPS feasibility. Constraints and enablers are identified at this stage and the routes modified accordingly.

**Step 3:** may be used if it is necessary to establish the flyability of the terminal routes.

(2) Note 1: Usually, holding patterns are designed along routes and the routes are therefore designed first. Where required, however, it may become necessary to identify the airspace available for holding and design the relevant terminal routes as a function the placement of the holding areas.

(3) Note 2: Throughout the design process, a qualitative analysis should be undertaken - see Part C, Chapter 3 and iterations of the Routes after the design of the Holds are required to stream-line the conceptual design of Routes and Holds.
(4) Note 3: Designers’ attention is drawn to the importance of the ATC System as an enabler (or constraint) in the context of designing Routes and Holds.

(5) Comment: When should designers design an ideal system as opposed to modifying the existing system? In most instances, a major change to the operating conditions of the Terminal Airspace would be a good time to attempt a clean start by designing an ideal route/hold system. Such major changes may include (i) the addition/closure of a runway at a major airport; (ii) the creation/closure of an airport within a Terminal Airspace; (iii) addition/removal of Terminal Area Radar; (iv) addition/removal of critical navigation or landing aids; (v) significant change to traffic distribution (e.g. as brought about by political events). Designers find it a useful exercise to periodically design an ideal system and use it as a benchmark against which to measure actual design.

5.4.10 Terminal Routes

R1. Terminal Routes Should Be Segregated As Much As Possible

R1 Full Description: To the extent possible from an ATM operational perspective, terminal routes should be segregated from each other both laterally and vertically so as to enhance safety and to minimise the constraining effect of these routes upon each other.

(1) This Guideline contains three elements, all of which aim to ensure that Terminal (arrival and departure) routes are kept apart as much as possible. Whilst Guideline R1.1 and R1.2 are alternative ways of resolving the SID/STAR interaction (though R1.1 is preferred, see below) Guideline R1.3 is an add-on which may be viewed as complementary to R1.1 and R1.2. Regardless of which guideline is used to resolve SID / STAR integration, optimising CCO, and particularly CDO from the highest levels possible, should be a key design principle.

R1.1: To the extent possible, terminal arrival and departure routes should be laterally segregated from each other;

Can the type of route shown in Figure below be designed for B-RNAV certified aircraft? Given that B-RNAV certification has no requirement for a database (the RNAV system is only required to accept manual entry of four waypoints) and that the turn anticipation is in the region of 22NM, B-RNAV. Terminal routes requiring precise turns cannot be designed for aircraft having only B-RNAV certification.

Can the type of route shown in Figure below be designed using P-RNAV? Yes. The requirement for a database is one of the fundamental differences between B-RNAV and P-RNAV. This said, whilst P-RNAV certified aircraft are capable of more precise turns, consistent track keeping is not guaranteed. For this, RNP RNAV with its Radius to Fix capability is required.

Does RNAV change how close the downwind can be designed to the landing runway? It does not. The minimum distance between the downwind and the landing runway is a function of aircraft performance e.g. the slower the aircraft the closer the downwind can be placed. This said, inertia of (particularly) large aircraft on the turn makes it impracticable to place the downwind closer than 5NM. (Placing the downwind closer than this increases the risk of aircraft over-shooting the final approach track when turning to final.)
Space Permitting, it is recommended that terminal routes are not designed through areas of known and/or frequent turbulent weather phenomena.

To the extent possible, designated VFR routes should be segregated from IFR arrival and departure routes. To this end, visual reporting points should be carefully selected.

**R1.2:** to the extent possible, terminal arrival and departure routes should be vertically segregated from each other as a function of aircraft performance: where arrival and departure routes are required to cross each other, the crossing point should be chosen so that the ‘optimum’ vertical profiles of climbing and descending have a minimum constraining effect on each other.

(2) Fulfilment of this Guideline requires an understanding and appreciation of aircraft performance. Aircraft performance information could be obtained from pilots on the design team. Of special interest would be optimum aircraft performance i.e. not constrained by ATC or environmental requirements. The aircraft performance in question concerns primarily the aircraft’s speed and rate of climb and descent in a temperature band common to the operating environment. Given that a Terminal Airspace usually caters to a wide range of different aircraft, account will need to be taken of this performance range. Designers should be aware that the same aircraft type may operate quite differently with different payloads or during different seasons. Seeing as some Terminal Airspaces are subjected to seasonal traffic peaks, the overall design plan should strive, as far as practicable, design routes in a manner that satisfies those (seasonal) peaks. However, the final result is likely to be a compromise.

(3) The figure for R.1.1 and the figure below can serve to illustrate the application of this Guideline. The left hand sketch of the figure below shows that the departing aircraft has flown ±7NM from take-off when the arrival is ±30NM from touchdown. By referring to the graph below, this crossing can be considered feasible because a departure at ±7NM after take-off is likely to be at approximately 3500 feet AMSL (and accelerating to 250kts, for example) when arriving aircraft at ±30NM from touchdown are likely to be between 7500 and 10,000 feet (dependent on the Rate of Descent). Thus the minimal vertical distance likely to exist between arriving aircraft and departing aircraft on ‘optimum profiles’ at this crossing point is 4000 feet.

(4) Using the right hand sketch of the figure below together with the graph, a different situation emerges, between the two arrival slopes and two departure gradients at 7% and 10% respectively. At the point marked CP, the right hand sketch of the figure below shows that the departing aircraft has flown ±22NM...
from take-off when it crosses the arrival which is ±32NM from touchdown. This is an unsuitable crossing because departures at ±22 NM after take-off on a 7% or 10% gradient are likely to be between 7600 feet and 11,000 feet respectively when the arriving aircraft at ±32 NM from touch down are likely to be 7930 feet and 10,225 feet respectively. Given that it is desirable to ensure that the optimum profiles facilitate ‘naturally’ the minimum vertical separation minima of 1000 feet, this crossing point is unsatisfactory.

(5) The above does not suggest that aircraft climb performance is the only factor to be considered in determining the vertical distance between the aircraft at the crossing point. Neither should it suggest that 1000 feet is the minimum vertical separation to be applied at all crossing points. On the contrary, designers and planners should take various other factors into account in the determination of the vertical distance between the aircraft at the crossing point. These include:

- History of level busts: where applicable. (Mitigation might include publishing level restrictions which ensure 2000 feet between the climbing and departing aircraft at the crossing point);
- Nuisance ACAS alerts: an appreciation of how ACAS Traffic and Resolution Advisories may be triggered by route geometry. (For information on ACAS ‘hotspots’ and ACAS safety information, see ACAS Safety Bulletin 18 of July 2002;
- Low Transition Altitude: Experience has shown that requiring climbing aircraft to stop their climb at or in the vicinity of a low Transition Altitude may increase the likelihood of level busts. The same may be true of arriving aircraft as regards the Transition level.

8 http://www.eurocontrol.int/acas/LatestNews.html
RNAV is all about point-to-point navigation; why is it necessary to design the downwind leg of RNAV STARs close to the runway. R1.2 concerns finding the most suitable crossing point between an arrival and departure route so as to restrict, to the minimum, the vertical profile of the crossing aircraft. The application of RNAV does not change the desirability of applying R1.2. Although users sometimes react adversely to the realisation that RNAV has not served to reduce track mileage in this instance, they usually react positively to the freer aircraft profiles.

What are the alternatives to designing a downwind as per R1.2? This question arises where the downwind as shown cannot be designed either because of noise sensitive areas close to the airport or where the richness of terrain makes such design impossible.

Fortunately, alternatives do exist especially if a robust and detailed equivalent of the graphs above is custom made for a Terminal Airspace. If this graph is developed with the assistance of pilots, it should provide a greater spread of descent/climb profiles which may provide alternatives which include -

- RE-locating the SID/STAR crossing points whilst respecting R1.2, if possible (e.g. the SID could continue on runway heading for a greater distance);
- raising the climb/descent level restrictions at the crossing point;
- permitting only ‘quieter’ aircraft to fly on the SID/STAR shown in figure above (these aircraft would be identified as a combined function of the graph below and data collected from noise monitoring points in the vicinity of the airport)
SAMPLE ARRIVAL/DEPARTURE PROFILES
(Aerodrome Elevation at M.S.L)

Max ARR Slope | DEP 3% Gradient | DEP 7% Gradient | Optimum descent | DEP 10% Gradient

Distance To Touchdown in NM

Distance From Take-Off in NM
**R1.3:** to the extent possible, terminal [departure] routes should be laterally segregated as soon as possible after departure, subject to guidelines R1.1 and R.1.2

(6) This Guideline may be considered the converse of Guideline R3 (which requires arrival routes to be merged progressively as they approach the entry point of a Terminal Airspace).

(7) Whilst this Guideline seeks to laterally segregate Terminal Departure Routes as soon as possible after departure, it should only be used within the limits of Guideline R1.2.

(8) The differences between the designs, shown in the two right-hand diagrams in the figure below, concern the arrangement of the departure routes. Whereas the departure routes fan-out in the top-right sketch, the departure tracks in the bottom right hand sketch are parallel after the first turn and likely to be spaced by a distance exceeding the Radar Separation minima. This configuration would probably make it easier to manage a relatively complex crossing of the downwind.

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If 3NM is the Radar separation used in a Terminal Airspace, will the aircraft operating on parallel RNAV terminal routes spaced at 5NM be ‘procedurally’ separated? No. In order for aircraft to be procedurally separated in such instances, the parallel RNAV terminal routes should be spaced at a distance detailed in ICAO Annex 11 Attachment B.

If 3NM is the Radar separation used in a Terminal Airspace, is it possible to design parallel RNAV terminal routes at 5NM? Yes - but the aircraft operating on the centrelines of these routes are not ‘automatically’ separated and it is incumbent upon the Radar Controller to ensure that the 3NM Radar Separation is not infringed. This technique of route design is sometimes used in high-density Terminal Airspace; the publication of such parallel RNAV terminal routes reduces the amount of Radar Vectoring that the controller has to do, though the Radar monitoring workload may be high.

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Aircraft performance and RNAV permitting, would be possible to build an altitude restriction into the right-turn departure tracks so that they can be ‘hopped over’ the arrival downwind track? Extreme caution should be exercised if an operational requirement is identified for a SID to climb above a STAR, as opposed to the failsafe option of the departure being constrained below an arrival route. This is because the existing PANS-ATM criteria related to the Area of Conflict (see Doc 4444 PANS-ATM, Chapter 5), are not generally considered useful in European Terminal Airspace. (This is because the PANS-ATM provisions do not provide distances from the crossing point which are considered practicable for European Terminal Airspace operations, most of which are conducted in a Radar environment. Furthermore, PANS-OPS obstacle clearance criteria cannot be used to determine track separation.

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When the traffic mix is populated by a high-number of low performance aircraft, it may be useful to design separate Terminal Departure or Arrival Routes to accommodate these aircraft. This can be particularly advantageous as regards noise. Examples include the design of SIDs with ‘early turnouts’ for less noisy aircraft, or the design of Terminal (Arrival) Routes for ‘lower’ performance aircraft (which may also simplify sequencing for ATC...)

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Whenever possible, VFR (departure) routes should be designed so as to clear the initial departure area used by IFR routes, as soon as possible
**R1.4** to the extent possible, missed approach tracks should be segregated from each other and from the initial departure track of terminal departure routes so as to extract the maximum benefits of operating independent runways and/or converging runways.  

(9) Requirements for the design of departure and missed approach procedures from parallel (or near parallel) runways are detailed in ICAO Doc 4444 PANS-ATM and Doc 8168 PANS-OPS. See also the ICAO Doc 9643 SOIR Manual.

**R2. TERMINAL ROUTES TO BE CONNECTED AND COMPATIBLE**

**R2 FULL Description:** TO THE EXTENT POSSIBLE, TERMINAL ROUTES SHOULD BE CONSISTENTLY CONNECTED WITH THE EN-ROUTE ATS ROUTE NETWORK AND BE COMPATIBLE WITH TERMINAL ROUTES IN ADJACENT (TERMINAL) AIRSPACES, IRRESPECTIVE OF THE RUNWAY IN USE.

(10) Closely related to Guidelines R1.1, this guideline establishes that Terminal Routes be integrated into the greater Route Network of ATS routes.  

**R2.1:** to the extent possible, terminal routes should consistently be connected with the en-route ATS route network irrespective of runway in use.  

(11) The points at which the en-route ATS routes and terminal routes connect should remain constant. There is no ‘automatic’ requirement for terminal routes to ‘fit in’ with the existing ATS route network. Adjustments to both the En-route and terminal routes should be accommodated so as to obtain the best overall result as regards the design and strategic objectives.
**R2.2:** to the extent possible, irrespective of runway in use, terminal routes should be compatible with routes in adjacent terminal airspaces (whether the terminal airspace is remote or immediately adjacent).

(12) This Guideline seeks to ensure the same consistency between terminal routes of adjacent Terminal Airspaces as is required in R2.1. Significantly, this Guideline draws attention to the fact that this compatibility be sought even with terminal routes in more ‘remote’ Terminal Airspace - even those located in a different sovereign airspace

**R2.3:** to the extent possible, change to the runway in use should create minimum operational complexity to the terminal routes structure.

(13) Whilst this Guideline effectively repeats the ideas embodied in R2.1 and R2.2, it is stated specifically with a view to drawing attention to the terminal routes inside the Terminal Airspace. As such, this Guideline suggests that the terminal route structure for one runway configuration should seek to mirror that of the inverse runway configuration so as to minimise operational complexity. Naturally, neither R2.1 nor R2.2 should be compromised, as far as practicable.

(14) The difficulty inherent in this guideline occurs particularly in those instances when the geographic distribution of traffic is unequal - as is often the case with Terminal Airspaces located on the geographic periphery of Europe.

(15) In Figure below, the crossing point marked with an X may appear to contradict R1.2

Whenever possible, this guideline should be applied in particular to VFR routes so as to minimise the likelihood of adding to complex operations when a change is made to the runway in use.
R3. TERMINAL ROUTES SHOULD BE MERGED PROGRESSIVELY AS THEY APPROACH THE TERMINAL AIRSPACE

**R3 Full Description:** TO THE EXTENT POSSIBLE, PUBLISHED TERMINAL ROUTES SHOULD BE PROGRESSIVELY MERGED AS THEY APPROACH THE TERMINAL AIRSPACE SO AS TO LIMIT THE NUMBER OF ARRIVAL GATES INTO THE TERMINAL AIRSPACE TO A MAXIMUM OF FOUR.

(16) This guideline aims to simplify the route structure within Terminal Airspaces by ensuring that the complex task of traffic merging is done outside the Terminal Airspace.

(17) Whilst the merging of arrival traffic flows should (ideally) be accomplished outside the Terminal Airspace, this does not suggest that the Terminal Airspace should only have four entry points. Indeed, there are two well known instances where it is desirable not to merge the arrival flows towards a common point. These are:
- where the aircraft performance mix is such that there is a marked speed difference in a large percentage of the traffic; or (/and)
- where the Terminal Airspace contains several major airports.

(18) In either of the above cases, it is usually better to merge the arrival flows towards what might be called entry gates, each of which may contain arrival flows which are segregated either for different performance or for different airport destinations. In exceptional circumstances, it may even be necessary to split a common arrival flow into segregated routes inside the Terminal Airspace, especially to segregate different aircraft (speed) performance.
5.5 Holding Areas

H1 HOLDING AREAS SHOULD BE LOCATED WHERE THEY WILL CREATE MINIMUM OPERATIONAL COMPLEXITY.

H1 Full Description: TO THE EXTENT POSSIBLE, PUBLISHED HOLDING AREAS SHOULD BE LOCATED SO AS TO ENSURE MINIMUM OPERATIONAL COMPLEXITY BETWEEN EN-ROUTE AND TERMINAL AIRSPACE (AND ADJACENT TERMINAL AIRSPACE).

(1) Two methods are commonly employed to meter aircraft bound for congested Terminal Airspaces: one uses departure delay mechanisms (to avoid aircraft holding on entering the Terminal Airspace), and the other uses holding patterns to stack aircraft for sequencing into the Terminal Airspace.

Comment:

(2) Whilst the choice of either method can be argued convincingly and applied efficiently, it is opportune to mention the reason commonly cited by proponents of the “holding pattern” method for this choice of option. The placement of holding patterns at strategic points prior to Terminal Airspace entry is based upon the idea that by keeping constant ‘pressure’ on the Terminal Airspace, less airspace is likely to be ‘wasted’ because the ‘metering’ of traffic is done closer to landing. Thus, where “holding patterns” are used, the metering and sequencing is likely to be tactical and respond in real time to the actual traffic situation (as opposed to the longer range/strategic mechanism that the departure delay method involves).

Because VFR flights usually hold over a visual reference point and the airspace required for VFR holding is generally much smaller than that required for IFR flights.

(3) This Guideline H1 has two elements, both of which are integral parts of the whole - and related to Guideline R3.

H1.1: to the extent possible, holding patterns serving a terminal airspace should ideally be located either at an entry point OR GATE or outside the terminal area.

(4) The reason for this is the same as that given for R3. This Guideline implies that holding patterns should not be located at Terminal Airspace exit points/gates or at the crossing point of Terminal Departure and Arrival Routes. (See Guidelines for Routes).

In contrast what this guideline suggests for IFR holding patterns, many designers find it useful to locate the VFR holding areas relatively close to the airport so as to facilitate the sequencing of VFR flights with IFR arrivals.

H1.2: to the extent possible, the location of holding patterns should be such as to create minimum operational complexity for both en-route and terminal airspace and for adjacent terminal airspaces.

(5) Ideally, the location of holding patterns should strive to create minimum overall complexity for the entire air traffic system. This implies the need for a collaborative approach (between En-route and Terminal and between Terminal Airspaces) and making the necessary trade-offs when seeking to locate holding patterns.
**H1.3:** to the extent possible, the location of holding patterns should remain constant, irrespective of the runway in use.

(6) This guideline supplements R3. The location of the holding patterns should not be affected by change to the runway in use.

<table>
<thead>
<tr>
<th>This guideline is of particular importance as regards VFR holding areas, and should be applied to the extent possible.</th>
</tr>
</thead>
<tbody>
<tr>
<td>As far as practicable, Terminal Holding Areas should not be located in areas of known and/or frequent turbulent weather phenomena, so that they can be used when airport operations have been suspended due to adverse weather..</td>
</tr>
<tr>
<td>When the traffic mix is populated by a high-number of low performance aircraft, it may be useful to design separate Terminal Holding Areas to accommodate these aircraft. This can be advantageous as regards noise and simplify sequencing for ATC.</td>
</tr>
</tbody>
</table>
H2 THE INBOUND TRACK OF A HOLDING PATTERN SHOULD BE CLOSELY ALIGNED WITH THE SUBSEQUENT TERMINAL ARRIVAL ROUTE.

**H2 Full Description:** TO THE EXTENT POSSIBLE, THE INBOUND TRACK OF PUBLISHED HOLDING PATTERN SHOULD BE ALIGNED WITHIN 30° OF THE SUBSEQUENT TERMINAL ARRIVAL ROUTE.

(7) This guideline aims to enhance the efficiency of the holding pattern by assuring that aircraft are not required to make excessive turn manoeuvres when leaving the holding pattern and thus risk over-shooting the turn. If such excessive turn manoeuvres are inevitable, a speed restriction could be included into the procedure to reduce the risk of overshooting the turn.
5.6 Flight Procedures

Terrain and Obstacle Clearance

The design principles addressed in this document refer to the conceptual design of the Airspace structures (routes, holds, ATC sectorisation etc.). PANS-OPS addresses the final stage of this design process by assuring the desired structures are clear of obstacles considering the criteria in ICAO Doc 8168 PANS-OPS.

The details of Flight Procedure design in accordance with obstacle clearance criteria are outside the scope of this document. For details on the safe design of procedures with respect to terrain and obstacle clearance, refer to ICAO Doc 8168 PANS-OPS and consult a qualified PANS-OPS designer.

In logical steps, PANS-OPS design is done after the conceptual design, assessment of the design concept, assessment of the design validation and the implementation planning. However, it can be useful to involve a PANS-OPS designer from the beginning of the project.
5.7 Navigation Specification

5.7.1 RNAV Routes & Holds

Differences and Similarities between Conventional and RNAV Routes

Route Placement

(1) The most obvious difference between RNAV and conventional routes concerns the freedom the designer has as regards route placement. In contrast to conventional terminal routes, RNAV routes need not be designed so as to pass directly over or be aligned directly with a ground-based navigation aid. This means that although RNAV-based routes rely on the navigation infrastructure (including GNSS which is not used to design conventional Routes), greater flexibility is provided as regards where the routes can be placed.

Waypoints

(2) Another significant difference between RNAV and conventional routes is that RNAV routes are defined by waypoints as opposed to conventional fixes. (Note, however, that a conventional fix may also be defined as an RNAV waypoint). Unlike conventional routes which are usually defined by tracks between fixes, an RNAV route is defined by tracks between waypoints.

Route Information

(3) A third noteworthy difference between RNAV and Conventional terminal routes is the way in which route information is provided to the operator. Whilst route information for both conventional and RNAV routes is provided to operators in ‘original’ AIP format consisting of charts and explanatory text, RNAV route information needs to ‘translated’ into a format that can be stored in a navigation database before it can be used by the aircraft navigation system.

(4) This transformation of aeronautical data from ‘State’ published format into usable data for the operator occurs in a series of steps. Using State-originated aeronautical information, data base suppliers collect and code this information in a standard data format known as ARINC 424 (Navigation System Database Specification). This data format, which is usable by navigation system databases, is then ‘packed’ by the original equipment manufacturer (OEM9) for use in the database of a particular operator (the ‘end’ user).

(5) This transformation of route information into ARINC 424 format is made possible by the use of ‘Path and Terminators’ developed by ARINC. ‘Path Terminators’ can be described as industry standard for describing route information. These Path Terminators are two-letter codes: the first describes the type of flight path (e.g. a track between two waypoints) and the second the route termination point (e.g. a fix). Thus, for example, track to a fix (TF) path terminator would be used to “code” a route between two waypoints.

Turns

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9 Original Equipment Manufacturer of the RNAV system.
From an airspace designer’s perspective, it is useful to understand that the design of turns on RNAV routes by PANS-OPS designers is different to conventional routes. As with straight segments of routes, turns also have to be coded into the route information using the Path and Terminator system. Turns can be coded in one of four ways:

<table>
<thead>
<tr>
<th>Fly-By Transitions</th>
<th>Fly-Over Transitions</th>
<th>Fixed-Radius Transitions</th>
<th>Conditional Transitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The navigation system anticipates the turn onto the next leg. In en-route mode (see below) turn anticipation can start as much as 20NM before the (turning) waypoint.</td>
<td>The aircraft overflies the waypoint before starting the turn onto the next leg. This type of turn is exclusive to Terminal Airspace, and then only when it is not possible to use a fly-by or fixed-radius transition e.g. to define an extended centre line.</td>
<td>In this instance, the aircraft flies a specific turn with a defined radius. This type of turn provides the most accurate, predictable and repeatable turn performance by all aircraft and is, generally, the preferred method for transitions with large track angle changes. Most current RNAV systems cannot accommodate this coding at present.</td>
<td>where the RNAV system initiates a transition once a specific altitude has been reached. Conditional transitions that involve a turn are defined by the preceding leg, the subsequent leg and an altitude restriction.</td>
</tr>
</tbody>
</table>

Note: From the designer’s perspective - particularly that of the PANS-OPS specialist - it is useful to be aware that the way in which the RNAV system executes the turn is determined by whether the RNAV system (or FMS) is operating in ‘en-route’ or ‘Terminal’ mode. Generally, it may be said that when in ‘en-route’ mode, the turn anticipation for fly-by transitions will be considerably greater in Terminal mode. The designer should be aware that all RNAV systems (and FMS) do not define ‘en-route’ and ‘Terminal’ mode the same way. Being aware of these aspects, the PANS-OPS procedure designer designs routes so that its coding ensures the greatest track predictability for ATC.

RNAV Holds

With the existing RNAV standards currently used in Europe - particularly P-RNAV in Terminal Airspace - it is possible to design RNAV holding patterns. Given the absence of fixed radius turn capability in such standards, however, the holding areas of current RNAV holding patterns is of similar shape and dimension to those whose designs are based on conventional navigation. Should the design of holding patterns become based upon RNP RNAV in the future, it should become possible to make significant reductions to size of the holding area (MASPS DO236()). On some occasions, this may allow for holding patterns to be placed where it is currently not possible so to do, or for three holding patterns to be placed in a space currently limited to two holding patterns.
RNAV - future prospects

Airspace designers and developers of ATM/CNS standards are becoming interested in the potential benefits that may accrue to ATM thanks to the potential availability of containment integrity inherent in the RNP RNAV MASPs. It is hoped that it will become possible to reduce the spacing between parallel RNAV routes and enhance or develop or extend the use of RNAV-based separation standards.

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10 In the MASPS (DO-236()), containment integrity is defined as .” A measure of confidence in the estimated position, expressed as the probability that the system will detect and announce the condition where TSE is greater than the cross track containment limit. Containment integrity is specified by the maximum allowable probability for the event that TSE is greater than the containment limit and the condition has not been detected. That is, $P(E_2) = \Pr(TSE > \text{containment limit and no warning is given})$
5.8 Terminal Airspace Structures

This chapter presents Design Guidelines for Structures and Sectors. They are intended to support creation of the design concept for a specific Terminal Airspace. The design of Structures and Sectors follows the design of Routes and Holds (previous chapter). Given the phased approach described in this document, constraints and enablers for Structure and Sectors are identified in a phased manner as described below. As with Routes and Holds, the structures and sectors need to be subjected to a qualitative assessment against the selected safety and performance criteria as well as the Reference Scenario, if appropriate.

![Diagram of Design Guidelines for Routes & Holds and Airspace & Sectors]

**STRIKING THE BALANCE**

A diagram oriented towards airspace structures and sectors is inserted below. Intentionally, its depiction is such as to draw designers’ attention to the fact that diverging user requirements - and national interests most frequently challenge the design of the airspace structure and ATC sectorisation.

![Diagram of Structures & Sectors: Objectives]

**ATC REQUIREMENTS**
- SAFETY, CAPACITY & EFFICIENCY
- SUFFICIENT AIRSPACE TO ACCOMMODATE:
  - ROUTES (TACTICAL AND PUBLISHED)
  - HOLDING PATTERNS
  - TRAFFIC SEQUENCING TECHNIQUES

**ENVIRONMENTAL REQUIREMENTS**
- Airspace Prohibitions
  - over cities, natural parks, residential areas

**USER REQUIREMENTS**
- Unhindered airspace access
GUIDELINES

In this section, design Guidelines related to Terminal Airspace Structures and ATC Sectorisation are described. Those related to Terminal Airspace Structures are preceded by a “St” and those to Sectorisation, by a “Se”. They are not prioritised.

Both sets of Design Guidelines are based on the four assumptions:

- **Assumption 1**: An air traffic control service is provided and Radar Surveillance is available within the Terminal Airspace; and

- **Assumption 2**: Within the context of needing to strike a balance between competing interests, these Design Guidelines aim primarily for ATM efficiency and capacity.

- **Assumption 3**: Strategic and Design Objectives, Assumptions, enablements and constraints have been identified by the design team. A concept design for Routes and Holds has also been developed.

- **Assumption 4**: the expression “terminal routes” is used in the same context as in previous chapters.

5.8.1 Phased Design Approach

As with routes and holds, a phased approach is suggested for the design of structures and sectors and identification of constraints and enablers.

**Step 1**: Using assumptions already identified, create a conceptual design of the Terminal Airspace structure to protect the Routes and Holds already designed.

**Step 2**: Refine the output of Step 1, by adding in constraints and identifying enablers.
**Step 3**: Building on Step 2 and based upon certain assumptions explore sectorisation options, if required (see below).

**Step 4**: Refine output of Step 3, add in constraints and identify enablers.

**Step 5**: Qualitatively assess the viability of Routes & Holds with new Structures and Sectors, using an Airspace Modeller, for example.

(2) The output from this phase together with the Routes and Holds designed previously constitutes the product of the design concept. This is then subjected to assessment and validation in the next phase.

### 5.8.2 Terminal Airspace Structures

**ST1**: TERMINAL ROUTES, HOLDING PATTERNS AND THEIR ASSOCIATED PROTECTED AIRSPACES ARE TO BE CONTAINED WITHIN CONTROLLED AIRSPACE

**ST1 FULL DESCRIPTION**: TO THE EXTENT POSSIBLE, WHERE THE TERMINAL AIRSPACE IS SURROUNDED BY UNCONTROLLED AIRSPACE, THE PROTECTED AIRSPACE OF DESIGNATED TERMINAL ROUTES AND HOLDING AREAS ARE TO BE CONTAINED WITHIN THE TERMINAL AIRSPACE IN BOTH THE LATERAL AND VERTICAL PLANE.

**ST1.1**: to the extent possible AND when necessitated by operational requirements, the upper limit of terminal airspace should coincide with the lower limit of superimposed controlled airspace in order to provide continuous protection to IFR flight paths.
The circle in the right hand diagram shows the area in which no protection is given to IFR flights on leaving the upper limit of the Terminal Airspace. Where Terminal Airspaces are located in remote areas, this design may be intentional.

**ST2: TO THE EXTENT POSSIBLE, A TERMINAL AIRSPACE SHOULD BE COMPATIBLE WITH THE ROUTES AND HOLDS TO BE CONTAINED WITHIN IT.**

Because the shape and design of a Terminal Airspace depends upon the Terminal routes and holds to be contained within it, and that Terminal routes/holds are based on certain assumptions, it follows that the shape of each Terminal Airspace will be unique.

Being three dimensional, Terminal Airspace structures have width, length and height/depth with defined lateral and vertical limits. That these limits need not be uniform is a natural result of this Guideline. Indeed, the structure’s lower limits are frequently stepped as may be the case with the upper limit.

*Note 1: If tactical vectoring is to be used by ATC, the Terminal Airspace dimensions should ensure that sufficient space is provided for sequencing and separation of traffic.*
ST2.1: to the extent possible, both vertical and lateral dimensions of a terminal airspace structure should be compatible with aircraft flight profiles, having taken obstacle clearance criteria into account.

(4) Whilst the above diagrams suggest that the Terminal Airspace structure is a function only of the aircraft performance, obstacle clearance must be accounted for as well. As such, they illustrate how to arrive at compatibility between the structure and the routes and holds protected by the structure. The diagrams show how the vertical limits and horizontal limits of the Terminal Airspace may be arrived at with sample climb and descent profiles. Tactical vectoring routes should also be accounted for when deciding the structure’s dimensions. The conclusion that may be drawn from these diagrams is that there is a relationship between the width/height of a TMA and aircraft profiles.

(5) Importantly, the lower limit of the airspace must not be lower than a minimum height described by ICAO - excluding the part of the structure that is to serve as a CTR (which by definition, starts at the surface).
(6) Compatibility needs also to be assured as regards non-designated Terminal routes e.g. Radar Vectoring. The Terminal Airspace should allow for sufficient space for Radar Vectoring to occur.

**ST3: TO THE EXTENT POSSIBLE, ONLY THE AIRSPACE NECESSARY TO CONTAIN THE TERMINAL ROUTES SHOULD BE DESIGNATED AS TERMINAL AIRSPACE SO AS NOT TO CONSTRAIN THE OPERATION OF NON-PARTICIPATING (USUALLY VFR) FLIGHTS.**

(7) Designers should keep in mind that VFR pilots usually navigate by visual reference points and as such, the boundary of the Terminal Airspace should be ‘easy’ for VFR pilots to detect.

(8) To this end, two sub-guidelines are provided.

**ST3.1: TO THE EXTENT POSSIBLE, in order to avoid unauthorised penetrations of the terminal airspace, the determination of its lateral limits should take into consideration the ability of non-participating VFR flights to identify visual reference points denoting the controlled airspace boundary**

(9) Although it is tempting to design a complex structure to avoid airspace wastage, if the limits of the structure are difficult for VFR pilots to detect, the structure could be instrumental in reducing the safety of operations by increasing the likelihood of unauthorised airspace penetrations.

**ST3.2 TO THE EXTENT POSSIBLE, in order to avoid unauthorised penetrations of the terminal airspace, the determination of its lower limits should take into consideration the needs of non-participating (usually) VFR traffic to operate freely beneath the terminal AIRSPACE** (1).

(10) Examples of Terminal Airspace whose lower limit is not the surface of the earth include TMAs and CTAs.
ST4: WHEN NECESSITATED BY OPERATIONAL REQUIREMENTS DESIRABLE, ADJACENT TERMINAL AIRSPACES SHOULD BE FUSED INTO ONE TERMINAL BLOCK SO AS TO REDUCE OPERATIONAL COMPLEXITY.

**ST4 Full Description**: WHERE ADJACENT TERMINAL AIRSPACES WHICH ARE IN CLOSE PROXIMITY TO ONE ANOTHER AND HAVE INTER-DEPENDENT TERMINAL ROUTEING SCHEMES, CONSIDERATION SHOULD BE GIVEN TO NEGOTIATING WITH THE APPROPRIATE AIRSPACE AUTHORITY TO FUSE THE TERMINAL AIRSPACES INTO ONE TERMINAL AIRSPACE BLOCK WITH A VIEW TO INCREASING THE ATM EFFICIENCY IN THE TOTALITY OF THE SINGLE BLOCK.

(11) The circle in the upper diagram of denotes both interacting traffic flows and a potential problem area in terms of crossing routes close to the Terminal Airspace limits, the problem is created by the fact that the boundary has been ‘forced’ to coincide with another e.g. a national boundary. The lower diagram shows that by creating one Terminal Airspace ‘Bloc’, ATM can be rendered more efficient by increasing the sectorisation options in the total airspace.

ST5: WHEN NECESSITATED BY OPERATIONAL REQUIREMENTS, CONSIDERATION SHOULD BE GIVEN AS TO WHETHER AND TO WHAT EXTENT, CERTAIN PARTS OF THE AIRSPACE ARE TO BE SWITCHED “ON” OR “OFF” IN ACCORDANCE WITH THE FLEXIBLE USE OF AIRSPACE CONCEPT.

(12) To accommodate such needs, a portion of the TMA can be published with its own identifier e.g. TMA II having its own dimensions, so airspace users and controllers can easily identify that portion of the airspace which is subjected to FUA.

**ST5.1**: Where airspace restrictions or reservations are established above or below Terminal Airspace, it is essential that, depending on the activity conducted, adequate buffers be established above/below these airspaces restrictions or reservations, in order to ensure that ATS can provide adequate safety margins.
5.9 SECTORS

(1) From a design perspective, the sectorisation of a Terminal Airspace is one of the most common ways in which to distribute workload between controllers so as to ensure the safe and efficient management of air traffic within the airspace volume. Whether Sectorisation is necessary is decided - almost exclusively - on the basis of ATC workload which may impact upon safety. Because the frequency and number of air traffic movements constitutes one of the main factors affecting ATC workload, the importance of the selection of a realistic traffic sample and identification of the predominant runway in use cannot be over-stressed. Once it has been properly analysed (as regards time and geographic distribution), it is assigned to the modified or new Terminal routes which have been designed. Qualitative assessment of the traffic sample supported by Airspace Modelling is a common method used to identify the need for Sectorisation.

(2) In order to appreciate the complexity of determining capacity of a TMA volume (or sector), it is worth mentioning the variety of factors which affect the number of aircraft that can be handled by a single controller in a given time period. None of these factors can be viewed in isolation. Each factor is a 'variable' in the overall capacity 'equation.'

- Design of Terminal routes. The more segregated the routes both vertically and laterally, the less the 'active' the workload of the controller.
- ATC facilitates optimised CDO, and to a lesser extent CCO. In the event of open-path STARs, predictability for pilots is required by the provision of accurate DTG information from ATC. Where DTG is provided, ATC workload will increase.
- Use of designated arrival and departure routes such as SIDs/STARs. Generally, the greater the number of published routes, the less RTF required (Note, however, that an excessive number of SIDs/STARs can create a high pilot workload or introduce errors).
- The accuracy of the navigation performance of aircraft operating on designated routes. The greater the accuracy, the less the need for controller intervention.
- Phase of flight. Generally, arrivals are more labour intensive than departing flights especially if extensive use is made of tactical routeing as opposed to designated routes such as STARs.
- The complexity of the instrument approach procedure: especially in terrain rich areas or for reasons of environmental mitigation, the Radar monitoring workload can be high with respect to complex manoeuvres.
- The altitude of the airport, ambient temperature and airport infrastructure affect runway occupancy and in-trail spacing interval. At 'hot and high' airports, holding may be required to compensate for any of these factors - which is work intensive.
- High mix of aircraft performance and/or aircraft navigation performance: Generally, the greater the mixes, the higher the workload as speed differences and navigation performance differences have to be catered for by the controller.
- Capabilities and facilities provided by the Radar System and the Flight
Planning Data Processing system. For example, it a controller is required to ‘manually’ perform the code-call-sign conversion, this creates additional workload.

(3) Once the need for sectorisation has been identified, the next question to be decided is whether sectorisation is possible. This possibility is determined by the available staff holding the appropriate qualifications, the availability of working positions and the capabilities of the ATM system. ‘Available’ staff/working positions may be included in the assumptions i.e. those that will be available when the project is implemented. If staff and or working positions are not available, designers could plan for sectorisation in the longer term and identify more qualified staff and working positions as enablers.

(4) Having determined that sectorisation is required and possible, the next decision concerns the type of sectorisation to be used. Generally, two types of Sectorisation are used in Terminal Airspace. These are:

- Geographical Sectorisation: where the airspace volume is divided into ‘blocks’ and a single controller is responsible for all the traffic in a single block i.e. sector; or

- Functional “Sectorisation” where divisions of the Terminal Airspace volume is determined as a function of the aircraft’s phase of flight. The most common type of Functional Sectorisation is where one controller is responsible for arriving flights in the Terminal Airspace whilst another is responsible for departing flights in the same Terminal Airspace volume.

(5) Several points are worth noting concerning sectorisation methods:

- As it is commonly understood, ‘Sectorisation’ generally refers to geographical Sectorisation. As such, it could be argued that Functional ‘sectorisation’ is a sub-set of geographic Sectorisation.

- Secondly, there are very few Terminal Airspaces which are sectorised...
either geographically or functionally. In reality, most Terminal Airspaces use a combination of functional and geographic sectorisation.

- Sectorisation of the Terminal Airspace volume can be demanding in terms of ATC system capability. When (geographic) sectors are stepped or when functional Sectorisation is used, the ATC system should be capable of supporting the sectorisation option e.g. by ‘filtering’ out traffic that is not under the direct control of the controller responsible for a sector.

5.9.1 Geographic Sectorisation

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller can fully exploit the space available in sector to manipulate best levels for inbounds/outbounds and expedite climb and descent without need for co-ordination.</td>
<td>Controller handles mixed traffic i.e. arrival, departure and transit traffic.</td>
</tr>
<tr>
<td>Easier to balance workload between sectors.</td>
<td>In instances where the sector division runs along the runway centre-line, departing aircraft departing in different directions may be controlled by different controllers after take-off. (Effective mitigation can be provided by putting appropriate procedures in place).</td>
</tr>
<tr>
<td>Can be less demanding in terms of the Radar Display and ATC system.</td>
<td>In cases where an aircraft is required to transit more than one geographic sector in the Terminal Airspace, this can add to complexity by requiring additional co-ordination.</td>
</tr>
<tr>
<td>Relatively easily to describe operational instructions for ATC areas of responsibility.</td>
<td></td>
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</tbody>
</table>

5.9.2 Functional Sectorisation

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller handles one traffic type i.e. either departures or arrivals because sector defined as a function of task. Usually, all Departing aircraft are on the same frequency after take-off. In some configurations, can prove more flexible to operate.</td>
<td>Vertical/Lateral limits of sector can prove overly restrictive as one (vertical) band is unlikely to cater for all aircraft performance types.</td>
</tr>
<tr>
<td></td>
<td>Difficult to balance workload between sectors especially where departure and arrival peaks do not coincide.</td>
</tr>
<tr>
<td></td>
<td>Can be demanding in terms of the Radar Display and ATC System.</td>
</tr>
<tr>
<td></td>
<td>Operating instructions for ATC can be difficult to formulate with respect to areas of responsibility.</td>
</tr>
</tbody>
</table>

(1) **Comment:** What is the difference between division of responsibility and areas of responsibility in the context of ATC Sectorisation? Usually, the former refers to division of responsibility between the different ATC Units i.e. between the Area Control Unit, Approach Control Unit and Aerodrome Control Unit. In contrast, the latter refers to dividing the workload of any one unit i.e. dividing the workload of the Approach Control Unit into two sectors such as Approach East and Approach West. In those cases where one Area Control sector is responsible for the entire FIR and one Approach Control sector is responsible for the entire Terminal Airspace, the division of responsibility is the ‘same’ as the sectorisation.
SE1: TO THE EXTENT POSSIBLE, LATERAL AND VERTICAL DIMENSIONS OF SECTORS SHOULD BE DESIGNED SO AS TO AVOID A REQUIREMENT TO ISSUE STEPPED LEVEL CLEARANCES, ESPECIALLY OVER SHORT DISTANCES. This is a requirement to enable optimized CCO/CDO.

SE2: THE PROTECTED AIRSPACE AROUND A HOLDING PATTERN SHOULD BE INCLUDED IN A SINGLE GEOGRAPHICALLY DEFINED SECTOR.

SE3: THE PROTECTED AIRSPACE OF A PUBLISHED TERMINAL ROUTE SHOULD BE CONTAINED WITHIN A SINGLE GEOGRAPHICALLY DEFINED SECTOR.

SE3 Full Description: WITH A VIEW TO PREVENTING UNAUTHORISED SECTOR PENETRATIONS, THE PROTECTED AIRSPACE OF PUBLISHED TERMINAL ROUTES SHOULD BE CONTAINED WITHIN A SINGLE GEOGRAPHICALLY DEFINED SECTOR WHERE A ROUTE CENTRE IS PARALLEL TO A SECTOR BOUNDARY, OR IT IS INTENDED THAT AIRCRAFT REMAIN WITHIN THE ORIGINAL SECTOR AFTER COMPLETING A TURN.

In those instances where extensive tactical vectoring is expected within a particular sector, it is advisable to place the sector boundary in such a manner so as to minimise the need for co-ordination between sectors.
SE4: WITH A VIEW TO ENSURING MINIMUM OPERATIONAL COMPLEXITY, A SECTOR SHOULD NOT BE DESIGNED IN ISOLATION FROM SURROUNDING SECTORS.

(3) This guideline is complementary to SE1. It is amplified by several sub-guidelines.

**SE4.1:** to the extent possible, crossing points of terminal and/or other routes should not be placed too close to a boundary of a geographically defined sector so as to allow the receiving controller sufficient anticipation time to resolve the conflict.

**SE4.2:** the vertical limits of a geographically defined sector need not be uniform i.e. fixed at one upper level or one lower level, nor need these vertical limits coincide with the vertical limits of (horizontally) adjoining sectors.

**SE4.3:** where airspace restrictions or reservations are established above or below terminal airspace sectors, it is essential that, dependent on the activity conducted therein, adequate buffers be established above/below these airspace restrictions or reservations, in order to ensure that ATS can provide an adequate margin of safety.

(4) This is the ‘equivalent’ of Guideline St.5.1
SE5: POTENTIAL SECTOR COMBINATIONS SHOULD BE TAKEN INTO ACCOUNT WHEN DETERMINING SECTOR CONFIGURATION.

SE 5 Full Description: POTENTIAL VERTICAL AND HORIZONTAL SECTOR COMBINATIONS SHOULD BE TAKEN INTO ACCOUNT WHEN DETERMINING SECTOR CONFIGURATIONS WITHIN A TERMINAL SO AS TO RESPOND MORE REALISTICALLY TO CHANGES IN TRAFFIC DEMAND. ANY SECTOR COMBINATION SHOULD ENSURE THAT OPERATIONAL COMPLEXITY IS KEPT TO A MINIMUM.

SE6: GEOGRAPHICALLY DEFINED PRE-SEQUENCING SECTORS SHOULD BE DESIGNED TO ENCOMPASS THE MAIN ARRIVAL FLOWS WITH A VIEW TO MERGING ARRIVAL FLOWS AS PER GUIDELINE R3.

SE7: TO THE EXTENT POSSIBLE, THE CONFIGURATION OF GEOGRAPHICALLY DEFINED SECTORS SHOULD REMAIN CONSTANT IRRESPECTIVE OF THE RUNWAY IN USE. (geog only)

(5) This guideline is aimed at avoiding unnecessary co-ordination between upstream or downstream sectors and avoiding complex changes to the FDPS and RDPS which may not be capable of accommodating such changes.

(6) Naturally, if a Final Approach director sector exists, this sector would have to be changed when a change is made to the runway in use.

SE8: WHEN NECESSITATED BY OPERATIONAL REQUIREMENTS, THE UPPER LIMIT OF A SECTOR SHOULD COINCIDE WITH THE LOWER LIMIT OF SUPERIMPOSED SECTORS IN ORDER TO PROVIDE PROTECTION TO IFR FLIGHTS.

(7) This guideline is the sector 'equivalent’ to Guideline ST1.1.
6 En-Route Design Methodology

6.1 Reference Scenario

6.1.1 Introduction

(1) The establishment of a Reference Scenario constitutes the first step in the design process undertaken before embarking upon the development of a new airspace design. Each airspace structure has characteristics and evolves at a different rate. The development of an airspace organisation is affected by a range of parameters that may vary, subject to local considerations. These factors underline the importance of the Reference Scenario and a Critical Review (Qualitative Analysis) with the following role:

- it provides a benchmark against which the design concept can be compared;
- it is an efficient way of refining the design objectives and ensuring that operational requirements are being addressed given that a design project is usually undertaken as a means of improving upon the existing design;
- it may help to refine the scope of the existing project;
- it prevents design ‘weaknesses’ identified in the Reference Scenario being repeated;
- airspace / procedure design principles can be identified that enable / do not enable CCO / CDO from higher levels; and
- LoAs can be reviewed to assess whether they are optimised in terms of fleet mix, potential flexible applications or could benefit from moving existing points or creating new points.

(2) Although the process of describing current Airspace operations is sometimes considered a tiresome exercise, one of its additional advantages is that it provides the opportunity to discover and correct inconsistencies related to the existing airspace design. Examples of these discoveries may include -

- published ATS routes - that are not used;
- missing links/connections;
- unnecessary airspace restrictions;
- out-dated procedures;
- publication errors in the AIP;
- non-optimal use of reserved airspace;
- what works well or does not work well.

6.1.2 What is the Reference Scenario?

(1) In general terms, the Reference Scenario is a description of the current Airspace structure/operations. The Reference Scenario describes the current layout of ATS routes (en-route, SIDs/STARs), Airspace structures, Airspace reservations (TRAs/TSAs/Danger areas), ATC sectorisation and how the traffic is managed within the airspace and in relation to surrounding airspace. The main purpose
of the Reference Scenario is to provide a benchmark against which the new/modified design is compared.

6.1.3 What is the ‘Pseudo’ Reference Scenario?

(1) The Reference scenario usually reflects the current airspace structure, though in some instances, use may be made of a ‘Pseudo’ current Reference Scenario. There are cases when the current Airspace structure is not used as the Reference Scenario. This occurs when, for example, previously validated modifications to any aspect of the Airspace (i.e. ATS routes, structure or sectorisation) are to be implemented in the short-term, before the implementation of the project that is to be assessed. In this case the design objective of such a study is not to identify the existing design weakness but to compare the new options against each other in order to identify the promising elements for further evaluation. As a means of establishing a benchmark for this comparison, the scenario incorporating most of the potential improvements will be chosen as the Reference Scenario.

(2) In this context we are talking about a ‘Pseudo’ current Scenario in which the yet-to-be-implemented change would thus be used as a ‘Pseudo’ Reference against which new changes are measured. This ‘Pseudo’ Reference could equally be based upon a new route network, a new airspace structure and/or the sectorisation.

6.1.4 Creating the Reference (‘Pseudo’ Reference) Scenario

(1) The creation of the Reference Scenario is mainly a paper exercise. Even so, the detail and quality of the information contained in the Reference Scenario should be such that someone unfamiliar with the Airspace structure and its operating practices would be able to form a comprehensive ‘picture’ of the airspace. The Reference Scenario is created from various sources. Ideally, all these sources should be used so as to build the most complete picture about the current or ‘pseudo’ current Airspace operations.

(2) Below, a condensed list is provided showing selected items needed in the statement of the Reference Scenario.

<table>
<thead>
<tr>
<th>Information</th>
<th>How to obtain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Traffic Demand and its geographic and time distribution (major traffic flows).</td>
<td>Traffic samples can be obtained from STATFOR / DDR or local ATC centre.</td>
</tr>
<tr>
<td>Analysis of the Traffic sample and the nature of traffic (e.g. overflying traffic, evolving traffic, Aircraft performance mix, flight level distribution etc.)</td>
<td>Traffic sample obtained above. Statistical analysis of existing data over the last few years.</td>
</tr>
<tr>
<td>Route Network (AIRAC Number, VST, VX, AAS).</td>
<td>AIP and traffic sample.</td>
</tr>
<tr>
<td>Airspace dimensions</td>
<td>AIP and Operational controllers / ATCOs.</td>
</tr>
<tr>
<td>Sectorisation (Terminal Airspace, Lower and Upper ACC sectors, adjacent Airspace)</td>
<td>Operational Controllers / ATCOs.</td>
</tr>
<tr>
<td>Traffic Management, i.e. co-ordination agreements between TMA and ACC, sectors, adjacent ACC units, civil/ military etc.</td>
<td>Local ATC Instructions and Letters of Agreement/ LOAs.</td>
</tr>
<tr>
<td>Existing constraints (e.g. city-pair level capping, route restrictions/limits, flight profile restrictions, etc.).</td>
<td>AIP / RAD / LOAs.</td>
</tr>
<tr>
<td>Barriers to optimize the vertical profile (CCO/CDO)</td>
<td>Local ATC expert / environmental specialist</td>
</tr>
</tbody>
</table>
(3) In detail the Reference Scenario contains different baseline parameters. The following elements should be considered in order to create the Reference Scenario:

Traffic Sample:
- Day/Month/Year;
- Current traffic distribution, Traffic Demand, Assigned Current, Forecast Assigned.

ATS route network:
- AIRAC Number;
- VST, VX, AAS;
- Free Route Airspace.
- CDRs.

Assignment Parameters:
- Rules (General);
- Rules (RAD);
- Penalisation;
- SID and STAR points;
- Airports;

Sectors:
- Elementary sectors;
- Configurations:
- Opening Schemes;
- TMAs.

Profile:
- Flight Level constraints / FLC;

Military Areas:
- TSAs, TRAs, CBAs, R, D, P.

(4) Having identified those parameters relevant for the project, a model of the airspace is build using an airspace modelling tool (e.g. NEST, SAAM¹¹). When the Reference Scenario (or ‘Pseudo’ Reference) has reached a certain stage of maturity it has to be critically reviewed by the project team and local experts. This qualitative exercise serves to show that when the design stage is reached, a continuous cross-checking process is required to ensure that performance

¹¹ SAAM stands for **System for traffic Assignment and Analysis at a Macroscopic level**. It may be viewed as a multi-functional tool for route network and airspace optimisation, seeking to bridge the gap between the design phase of airspace planning and the simulation of those ideas (either in fast/ FTS- or real-time simulation/ RTS).
criteria are met and that the assumptions, constraints and enablers are consistent with the design.

6.1.5 Critical Review of the Reference Scenario (Qualitative Analysis)

(1) Once the Reference (or ‘Pseudo’ Reference) Scenario has been described, it should be critically reviewed. This critical review is also known as qualitative analysis\(^\text{12}\) which involves operational experts closely analysing the existing Airspace operations, i.e. each element of the airspace organisation and how effectively and safely it works with a view to identifying operational problem areas (hotspots) before deciding on a solution.

(2) This is the stage at which existing constraints, the potential improvements and enablers are identified. Additionally a comprehensive inventory of ATM/CNS elements is needed as well as expert input in order to identify realistic assumptions, realistic enablers and realistic constraints that form the basis of the Reference Scenario.

(3) Assumptions have to be identified and selected with care. One of the most important assumptions is a representative traffic sample/traffic demand. The closer the implementation date the easier the assumptions are to select. Some assumptions are based upon factors/elements (e.g. route network) whereas other assumptions are likely to be no more than educated guesses built on experience and statistics (future traffic sample). The final report must properly reflect both.

(4) Constraints stand in contrast to assumptions in that, they suggest the absence of certain elements of ATM/CNS or limitations. Typical constraints include city-pair level capping/level constraints, route availability constraints, the requirement to satisfy environmental needs, etc. At best, it may be possible to mitigate constraints using enablers. At worst, constraints have to be accepted because there is no alternative ‘solution’.

(5) Enablers refer to any aspects of ATM/CNS that may be used to mitigate the constraints identified and/or any factors which may be relied upon to ‘enable’ ATC operations in the airspace designed (e.g. equipment, systems, navigation infrastructure, procedures, airspace design). In view of the costs that enablers sometimes incur, a Cost Benefit Analysis may be required to determine whether the benefits provided by the enablers outweigh the costs. If this is not the case, it may be necessary to identify alternative mitigation.

(6) The Critical Review is concerned with establishing ‘What is wrong?’ or ‘What factors limit the Reference Scenario?’ for possible later resolution as well as identifying aspects that work well so that these benefits are not lost. The main objective of the critical review is to obtain a model of the traffic flows and airspace structure that reflect reality and thus obtaining a realistic Reference Scenario.

(7) In this context, several Workshops should be organised between the project team and operational experts in order to describe the major traffic flows, identify hotspots as well as high density/conflict areas and to analyse the problems identified.

\(^{12}\) The expression \textit{Qualitative Analysis} is significant in that it implies that expert judgement is required in order to make a meaningful analysis.
Making intensive use of a modelling tool (like NEST or SAAM or CAPAN) supporting documentation could be obtained in form of maps visualising major traffic flows, segment loads, traffic density, conflicts as well as statistical data for sector traffic loadings, workload and capacity.

These performance output/ data could serve at a later stage to compare the relevant parameters of the Reference Scenario against potential losses/ benefits of the new or modified design (Scenarios).

Success criteria to judge the reference scenario:
- Acceptance by the team;
- Other.

### 6.1.6 Comparing Scenarios

The Reference (or ‘Pseudo’ Reference) Scenario serves, at a later stage, as the yard-stick against which the success of the new or modified design is measured.

It is significant not to change too many parameters from one Scenario to another to be able to assess the impact of the modifications made. Additionally, it is essential to be well aware of the assumptions made in order to have later on not only a good understanding but also confidence in the results presented.

### 6.1.7 Refining Design Objective(s)

One of the 'outputs' of the Critical Review process is that current design weaknesses or shortcomings in the current operation may be 'added' to the list of design objectives or used to refine the design objectives.

### 6.1.8 Conclusion

The establishment of the Reference Scenario is the first step of the Design Process and is undertaken prior to embarking upon the Design Concept. The Reference Scenario usually reflects the current Airspace structure, though in some instances, use may be made of a ‘Pseudo’ current Reference Scenario.

The Reference Scenario is subjected to qualitative analysis known as a Critical Reviewing in order to refine the design objectives and to help identify existing design weaknesses. This ensures the creation of a useful benchmark for comparison with the Design Concept.
6.2 Safety & Performance Criteria

(1) This chapter describes the formulation of the Safety and Performance Criteria:

- specify minimum safety and performance requirements of the airspace concerned;
- provide the metrics against which the safety and performance of the proposed design can be measured;
- can be translated into project and/or design objectives;
- must respond to requirements set in the Single European Sky Performance Scheme.

(2) The significance of safety and performance criteria has increased as a result of the Single European Sky II legislation, but also since the introduction of mandatory ICAO and European requirements for States to undertake a safety assessment when making changes to their airspace design.

(3) 'Safety Criteria' are not discussed in isolation but rather described within the greater context of safety case development. The latter is a generally accepted way of undertaking safety assessments.

(4) It is important to note that the local airspace design team bears the responsibility for complying with the safety policy prescribed by the national regulator, and that none of the material contained in this chapter should be construed as relieving the airspace design team of this obligation.

6.2.1 Qualitative and Quantitative Assessment

(1) The need to assess the safety or other performance of an Airspace design is one reason for establishing safety and performance criteria. Assessment is an ongoing process: qualitative assessment begins at conceptualisation and continues through implementation and provides the foundation for quantitative assessment.

(2) Qualitative assessment is achieved by expert (air traffic control/operational) judgement being used to assess the design, using ICAO standards, recommended practices and procedures as a benchmark. Qualitative Assessment is an on-going process: as well as providing the basis for the design concept, this expert judgement is also used to qualitatively assess all phases of the design methodology, and it is integral to quantitative assessment and to safety measurement - even when the emphasis appears to be on measurement against an absolute threshold.

(3) Quantitative assessment is concerned with ‘quantified’ results produced in the form of numerical data. e.g. capacity increased by 20%.

(4) It is perhaps because quantitative assessment appears to provide ‘tangible’ values that these results are perceived as being preferable to those of a qualitative nature. But this perception is inaccurate - for at least two reasons:

(i) Qualitative assessment made by expert ATC judgement is the primary way to safe-guard ICAO SARPs and procedures during the design process; and if total reliance is placed upon quantitative results without qualitative analysis (i.e. using expert judgement to interpret the results), the value of the quantitative assessment is likely to be less.

(ii) Due to the complex and highly variable nature of airspace and air traffic
operations, quantitative safety assessment models tend to limit the number of operational elements to those having the greatest effect, which can return inaccurate results. For this reason, quantitative assessment needs to be balanced by qualitative assessment, i.e. operational judgment and experience for the complex interactions, conditions, dependencies and mitigations for which quantitative assessment cannot provide a meaningful measure.

6.2.2 Evaluating Safety

**SAFETY SHALL BE ENHANCED OR AT LEAST MAINTAINED BY THE DESIGN OF (OR ALTERATION TO) AIRSPACE.**

(1) This overriding principle includes a recommendation to:

- Comply with ICAO standards, recommended practices and procedures
- Subject any airspace design (or change) to a safety assessment.
- Analyse, evaluate and validate any design (or change) to airspace.

(2) ICAO Annex 11 and Doc 4444 PANS-ATM includes requirements for a Safety Assessment to be undertaken when making certain modifications to the Air Traffic Management System. Significantly, ICAO has detailed those instances in which a Safety Assessment is required. Because airspace designers must ensure and demonstrate that an airspace design is safe (i.e. provide evidence of safety through a safety assessment process), this section provides a broad overview of how safety can be evaluated. Two methods are commonly used to evaluate safety: one is comparative (or relative), the other absolute. The use of one method does not exclude the other and they are combined.

(3) Airspace designers are familiar with the comparative (or relative) method because it is the most frequently used. When safety is evaluated using this method, the safety of the proposed Airspace design is compared to an existing
design (called a Reference Scenario) with results indicating an increase/decrease or maintenance of safety.

(4) In contrast, the absolute method involves evaluating safety against an ‘absolute’ threshold. An example of such an absolute threshold could be: that the risk of collision is not to exceed 5 fatal accidents per 1 000 000 000 flight hours. (This would more commonly be expressed as a requirement to meet a target level of safety (TLS) of 5x10⁻⁹). A collision risk analysis using a collision risk model is the usual way in which a determination is made as to whether a TLS is met.

(5) It should be noted that the safety of an airspace design is not only dependent upon the correct application of design criteria when designing routes, holding areas, and airspace structures designed in accordance with the design rules and procedures contained, inter alia, in ICAO Annex 11 and Doc 8168 PANS-OPS (especially Vol. II).

(6) Safety factors are considered before and during this design phase, by, for example:

- developing a feasible airspace design concept prior to the application of the PANS-OPS design criteria; and
- ensuring the accuracy of critical aircraft and operational assumptions which are used to form the basis of the PANS-OPS design;

(7) In the ‘greater’ context, the design is also required to satisfy the safety objectives that are included in, but not limited to, the generic ATC objectives and whether these are met is usually determined by qualitative assessment. Thus whilst Annex 11 and Doc 8168 PANS-OPS provide rules relating to airspace dimensions and obstacle clearance criteria respectively, qualitative assessment criteria are included in, but not limited to Doc 4444 PANS-ATM and various ICAO Annexes.

Comment:

(8) How does the designer know when safety should be evaluated using the absolute method? Typically, the absolute method is to be used when required by ICAO. This usually involves instances when the change envisaged is radical and untried elsewhere. For example:

- reduction of the vertical separation minima (RVSM);
- determination of new spacing between parallel ATS routes for which lateral navigation accuracy is specified with a view to applying the separation minima in Doc 4444 PANS-ATM, Chapter 5, as a basis for route spacing in Terminal Airspace.

(9) As most airspace redesign relies on existing ICAO provisions and does not involve radical changes such as those introduced with the RVSM example, the comparative/relative method is the most frequently used.
6.2.3 The Safety Case Approach

(1) The pre-implementation process involves the development of a safety case comprising a reasoned safety argument based on a Functional Hazard Assessment (FHA) and Preliminary System Safety Assessment (PSSA). After implementation, the safety case is revised as well as a System Safety Assessment (SSA) - (See diagram below).

6.2.4 Other Performance Criteria

(1) Performance criteria relate to the way in which the success of an airspace design is measured. Whilst ‘safe’ performance may be viewed as the ‘first’ measurement of success, it is not enough for airspace to be safe if it does not deliver the performance expected in terms of capacity and environment, amongst others.

(2) As with the safety criteria, Performance criteria are closely linked to the Design Objectives (and, of necessity, the generic set of ATC Objectives described by ICAO in Annex 11). The Performance criteria to be selected become evident when answering the question “What determines the success of the airspace design?” Differently put, “How can one confirm that the objectives have been met?”.

(3) Examples of performance criteria in en-route airspace:

- The average en-route ATFM annual delay per flight for an ACC is in line with the reference value provided by NM;
- Distance, time and emissions savings can be demonstrated at European ATM network level;
- Reduced workload;
- Increased sector capacity;
- Optimisation of vertical flight efficiency for CDO and CCO (to / from cruising levels where possible).
Having decided upon the performance criteria (usually embodied in the strategic and design objectives), it is necessary for the Airspace design team to select the appropriate tool so as to correctly measure these criteria.

### 6.2.5 Evaluating Capacity and Environmental Impact

Although the comparative and absolute methods are commonly used in a safety context (above), other performance criteria can also be evaluated in either a comparative or absolute manner. See examples below.

<table>
<thead>
<tr>
<th>Comparative</th>
<th>Absolute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. The average en-route ATFM annual delay for X ACC has reduced by at least 0.5 minutes per flight compared to last year.</td>
<td>1a. The average en-route ATFM delay per flight for an X ACC is 0.3 minutes, in line with the reference value provided by NM.</td>
</tr>
<tr>
<td>1b. Distance, time and emissions savings at network level can be demonstrated compared to the reference scenario.</td>
<td>1b. The city pair X-Y demonstrates a total weekly distance saving of at least 3000NM, along with the associated time and emissions savings.</td>
</tr>
<tr>
<td>2a. Sector capacities have increased.</td>
<td>2a. Sector capacities are now at 48 - 50 movements/hour.</td>
</tr>
<tr>
<td>2b. Workload has reduced.</td>
<td>2b. Workload has reduced by 10%.</td>
</tr>
<tr>
<td>2c. Track mileage flown by arriving aircraft is not extended by more than 5%.</td>
<td>2c. Track mileage flown by arriving aircraft does not exceed xx NM for a certain flow.</td>
</tr>
<tr>
<td>2d. Average time in level flight for arrivals is reduced by 10 seconds</td>
<td>2d. Average time in level flight for arrivals does not exceed 80 seconds from top of descent</td>
</tr>
</tbody>
</table>

Appropriate environmental modelling tools e.g. IMPACT, should be used to compare the environmental impact, in terms of fuel burn and CO2 emissions impacts including any potential trade-offs, between the baseline scenario and any future scenario. For more information, support may be found in the SESAR Environmental Assessment Process document - SESAR Deliverable D4.0.080.

### 6.2.6 Safety, Performance and Project Planning

- **Strategic Objectives**: Increase existing capacity; reduce environmental impact; meet the Target Level of Safety.
- **Design Objectives**: Create new airspace structures to increase capacity and flight efficiency
- **(ICAO ATC Objectives)**: Prevention of collision; maintaining a safe and orderly flow of air traffic i.e. creating a design that will be conducive to these objectives)\(^\text{13}\).
- **Safety Criteria**: the route spacing between parallel Terminal Routes is required to meet a target level of safety of 5 x 10\(^{-9}\).

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\(^{13}\) inserted for completeness.
(5) **Performance criteria:** The airspace design will be considered a success if, for example:

- West Sector demonstrates a capacity increase of 20%; and
- (quantitative) reduction in route extension from 6.235 to 4.14% for a particular flow
- (qualitative) A better de-confliction of a particular crossing point.
6.3 Assumptions, Constraints & Enablers

6.3.1 Background

(1) The design methodology process is applied to ensure that flight performance improvements goals and targets are met through the enhancements in the areas concerned.

(2) The prime beneficiaries from the airspace design process are the airspace users, civil and military. The benefits are expected to be reflected by allowing for more route options, possibly identical to their preferred trajectories, minimal en-route extensions, reduced fuel consumptions from optimised CCO / CDO, improved flight economy and more reliable fleet planning.

(3) The secondary beneficiary group is the ANSPs, civil and military, belonging to the European network operational stakeholders whose contribution to the overall performance of the network is significant.

(4) The benefits for the ANSPs are seen in the areas of improved efficiency, reductions of the controller workload, and increased contributions to improved safety levels.

(5) The benefits are closely linked with the performance targets, which can be achieved if, inter alia, en-route design methodology is adhered to.

(6) The main objectives of the design methodology, which complements processes in function of capacity gains, are:

- to offer route options that are closer or identical to the users' preferred trajectories by reducing route extensions by 2 km yearly;
- to allow possibility for multi-option routings;
- to simplify the usage of ATS route network in both, en-route and terminal areas;
- to support further expansion of the Free Route Airspace;
- optimisation of vertical flight efficiency for CDO and CCO (to / from cruising levels where possible);
- to provide for more efficient civil / military coordination;
- to provide for more efficient ATFCM.

6.3.2 Introduction

(1) The performance criteria together with the assumptions, enablers and constraints are established before an airspace is designed conceptually or any other design phase is undertaken. Moreover, it is important to note that assumptions, constraints and enablers underpin all phases of the design process and therefore remain constant throughout the design process unless
one of the aims of a validation phase is to test an assumption or enabler, or constraint. This requirement for consistency is illustrated below.

6.3.3 Assumptions

(1) It is important to specify the assumptions applied when establishing the published limits of any airspace structures. Any such assumptions, particularly with regards to contingencies, should also form part of the safety assessment. Assumptions refer to elements of ATM/CNS, which are assumed to be ‘true’ for purposes of airspace design. ATM/CNS covers a wide variety of fields, which often requires most designers to consider factors beyond the limits of their own expertise. Assumptions may also have to be made concerning factors beyond direct ATM/CNS e.g. certain weather phenomena.

(2) All elements of ATM/CNS should be taken into account when identifying assumptions. The list of assumption given below is not exhaustive:

- Traffic demand - refers to a traffic sample, which is considered representative of the traffic to use the airspace/route network, which is object of redesign. Traffic distribution by traffic flows and city pairs should
also be considered. The traffic sample is obtained from STATFOR medium-term forecast.

- Fleet assumptions (for GAT) - prevailing aircraft types, overall aircraft performance, including aircraft navigation capabilities.
- Military operations - OAT flights, size and anticipated occupancy of reserved airspaces, and military requirements.
- ASM/ATFCM - refers to the tools and procedures applied in the integrated functions of ASM and ATFCM. Considerations should be given to the use of Airspace Data Repository (ADR) and Demand Data Repository (DDR).
- Utilisation of routes based on real-time knowledge of available airspace (updated in the ADR).
- ATC Tools - conflict detection tools (MTCD and tactical support), monitoring aids (MONA), and system supported coordination (SYSCO). In addition, availability of AMAN (arrival manager tool) and in particular Extended Arrival (AMAN in en-route) should be looked at as an area of assumption identification. These are elements that support proactive planning aiming to achieve conflict-free trajectories over an appreciable time horizon, thereby increasing the sector team efficiency, and capacity. The assumption should refer to the ATC support tools capabilities of an ACC responsible for the airspace which is object of a design project.
- Communication - level of implementation of data link, availability of sufficient frequency channels to accommodate required sectorisation.
- Navigation - navigational aspects of network performance enhancements could be referred to as navigation specification suitable to support operations of aircraft fleet expected to use the airspace in question and the respective route network. Namely, identified navigation assumptions should respond to the operational requirements of specific airspace concepts.
- In case of aiming at capacity gains in the interface between ARN and TMA and within TMA, the applicability of Advanced-RNP 1 should be considered especially where CDAs are conducted
- Surveillance - assumptions should make reference to Mode S ELS, ADS-B, and WAM capabilities
- Standards Rules and Procedures - the applicability of standards, rules and procedures that constitute the legal framework for the proposed airspace solutions and improvements. Standards refer to various ICAO documents prescribing the design procedures, e.g. Doc 9613, Doc 9905, Doc 7030, etc. Rules and procedures refer to the set of EU Regulations, EUROCONTROL Specifications and Guidelines, governing processes of ATM.

### 6.3.4 Constraints

(1) Constraints stand in contrast to assumptions in that they suggest the absence of certain elements of ATM/CNS or limitations created by external factors, e.g. lack of supporting institutional arrangements. In general terms, constraints can be said to have a negative impact upon the ATC operational requirements of an Airspace design. At best, it may be possible to mitigate constraints using enablers. At worst, constraints have to be accepted because there is no alternative ‘solution’.
Constraints should be identified against the elements listed above.

6.3.5 Enablers

(1) Enablers refer to any aspects of ATM/CNS that may be used to mitigate constraints identified and/or any factors that may be used to 'enable' operations in the airspace designed. Importantly, the identification of enablers may take the form of functional requirements (which are then 'translated' into technical requirements or specifications) requiring follow up work on the part of ANSP and may be outside the scope of the design project.

(2) In case of enablers taking form of a state or international agreements, a follow up work on the part of the states’ institutions may be required.

(3) There are three enabling groups: the improvement of Air Traffic Management, CNS - Technical Requirements, and Institutional processes:

Air Traffic Management

- FUA upgrading, with more pro-active co-ordination between AMCs, FMPs and the Network Manager Operations Centre (NMOC), supported by a common real time environment data base is necessary for better use of the airspace. These are some examples of enablers belonging to the ASM area: Airspace Data Repository (ADR, AUP, UUP and e-AMI to accommodate changes to the ATC FPL up to and beyond estimated off block time. Extended functionality of the ADR will also be needed to notify airspace users of changes to the dimensions of the terminal airspace or TRAs/TSA in the lower airspace.

- Procedures for re-routing in accordance with IFPS development plans.

- Adapted airspace organisations and airspace management.

CNS and ATC Systems - Technical Requirements

(4) CNS Enablers can be clustered into two groups: ground and airborne. Despite their different roles, it is clear that many airborne and ground enablers need to be integrated if the benefits of Airspace Configurations are to be realised. The interdependence of these enablers necessitates synchronised implementation of certain enablers if the desired benefits are to be achieved.

- In order to take advantage of the multi-option routings an inter-active link between IFPS and FDPS (ATM system) is an essential prerequisite.

- The enhanced responsiveness of the flight planning system and its connection with the airspace environment database, AOs, ATC and ATFM is of utmost importance.

- The capability to navigate to B-RNAV standards as a minimum.

- Offset capabilities are essential for improvements at the interface with TMAs where airspace is limited.

Institutional Processes

(5) Institutional enablers include guidance material, standards and rules. In the context of achieving a proposed airspace design, it would be an infrequent situation that requires the commencement of a new rule making process. It is anticipated that amendments to some of the current rules, governing ATM processes, may be required.
In addition, some airspace design solutions may require enablers as listed below:

- National/International agreements describing cross border sectorisation or other cross border activities;
- Proposals for amendments of various ICAO documents, i.e. European ANP, Doc 7030, etc.;
- EUROCONTROL specifications;
- Procedures for various ATM processes;
- ATS procedures for an airspace where RNAV or RNP applications are utilized;
- Letters of Agreement defining operational and technical aspects of cross border processes;
- State approval process for RNAV and RNP operations.
6.4 Route Network Design

6.4.1 Route design

(1) This chapter describes the ATS Route Network Design phase where new scenarios are developed.

(2) To develop an optimum European airspace structure the cooperative decision making processes go through a “top down” European ATM network approach. It begins with the identification of known problems and uses forecast traffic demand to formulate route proposals for the major traffic flows, taking into account all civil and military requirements.

![Diagram](image)

6.4.2 Methodology for airspace structure development

Basic Structure

(1) A network of ATS routes should form the basis for the determination of the airspace organisation and the required air traffic services and facilities. It should be so established as to enable a majority of flights to operate along, or as near as possible to, the direct route from point of departure to destination. European ATS route structures should be set up along broad alignments joining major origin/destination areas. These alignments must be structured in an operationally viable way.

(2) The restructuring of the ATS route network should be performed in an evolutionary manner. As the restructuring of entire portions of the airspace, e.g. a major traffic axis, is agreed, implementation should not be delayed whilst...
waiting for the plans for restructuring of additional portions to be completed. States may need to ensure, where they cannot accept proposals being made, that they present an alternative.

**International Planning**

(3) The process should provide an internationally agreed broad and basic concept of the European airspace and associated ATS route structure serving as a basis for national or regional planning. Major changes of airspace and ATS Route structure affecting the basic ATS route network should be made with prior co-ordination and exchange of information with the largest possible number of international parties concerned. This should be carried out well in advance and preferably in multilateral fora.

**Relationship between Network and Sectorisation**

(4) There is a close two-way relationship between the network’s structure and sectorisation. Consequently, from the planning phase onwards, it is necessary to ensure that a sectorisation scheme, including possible delegation of ATS, is feasible and viable in relation to the planned network. In particular, the definition of the directions in use on unidirectional routes, as well as the final alignment of these routes may have to be adapted to account for sectorisation efficiency. This should be validated through simulations.

**Civil/Military Interface**

(5) Civil and military concerned parties should cooperate in accordance with FUA concept principles to ensure a more efficient and flexible use of airspace.

**Extension of the FUA concept**

(6) Extension of the FUA concept to additional direct routings should be made available under pre-defined civil/civil conditions (Staffing/sectorisation/traffic density). Against current practice, i.e. direct routing is applied inside one sector, this would mean allowing ATC to use direct routings within larger airspaces (groups of sectors/ACCs). The automated reprocessing of flight plans would facilitate the further application of this concept.

**Network Architecture**

(7) The definition of major traffic flows should include heavily loaded intra-European routes and/or segments that should be integrated in the overall structure at an early stage of the planning. The architecture of the network should normally be developed from the core area towards the periphery.

(8) Efforts to eliminate specific traffic bottlenecks should include, as a first step, an in-depth analysis of the factors causing the congestion. In this regard, particular care should be taken to avoid worsening the situation in one area by attempting to improve it in another.

(9) In the context of complex multiple crossing points, “Roundabout” means the grouping of unidirectional routes of the same series of flight levels (odd and even) on to two different points (areas), thus separated one from the other, in order to allow the establishment of two different sectors and thereby achieving a spread of the workload.

(10) “Roundabout” network structures should be conceived to fit with specific sectorisation and to allow the splitting of multiple crossings into different sectors.
Direct routeings:
Square shaped crossing points (even levels) and diamond shaped crossing points (odd levels) are complex and may result in an overloaded sector which cannot be split. (limited maximum capacity)

Structured routeings with “Roundabouts”:
The resulting location of the actual crossing points makes it possible to split the former sector into two sectors and enhance the maximum capacity.

(11) The number of ATS routes should be kept to a minimum but should be in line with the traffic demand in respect of ATM capacity and most direct routing.

(12) Although it is accepted that a large number of ATS routes can improve route capacity, it is also recognised that a large number of crossing points, especially in congested areas, can reduce sector capacity. Planners should optimise capacity by introducing new routes with as few crossing points as possible and these crossing points should be well clear of congested areas.

(13) Whenever in the planning phase and based on forecast demand, an ATS route has been planned to accommodate a specific flow of traffic, its subsequent implementation should - if the traffic demand by that time is no longer met - be reconsidered. Redundant ATS routes should be deleted.

(14) Use of unidirectional routes should be extended, particularly in areas where the interaction of climbing and/or descending traffic is a limiting factor, with the expectation of achieving higher ACC sector capacities due to an improved traffic structure.

Planning of Routes

(15) Planning should ensure that where dualised routes are used unidirectional for opposite traffic flows, cross-overs are avoided as far as possible.
(16) Crossing areas should not conflict with climb or descent lanes of major airports.

(17) The extension of crossing areas between ATS routes should be kept to a minimum (crossing at right angles).

(18) Currently, two different applications of the ICAO table of cruising levels coexist in the EUR Region. This leads to a requirement for aircraft transiting the boundary between the two application areas to change flight levels. Consideration should be given to the possible increase of system capacity which would result from a less rigid application of the present method of segregation of eastbound and westbound flight levels. This is already practised in some “one-way” ATS routes.

(19) It should be recognised that the definition of a given flight level allocation scheme will have a direct impact upon the way in which major crossing points will have to be organised.
Short haul Routes and Levels

(20) Specific routing and/or flight level allocation for short haul city pairs may be established.

Connecting Routes

(21) The traffic in Europe is predominantly short/medium haul traffic with nearly half of the flight distance spent in climb and descent phases. From the first stage of the network planning, it is therefore necessary to consistently integrate major connecting routes in the whole structure and to ensure TMA-Network interfaces compatibility (see Solution A below). This is valid for the major origin/destination areas.

(22) Fixed routes systems based on RNAV should, if necessary, be applied at airports with high traffic density to specialise arrival and departure routes. Such route systems (specialised routes) should be designed to enable arriving, departing and overflying traffic to be separated systematically, while seeking to permit economical flight paths (see Solution B below). In order to optimise the use of airspace and aerodrome capacity route systems should be designed, where possible, to take account of different aircraft performance capabilities.

6.4.3 En-Route Spacing

Route Spacing

(1) When designing ATS routes, there is a strong connection between aircraft-to-aircraft separation and navigation specification. That translates into route spacing requirements defined in the ICAO documentation. For route spacing below ICAO specifications, a safety case shall be required for individual projects.
6.4.4 Guidelines for ATS route publication

Publication of vertical limits expressed by FLs

(1) ICAO Doc 10066 PANS-AIM states that a detailed description of an ATS route shall be published, and that this shall include the publication of upper and lower limits. The distinction and use of VFR FLs for vertical limits of control areas is prescribed by ICAO Annex 11, Chapter 2.

(2) In order to harmonise the publication of these limits in their AIPs, States shall:

<table>
<thead>
<tr>
<th>Above the lower limit or minimum en-route altitude and below FL290</th>
<th>Use VFR flight levels in accordance with ICAO Annex 2, Appendix 3, page 1 (e.g. FL035 or corresponding altitude, ... FL285)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This provision is because in RVSM environment FLs for VFR flights are below FL290.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Above FL290 and below FL410</th>
<th>Use number representing the layer/intermediate level between IFR flight levels, ending on ... .5 (e.g. FL295 ... FL405)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This provision is because in RVSM environment above FL290 the FLs for IFR flights are separated by 1000FT and are expressed mathematically by ODD and EVEN numbers. ODD FL corresponds to FL310 while EVEN FL corresponds to FL320 and intermediate level is FL315.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Above FL410</th>
<th>Use number representing the layer/intermediate level between IFR flight levels, ending on ... 0 (e.g. FL420 ... FL500 ...)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This provision is because in RVSM environment above the last RVSM FL410 the FLs for IFR flights are separated by 2000FT and are expressed mathematically only by ODD numbers. ODD FL corresponds to FL450 while EVEN FL corresponds to FL470 and intermediate level is FL460 (mathematically EVEN number).</td>
<td></td>
</tr>
</tbody>
</table>

(3) The lower limit specified for the upper ATS–route shall constitute the upper vertical limit of the lower ATS route.

(4) Similarly, in order to describe upper and lower limits of military exercise and training areas and air defence identification zones in their AIPs, States should apply the above principles.

Publication of applicability times/conditions

(5) ICAO Doc 10066 PANS-AIM does not define the format for published times of availability and other conditions in the AIP for ATS routes. It only states that such information should be inserted as remarks to the detailed description, complemented by the Doc 8126 - AIS Manual description of ATS route tables for the AIP ENR chapter, illustrating the remarks column using free, non-standardised text.

(6) In order to harmonise AIP publication describing times and conditions when an ATS route, including CDR, is available for flight planning in their AIPs, States shall apply the following procedure.
(7) In case of timely repetition during the equal periods, information in the remarks column of the AIP ENR 3 shall clearly describe the following situations for the ATS route:

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Column Remarks (Examples)</th>
</tr>
</thead>
</table>
| **Permanent** | • For any ATS route except Conditional ATS route as qualified by ERNIP Part 3:  
No mandatory requirement for explicate indication that ATS routes is permanent but abbreviations PERM or H24 might be use when and if required  
• For Conditional ATS route as qualified by ERNIP Part 3:  
CDR 1 H24 or CDR 2 H24 or CDR 3 H24 |
| **Daily**     | • For any ATS route except Conditional ATS route as qualified by ERNIP Part 3:  
23:00 - 05:00 (22:00 - 04:00)  
Not available - outside the time period.  
• For Conditional ATS route as qualified by ERNIP Part 3:  
CDR 1 followed by  
23:00 - 05:00 (22:00 - 04:00)  
together with what happens outside this time period, i.e. not available (NOT AVBL) or permanent (PERM) or CDR... and/or all other possible combinations. |
| **Weekly**    | • For any ATS route except Conditional ATS route as qualified by ERNIP Part 3:  
MON - FRI 23:00 - 05:00 (22:00 - 04:00)  
FRI 14:00 (13:00) - MON 06:00 (05:00)  
Not available - outside the time period.  
• For Conditional ATS route as qualified by ERNIP Part 3:  
CDR 1  
MON - FRI 23:00 - 05:00 (22:00 - 04:00)  
FRI 14:00 (13:00) - MON 06:00 (05:00)  
together with what happens outside this time period, i.e. not available (NOT AVBL) or permanent (PERM) or CDR... and/or all other possible combinations. |
| **Vertically**| • For any ATS route with conditional route categories as qualified by ERNIP Part 3:  
CDR time period: apply above procedures;  
CDR different category:  
CDR 1 FL285 - FL460 MON - FRI 08:00 (07:00) - 10:00 (09:00), applicability of permanent use (PERM) outside the described period and FLs, and/or all other possible combinations. |
| **Extended Holiday period** | • For any ATS route except Conditional ATS route as qualified by ERNIP Part 3:  
PERM from 20 DEC to 07 JAN or according to Public Holiday (PH) described in AIP GEN 2.1 and/or other AIS publications; |
Not available - outside the time period.

- For Conditional ATS route as qualified by ERNIP Part 3:
  CDR 1 H24 from 20 DEC to 07 JAN or according to Public Holiday (PH) described in AIP GEN 2.1 and/or other AIS publications;
  CDR 3 other times and/or all other possible combinations.

(8) When the single CDR Category (SCC) environment is implemented, CDR 1 status should be published in AIP with the indication “actual availability in accordance with conditions published daily in EAUP/EUUP”.
6.5 Free Route Airspace (FRA) Design

6.5.1 FRA concept

Definition

A specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control.

Scope

(1) The overall scope of the Free Route Airspace (FRA) Concept is to provide an enabling framework for the harmonised implementation of FRA in Europe whenever a State / FAB / ANSP, a group of States / FABs / ANSPs decides to proceed with such implementation.

(2) The FRA Concept forms the basis for a common understanding for all ATM partners involved in FRA implementation. The FRA Concept encompasses various FRA implementation scenarios that will:

- Meet the Safety Objectives;
- Be compatible with existing operations;
- Be sustainable through further development;
- Be capable of expansion/connectivity to/with adjacent airspace;
- Be capable of being exported to other regions.

(3) The FRA Concept implementations shall be defined in Concept of Operations Document (CONOPS).

Enablers

The enablers are:

- Appropriate System Support - enhancement for the purposes of Flight Planning and ATFCM;
- Procedures - enhanced procedures where necessary for operations within FRA and at its interfaces;
- Adaptations to airspace structures;
- Adaptations to airspace management procedures;
- No additional equipment requirements or flight planning procedures changes are foreseen for aircraft operators. Nevertheless, modifications to flight planning systems may be required to ensure that full benefit of the FRA can be realised.

Airspace Classification

(4) FRA will, in principle be classified as Class C airspace, with certain agreed exemptions (e.g. above FL460, within the Oceanic Transition Areas).

Flight Level Orientation

(5) The Flight Level Orientation Scheme (FLOS) applicable within FRA shall be promulgated through the relevant national AIS publications. (This does not constitute a change to the current system of two FLOS in Europe).
Limited Applicability of FRA

*Time Limited*

(6) Even though the goal is to implement FRA on a permanent basis, a limited implementation during defined periods could facilitate early implementation. Procedures for transitioning between FRA and fixed ATS route operations shall be set.

*Structurally Limited*

(7) In complex airspace, the full implementation of FRA could potentially have a detrimental effect on capacity. In such airspace, States / FABs / ANSPs may decide to implement FRA on a structurally limited basis, for example by restricting the available FRA Horizontal entry/exit points for certain traffic flows, which could increase predictability and reduce the number of potential conflicts.

Airspace Organisation

*General*

(8) FRA forms an integral part of the overall European ATM network, interfacing vertically or laterally with adjoining fixed ATS route operations airspace.

(9) Airspace reservations will remain, and as all airspace users will have equal access to FRA, harmonised application of the FUA Concept and Civil/Military Coordination are taken into account in order to ensure harmonised procedures and service provision for the benefit of all the airspace users.

*Applicable Airspace*

(10) The FRA Concept is applicable to any area where FRA is implemented within the European airspace network.

*Vertical Limits of FRA and Their Publication*

(11) This FRA Concept is aimed at facilitating the harmonised implementation of FRA wherever and whenever a State/FAB/ANSP decides to do so. In this context, there is no specific recommendation on the minimum FL of such implementation.

(12) The vertical limits of the FRA shall be published in national AIS Publications.

(13) The setting of the lower limit of FRA shall not adversely impact adjacent areas where FRA is not yet implemented or where only limited application of FRA is in place.

(14) Nevertheless, with goal being a harmonised airspace structure across the European network, the following recommendations are made:

- The lower vertical limit shall be coordinated at European network level to ensure interconnectivity with adjoining airspace and this could vary in different areas or at different times within a particular FRA.
- The minimum level should be the lowest feasible, taking into account the complexity of the airspace and the demand.

*Horizontal Limits of FRA and Their Publication*

(15) The horizontal limits of the FRA shall be published in national AIS Publications. In order to gain full benefits from its applicability, the horizontal limits should be preferably based on operational requirements, not necessarily on FIR/UIR or ATC unit boundaries.
(16) FRA Horizontal entry/exit points into/out of the FRA shall be published in national AIS publications with a clear reference to the FRA and to the nature of the point (entry, exit or entry/exit point).

(17) In areas where the shape of the lateral boundaries of an FIR/UIR or ATC unit are such that direct routings could lead to exiting for a short time into adjacent airspace, all efforts shall be made to ensure that applicability of FRA is organised based on operational requirements and appropriate arrangements are made with the adjacent ATC units/States. If such situations are unavoidable, the appropriate publication of FRA Horizontal entry/exit points shall be ensured.

(18) If FRA is implemented in adjacent FIRs/UIRs, the publication of the FRA shall clearly reflect this cross-border application. The publication of FRA Horizontal entry/exit points on the common FIR/UIR boundary is not necessary from an operational perspective.

(19) FRA Horizontal entry/exit points into/out of FRA shall take into account adjacent airspace where FRA is not implemented. FRA Horizontal entry/exit points will be defined to allow for a structured transition between the two operational environments, this may not necessarily be at the FIR or ATC unit boundary.

(20) In order to ensure overall European airspace structure interconnectivity, the FRA Horizontal entry/exit points from/into adjacent non-FRA shall ensure interconnectivity with the fixed ATS route network.

*Vertical Connection between FRA and the underlying Fixed ATS Route Network*

(21) The vertical connection between FRA and the underlying fixed ATS route network shall take into account the various climbing and descending profiles. The interconnectivity between FRA and the underlying fixed ATS route network shall be ensured through the availability of a set of waypoints reflecting the typical climbing/descending profiles. The publication of extended SIDs/STARs or published connecting ATS routes are also operationally recommended options.

**Maximising Efficiency of FRA**

(22) To maximise the efficiency of FRA and to ensure safe and efficient transfer of flight, all efforts need to be made to ensure any required realignment of the fixed ATS route network in adjacent airspace not applying FRA. Wherever a fixed ATS route network will remain in operation below the FRA, this underlying ATS route network shall be refined and coordinated at network level to take into account the needs of free route operations in the airspace above.

**Access To/From Terminal Airspace**

(23) Access to/from Terminal Airspace will need to be considered and appropriate refinements to TMA structures initiated, including the definition of additional SIDs/STARs to permit more flexibility. This could have implications for the management of Terminal airspace.

**Notes:**

1. **In case of implementation of FRA down to the upper limit of Terminal Airspace, the entry/exit points into/out of FRA should preferably be the last point of the SID and the first point of the STAR. In some cases, a redesign of the SID/STAR will be required and, depending on airspace complexity, extensions may need to be investigated to ensure appropriate traffic segregation.**

2. **If for some airports no suitable SID/STAR is available, flight planning using DCT should be facilitated.**
Publication of a Contingency ATS Route Network

(24) There is no over-arching requirement for a European contingency fixed ATS route network.

Maintenance of a Fixed ATS Route Network within FRA

(25) Wherever a fixed ATS route network is maintained within FRA, details shall be published in AIS publications.

Airspace Reservations

(26) In the context of FRA Concept, “airspace reservation” refers to airspace of defined dimensions for the exclusive use of specific users, including TRA, TSA, CBAs, D, R, P, Areas and any specially activated areas. These are special designed areas within which both civil and military activities could take place.

(27) Airspace reservations are permanently active (such as prohibited areas) while others are active for varying periods of time and at varying levels. (e.g. TSA and similar exercise areas). Active airspace reservations are crossed or avoided depending on the degree of coordination (including civil/military coordination) and the status of the activity in the area. This will remain the case in FRA.

(28) There is the potential for airspace reservations to be reconfigured to meet different task needs.

(29) In areas where coordination procedures (including civil/military coordination procedures) and airspace conditions permit, the airspace users are permitted to flight plan routeings through airspace reservations.

(30) In some cases, tactical rerouting will be given if airspace is not available for crossing. The expected maximum additional length of a tactical rerouting shall be promulgated through national AIS publications.

(31) In other cases, when such airspace is not available for crossing, FRA intermediate points will be defined to facilitate flight planning clear of the airspace reservation and ensure sufficient separation from the activity. The promulgation of these FRA intermediate points shall be ensured through national AIS Publication. If these points are to be used only for avoidance of airspace reservations, specific conditions for the use of these points for flight planning shall be published in the RAD. An overall standardisation of the separation from airspace reservations will be required, in the longer term, especially for cross-border operations.

(32) Publication of activation time of airspace reservations should be considered.

Note: The possibility of using geographical coordinates should be considered.

(33) Procedures shall be developed between the Network Manager Operations Centre (NMOC) and all interested parties to ensure a harmonised application of procedures for the avoidance of airspace reservations.

Route Availability

(34) The role, format and applicability of the Route Availability Document (RAD) have been adapted to accommodate FRA requirements.
Sectorisation

(35) The present sectorisation scheme may need to be restructured to accommodate traffic flows both within FRA and according to the underlying fixed ATS route network. Instead of having regularised flows of traffic along the ATS route network crossing at recognised points, the traffic will potentially be spread across the whole of a sector.

(36) Sector design will need to respond to this change and may need to be more flexible as traffic demand varies.

(37) The Free Route Airspace sectors should be:
   - Unconstrained by FIR/UIR or State boundaries.
   - Capable of being reconfigured to meet demand. A structured methodology where sectors are taken from a library of designs already known to the internal and external systems is likely in areas where there are significant fluctuations of traffic flow orientation. Changes to sector definition will need to be notified to the Network Manager Operations Centre (NMOC) and should be transparent to adjacent units.

(38) Sector Design Criteria should, at least, take into account:
   - the principle traffic flows and orientation;
   - minimising short transits through sectors;
   - minimising sector and ACC re-entry;
   - positions of airspace reservations;
   - coherency with adjoining fixed ATS route network sectors and connecting ATS routes to SIDs/STARs;
   - civil/military coordination aspects.

(39) Sectors shall be aligned as far as possible so that the number of flights with short transit times is reduced to a minimum. If this is not feasible such traffic should be exempted from Network Manager traffic counts. Appropriate rules shall be set in this context.

(40) More flexibility in defining a larger number of elementary sectors/airspace volumes and sector configurations will need to be explored. Sectors will need to be designed to minimise short transits and to avoid sector/ATC unit re-entry of flights. Operationally designed, cross-border sectors may be needed where FRA is implemented in adjacent areas.

(41) A more extensive application of cross-border sectors is likely to be required to reflect better variations of traffic patterns. Local FMPs will have to take a more proactive role in the selection of optimum sector configurations. Active sector configurations shall be dynamically communicated to the Network Manager Operations Centre (NMOC).

Sector and Traffic Volumes Capacities/Monitoring Values

(42) Sector capacities shall take into account the more dynamic variations of traffic patterns. Definition of traffic volume capacities/monitoring values shall take into account a minimum transit time. Appropriate procedures shall be put in place by the Network Manager Operations Centre (NMOC) to exempt such flows from sector traffic counts.
**ATS Delegation**

(43) In areas where operational boundaries do not coincide with FIR/UIR boundaries, and delegation of ATS is effective the operational boundaries of FRA shall be published in the national AIS publications of both States. The Letters of Agreement between the concerned ATS units shall be amended accordingly to reflect any changes to the applicable procedures in the airspace where ATS is delegated.

**Airspace Management**

**General**

(44) ASM in FRA will differ from that of the fixed ATS route network in that AOs will no longer be given information on which routes are available, but will need to know which airspace is available/not available. For the transit period of a given flight through FRA, the airspace users will need to know the activity of all pertinent airspace reservations areas to enable the selection of a flight path that will avoid them.

(45) ATC units, corresponding military authorities, airspace users and the Network Manager will need to know and share the same updated information with regard to activity of airspace reservations.


**OAT Handling**

(47) OAT en-route shall benefit in a similar way from the implementation of FRA. There is no identified need for maintaining an OAT route structure within FRA.

**Letters of Agreement and Coordination Procedures**

(48) Letters of Agreement shall be adapted to reflect the specificities of FRA in regard to transfer points, flexible changes in sectorisation, links with the fixed ATS route network, high fluctuations in traffic flows, possibility to leave/enter the airspace at random points, etc.

(49) Appropriate mentioning of ATS delegation in areas involving FRA shall be fully considered.

(50) The automatic exchange of flight data between ACCs/UACs will need to consider the possibility of transfer at random points.

(51) Transfer procedures and restrictions currently stipulated in the existing Letters of Agreement may no longer be applicable in Free Route Airspace. Appropriate procedures shall be defined to reflect these new provisions.

(52) It is recommended to regularly review individual LoA restrictions with the aim to improve the efficiency of the vertical profile and enable more optimised CCO and CDO where possible. As part of this review, several good practices may be followed. These include the following:

- LoAs should enable optimal descent profiles and may be designed on a flexible basis that can be adapted to runway direction, high / low demand periods, seasonal traffic, week / weekend traffic patterns and should be regularly reviewed on an individual restriction basis.

- LoAs may benefit from moving existing points or creating new points to
both enable a higher transfer of control point or more optimum descent profile. Such changes should be promoted during the regular LoA review.

**Flight Planning**

**General**

(53) Within FRA, flight planning procedures are needed that are understandable and easy to use and that are coherent with procedures for the fixed ATS route network.

(54) Principles are outlined for GAT and OAT flight planning, dealing primarily with GAT but will specifically mention OAT requirements where necessary.

(55) Except in FRA where it is published that tactical rerouting will be given, the onus is on the originator of a FPL to submit a routeing through Free Route Airspace that avoids active airspace reservations.

(56) ATC, AOs and the Network Manager Operations Centre (NMOC) should have the same information regarding the intended profile and routing of a flight, regarding both the initial flight plan and any subsequent revisions to that information. The development of appropriate tools will indicate real time and future activity status of airspace reservations to all users.

(57) Within the FRA there will be no limitations on the use of DCT, other than those recommended by ICAO.

(58) Changes to airspace users’ flight planning systems may be required to enable all airspace users to take full benefit of the FRA.

(59) The IFPS will be modified to enable flight plan processing and checking in the context of variable lower levels of FRA in various parts of the European airspace. Similarly, the IFPS shall enable appropriate flight plan processing and checking for the transition from FRA to fixed ATS route network airspace whenever FRA will be implemented for limited time periods, e.g. during night time only.

**Flight Plan Format**

(60) No change is envisaged to the ICAO flight-plan format in respect of FRA. OAT flight plans shall continue to comply with national regulations.

**Use of Unpublished Intermediate Points for Flight Planning**

(61) In order to benefit from the best operating conditions, airspace users may be allowed to use any intermediate unpublished points for flight planning defined by geographical coordinates or by bearing and distance. Such possibility shall be clearly promulgated in national AIS publications. Where such utilisation is not possible, publication of FRA Intermediate points shall be ensured.

**Flight Planning Routeings Through Airspace Reservations**

(62) For the transit period of a given flight through FRA, the AO will need to know the activity of all pertinent airspace reservations areas to enable the selection of a route that will avoid them, except where none are published and tactical re-routeing is provided. The requirement for ‘hard checking’ of such flight plans needs to be considered.

(63) The selection of the route shall be based on the FRA Intermediate points published to this effect.
In areas where civil/military coordination procedures and airspace conditions permit, the airspace users can be allowed to flight plan through airspace reservations. Tactical re-routings could be expected in case of areas not being available for civil operations.

Route Description

FRA published significant points or unpublished points defined by geographical coordinates or by bearing and distance shall be described using the standard ICAO format. Route portions between all these FRA points shall be indicated by means of DCT in accordance with ICAO Doc 4444 PANS-ATM.

Flight Planning Facilitation Through the Use of DCTs

The use of published FRA Horizontal entry points with associated FRA Horizontal exit points might be required in certain cases to facilitate flight planning in FRA. This is especially valid in cases where only limited combinations of entry/exit points are permitted within FRA. Similarly, a number of DCTs might not be allowed for use by the airspace users. The publication of such DCTs will be ensured at network level, through the RAD. This approach shall ensure the respect of the status of airspace within various FIRs (e.g. min/max FLs, avoiding penetration of uncontrolled airspace, availability period, etc.).

Cruising FL Change

The airspace users may use any published significant point or unpublished point, defined by geographical coordinates or by bearing and distance for indicating changes to the cruising FL. The airspace users shall observe the Flight Level Orientation Scheme applicable within the respective FRA.

Flight Plan Submission

GAT flight-plans will be submitted to IFPS within the appropriate time-parameter. RPLs may continue to be submitted for flights that will transit FRA, but they might not have the full benefit of optimum route selection derived from precise information on airspace availability. They will continue to be checked by IFPS following normal procedures for proposing alternative routes when necessary.

Flight plan filing limitations shall be promulgated for areas where FRA is structurally limited - i.e. only limited combinations of entry/exit points are permitted.

Flight Plan Checking and Correction

In addition to the normal flight plan validation rules within IFPS, the flight-planned route through FRA airspace shall be considered invalid if it:

- Fails to comply with published FRA Horizontal entry/exit, FRA Departure/Arrival Connecting Points and any other airspace utilisation requirements;
- Infringes an airspace reservation, unless otherwise defined.

The flight plan shall also follow the published FLOS for the corresponding airspace.

In proposing alternative routes, IFPS will not be able to consider all the varying AO criteria for route selection. IFPS will propose routes on the basis of shortest distance and/or alternative FL above or below airspace reservations.

In case of time-limited application of FRA, IFPS shall check the flight plan to ensure that it complies with the time parameters of the FRA.
Flight Plan Distribution

(74) Real time updates to airspace availability should lead to a recalculation of the submitted flight profile by IFPS before the FPL is distributed. To ensure that subsequent route corrections can be offered for affected flights, an appropriate distribution time parameter will need to be set. Once this parameter has passed and FPLs are distributed, further route updates will not be processed.

(75) Flight Plans shall be distributed to appropriate ATS providers, relevant military organisations and other authorised parties decided by National Authorities. The IFPS shall ensure the appropriate calculation of the flight profile to enable a correct distribution of the flight plan to all interested parties.

(76) For large scale applications of free route airspace, the flight plan distribution will need to be ensured to the appropriate ATC units and sectors, hence the importance of having updated information on active sector configurations. In addition, the ATC units, the airspace users and NMOC will need access to exactly the same information, both for the initial flight plan and subsequent updates. The importance of completely up-to-date information on the status of airspace reservations is to be again underlined.

DCT Limits

(77) Existing limitations on the DCTs (in distance and for cross border DCTs) will need to be reviewed.

(78) The current DCT limits are applicable to an administrative airspace (FIR/UIR) which does not always coincide with the operational airspace boundaries. In case of ATS delegation, this prevents the creation of a DCT covering the complete operational airspace.

(79) The possibility of flight planning DCT across two or more FIR/UIR boundaries shall be made available. This will require IFPS to compute and communicate to all ACCs entry/exit positions for their area of responsibility.

(80) If the DCT limits are different in the airspace below the FRA, the IFPS calculation could raise errors for traffic flying in both airspaces. This is the case for the traffic climbing/descending between the FRA and the fixed ATS route network.

FRA zones unavailable for flight planning

(81) When and where required to prevent inappropriate flight trajectory airspace crossings or to properly manage ATC operationally sensitive areas inside or across relevant FRA area/s establishment of No Planning Zone/s (NPZ) might be considered in accordance with provisions in ERNIP Part 1, 6.9.1.
Air Traffic Flow and Capacity Management

General

(82) Airspace users shall comply with normal ATFCM procedures both within and outside FRA.

(83) Large scale applications of free route airspace or implementation of free route operations in adjacent ATC units will generate a large variation of trajectories. Real-time updates of the airspace situation with respect to both sector configurations and airspace reservations will be required in order to offer the most updated ATFCM situation at network/local levels.

Sector Configuration Management

(84) In areas where adjacent airspace is FRA, the volatility of the traffic flows will be higher than today. This will require a larger number of elementary sectors, a larger number of sector configurations and a more flexible and dynamic adaptation of the sector configuration to the traffic demand/pattern.

(85) Changes to sector configurations will need to be notified in real time to the Network Manager Operations Centre (NMOC) to enable optimum network management actions. Appropriate procedures and system support to enable this flexibility shall be required. System support shall be in place to better predict trajectories in an environment where trajectories will be more volatile than in a fixed ATS route network.

(86) In addition, procedures need to be defined to allow the Network Manager Operations Centre (NMOC), through collaborative decision making processes, to propose the most optimum configurations, taking into account the expected traffic pattern at network level.

(87) Variable sector monitoring values, communicated in real time to the Network Manager Operations Centre (NMOC), will be required to reflect the changing traffic complexity.

Sector and Traffic Volumes Capacities/Monitoring Values

(88) The use of traffic volumes and exclusions will need to be considered, as large variations in traffic patterns could appear in the context of large scale applications of free route airspace or even when two adjacent ATC units allow free route operations.

Letters of Agreement Restrictions

(89) A number of restrictions currently stipulated in the existing Letters of Agreement and implemented by the Network Manager Operations Centre (NMOC) for flight planning or ATFCM purposes may no longer be applicable in free route airspace. Such provisions will need to be reviewed.

Re-Routeing Proposals

(90) The possibility for IFPS to propose routes to airspace users, taking into account the best operating conditions in free route airspace, shall be considered. New procedures will be required to define rerouting within free route airspace. System support will be required to facilitate this task. The provision of a time window for the period the FPL/RPL will be suspended or invalid should be considered (FLS/REJ).
ATFCM/IFPS Tool Support

(91) The management of FRA is different to that of the fixed ATS route network and the Network Manager Operations Centre (NMOC) will need additional system support and new procedures in certain areas such as:

- Taking into account routing schemes outside FRA;
- The expected increase in RPL updates;
- Tools for ATFCM planning within FRA;
- Tools for re-routeing;
- Tool to calculate and manage traffic loads at a local level (FMP) and central level.

Cross-border FRA Expansion

General Provisions

(92) When changes are foreseen in the cross-border application of FRA, agreement shall be reached on the FRA Concept implementation between all participating and new State(s) / FAB(s) / ANSP(s).

(93) The effects of a change in the cross-border application of FRA are not limited to the State(s) / FAB(s) / ANSP(s) that are directly affected by the cross-border application of FRA (i.e. adjacent State(s) / FAB(s) / ANSP(s)). For this reason, proper coordination shall take place to evaluate the effects of the change of the cross-border application of FRA.

Requirements

(94) If State(s) / FAB(s) / ANSP(s) intend to implement cross-border FRA with an already existing adjacent FRA area, the implementing State(s) / FAB(s) / ANSP(s) shall:

- Inform, as soon as is practicable, NM and all State(s) / FAB(s) / ANSP(s) within the existing adjacent FRA area;
- Reach agreement on the common cross-border FRA concept implementation with NM and with all State/s / FAB/s / ANSP/s within the existing adjacent FRA area regarding procedures, ATC systems, AIS publications, RAD, etc.;
- Perform a Network Impact Assessment together with NM;
- Inform, as soon as is practicable, third party State(s) / FAB(s) / ANSP(s) (not part of “new” cross-border FRA area) to allow them to evaluate the impact on procedures, ATC systems, AIS publications, RAD, etc.

6.5.2 FRA - AIP Publication

Terminology in GEN 2.2 Abbreviations used in AIS publications

(1) Common terminology and relevant terms/abbreviations for FRA operations will be used and published in the AIP, GEN 2.2.

(2) A general Glossary of FRA Terms/Abbreviations is available in the paragraph 6.5.4. This may not be an exhaustive list and as such does not prevent States to insert additional FRA terms/abbreviations if required.
The FRA relevant terms/abbreviations that are not defined in ICAO Doc 8400 PANS-ABC, will be marked with an asterisk to indicate “non-ICAO” status - in accordance with ICAO SARPs. It is important that, for those “non-ICAO” terms/abbreviations, the harmonised terminology presented in sub-section 6.5.4 is used.

In accordance with ICAO Doc 10066 PANS-AIM, a list of alphabetically arranged definitions/glossary of terms can also be added in GEN 2.2.

**FRA General Procedures in ENR 1.3 Instrument Flight Rules**

Procedures related to the FRA, including explanation and definitions of applied FRA relevant points, will be described in a dedicated AIP section.

As the FRA procedures are seen as supplementary to the general IFR procedures, they will be described in the AIP section ENR 1.3 Instrument Flight Rules.

To adhere to the ICAO AIP template structure to the maximum extent, a new (additional) sub-section - ENR 1.3.4 “Free Route Airspace - general procedures” will be created (see sub-section 6.5.5 for detailed content).

In case of cross-border FRA implementation, the involved FIRs/UIRs or CTAs/UTAs shall be indicated in ENR 1.3.

**Notes:**

1. *FRA procedures specifically related to flight planning and submission of a correct flight plan shall be published in AIP section ENR 1.10 Flight planning.*
2. *Definitions of applied FRA relevant points are appropriate in ENR 1.3 together with information on FRA general procedures, recognising that publication of a list of definitions in GEN 2.2 is not mandatory.*

**Flight planning in ENR 1.10**

Within FRA, flight planning procedures need to be understandable, easy to use and coherent with procedures for the fixed ATS route network. National AIPs should provide clear procedures and principles for FRA flight planning; such procedures must be harmonised to the largest possible extent.

ENR 1.10 (ref. ICAO Doc 10066 PANS-AIM, Appendix 2) is the placeholder for information relevant for FRA flight planning for eligible flights, enabling of correct flight planning and submission of a flight plan. This relates to e.g. usage of significant points for flight planning purposes and/or instructions of mandatory items and/or format of the information, enabling the completion of the flight plan.

Any special cases, e.g. rules on availability and/or, restrictions for flight planning shall be considered to be published in the framework of utilisation through the Route Availability Document (RAD). In this case, the RAD promulgation in AIP shall be made in accordance with ERNIP Part 1, Annex 3. In case of establishment in relevant FRA area/s of No Planning Zone/s (NPZ), it shall be published in accordance with provisions in ERNIP Part 1, Annex D.

Instructions regarding DCT which could be filed in the flight plan in accordance with ICAO Doc 4444 PANS-ATM, Appendix 2, FLIGHT PLAN, ITEM 15, (c) Route (including changes of speed, level and/or flight rules), could be inserted in a dedicated subsection of AIP ENR 1.10.

Example: Instruction on DCT limitations/usage in the flight plan could be placed under AIP ENR sub-section 1.10.5:
“... ENR 1.10.5 Use of “DCT” in flight plan, Item 15, (c) Route (including changes of speed, level and/or flight rules)\)...”.

Free Route Airspace structures in ENR 2.1 and ENR 2.2 - General rule

The FRA structures, including sectors, will be published in:

- **ENR 2.1 FIR, UIR, TMA and CTA** - if based on FIR/UIR or ATC unit boundaries:
  - If the FRA structure coincides entirely with the published lateral/vertical limits of the FIR/UIR or the area of responsibility of the ATC unit, only a reference to FRA operations to the respective airspace needs to be published in the Remarks column.
  - If the FRA structure coincides entirely with the lateral limits of the published FIR/UIR or the area of responsibility of the ATC unit, but applies other vertical limits, insert the applicable FRA vertical limits in the Remarks column to the respective airspace.

  or:

- **ENR 2.2 Other regulated airspace** - if the FRA lateral limits do not coincide with FIR/UIR or ATS unit boundaries.

Cross-border application of FRA in ENR 2.2 Other regulated airspace

If FRA is implemented cross-border between adjacent FIRs/UIRs or CTAs/UTAs, the publication of the FRA information shall clearly reflect this cross-border application.

In addition to inserting in ENR 1.3 information on the involved FIRs/UIRs or CTAs/UTAs, the ENR 2.2 is the adequate placeholder for description of the cross-border FRA structure.

Cross-border sectors (e.g. applicable ATC sectors, portions of CTA/UTA) may be defined where FRA is implemented in adjacent FIRs/UIRs or CTAs/UTAs. ENR 2.2 is the adequate placeholder for publication of these sectors (as the sector borders do not coincide with FIR/UIR boundaries, see general rule).

*Note: The publication of FIR/UIR crossing points (5LNC in ENR 4.4) on the common boundary is not necessary, unless required for operational reasons. In that case, a reference to the other State(s) AIP(s) is made for common crossing points in ENR 4.4.*

It is recommended to only publish in AIP ENR 2.2 the State’s FRA area up to the border of the FIR/UIR (geographical coordinates, vertical limits, FRA name/ID, information on involved FIR/UIR, ATC unit providing the service and any other relevant information) instead of the total FRA area, and refer to the other involved States’ AIPs for continuing information.

*Note: This practice allows adhering to current ICAO provisions on publication and allows from a data management perspective constructing the overall FRA volume in accordance with involved Data Providers’ respective EAD area of responsibility.*

The boundary of the total area for the involved (cross-border) FIR/UIRs may be described in ENR 2.2 if the same vertical limits apply, with the FRA name/ID, geographical coordinates, vertical limits, and information on involved FIR/UIR.

**Delegation of the responsibility for provision of ATS in ENR 2.2 Other regulated airspace**

Appropriate AIP publication of areas where the responsibility for provision of ATS is delegated shall be assured, in order to facilitate the publication of the FRA applicability in these areas.
(22) The following AIP placeholders are available in the ICAO AIP Specimen (Doc 8126) for publication of delegation of the responsibility for provision of ATS:

- **GEN 3.3 - Air Traffic Services**
  - **GEN 3.3.2 Area of Responsibility**
    - Brief description of area of responsibility for which air traffic services are provided

- **ENR 2.2 Other regulated airspace**
  - **ENR 2.2.2 The area involved in the transfer of ATS responsibility**
    - Details on the description of the areas within another bordering FIR where ATS is provided under delegated authority as part of the area of responsibility, and the provided services (ATC unit).

(23) While publication of ATS responsibility in GEN 3.3 does not need to be reassesssed, appropriate publishing of ATS delegation in areas involving FRA shall be fully considered.

(24) In line with the FRA Concept, FRA should preferably apply in the entire Area of Responsibility (AoR) of an ATC unit providing the service, including the areas where the ATS responsibility is delegated.

(25) In case of ATS delegation, FRA boundaries shall be either published in both State AIPs or a reference to the other State(s) AIP(s) is made.

(26) In the case where delegation of ATS is effective and where the ATC unit providing the service has implemented FRA in its AoR, but by agreement between the States/FABs/ANSPs concerned it is decided that FRA shall not apply in one (or more) delegated area(s), the operational boundaries of FRA shall be published in the AIPs of both States in ENR 2.2 (ref. sub-section 6.5.1).

**FRA Connecting Routes to/from terminal airspace and aerodromes**

(27) In the context of the FRA concept, access to/from terminal airspace and connection to/from aerodromes need to be considered. This may require definition of FRA connecting routes to facilitate flight planning, providing e.g. the route from FRA departure/arrival points to a published SID/STAR points at an aerodrome, or from/to an aerodrome within the TMA, which does not have SID/STAR.

(28) FRA connecting routes to/from terminal airspace should enable a continuous climb or descent profile wherever possible.

(29) For the publication of defined FRA connecting ATS routes, the AIP placeholder ENR 3.5 may be used, with a dedicated section named “FRA Connecting Routes”. This placeholder is appropriate for publishing the complete connecting route package for a terminal area.

(30) The description of established connecting routes shall be coherent with published FRA general procedures in ENR 1.3 and flight planning instructions for FRA published in ENR 1.10.

(31) Alternatively, the description of the FRA connecting routes can also be published together with details on flight procedures (AD 2.21 Flight procedures) for the aerodrome concern, if appropriate.

**FRA Significant Points in ENR 4.1 and ENR 4.4**

(32) FRA significant points will be published in national AIPs with a clear reference to the Free Route Airspace and to indicate the FRA relevance of the point.
As NAVAIDs can be used as a FRA significant point, the publication of appropriate FRA relevance shall be considered for publication also for en-route navigation aids.

Publication of FRA relevance on 5LNC and navigation aids - en-route falls under:

- ENR 4.1 Radio navigation aids - en-route; and
- ENR 4.4 Name-code designators for significant points.

Publication of FRA relevance shall be done either in the column “Remarks” or in added column named “FRA relevance” by an extension to the respective tables.

The FRA relevance of the significant points shall be indicated by the following letters and published within brackets:

- (E), for “FRA Horizontal Entry Point”
- (X), for “FRA Horizontal Exit Point”
- (I), for “FRA Intermediate Point”
- (A), for “FRA Arrival Connecting Point”
- (D), for “FRA Departure Connecting Point”

The FRA relevance indication letter/s shall be published within brackets as follows:

- FRA (...) - when publication is done in column “Remarks”;
- (...) - when publication is done in separate column.

Any unique combinations of letters can be published.

The fictitious AIP publication examples below are based on the ICAO Doc 10066 PANS-AIM, Appendix 2 on required information for ENR 4.1 and 4.4, and include adapted tables with the option to an additional column for information of FRA relevance.

The explanation of the letters indicating the FRA relevance may be published in textual format in conjunction to the ENR 4.1 and ENR 4.4 table (see examples below).

Examples:

ENR 4.1 Radio navigation aids - en-route

Legend for FRA relevance: (E) = “Horizontal Entry point”, (X) = “Horizontal Exit point”, (I) = Intermediate point”, (A) = “Arrival Connecting point”, (D) = “Departure Connecting point”.

<table>
<thead>
<tr>
<th>Name of station (VAR) (VOR: Declination)</th>
<th>ID</th>
<th>FREQ (CH)</th>
<th>Hours of operations</th>
<th>Coordinates</th>
<th>ELEV DME antenna (ft)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>AALBORG VOR (1°E 2008)</td>
<td>AAL</td>
<td>116.700MHZ</td>
<td>H24</td>
<td>570613N</td>
<td>DOC FL 500/100 NM</td>
<td>FRA (I)</td>
</tr>
<tr>
<td>KORSA VOR/DME (1°E 2008)</td>
<td>KOR</td>
<td>112.800MHZ</td>
<td>H24</td>
<td>552622N</td>
<td>DOC FL 500/80NM</td>
<td>FRA (A): EKCH, EKRR</td>
</tr>
</tbody>
</table>

Option of additional column for the FRA relevance information
### European Airspace Design Methodology Guidelines

#### European Route Network Improvement Plan - Part 1

<table>
<thead>
<tr>
<th>Name of station (VAR)</th>
<th>ID</th>
<th>FREQ (CH)</th>
<th>Hours of operations</th>
<th>Coordinates</th>
<th>ELEV DME antenna (ft)</th>
<th>FRA relevance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>AALBORG VOR (1°E 2008)</td>
<td>AAL</td>
<td>116.700MHZ</td>
<td>H24</td>
<td>570613N 0095944E</td>
<td>(I)</td>
<td>DOC FL 500/100 NM</td>
<td></td>
</tr>
<tr>
<td>KORSA VOR/DME (1°E 2008)</td>
<td>KOR</td>
<td>112.800MHZ</td>
<td>CH75Y</td>
<td>552622N 0113754N</td>
<td>136.2</td>
<td>(A)</td>
<td>DOC FL 500/80NM (A):EKCH, EKRK STAR EKCH and EKRK</td>
</tr>
</tbody>
</table>

**ENR 4.4 Name-code designator for significant points**

*Legend for FRA relevance: (E) = “Horizontal Entry point”, (X) = “Horizontal Exit point”, (I) = Intermediate point”, (A) = “Arrival Connecting point”, (D) = “Departure Connection point”.*

<table>
<thead>
<tr>
<th>Name-code designator</th>
<th>Coordinates</th>
<th>ATS route or other route</th>
<th>Remarks/Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIMAK</td>
<td>585036N 0272804E</td>
<td>N/A</td>
<td>FRA (D): ESSA; FRA (E): ODD FL for entering aircrafts</td>
</tr>
<tr>
<td>LOGNA</td>
<td>575035N 0213937E</td>
<td>M611, P31, Q33, Q141</td>
<td>FRA (I) FRA (A): ESSA</td>
</tr>
<tr>
<td>LURIG</td>
<td>553426N 0155935E</td>
<td>N/A</td>
<td>FRA (EX)</td>
</tr>
</tbody>
</table>

**Additional column added for FRA relevant information**

<table>
<thead>
<tr>
<th>Name-code designator</th>
<th>Coordinates</th>
<th>ATS route or other route</th>
<th>FRA relevance</th>
<th>Remarks/Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIMAK</td>
<td>585036N 0272804E</td>
<td>N/A</td>
<td>(DE)</td>
<td>(D): ESSA; (E): ODD FL for entering aircrafts</td>
</tr>
<tr>
<td>LOGNA</td>
<td>575035N 0213937E</td>
<td>M611, P31, Q33, Q141</td>
<td>(IA)</td>
<td>(A): ESSA</td>
</tr>
<tr>
<td>LURIG</td>
<td>553426N 0155935E</td>
<td>N/A</td>
<td>(EX)</td>
<td></td>
</tr>
<tr>
<td>NEGVA</td>
<td>690920N 0144854E</td>
<td>N3</td>
<td>(EX)</td>
<td>(I): FL175 - FL660 2300-0400 (2200-0300); (EX): ODD FL for entering aircraft, EVEN FL for exiting aircraft 0400-2300 (0300-2200).</td>
</tr>
</tbody>
</table>

(41) In case the ENR 4.4 significant point is dedicated to FRA only and not part of a specific ATS route, the corresponding information in column 3 should state “N/A” (Not Applicable).

(42) The States have to ensure publication of the FRA relevance on significant points on all appropriate AIP charts (see sub-section 6.5.3).

If and when required, specific information with respect to the FRA relevance of the significant points may be published. As specific information is considered:

- Vertical FL band in FRA relevance, if different inside the FRA area from general FRA vertical limits;
- FLOS over relevant FRA significant point;
- Aerodrome/s related to the appropriate FRA Arrival Connecting Point and/or FRA Departure Connecting Point.
- Different FRA relevance on the same significant point during defined time periods.
The specific information is published in the ENR 4.1 and ENR 4.4 column “Remarks”, as follows:

- When FRA relevance indicator are published in the Remarks column:
  - the specific information is published after the last bracket, separated by colon (\`).
  - When different specific information applies for one or more FRA relevance indicators, each indicator is published separately within brackets preceded by the word FRA, and thereafter the specific information.
- When FRA relevance indicators are published in a separate column:
  - the FRA relevance indicator/s is repeated within brackets, and the specific information is published after the bracket, separated by colon (\`).
  - When different specific information applies for one or more FRA relevance indicators, each FRA relevance indicator is published separately within brackets, and thereafter the specific information.
- Multiple values applicable for the same FRA relevance indicator are separated by comma (,).
- FRA relevance indicators with individual specific information are published on separate rows.
- Entries for different FRA relevance indicators are separated by semicolon (\;).
- Published information:
  - (A) (= arrival aerodromes) or (D) (= departing aerodromes) followed by relevant location indicator.
  - “FL” (= flight level) “BLW” (= below FL), “ABV” (= above FL) followed by applicable vertical limits and/or flight level/s.
  - “ODD FL” or “ODD FL for entering/existing aircrafts”, “EVEN FL” or “EVEN FL for entering/exiting aircrafts”.
  - HHmm-HHmm (HHmm-HHmm) = Defined time period of the FRA relevance. Times applicable during the summer period are published in bracket after the times published for the winter period. If winter period and summer period are the same during the whole year, no time is published in brackets.
<table>
<thead>
<tr>
<th>Application</th>
<th>Publication format and examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Association with aerodromes</td>
<td>If added column is used for FRA relevance</td>
</tr>
<tr>
<td>(AD) (A): LDZA; (D): LDLO or (AD): LDLO (if applied to both arrival and departure traffic)</td>
<td>FRA (A): LDZA</td>
</tr>
<tr>
<td>(AD) (AD): LDLO, LDZD</td>
<td>FRA (D): LDLO</td>
</tr>
<tr>
<td>Within defined vertical limits</td>
<td>FRA (I): 5500 FT AMSL - FL245; FRA (X): FL245 - FL660</td>
</tr>
<tr>
<td>(IX) (I): 5500 FT AMSL - FL245; (X): FL245 - FL660</td>
<td>FRA (I): FL175 - FL660</td>
</tr>
<tr>
<td>(I) (I): FL175 - FL660</td>
<td>FRA (I): FL175 - FL660</td>
</tr>
<tr>
<td>Below, above or at defined flight levels</td>
<td>FRA (E): BLW FL285; FRA (X): ABV FL285</td>
</tr>
<tr>
<td>(EX) (E): BLW FL285; (X): ABV FL285</td>
<td>FRA (I): ABV FL285</td>
</tr>
<tr>
<td>(I) (I): ABV FL285</td>
<td>FRA (E): ODD FL</td>
</tr>
<tr>
<td>(EX) (EX): BLW FL285</td>
<td>FRA (E): EVEN FL</td>
</tr>
<tr>
<td>(X) (X): FL320, FL380 only</td>
<td>FRA (EX): ODD FL for entering aircraft, EVEN FL for exiting aircraft</td>
</tr>
<tr>
<td>FL applicability (FLOS)</td>
<td>FRA (E): ODD and EVEN FL except FL320 and FL380</td>
</tr>
<tr>
<td>(EX) (E): ODD FL; (X): EVEN FL or (EX): ODD FL for entering aircraft, EVEN FL for exiting aircraft</td>
<td>FRA (E): EVEN FL</td>
</tr>
<tr>
<td>(E) (E): ODD and EVEN FL, except FL320 and FL380</td>
<td>FRA (E): EVEN FL</td>
</tr>
<tr>
<td>(E) (E): EVEN FL</td>
<td></td>
</tr>
<tr>
<td>Different FRA application during defined time period</td>
<td>FRA (I): FL175 - FL660 2300-0400 (2200-0300); FRA (E): ODD FL; FRA (X): EVEN FL 0400-2300 (0300-2200)</td>
</tr>
<tr>
<td>(IEX) (I): FL175 - FL660 2300-0400 (2200-0300); (E): ODD FL; (X): EVEN FL for exiting aircraft 0400-2300 (0300-2200)</td>
<td></td>
</tr>
</tbody>
</table>
Airspace reservations in ENR 5

(44) The following AIP sections are used for publication of information of Special Areas (SA):

- ENR 1.9 Air Traffic Flow Management and Airspace Management - to include general information on CDR and TSA/TRA.
- ENR 5.1 Prohibited, Restricted and Danger Areas.
- ENR 5.2 Military Exercise and Training Areas and Air Defence Identification Zone (ADIZ) shall be used for any “special use airspace” (CIV/MIL) including TSA/TRA specific information.

(45) There is the potential for airspace reservations to be reconfigured to meet different task needs and this will require updates to ENR 5.1 and ENR 5.2.

(46) AIP publication of 5LNC for Special Area for FRA purposes:

(47) When airspace reservations are not available for crossing, 5LNC will be defined to facilitate flight planning clear of the airspace reservation and ensure sufficient separation from the activity. The publication of these 5LNC shall be ensured in ENR 4.4 and utilisation rules shall be described in the RAD.

(48) If these points are to be used only for avoidance of airspace reservations, such flight planning limitations shall be clearly published in the RAD.

Notes:

1. Publication of the Special Areas (SA) and their availability times should be made available, in addition to national AIP publications, to EUROCONTROL/NM to ensure accurate information on their availability.

2. Information on airspace activations is published in AUP/UUP or by NOTAM (as a standard AIS procedure for AIS dynamic data publication, see ERNIP Part 3 - ASM Handbook) and handled through the Network Manager.

6.5.3 FRA - Charts Publication

(1) The chart types that can be affected by FRA implementation are En-route Charts and Aerodrome Charts as specified below.

ENR 6 En-route Charts

(2) Two alternatives are available:

- To embed the relevant information into the existing En-route charts. In case FRA vertical limit coincides with the LOWER/UPPER limits, States may recognise no need to publish a separate chart.

or

- If the FRA vertical limit does not coincide with the LOW/UPP limit - a new FRA dedicated En-route chart may need to be developed and published in the AIP as a new sub-section of ENR 6. EN-ROUTE CHARTS (ENR 6.x);
- This FRA chart will accompany the LOW/UPP En-route Chart(s).

(3) If the cross-border FRA implementation is encompassing multiple states, a new FRA dedicated En-route chart may be published as a new sub-section of ENR 6. ENROUTE CHARTS (ENR 6.x)

- This chart will encompass the total FRA boundary (perimeter) of the involved States.
The chart may exclude involved States FRA related significant points, to avoid clutter in the chart. For information on related significant points within, a reference to each individual States AIP is sufficient.

**Aerodrome Charts (SID/STAR and Area Charts)**

(4) In the context of the FRA Concept, the access to/from terminal airspace needs to be considered and appropriate refinements to TMA structures initiated, including the definition of additional SIDs/STARs to permit more flexibility.

(5) Updates and changes to Aerodrome Charts (ref. Doc 10066 PANS-AIM, Appendix 2, AD 2.24) may be needed if SIDs/STARs are extended, or for publishing connecting ATS routes. Therefore, FRA implementation may affect also the Area Chart - ICAO, if published by States.

○ Charts supporting FRA implementation in mountainous terrain - To be developed

**FRA Chart symbols**

(6) The examples are available in the Example 1 below.

a) FRA boundary in coincidence with FIR with on-request entry/exit point;

b) Independent FRA boundary with compulsory entry/exit point.

**Example 1**

![Image](image.png)

BUMAB (EX)

(7) The FRA relevance of a significant point shall be indicated by the following letters and published within brackets:

(E), for “FRA Horizontal Entry Point”;
(X), for “FRA Horizontal Exit Point”;
(I), for “FRA Intermediate Point”;
(A), for “FRA Arrival Connecting Point”;
(D), for “FRA Departure Connecting Point”.

(8) Any unique combinations of letters can be published.

Examples:

(EX) - Horizontal entry/exit point.
(XD) - Horizontal exit/departure connecting point.

(9) Letter(s) in the charting symbol are not viable options as might be unreadable on the charts. Suggestion is made to add FRA related information in the label like in the example above.

(10) Based on the best practice applied by EUROCONTROL ERC/ERN Charts and in cooperation with charting experts, green colour is suggested.

(11) These proposals have been developed to comply with ICAO Annex 4, Appendix 2:
Conformity with ICAO symbols 121 (Annex 4, Appendix 2-18); and green colour suggested for FRA related points;

Conformity with ICAO airspace classifications 126 (Annex 4, Appendix 2-19); and green colour for FRA related boundary.

6.5.4 FRA Glossary of terms

- **Aeronautical data** (ICAO Annex 15 Aeronautical Information Services)
  A representation of aeronautical facts, concepts or instructions in a formalized manner suitable for communication, interpretation or processing.

- **Aeronautical information** (ICAO Annex 15 Aeronautical Information Services)
  Information resulting from the assembly, analysis and formatting of aeronautical data.

- **Aeronautical Information Publication (AIP)** (ICAO Annex 15 Aeronautical Information Services)
  A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

- **Area navigation route** (ICAO Annex 11, Doc 4444 PANS-ATM).
  An ATS route established for the use of aircraft capable of employing area navigation.

- **ATS route** (ICAO Annex 2, Annex 11, Doc 4444 PANS-ATM)
  A specified route designed for channelling the flow of traffic as necessary for the provision of air traffic services.

  *Note 1.* - The term “ATS route” is used to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure route, etc.

  *Note 2.* - An ATS route is defined by route specifications which include an ATS route designator, the track to or from significant points (waypoints), distance between significant points, reporting requirements and, as determined by the appropriate ATS authority, the lowest safe altitude.

- **Cross-border FRA**
  A specified Free Route Airspace that comprises part and/or the whole areas of responsibility of at least two adjacent ATC units (e.g. ACCs, UACs, etc.) or FRA areas where common procedures are applied regardless of national and/or operational boundaries.

- **DCT** (Doc 8400 PANS-ABC, ICAO Abbreviations and Codes)
  Direct (in relation to flight plan clearances and type of approach)

  Decoded abbreviation/indicator DCT (Direct) or Encoded abbreviation/indicator Direct (DCT) should be used only:

  - for flight planning purposes when submitting FPL;
  - when executing specified type of approach.

- **Free Route Airspace (FRA)**
  A specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control.
FRA Arrival Connecting Point (A)
A published Significant Point to which FRA operations are allowed for arriving traffic to specific aerodromes. The FRA relevance of such points shall be included in ENR 4.1/4.4 columns as (A). Indications on their use for arrivals to specific aerodromes shall be notified via the RAD.

FRA Departure Connecting Point (D)
A published Significant Point from which FRA operations are allowed for departing traffic from specific aerodromes. The FRA relevance of such points shall be included in ENR 4.1/4.4 columns as (D). Indications on their use for departures from specific aerodromes shall be notified via the RAD.

FRA Horizontal Entry Point (E)
A published Significant Point on the horizontal boundary of the Free Route Airspace from which FRA operations are allowed. The FRA relevance of such points shall be included in ENR 4.1/4.4 columns as (E). If this point has specific conditions of utilization, this shall be described in the RAD.

FRA Horizontal Exit Point (X)
A published Significant Point on the horizontal boundary of the Free Route Airspace to which FRA operations are allowed. The FRA relevance of such points shall be included in ENR 4.1/4.4 columns as (X). If this point has specific conditions of utilization, this shall be described in the RAD.

FRA Intermediate Point (I)
A published Significant Point or unpublished point, defined by geographical coordinates or by bearing and distance via which FRA operations are allowed. If published, the FRA relevance of such points shall be included in ENR 4.1/4.4 columns as (I). If this point has specific conditions of utilization, this shall be described in the RAD.

Route Availability Document (RAD)
A common reference document containing the policies, procedures and description for route and traffic orientation. It includes route network and free route airspace utilisation rules and availability.

Significant Point (ICAO Annex 11 Air Traffic Services)
A specified geographical location used in defining an ATS route or the flight path of an aircraft and for other navigational and ATS purposes.

Note: There are three categories of significant points: ground-based navigation aid, intersection and waypoint. In the context of this definition, intersection is a significant point expressed as radials, bearings and/or distances from ground-based navigation aids.

Special areas (SA)
“Airspace reservation” refers to airspace of defined dimensions for the exclusive use of specific users. These are special designed areas within which both civil and military activities could take place, including CBA, TRA, TSA, D, R, P and any specially activated areas.

Way Point (ICAO Annex 11 Air Traffic Services)
A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Waypoints are identified as either:

- Fly-by waypoint (ICAO Doc 8168 PANS-OPS Volume II) A waypoint which requires turn anticipation to allow tangential interception of the next segment of a route or procedure, or
- **Flyover waypoint (ICAO Doc 8168 PANS-OPS Volume II)** A waypoint at which a turn is initiated in order to join the next segment of a route or procedure.
ENR 1.3 INSTRUMENT FLIGHT RULES

1. Rules applicable to all IFR flights
   ...

2. Rules applicable to IFR flights within controlled airspace
   ...

3. Rules applicable to IFR flights outside controlled airspace
   ...

4. Free Route Airspace general procedures

4.1 Area of application

E.g. “FRA procedures are available in Amswell FIR above FL245. If applicable specify airspace where provision of service is delegated to another ANSP. For further details see ENR 2.2. and ENR Charts.”

4.2 Flight Procedures

4.2.1 General

E.g. “Traffic will be subject to General Rules (ENR 1.1), RAD and Letters of Agreement (LoA) between neighbouring ACCs.”

E.g. “Within FRA users will be able to plan user-preferred trajectories through the use of significant points included in AIP … (State) ENR 4.4 Name-code designators for significant points and ENR 4.1 Radio navigation aids - en-route, respectively. Segments between significant points will be indicated by means of “DCT” instructions.”

DCT usage / limitations

E.g. “Within the FRA area there will be no limitations on the use of “DCT”.

4.2.2 Overflying traffic

E.g. “Overflying traffic should plan directly from Amswell FIR entry point to the Amswell FIR exit point.”

4.2.3 Access to/from Terminal Airspace

E.g. “Arriving traffic should plan directly from Amswell FIR entry point to the FRA Arrival Connecting Point (A) / STAR initial waypoint.”

E.g. “Departing traffic should plan directly from FRA Departure Connecting Point (D) / SID final point to the Amswell FIR exit point.”

Flight planning within the FRA area will comply with adjacent ATS route network orientation.

E.g. “For southbound traffic via NELSO connecting to UN741, ODD and EVEN levels are available 50 NM prior arriving NELSO waypoint.”

4.2.4 Cross-Border Application

Cross-border - DCT - (NOT) allowed.

Describe the exception of the segments as applicable.

E.g. “Airspace users will have to plan their trajectory inside FRA in Amswell FIR through the use of the intermediate significant points.”
e.g. “Intermediate waypoint NARTA suggested for traffic passing through Denham FIR / UIR.”

e.g. “Exceptional cross-border DCT segments allowed are:
RALUS DCT ALAGU
RALUS DCT AMSSEL
BABEX DCT ALAGU
BABEX DCT AMSSEL
BABEX DCT OSLAD”

4.3 Airspace Reservation - Special Areas

4.3.1 Re-routing Special Areas

e.g. “AOs will plan their trajectory inside FRA disregarding all segregated airspace. In case there is no availability to cross segregated areas,”

or

e.g. “AOs will plan their trajectory around segregated airspace, when not available for civil operations, by using the 5LNC published for this purpose in ENR 4.4.”

4.3.2 Promulgation of route extension

e.g. “In case there is no availability to cross the segregated area, it is expected that the average flight extension to be considered by aircraft operators is approximately 5NM; in exceptional occasions 15NM. However, in most of the cases radar vectors shall be provided by ATC.”

4.4 Additional FRA Procedures

e.g. “For speed and level changes inside FRA in Amswell FIR on flight plan Item 15, additionally to a significant point and only for this purpose, aircraft operators may also use geographical coordinates.”

e.g. “In terms of flight planning, Item 15, flight levels (FLs) within Amswell FIR FRA area will respect the table of cruising levels included in ENR 1.7, with the exception of waypoint RIVRO. By Letter of Agreement, traffic intending to enter Amswell FIR via RIVRO must enter at ODD FLs and traffic intending to exit Amswell FIR via RIVRO must exit at EVEN FLs.”

4.5 Route Availability Document (if required)
ENR 2.2 OTHER REGULATED AIRSPACE

1. General

... 

2. The area involved in the transfer of ATS responsibility

... 

3. Contingency planning in Broxby ACC (conflict free allocation scheme)

3.1 General
The …… (State) Air Traffic Services Contingency Planning is based on strict operating criteria. Its method, structure and applicability are universal and based on the consequences of technical or catastrophic failure that may occur in the Air Navigation System. It contains material dealing with planning for TMAs and En-Route contingencies.

Whenever a contingency occurs, the Network Manager and …… ACCs will be informed accordingly.

The Conflict Free FL allocation Scheme structure will apply to all Scenarios.

3.2 Types of Contingency

3.2.1 Scenarios for Contingency and Capacities:

Scenario 1:
...

Scenario 2:
...
6.5.6 FRA Check List of Implementation Actions

**General Checklist of Actions**

1. The presented check list of implementation actions applies to the new FRA projects.

*Note: The checklist of implementation actions is also applicable to other major airspace changes.*

<table>
<thead>
<tr>
<th>Ref</th>
<th>Topic</th>
<th>Description</th>
<th>Rationale</th>
<th>Responsible / Involved</th>
<th>Deadline</th>
</tr>
</thead>
</table>
| 1.  | Local FRA CONOPS discussed with NM to ensure harmonised network FRA implementation | • General scope;  
• 4D description of the FRA volume;  
• Cross-Border impacts;  
• Enablers and constraints;  
• Impact on ATM (ATS / ASM / ATFCM) Procedures;  
• Impact on flight planning procedures;  
• Impact on Publication;  
• Impact on local / AO / CFSP / NM systems;  
• Identification of benefits. | To ensure network harmonised FRA implementation | ANSP(s) / NM | T0 - (24 - 30) months depending on the expected impact of the change; input concerning the implementation plan from ERNIP Part 2. |
| 2.  | Airspace Design | • Establish the airspace volume (horizontal and vertical limits);  
• Horizontal connectivity E/X points;  
• Vertical connectivity A/D points;  
• Connecting routes;  
• RAD restrictions;  
• Use of geographical coordinates as Intermediate (I) points;  
• Usage of Intermediate (I) points;  
• Airspace reservations;  
• Flight Plan Buffer Zones (FBZs);  
• No Planning Zones (NPZs);  
• ATS delegation;  
• Sector design;  
• Optimised CCO / CDO. | To ensure interconnectivity and interoperability with adjacent horizontal and vertical airspace and to ensure optimised vertical flight efficiency | ANSP(s) / NM / Military / AOs | T0 - 12 months |
| 3.  | Airspace Management Process | • Priority Rules;  
• CDM requirements;  
• Utilisation of AUP / UUP;  
• Information Sharing;  
• Rerouting;  
• OAT Handling. | To ensure seamless network application of ASM/FUA procedures | ANSP(s) / NM / Military | T0 - 12 months |
| 4.  | ATC Procedures and Letters of Agreement | • Definition of all required procedures internally and with neighbouring ATC units. | To ensure appropriate interconnectivity | ANSPs | T0 - 6 months |
| 5.  | Air traffic flow and capacity management | • Sector Configuration Management  
• Sector and Traffic Volumes (Capacities / Monitoring Values);  
• Re-routing Proposals;  
• ATFCM Procedures. | To ensure seamless network application of ATFCM procedures | ANSP(s) / NM | T0 - 6 months |
| 6.  | CAA / NSA Involvement | • Consultation with CAA / NSA / Military;  
• Safety case;  
• Mitigating actions (if required).  
• Prepare and send to ICAO PIA if implementation over High Seas;  
• Approval by CAA / NSA. | To ensure safe implementation and fulfilment of all regulatory requirements | ANSPs / CAA / NSAs / Military | T0 - 9 months |
| 7.  | Awareness and consultation | • CONOPS.  
• Airspace design and airspace management.  
• ATC Procedures and Letters of Agreement. | To ensure network harmonised FRA implementation | ANSPs / NM through the NM CDM process to all operational | T0 - (12 - 18) months |

(1) Note: The checklist of implementation actions is also applicable to other major airspace changes.
<table>
<thead>
<tr>
<th>Ref</th>
<th>Topic</th>
<th>Description</th>
<th>Rationale</th>
<th>Responsible / Involved</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>AIS / RAD Publication</td>
<td>• AIC Publication.</td>
<td>To ensure network harmonised FRA implementation</td>
<td>ANSPs / NM</td>
<td>T0 - (6 - 12) months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• AIP Publication.</td>
<td></td>
<td>ANSPs</td>
<td>2 AIRAC cycles</td>
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<tr>
<td></td>
<td></td>
<td>• RAD.</td>
<td></td>
<td>ANSPs / NM</td>
<td>T0 - (6 - 12) months</td>
</tr>
<tr>
<td>9.</td>
<td>NM Integration / Pre-validation Check</td>
<td>As described below in NM pre-validation Checklist of Actions.</td>
<td>To ensure network harmonised implementation</td>
<td>ANSPs / NM / AOs / CFSPs</td>
<td>T0 - 6 months</td>
</tr>
<tr>
<td>10.</td>
<td>Implementation</td>
<td>• FRA Project Implementation.</td>
<td>To ensure network harmonised FRA implementation</td>
<td>ANSPs / NM / AOs / CFSPs / Military</td>
<td>T0</td>
</tr>
<tr>
<td>11.</td>
<td>POST implementation</td>
<td>• Lessons Learnt.</td>
<td>To ensure network harmonised FRA implementation</td>
<td>ANSPs / NM / AOs / CFSPs / Military</td>
<td>T0 + (1 - 2) AIRAC cycles</td>
</tr>
<tr>
<td>12.</td>
<td>Fine-tuning of implementation</td>
<td>• Implementation of further changes depending on lessons learnt.</td>
<td>To ensure network harmonised FRA implementation</td>
<td>ANSPs / NM / AOs / CFSPs / Military</td>
<td>T0 - (1 - 6) AIRAC cycles</td>
</tr>
</tbody>
</table>

**NM Pre-validation Checklist of Actions**

**STEP 1**

Operational validation with NM (Operations Planning and Network Operations) should start at least 6 AIRAC cycles prior to the implementation date. The States/FABs/ANSPs shall include in the validation, inter alia:

- Airspace organisation;
- Procedures;
- Restrictions (Pan-European Annex and Appendices - Including city pair level capping, En-route and Airfield DCT limits, Flight Profile Restrictions);
- Flight planning aspects;
- Description of military airspace and civil/military procedures.

**STEP 2**

Include neighbours in the operational validation, at least 5 AIRAC cycles prior to the implementation date. The States/FABs/ANSPs shall include in the validation, inter alia:

- Airspace organisation - transfer points;
- Procedures - Letters of agreement;
- Restrictions (Pan-European and Appendices - Including city pair level capping, En-route and Airfield DCT limits, Flight Profile Restrictions);
- Flight planning aspects;
- Description of military airspace and civil/military procedures at interfaces.

**STEP 3**

For the purpose of the validation with NM (Operations Planning and Network Operations) and neighbours, it is desirable that draft AIS publications are already available and include information on:

**Characteristics of a FRA published in AIP (eventually promulgated by AIC)**

**Lateral Limits:** have to be the ones of an ATC Unit Airspace (AUA) (CTA, TMA …) or a group of them;

**Vertical Limits:** can be implicit (FRA is available at all levels within the AUA) or a subset of them (Vertical band);
FRA Horizontal Entry/Exit Points;

FRA Departure/Arrival Connecting Points (if any);

FRA Intermediate Points: either none allowed, or all allowed, or only via specific points;

Applicable time: not necessarily H24.
(These characteristics and definitions are implemented in CACD via the Restrictions model. A new type of DCT restriction is created - FRA DCT Restriction)

Military airspace: Description of military areas and of the procedures to be followed in case of active/non-active areas.

Ensure that NM has all the information and that this information continues to be delivered post implementation.

STEP 4

Following validation of all data, there might be a need to change some of the publication data and information. Such changes should be operated in such a way that the final AIS publication is made at least 2 AIRAC cycles prior to implementation. The publication shall be made by using the templates developed to that purpose in the ERNIP Part 1. Publicity towards AOs must be also ensured.
6.6 Navigation Specification

6.6.1 Introduction

(1) As the en-route design often involves route realignments, to maintain sensor-specific routes and procedures would be inflexible and costly. To overcome the constraining elements, reflected through the inflexibility of route alignments often caused by a current conventional navigation infrastructure, other navigation solutions should be considered. The performance based navigation, may pose either as a strong enabler, or as one of the navigation assumptions, for the airspace design solutions.

6.6.2 Navigation specifications options

(1) The navigation specification presents a set of aircraft and crew requirements needed to support performance based navigation operations within a defined airspace.

(2) Depending on the type of airspace, and possibly to accommodate closer route spacing, adequate navigation enablers are proposed referring to airborne navigation equipment and the Navigation Specifications prescribing their performance.

(3) Once it is established that a certain sub-set of navigation functionalities are needed to enable an Airspace Concept and that the fleet is appropriately capable, what remains is to select a navigation specification from ICAO Doc 9613 PBN Manual that matches, in terms of navigation performance, the ones required for the Airspace Concept.

(4) Selecting navigation specification is a simple step if preceding airspace design phases have been done in an integrated manner. Assumptions identification has to be done carefully when it comes to fleet analysis whilst giving due consideration to an ICAO Navigation Specification. This match could be difficult to achieve because it is seldom cost effective to select a navigation specification that would require a significant proportion of fleet to retrofit RNAV systems to provide specific functionality.

(5) The Navigation Specification can be either RNAV or RNP. The difference between the two is that RNP specification includes a requirement for on-board, self-contained, equipment for performance monitoring and alerting.

6.6.3 Navigation functional requirements

(1) Both specifications, RNAV and RNP, include requirements for certain navigation functionalities that should be taken into account when airspace design proposals are developed. Some of the functionalities associated to a navigation specification may influence not only route spacing and separation minima, but also the airspace concept as such. When proposing airspace design solutions, one should take into account the following set of navigation functionalities, as a minimum:

- continuous indication of aircraft position relative to track to be displayed to a pilot flying, on a navigation display;
- display of distance and bearing to the active (To) waypoint;
- display of ground speed or time to the active (To) waypoint;
• navigation data storage;
• appropriate failure indication of the RNAV system.

(2) A strategic objective concerning the airspace improvements will allocate requirements to various system components, such as communication, navigation, ATS surveillance, air traffic management and flight operations. Navigation functional requirements, in the context of performance-based navigation, need to be identified.

**Requirements determination**

(3) The process should start from the airspace users’ needs and consequently airspace requirements. When it comes to determining airspace users’ requirements, a balance amongst overall safety, capacity and efficiency should be established. Trade-offs between competing requirements will have to be made.

(4) An important step towards the determination of the users’ and airspace requirements should be assessment of aircraft fleet capability. Namely, owing to the fact that some five generations of aircraft may be simultaneously using the airspace in question, the proposed airspace solutions should accommodate them all.

(5) It is important to know the characteristics and level of equipage of the fleet operating in the airspace. Several characteristics to be observed are listed hereafter:

• aircraft equipped with GNSS capability;
• failure of GNSS could be mitigated by other means of navigation (DME based RNAV, conventional navigation, ATS surveillance);
• IFR approved aircraft carry VOR and DME integrated into RNAV system;
• extent of need for aircraft inertial systems to cover potential NAVAIDs signal gaps.

(6) Handling traffic with mixed navigation equipage, depending on the level of mixed equipment and operations, adversely affect capacity of the airspace and place additional workload on controllers.

(7) NAVAID infrastructure assessment is also an important step since the majority of current route network is supported by ground-based NAVAIDs. Nevertheless, the use of RNAV is expanding allowing operators to take advantage of on-board systems.

(8) A full transition to RNAV-based en-route should be considered. However, it may take years for GNSS to be used by a significant majority of operators, so ground-based NAVAIDs should be considered as an alternative input to RNAV systems, as a support to reversionary conventional navigation or even to use them for the provision of conventional navigation environment for non-RNAV-equipped users.

(9) The following should be taken into account when assessing NAVAID infrastructure for the given airspace:

• rate at which operators using the airspace in question, equip with GNSS-capable avionics;
• extent of the requirement to retain some ground NAVAIDs for operators not equipped with GNSS, or as a back-up to GNSS;
the existing NAVAID infrastructure and its age.

Implementation of RNAV applications must not be a cause for installing new NAVAID infrastructure. RNAV applications should ideally result in moving some of the existing infrastructure (DMEs removed from VORs, etc.).
6.7 Flight Procedures

6.7.1 Terrain and Obstacle Clearance

(1) The design principles addressed in this document refer to the conceptual design of the Airspace structures (routes, holds, ATC sectorisation etc.). PANS-OPS addresses the final stage of this design process by assuring the desired structures are clear of obstacles considering the criteria in ICAO Doc 8168 PANS-OPS.

(2) The details of Flight Procedure design in accordance with obstacle clearance criteria are outside the scope of this document. For details on the safe design of procedures with respect to terrain and obstacle clearance, refer to ICAO Doc 8168 PANS-OPS and consult a qualified PANS-OPS designer.

(3) In logical steps, PANS-OPS design is done after the conceptual design, assessment of the design concept, assessment of the design validation and the implementation planning. For En-route applications, PANS-OPS criteria are generally not as restrictive as in Terminal Airspace because of the higher altitudes of the route segments.
6.8 Sectorisation

6.8.1 Introduction

(1) Many of the constraints in the European airspace are caused by less than optimum sectorisation and/or inadequate sector capacities. The achievement of optimum sector capacity is a crucial objective if delays are to be minimised and sector overloads avoided.

(2) A number of studies and analyses have been carried out in Europe, and have identified the close relationship between sectorisation and route network configuration. This relationship must be taken into consideration for planning the improvement of the European ATM network.

(3) To achieve optimum capacity and flight efficiency, it is essential to ensure full coherency of all the airspace structure’s elements, including the way it is used, specifically:
   - the fixed ATS route network;
   - areas of free route airspace;
   - terminal airspace;
   - other airspace structures such as segregated airspace;
   - ATC sectorisation and sector configurations; and
   - the associated modus operandi.

6.8.2 Developing Sectorisation

(1) Air traffic control is based on sector structures. Sectorisation subdivides the airspace into manageable areas, for which throughput and capacity can be quantified.

(2) The main constraints on ATM capacity are airspace limitations and controller workload. By reorganising existing sectors or providing additional sectors, one can reduce the number of routes/crossing points (conflicts) and the number of aircraft on the frequency at any time. This results in a reduction of workload and can enable an improved sector productivity, while maintaining at the same time a balanced coordination workload (e.g. through the use of improved/automated coordination procedures).

(3) The sub-division of the airspace into smaller and smaller sectors is a finite strategy and a point is reached when the benefit of further reduction is outweighed by other factors, particularly the corresponding increase in coordination tasks: the increase of capacity is not proportional to the number of sectors available (law of diminishing returns). In addition, the creation of additional sectors has a high financial cost, particularly in terms of controllers but also in terms of infrastructure and software - therefore less costly options should always be explored first, for example, by improving the productivity of existing sectors.

(4) For a major airspace reorganisation project, the definition of supporting sectorisation would normally be made as follows:
   - Determine the maximum number of operational sectors, taking into account staff and infrastructure availability and system capability.
• Define optimum sector configurations for known variations in traffic flows (e.g. morning v evening, week v. weekend), based on the principles outlined in this chapter.

• Define the boundaries of individual operational ATC sectors.

• Define the elementary airspace blocks to enable the required modular sectorisation and sector configurations.

• If required (e.g. for an ACC with many sectors), define a number of sector groups (taking into account controller validations and working roster, operation of collapsed sectors during off-peak periods, frequency management etc.).

### 6.8.3 General Principles for Sector Development:

1. The following principles for the establishment, modification and validation of en-route and terminal sectorisation should be followed.

2. Sectorisation should be:
   - based on operational requirements;
   - planned in coordination with neighbouring ACC/FAB;
   - evaluated at European ATM Network level;
   - drawn up independent of FIR or national boundaries;
   - operationally efficient, i.e. maximise ATM capacity while accommodating user demand;
   - consistent with the evolution of the route network;
   - consistent with the airspace utilisation (CDR availability / routeing scenarios);
   - sufficiently flexible to respond to varying traffic demand and to temporary changes in traffic flows (morning, evening, week, week-end traffic), for example:

   Different combinations of airspace blocks and/or sectors to balance varying demands

```
S_1
\[S_1\times 2\]
S_2
\[S_2\times 3\]
S_3
```

the reconfiguration of sector boundaries through use of air blocks to match prevailing traffic flows

```
S_1 \text{ or } S_1 \text{ minus } A
\[A\]
\[S_2 \text{ or } S_2 \text{ plus } A\]
```

• constructed to ensure operational and procedural continuity across national borders;

• designed to take into account military requirements and those of other
airspace users;
- configured to ensure optimum utilisation of the ATS route network (balanced load on the sectors);
- configured to minimise coordination workload;
- designed, where appropriate, based on specialisation of task according to the nature of traffic;
- designed, in general, to be laterally larger for high level sectors than the underlying lower sectors - low level sectors are normally more complex with more evolving traffic;
- designed according to the following factors:
  - traffic volume/density including latest data and forecasts;
  - traffic complexity;
  - nature of traffic (en-route, climbing or descending traffic);
  - ATC system capability;
  - Interface with adjacent airspace.

6.8.4 Specific Principles for Sector Capacity Enhancement:

(1) Increasing sector productivity through a reduction in controller workload can be achieved in a number of ways, e.g. by reducing the complexity of the airspace structure, resulting in a more balanced distribution of traffic and balancing controller workload within different sectors.

**Organisation of traffic flows**

- keep the number of ATS routes controlled by a sector to a minimum;
- specialisation of routes (dualised routes/strategic deconfliction of ARR/DEP routes):

- deconfliction of traffic flows (elimination of unnecessary crossovers)
• organisation of traffic flows (segregation of main traffic flows):

![Diagram showing current situation and possible solution for traffic flows.]

• appropriate relocation of crossing points where possible:

![Diagram showing current situation and possible solution for traffic flows.]

The use of 'balconies' to allow for direct coordination between upper adjacent lower sectors (including cross border). In example below the left-hand diagram indicates a lateral view of a simplified four sector boundary. The ideal descent profile creates unnecessary coordination for sector S1 that would be resolved by introducing level constraints, indicated by the dashed line. However, by creating a balcony, as shown in the right hand diagram, the coordination could be made directly between S2 and S3.

![Diagram showing ideal and probable flight profiles with sector boundaries.]

Conflict Points:
• limit the number of conflict points in the same sector involving major traffic flows;
• rationalise crossing points where possible;
• avoid to have different sectors feeding the same sector with converging traffic requiring separation (two coordination tasks for the receiving sector);

• avoid to have conflict points close to the boundary of a sector for entering traffic (increasing workload because of excessive coordination/insufficient anticipation time).

Sector Function
• the number of different functions (arrival, departure, en-route) carried out by one sector should be minimised;
• ‘Flight Level Allocation’ procedures should be considered and the optimum system applied.

Sector Size
• Sector dimension should:
  o be small enough to accommodate sector functions;
  o provide a balanced workload;
  o allow, as far as possible, one dedicated function;
  o allow reasonable transit time and manageable instantaneous loads;
  o be big enough to allow sufficient anticipation and resolution of conflicts with minimum coordination;
  o allow the establishment of holding patterns with minimum coordination.
• The optimum size of each sector will vary - low traffic density and complexity allows bigger sectors, but as density and complexity increase, smaller sectors are needed.
Sector Shape

Sectorisation should:

- be based on operational requirements rather than national boundaries;
- promote overall system flexibility (combining/splitting of sectors as needed);
- reduce coordination/workload and facilitate radar hand-over;
- avoid to have too short a transit time within one sector, either by adjusting the sector boundaries or delegating Air Traffic Services (ATS) in the airspace concerned;

Double coordination

Air traffic services (ATS) delegation from S4 to S3

- be aligned according to main traffic flows;
- take into account the ideal profile and performance of aircraft;

Aircraft constraint

ATS delegation from S4 to S2

Same ACC or different

NO

YES

双重协调

航空交通服务 (ATS) 从 S4 到 S3

- 与主要交通流量对齐；
- 考虑到飞机的理想剖面和性能；

航空交通服务 (ATS) 从 S4 到 S2

相同 ACC 或不同

NO

YES
- promote overall system flexibility in support of fuel-efficient direct routes;
- have varying division levels/level splits to accommodate local traffic patterns and aircraft performance (a "standard" division FL between Upper and Lower Airspace has been identified to be a constraint);
- define horizontal sector splits, if overflying traffic is dominant (sector slices);
- define geographical sector splits, if climbing and/or descending traffic is dominant.

**Application of principles**

(2) With regard to the all of the foregoing principles, local requirements will dictate their appropriateness or otherwise. Airspace planners must ensure that the application of any of the criteria or the solution of a local problem does not adversely affect adjacent airspace, nor the overall capacity of the network as a whole.

**Sector Groups**

(3) A sector group is a group of operational sectors that strongly interact with each other through close and complex coordination that can be combined into variable configurations.
General Criteria for determining Sector Groups

(4) The notion of areas of weak and strong interaction may help to define the boundaries. Areas of strong interaction are likely to occur in airspace where the ATC task is more complex due to one or more influencing factors including; high traffic density, nature of traffic, number of conflict or crossing points, airspace restrictions. Areas of weak interaction would occur in airspace where there are fewer conflicts, traffic is in stable flight and the ATC task less complex.

(5) The definition of Sector Groups must be based on an optimised route network and supporting sectorisation, integrating direct routes, multiple route options and associated alternatives. It must also take full account of military operational requirements.

(6) Particular emphasis should be given to the efficient connectivity with terminal airspace.

(7) Sector groups should contain elementary sectors with strong/complex interaction that necessitate close coordination between controllers. The criteria to define Sector Groups are a combination of traffic density, nature of traffic (climbing/descending) and route topology (crossing flows, close crossing points). Within a Sector Group, several different combinations of sectors (sector configurations) are possible, depending on traffic flows.

(8) Weak interaction between sector groups will identify the zones of reduced complexity, where there are fewer conflicting flows and less evolving traffic. In areas of high traffic density and high complexity where there is no obvious area of weak interaction, it might be necessary to artificially create these zones to permit the definition of a Sector Group where appropriate (as is often done at the FIR borders, to facilitate inter-centre coordination).

Specific Criteria for the establishment of Sector groups

- The borders of sector groups should be based on operational requirements and need not coincide vertically.
- Sector Groups should be designed to enable sufficient distance for conflict resolution in all routing options.
- Traffic profiles should be of a similar nature as far as possible. (evolving, in level flight etc.).
- It is not an essential requirement to envelop segregated airspace within one Sector Group. However, the primary route and the alternate option should, in general, be contained within the same Sector Group to capitalise on the potential for flexible re-routing.
• The Sector Group should be configured to contain the traffic for sufficient time to be operationally practical.
• The Sector Group should be configured to allow for flexible sector configuration.
• Conflict points situated in close proximity to each other should be contained in the same Sector Group but ideally not in the same sector.
• A Sector Group should have an operationally manageable number of sectors, likely to be 4/6 sectors in the congested areas and 6/8 sectors in the other areas.
• Similarly Average time flown within a Sector Group should not be too excessive to fit the general criteria on optimal numbers of sectors.
• Vertical limits of the sector groups will vary according to their location and to the type of traffic contained within.

6.8.5 Increasing Sector Capacity and Efficiency

(1) An increase in network capacity can be achieved through sectorisation in three ways - by increasing individual sector throughput, by optimising network utilisation through dynamic sector management, and by increasing the number of sectors open at a particular time.

**Increase sector throughput**

(2) Enhance existing sector productivity, by increasing the monitoring value without additional changes, i.e. allow more aircraft per hour into the same airspace volume without application of ATFM regulations.

Enablers:
• Improved civil military coordination and full implementation of FUA;
• Improved controller confidence in ATF(C)M (through increased reliability), allowing removal or reduction of declared sector capacity ‘buffer’;
• Reduction in controller workload through:
  o reduced complexity through airspace structure development (dualisation of routes, reduction in conflict points, more balanced workload).
• implementation of best practice procedures (reduced coordination, increased efficiency);
• enhanced system support (e.g. automated support for exchanging coordination data, conflict detection, air/ground data link, ground based safety nets);
• Application of a structured contingency plan and controller training programme (to allow increased sector throughput during contingency situations). Simulation facility necessary.

(3) Restructure a group of congested sectors allowing higher sector throughput by reorganising an existing group of sectors to optimise the airspace structure; thus retaining the same overall number of sectors, but with generally higher declared sector capacities.
(4) **Enablers:**
- Airspace structure development (planning, design, computer modelling, fast- and/or real time simulation);
- Dedicated operational planning staff;
- Release of active controllers to participate in simulations.

(5) Increasing sector capacities or monitoring values requires the full support and involvement of the Air Traffic Control team. The Network Manager Operations Planning unit can provide expert and technical support for airspace design and sector capacity evaluation. The Capacity Analyser (CAPAN) fast time simulator can be used to assess sector capacities for current or planned airspace structures.

**Optimise network utilisation through dynamic sector management**

(6) Optimisation of available capacity through dynamic management of the sectorisation to accommodate different traffic flows will ensure that capacity is available where and when it is needed. Traffic flows can change very quickly, so a flexible, dynamic ATM system and a proactive flow manager are essential.

(7) **Enablers:**
- Improved traffic predictability (ETFMS, ATFCM);
- System support for dynamic sectorisation;
- Flexible configuration management;
- Proactive flow manager;
- Enhanced ASM - improved FUA;
- Controller flexible rostering;
- Controller multi-sector endorsements.

(8) Dynamic, flexible sectorisation is key to an optimum use of the airspace. With the above enablers in place, the design of dynamic sectorisation begins with the creation of elementary airspace blocks that can be combined and recombined in various ways to accommodate diverse traffic flows (morning/evening, peak/off-peak, week/weekend, summer/winter).

(9) An elementary airspace block may or may not be the same airspace volume as one of the operational ATC sectors. ACCs that effectively use dynamic sectorisation usually define a higher number of elementary blocks, providing maximum flexibility in the number and configuration of the operational sectors. In most cases, the geographical dimensions are the same but a high number of vertical splits are defined, allowing the division flight level of the operational sectors to be adapted according to the demand, and balance controller workload.

**Increase number of sectors open**

(10) Extend sector opening times (when delays occur outside peak period).

(11) **Enablers:**
- Controllers

(12) Flexible staff rostering - controllers available when needed
(13) Create additional sectors (when delays occur during peak period). When delays occur during maximum configuration because existing sectors or sector groups become congested, the creation of additional sectors should be considered.

(14) Enablers:

- Operational planning staff;
- Airspace structure development (computer modelling, simulation);
- Additional controllers;
- Infrastructure (sector suites, system hardware);
- System capability and support (software);
- Available frequency with required coverage and protection.

6.8.6 Identification of Control Sector

(1) Control sectors (elementary and/or collapsed) identifiers are required in order to maintain interoperability of different systems, including the Network Manager Operations Systems and data that need to be made available to the Network Manager.

(2) A Control sector shall be identified in accordance with provisions in ERNIP Part 1, Annex E.
6.9 Other Airspace Structures

6.9.1 No Planning Zone

(1) In order to avoid short crossing of multiple ATC airspaces and to manage ATC operationally sensitive areas, relevant zone unavailable for flight planning may be established.

(2) Within the airspace volume representing such zone the planning of flight trajectory is either not permitted or allowed under certain specified conditions. In order to assist the airspace users in the presentation of the intended flight operation, the flight planning limitation/s shall be defined in the Route Availability Document (RAD).

(3) Airspace users can avoid such zone by flight planning via appropriate significant points around it or in accordance with allowed conditions.

(4) Such a zone is named “No Planning Zone” (NPZ) and shall be published in accordance with provisions in ERNIP Part 1, Annex D.
7 ASM and Airspace Design

7.1 General

7.1.1 Flexible Use of Airspace (FUA) Concept

(1) ASM design principles are based on the Flexible Use of Airspace (FUA) Concept.

(2) The Concept of the Flexible Use of Airspace (FUA) endorsed at MATSE/4 in June 1994 and supported by the European Parliament on 27th September 1994 has been gradually implemented in the ECAC States as from the 28th March 1996.

(3) The regulatory framework for the FUA Concept has been defined through the EC/EUROCONTROL Single European Sky package, in particular through:

- COMMISSION REGULATION (EC) No 2150/2005 of 23 December 2005 laying down common rules for the flexible use of airspace; and
- EC/EUROCONTROL Specification for the application of the Flexible Use of Airspace (FUA)
- Airspace Management Handbook (ASM Handbook) for Application of the Concept of the Flexible Use of Airspace

(4) The basis for the FUA Concept is that 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. Consequently, any necessary airspace reservation or segregation should be only of a temporary nature.

(5) A more effective sharing of European airspace and efficient use of airspace by civil and military users stemming from the application of the FUA Concept is realised through joint civil/military strategic planning, pre-tactical airspace allocation and tactical use of the airspace allocated.

(6) Airspace Management (ASM) procedures at the three levels; Strategic ASM Level 1, Pre-Tactical ASM Level 2 and Tactical ASM Level 3 are described in the ERNIP Part 3 - ASM Handbook.

7.1.2 Flexible Airspace Structures

(1) The FUA Concept uses airspace structures that are particularly suited for temporary allocation and/or utilisation.

(2) The different airspace structures; Conditional Routes (CDRs), Temporary Segregated Areas, (TSAs), Temporary Reserved Areas (TRAs), Cross-Border Areas (CBAs) or those Danger or Restricted Areas (D, R) subject to pre-tactical or tactical allocation under the Temporary Airspace Allocation (TAA) process, as well as Reduced Co-ordination Airspace (RCA) or Prior Co-ordination Airspace (PCA) procedures used for flexible airspace management are detailed hereafter.

7.1.3 Strategic ASM Level 1 - National High-Level Policy Body Functions

(1) In accordance with FUA principles, Strategic ASM at Level 1 consists of a joint civil and military process, within the high-level civil/military national body which formulates the national ASM policy and carries out the necessary strategic planning work, taking into account national and international airspace users’ requirements.
The permanent "National High-Level Policy Body" is required to establish a joint civil and military process to perform the following minimum functions:

- formulate the national policy for airspace management;
- reassess periodically the national airspace structures including ATS routes and Terminal Airspace with the aim of planning, as far as possible, for flexible airspace structures and procedures;
- validate activities requiring airspace segregation and assess the level of risk for other airspace users;
- plan the establishment of flexible airspace arrangements (CDRs, TSAs, CBAs, RCAs, PCAs, .. ) and conduct, if required, associated safety assessment;
- change or modify, if required and if practicable, Danger and Restricted Areas into temporary allocated airspace;
- establish controlled airspace and ATS airspace classifications (see Section 2) taking into account the FUA concept;
- publish in national AIP the airspace structures including ATS routes and ATS airspace under its jurisdiction;
- co-ordinate major events planned long before the day of operation, such as large scale military exercises, which require additional segregated or reserved airspace, and notify these activities by AIS-publication;
- periodically review the national airspace needs and, where applicable, cross-border airspace utilisation.

7.1.4 Need for National Airspace Planning Arrangements for Change Process

In order to ensure that airspace is utilised in a safe and efficient manner and that in the near future, a co-ordination process for airspace planning between neighbouring States will be properly set-up, there is a need first that all European States establish National Airspace Planning Arrangements.

Such National Airspace Planning Arrangements should clearly establish policies for the effective allocation and use of airspace and its supporting infrastructure and should define the process and responsibilities to ensure that proposed changes to airspace are initiated, considered, refined, approved and finally implemented in a safe and effective manner.

To that end, an outline of such airspace change process is provided in the ERNIP Part 3 - ASM Handbook to assist European States in developing their National Airspace Planning Arrangements through which subsequent changes to the national airspace organisation could be made taking into account the needs of all stakeholders.

7.1.5 Temporary Airspace Reservation and Restriction Design Principles

Temporary airspace reservation and restriction design is based on the Temporary Airspace Allocation (TAA) process. Since the demands on the use of airspace are manifold, some of which are not compatible with civil aviation (e.g. rocket firing) and because there exist sensitive areas on the ground that need protection from possible disturbance by over-flying aircraft, it is recognised that there is a need for States to establish airspace restrictions of varying
degrees of severity. In addition, there are aerial activities by specific users or user groups, which may require the reservation of portions of the airspace for their exclusive use for determined periods of time.

(2) Whenever such restrictions and/or reservations have to be imposed, they invariably constitute a limitation to the free and unhampered use of that airspace with the associated effects on flight operations. It is therefore evident that the scope and duration of reservation/restriction established should be subject to very stringent scrutiny in order to keep undesirable effects to the minimum consistent with the reason causing their creation.

(3) **Definition of the TAA Process**: The Temporary Airspace Allocation (TAA) Process consists in the allocation process of an airspace of defined dimensions assigned for the temporary reservation (TRA/TSA) or restriction (D/R) and identified more generally as an "AMC-manageable" area.

(4) To achieve this and in order to improve efficiency and flexibility of aircraft operations, States will endeavour to use the "Temporary Airspace Allocation" (TAA) process summarised in the following diagram:
Criteria and Planning Consideration for the Establishment of the TAA Process

- **Airspace Request**: Validation of activities requiring airspace reservation/restriction
  - **Potential hazard to participating, and non-participating**
    - **Y**: Activities manageable at ASM Level 2 by AMC?
      - **Y**: Assessment of the level of risk for and disruptions to other airspace users.
        - **Y**: Transit might be allowed?
          - **Y**: AIRSPACE RESERVATION
          - **N**: AIRSPACE RESTRICTION THAT CAN BE ALLOCATED BY AMC
            - **D**: Danger Area
            - **R**: Restricted Area
              - **N**: Need to prohibit flights?
                - **Y**: Prohibited Area
                - **N**: Reduced use pre-notified
  - **N**: Prior co-ordination required?
    - **Y**: JOINT USE OF AIRSPACE
      - **PCA**
      - **RCA**
    - **N**: Determination of the needs in terms of space, time & conditions of use.
      - **Y**: NOTAM
      - **N**: AIP
      - **Y**: AUP
        - **TAA PROCESS**
          - **TRA**
          - **TSA**
          - **LoA**
          - **Prohibited Area**

Activities might be allowed?
7.1.6 Validation of Activities Requiring Airspace Reservation/Restriction

(1) In general, airspace should only be reserved or restricted for specific periods of time which should stop as soon as the associated activity ceases. In practice, the TAA process includes all the AMC-manageable structures whenever their use can be linked to a daily allocation for the duration of a planned activity. Thus, when designating airspace volumes, States should establish, as far as possible, AMC-manageable structures.

Criteria governing the evaluation of national airspace needs and validation of activities

(2) When States initiate their evaluation of short-term national airspace needs, or have to deal with a new airspace request, they should:

- ensure that the activities relating to the request for temporary reservation or restriction are valid and justify such action;
- consider the feasibility of avoiding any potential hazard and/or disruption to other airspace users, through appropriate civil/military co-ordination procedures, so that a joint use of airspace will be possible;
- if the joint use of airspace is not possible, determine the needs in terms of space, time and the conditions of use, that are required to confine the activities, to minimise the potential hazard and to minimise disruption to other airspace users;
- assess the level of risk for other airspace users and determine how a request can best be met with the least interference to other users.

Criteria governing the choice between Airspace Reservation and Restriction

Having assessed the need for an AMC-manageable area, where the activities are suitable for daily management and allocation at Level 2, States should:

- whenever possible, establish an airspace reservation using guidelines included in this document;
- if not, - where either because of difficulty in the notification of airspace status to interested airspace users or because of national legal requirements - establish an airspace restriction (R or D) in accordance with guidelines defined in this document.

(3) Finally, States should keep established airspace reservations and airspace restrictions under regular review so as to determine whether they are still required or whether modification may be necessary in the light of changed requirements.
7.2 Guidelines for Establishment of Airspace Reservation and Restriction

7.2.1 Modularity

(1) The principle of modularity in design is a basic principle that should be considered wherever possible when designing either an airspace reservation or airspace restriction.

(2) Modularity applied in the airspace reservation and/or restriction design is an enabler for dynamic airspace management.

(3) The elements of the dynamic airspace structure planning are:
   • greater choice of routes by including route options supplemented by suitable alternatives as a function of modularity of airspace reservation or restriction;
   • greater flexibility to respond to short notice military operational requirements for existing or additional portion of airspace;
   • provision of proactive route activation/airspace reservation or restriction allocation through a collaborative decision making process to accommodate short-term changes in routings and civil traffic demand in coordination with airspace reservation or restriction requests, adjusted to match the military training and operational profile.

(4) ASM Level 1 establishes airspace structures and defines their conditions of use through a series of options based on sub-division of temporary airspace reservations or restrictions and an increased number of related CDR routes. These subdivided airspace reservations or restrictions are to be published as such in the AIP.

(5) The modularity of reserved and or restricted airspace enables activation/de-activation process of the subdivided areas to allow for the accommodation of daily changes in traffic situations and airspace users’ requirements. In case of a modular design of the airspace, the request should contain only the appropriate number of modules required for the activities concerned.
### 7.2.2 Relationship between Airspace Reservation/Restriction and the FUA Concept

(1) The table below summarises the relationship between the Airspace Reservation (TRA, TSA), Airspace Restriction (P, R, D) and the FUA Concept.

<table>
<thead>
<tr>
<th>AIRSPACE RESERVATION</th>
<th>AIRSPACE RESTRICTION</th>
<th>Depiction on the ASM Planning Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMC manageable, allocated at ASM Level 2</td>
<td>TRA</td>
<td>Restricted Area</td>
</tr>
<tr>
<td>AMC manageable, allocated at ASM Level 2</td>
<td>TSA</td>
<td>Danger Area</td>
</tr>
<tr>
<td>Not AMC manageable, but real-time activity notified at ASM Level 3</td>
<td>Restricted Area</td>
<td>Medium pink border</td>
</tr>
<tr>
<td>Not suitable for Level 2 allocation nor for Level 3 notification</td>
<td>Prohibited Area</td>
<td>Plain light pink</td>
</tr>
</tbody>
</table>

### 7.2.3 Guidelines for Establishment of Airspace Reservation

**Activities Requiring Temporary Airspace Reservation**

(1) States should establish, whenever possible, an airspace reservation over their land and/or territorial waters:

- in response to an operational need to accommodate civil, military, R&D, training or test-flights which, due to the nature of their activities, must be temporarily “protected” from non-participating traffic;
- for military training activities conducted under positive control, when aircraft manoeuvres are unpredictable, sensitive to external interference, or difficult to alter without adversely affecting the mission;
- for civil and military activities where the level of risk is not permanently present and where a temporary airspace reservation or segregation for a period is manageable at Level 2.

(2) States should clearly identify the activities for which the reservation/segregation of airspace is required from other activities and assess if they can be conducted simultaneously with traffic transiting together with their location in relation to the major traffic flows, in order to define the type of airspace reservation to be applied.

**Different Types of Temporary Airspace Reservation (TRA, TSA)**

(3) While it is recognised that there exist legitimate reasons for establishment of airspace reservations, experience also indicates that depending on the activities, some “reserved” airspace may be transited by another airspace user under specific conditions and/or based on appropriate co-ordination procedures. For this reason, different areas can be established taking into consideration the activity that would take place associated with the transit possibility.
Temporary Reserved Area (TRA) is a defined volume of airspace normally under the jurisdiction of one aviation authority and temporarily reserved, by common agreement, for the specific use by another aviation authority and through which other traffic may be allowed to transit, under ATC clearance.

Any ATC clearance for crossing an active TRA will be subject to prior co-ordination requirements in accordance with appropriate co-ordination procedures established between civil and military ATS units concerned.

Temporary Segregated Area (TSA) is a defined volume of airspace normally under the jurisdiction of one aviation authority and temporarily segregated, by common agreement, for the exclusive use by another aviation authority and through which other traffic will not be allowed to transit.

In order to permit all airspace users and ATS providers to be fully aware of areas subject to temporary reservation/segregation, Temporary Reserved Areas (TRAs) and Temporary Segregated Areas (TSAs) will be published in the national AIPs.

To that end, two procedures can be established in Letters of Agreement between the appropriate civil and military control units. These LoAs would need to specify the criteria required by the military authorities to permit or not GAT to fly “off-route” (e.g. radar performance, controller’s workload, amount of OAT traffic expected).

The Reduced Co-ordination Airspace (RCA) procedure is used to allow GAT to fly “off-route” without requiring civil controllers to initiate co-ordination with the military controllers.

The RCA procedure is usually applied for a very large area such as the entire FIR/UIR, but also for critical ACC sectors which have different capacity figures according to the existence of military activity or not.

The Prior Co-ordination Airspace (PCA) procedure, as another way of booking airspace, involves a given block of controlled airspace within which military activities can take place on an ad-hoc basis with individual GAT transit allowed under rules specified in LoAs between civil and military units concerned.

So as to minimise the need for individual off-route co-ordination, the PCA procedure will mainly be applied for airspace established outside the major traffic flows providing for the optimum GAT flight profile.

The airspace booking through the PCA procedure will be co-ordinated primarily between the ATS Providers concerned because they will be in the best position to put the reservation into effect. Therefore, Prior Co-ordination Airspace (PCA) will not be published in AIPs, but only in Letters of Agreement between the appropriate civil and military control units.

When the RCA procedure is in force, these Letters of Agreement should define the criteria required for the application of the PCA procedure with specific notice periods to allow the safe return of GAT flights to the ATS route network. Conversely, when military activities within a Prior Co-ordination Airspace (PCA) cease or decrease, the RCA procedure will be initiated.

**Degree of Airspace Segregation - Choice between RCA, PCA, TRA and TSA**

From the joint/shared use of airspace to the temporary reservation/segregation of airspace, an airspace segregation scale can be defined as described below.
(16) AOs will normally use the permanent ATS routes established outside TSAs, TRAs and/or PCAs. However, if available, they will be allowed to file a CDR or even a direct track (not in case of a TSA) and will therefore be re-routed around an active PCA or TRA. When an area (TRA, TSA) is not active, the traffic may expect “short track” through it on the initiative of the ATS Provider.

Establishment of Prior Co-ordination Airspace (PCA)

(17) The RCA procedure (see the ERNIP Part 3 - ASM Handbook) and PCA procedure will be implemented exclusively within controlled airspace in known traffic environment, and their use will be complementary according to co-ordination procedures laid down in associated LoAs to ensure a maximum joint use of airspace.

(18) The purpose of PCA is to temporarily book airspace, for the use of specific users that is located outside the major GAT traffic flows. A PCA should be established within a controlled airspace in a known traffic environment, where en-route GAT VFR flights are not permitted (e.g. Class C above FL195) to guarantee that information on the airspace status will be provided to the required audience.

(19) A PCA will mainly be used to separate general and commercial aviation operating in controlled airspace in a known traffic environment from high-speed military operations such as air combat training and formation flying.

Establishment of Temporary Reserved Area (TRA) or Temporary Segregated Area (TSA)

(20) When there is a need to inform in advance airspace users of any potential activity requiring to temporarily reserve/segregate an area and/or when such activity is located within a busy GAT environment, a TRA/TSA will be created and published in AIPs.

(21) TRA and TSA will be airspace of pre-defined dimensions. They may be subdivided at Level 1 and published as such in AIPs. AMCs may then be able to allocate them fully or partially in accordance with national policy.

<table>
<thead>
<tr>
<th>SEGREGATION OF AIRSPACE</th>
<th>PUBLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>JOINT USE OF AIRSPACE</td>
<td>RCA</td>
</tr>
<tr>
<td>NOT SEGREGATED</td>
<td>Published in LoAs for ATS Providers information only.</td>
</tr>
<tr>
<td></td>
<td>PCA</td>
</tr>
<tr>
<td></td>
<td>LoA</td>
</tr>
<tr>
<td>SHARED USE OF AIRSPACE</td>
<td>TRA</td>
</tr>
<tr>
<td>- the Reduced Co-ordination Airspace allows GAT transit without prior co-ordination.</td>
<td>Published in AIPs for all Airspace Users and ATS Providers Information</td>
</tr>
<tr>
<td></td>
<td>TSA</td>
</tr>
<tr>
<td>- the Prior Co-ordination Airspace allows a shared use of airspace with military activities located outside the major traffic flows providing for the optimum GAT flight profile.</td>
<td></td>
</tr>
<tr>
<td>- the Temporary Reserved Area allows the transit of the area under specific co-ordination procedures.</td>
<td></td>
</tr>
<tr>
<td>SEPARATE USE OF AIRSPACE</td>
<td>FULLY SEGREGATED</td>
</tr>
<tr>
<td>- the Temporary Segregated Area reserves airspace for the exclusive use of specific users.</td>
<td></td>
</tr>
</tbody>
</table>
TRA and TSA are established as pre-defined volumes of airspace so as to safely encompass either pre-planned military-type missions within a specific area (e.g. combat manoeuvres, practice air intercepts,...) or activities in movement (e.g. aerial refuelling, en-route mass formations,...). TRA and TSA could also be required for civil activities such as special test-flights or even for radar vectoring within pre-defined areas of potentially very high density of traffic.

TRA or TSA activation times are defined in accordance with the following parameters:

1. Published Hours
   “Published Hours” cover(s) the maximum possible activation time.
   “Published Hours” are published in AIPs in the Activation Time Column.

2. Planned Hours
   “Planned Hours” will be specified daily by AMCs and published in the national AUP.
   “Planned Hours” will always take place within the “Published Hours”.

3. Real Activation Time
   “Real Activation Time” is the actual period of use of the area known from the Operating Authority.
   “Real Activation Time” will normally take place within the “Planned Hours”.

Establishment of Cross-Border Areas (CBAs)

For cross-border activities, the same guidelines will be used for the establishment of a Cross-Border Area (CBA) either in a form of a TRA or a TSA. Specific elements which require to be taken into consideration for the establishment of such TRA or TSA across international boundaries are listed in the ERNIP Part 3 - ASM Handbook - Section 3.

When the possibility exists to rationalise the requirements for national TRAs/TSAs as well as D and R areas on both sides of a border, the neighbouring States concerned should endeavour to optimise the airspace and route structures in the area around the border by establishing a “Cross-Border Area” (CBA). This can be achieved by establishing such CBAs in the form of either TRAs/TSAs, or AMC-manageable D and R areas, with, where applicable, associated CDRs so as to benefit both GAT and OAT operations without any boundary constraints.

CBAs are established to allow military training and other operational flights on both sides of a border. CBAs, not being constrained by national borders, can be located so as to benefit both GAT and OAT operations. CBAs, combined with the potential use of CDRs through them, permit the improvement of the airspace structure in border areas and assist in the improvement of the ATS route network.

Political, legal, technical and operational agreements between the States concerned are required prior to the establishment of CBAs. Formal agreements for the establishment and use of CBAs have to address issues of sovereignty, defence, legality, liability, operations, the environment and Search and Rescue.
The process of establishing and designing a CBA includes a definition of the framework agreement between the States concerned, should address the following CBA issues:

- ATS delegation;
- airspace classification;
- ATC sectorisation;
- separation criteria between civil and military flights; and
- possibility of subdivision of CBAs.

7.2.4 Guidelines for Establishment of Airspace Restriction

Requirements for Airspace Restriction (Danger, Restricted or Prohibited Areas)

(1) The FUA Concept recommends that where possible, D and R Areas are replaced by an airspace reservation (see paragraph 7.2.2 above) or modified by applying the TAA process when the airspace restriction is manageable at Level 2. However, States may have a continuing requirement to retain D and R Areas; e.g. Danger Areas over the High Seas (see paragraph 7.2.5).

(2) Other D and R areas in some ATS classes of airspace may also not be suitable for replacement by an airspace reservation (TRA, TSA), either because of difficulty in the notification of airspace status to interested airspace users, or because of national and international legal requirements. For example a TSA, though managed as closely as possible to real-time requirements, may be more restrictive than existing D and R areas which can be penetrated by non-participating aircraft under specific and published conditions. Should the changing of some D and R Areas into TRA or TSA impose unreasonable constraints to users or be necessary for legal purposes, States should retain these D and R Areas.

Criteria for pre-defining airspace restriction volumes (P/R/D)

For the delineation of any restricted airspace volumes (P, R or D), the State 'Due Regard' obligation should be strategically observed so that participating activity will not endanger non-participating aircraft operating at or near its published limits. Distinct/individual boundaries should preferably be defined for activities in adjacent airspace. However, where it is necessary to define a common boundary, appropriate spacing criteria governing operations in the proximity of the common boundary should be established.

The AIP should identify those D and R areas managed and allocated at Level 2. To that end, some States may add suitable qualifiers to these D and R designators to indicate the Level 2 management of these areas. The period and conditions of use of these AMC-manageable areas will be published in AUPs in the list “CHARLIE” of Temporary Airspace Allocation (TAA).

Other D and R areas, not suitable for Level 2 management, should be identified as such and completely defined in the national AIPs. Within these published times the activity will take place without any allocation by AMCs unless users and/or managers of these airspace restrictions are able to notify their activities for the following day.
7.2.5 Establishment of Airspace Restriction/Reservation over the High Seas

(1) The basis of the agreement reached on the FUA Concept is that, it should not be in contradiction with the Chicago Convention and its Annexes or the United Nations Convention on the Law of the Sea. Access to high seas airspace cannot be denied, nor can State aircraft be forced to participate in the application of the FUA concept. Any procedure or agreement developed must not give the operators of State aircraft the perception that their operations could be restricted in any way. Procedures and/or agreements must also acknowledge that negotiating the use of the airspace is the ideal; however there would be circumstances when only notification of operation would be possible or operational considerations may preclude either negotiation or notification.

(2) As regards airspace reservations, over the high seas only D areas may be established in accordance with ICAO Annex 2 - Rules of the Air. In this context it should be noted that the establishment of such areas are to be without prejudice to the rights and duties of States under the Convention on International Civil Aviation (Chicago Convention) and its Annexes, or the 1982 UN Convention on the Law of the Sea. However, the States should introduce the flexible management of such D areas to the extent possible and based on the actual use of airspace.

(3) The FUA concept may be employed over the high seas in accordance with the principles used for airspace of sovereign territory. When so applied, it should be recognized that State aircraft of all other States can exercise their right to fly in any airspace over the high seas under the principle of “due regard” as described in the Chicago Convention, (Article 3 a) and d)) However, State aircraft should comply with the ICAO provisions to the extent possible.

(4) Civil aircraft and State aircraft operating in accordance with ICAO provisions are required to comply with the provisions of Annex 2, which apply without exception over the high seas. In particular, the provisions of Annex 2, paragraph 3.6.1.1 regarding the requirement to obtain a clearance before operating as a controlled flight, and paragraph 3.6.5.1 regarding the requirement to establish two-way communication with the unit providing air traffic control service, are to be observed.

(5) In order to provide added airspace capacity and to improve efficiency and flexibility of aircraft operations, States should establish agreements and procedures providing for a flexible use of airspace including that reserved for military or other special activities. The agreements and procedures should permit all airspace users to have safe access to such airspace. When applicable, such agreements and procedures should be established on the basis of a sub-regional agreement.

7.2.6 Guidelines for Spacing

General

(1) For the delineation of any reserved or restricted airspace volumes (TRA, TSA, CBA, D, R and P areas), the State 'Due Regard' obligation should be strategically observed so that activity in that airspace structure will not endanger non-participating aircraft operating at or near its published limits.

(2) The establishment of a reserved or restricted airspace published boundary should always be complemented by spacing criteria. These can be part of the national air law and/or take the form of LoAs between units involved. Such rules
should be as flexible as possible taking into account the efficient airspace design and operation ensuring no waste of airspace.

(3) In defining these spacing criteria, States should ensure that safety is assured in all circumstances through:

- the definition, if so required, of specific spacing minima depending on the activities conducted in reserved airspace, with the addition of an adequate spacing volume;
- the application of appropriate LoAs between civil and military units involved;
- the promulgation of the first usable IFR flight levels above/below an area in the definition of associated ATS routes.

**Baseline Spacing principles**

(4) Aircraft operators must have the opportunity to submit a flight plan that does not infringe the volume of airspace associated with an active segregated/reserved airspace.

(5) The objective is to ensure that this volume of airspace is published, including the totality of airspace to be avoided by non-participating aircraft, unless authorised by the appropriate ATS authority.

(6) The methodologies employed to achieve the necessary spacing should be compatible with both the predetermined ATS route network and free route airspace (if applied) environments.

(7) Delineation of the boundary of the reserved/restricted airspace

(8) According to ICAO Annex 15 all positional data (geographical coordinates) has to be with reference to WGS-84.

(9) There is a need for a common reference to be applied in computation of trajectories, boundaries with regard to the earth model (great circle on a sphere, geodesic, ellipsoid).

(10) The horizontal border of a segregated airspace is specified as a sequence of segments, which can be "straight lines", "along the parallel", "arc of circle", "follow the State boundary". All digital encoding formats (ARINC 424, AIXM, etc.) are facing common problems with regard to the encoding of this data. The most common ones are mentioned here:

- In ARINC 424 straight lines are encoded as “Great Circle” with the Earth being assumed as a sphere. In modern geographical information systems, the most accurate representation of “straight lines” is a geodesic curve on the WGS-84 Ellipsoid. The difference between the two encodings can be significant when calculating the intersection between the intended aircraft trajectory and a segregated area located some 50 NM away, for example.

- “along the parallel”, or along a constant latitude, is different from a straight line. For spatial calculations they are interpolated with a certain density - replaced with a number of "straight" segments. Common rules have to be agreed for such interpolations in order for all systems to get the same calculation results.
• “arcs and circles” also require interpolation and specific projections to be used for spatial calculations. In particular “arc by centre point” is a problematic construct because it is typically over-specified and the different values (centre, radius, start/end points) need to match perfectly, which is really the case.

• “follow the State boundary” is the most problematic construct, because State boundaries are not published in the national AIP. End users use different sources of State boundaries, with different interpolations. The EAD offers a “default set” of national boundary data, but this was not yet agreed by all European States. Best solution would be to avoid using references to State boundaries and other geographical features (rivers, coastlines, etc.) in the definition of segregated areas because they are very imprecise.

• Following the aforesaid the horizontal border of reserved/restricted airspace should be described by the use of geodesic curves or lines of constant latitude.

Spacing methodology

(11) The agreed objective requires that the necessary spacing between the participating traffic/activity inside a TRA/TSA/CBA/D/R/P be contained within the overall definition of such reserved/restricted airspace. The extent of this spacing or buffer will be determined by the relevant authority within the State, according to the nature of the activity, taking place within the airspace. This may be further influenced by whether or not the reserved/restricted airspace is permeable to GAT (e.g. coordinated tactical crossing) and has a separation service provided by the operator of that segregated airspace.

(12) It follows therefore that non-participating aircraft (whether avoiding the segregated airspace or transiting under agreed procedure) need only know the boundary of the segregated airspace; participating aircraft (e.g. reserved/restricted airspace activity aircraft) may need to know additional details through their relevant publications.

(13) The following methodology should be followed to determine the extent of segregated airspace:

a) Define activity;
b) Define operational volume including necessary safety volume;
c) Choose denomination based on need for segregation: TSA and/or TRA, and D, R or P as appropriate;
d) Define regulatory description;
e) Add spacing volumes (lateral, vertical, time) when needed (TSA);
f) When no spacing volume needed, define separation rules and procedures;
g) When airspace is too limited to integrate a designed airspace volume in the existing environment, define procedural mitigation;
h) Perform supporting safety case.
When establishing CBAs it is essential to avoid different spacing elements either side of a boundary not to increase the complexity of flight planning or waste airspace. The impact of this disparity would be removed if the resultant CBA boundary was nevertheless consistent. This is why the spacing volume applied to a CBA must be harmonised across both sides of the boundary where this would otherwise lead to a non-consistent boundary.

The delineation of reserved/restricted in the upper airspace needs to be harmonised in relation to the navigation tolerance requirements, similarly for the lower airspace, but there may be differences between upper and lower airspace navigation tolerance requirements as some states have different design criteria in controlled compared with uncontrolled airspace (e.g. Class C versus Class G).

### 7.2.7 Guidelines for Establishment of Conditional Routes (CDR)

#### General Presentation of the CDR Concept

1. The Conditional Route (CDR) concept encompasses, by definition, all non-permanent ATS routes. CDRs are non-permanent parts of the published ATS route network that are usually established:
   - through areas of potential temporary reservation (e.g. TRA or TSA), with CDR opening/closure resulting from associated military activities, and/or
   - to address specific ATC conditions (e.g. traffic restrictions or ATC sectorisation compatibility) with CDR opening/closure resulting from purely civil needs;
   - CDRs are established by the ASM Level 1, allocated at ASM Level 2 by the AMC and utilised at ASM Level 3 by ACCs. CDRs are usually established and utilised as a part of pre-planned routing scenarios. CDRs permit the definition of more direct and alternative routes by complementing and linking to the existing ATS route network.

#### Criteria for Definition of Routing Scenarios

2. CDRs should be planned to complement the ATS Route network and should lead to the development of flexible, but pre-defined routing scenarios. Scenarios based on CDRs should take due account of the:
   - Expected traffic demand and nature of the traffic: manoeuvring, overflying, arrival or departure;
   - Foreseen period of CDR availability and the CDR Category;
   - Expected impact on ATC Sector Capacity and flight economy resulting from CDR use;
   - Flexibility of an eventual change in ATC sectorisation configuration required for activation/de-activation of CDRs;
   - Existing national boundaries, airspace and route structure and TMA interface: possibility of cross-border CDRs;
   - Possible impact on ATS airspace classification: the airspace class may be different when the change of area status from TRA/TSA to CDR leads to the provision of different air traffic services;
   - Application of RNAV techniques;
   - Capability of the FPPS to activate the different routing scenarios;
• Impact on OAT and GAT controllers’ workload.

Criteria Governing the Categorisation of Conditional Routes

General

(3) CDRs can be divided into different categories according to their foreseen availability, flight planning possibilities and the expected level of activity of the (possible) associated AMC-manageable areas. A CDR can be established at ASM Level 1 in one or more of the three following categories:

• Category One (CDR1) - Permanently Plannable CDR during the times published in AIPs;
• Category Two (CDR2) - Non-Permanently Plannable CDR, and
• Category Three (CDR3) - Not Plannable CDR.

CATEGORY ONE (CDR1) - Permanently Plannable CDR during the times published in AIPs

(4) When a CDR is expected to be available for most of the time, it can be declared as permanently plannable for stated time periods and published as a Category One CDR (CDR 1) in AIPs. CDRs 1 can either be established on an H24 basis or for fixed time periods.

(5) CDRs 1 forms part of the strategic ATS route planning process and complements the permanent ATS route network. Consequently, CDRs 1 are expected to be available for the time period declared in the AIP. Any closure of a CDR 1, which needs action to re-file the flight plan, has therefore to be published with appropriate advance AIS notice.

(6) In the event of a short notice unavailability of a CDR 1, aircraft will be tactically handled by ATC. Aircraft operators should consider the implications of such a possible re-routing and use of the alternate ATS routes published for each CDR 1 in the “Remarks” column of the AIP.

(7) Therefore, when deciding on the categorisation of a Conditional Route as CDR 1, the impact of its unavailability on ACCs handling must be carefully assessed. But, when national ATS route closure process can be transparent to the aircraft operators and has no impact on neighbouring States, CDR 1 unavailability will be managed by the AMC at Level 2 in a similar way as CDR 2 availability and be promulgated as such in Airspace Use Plans (AUPs) only for information to Approved Agencies (AAs) and ATS units concerned.

(8) Any foreseen period of non-availability of CDRs 1 known or decided at pre-tactical level would if practicable, be promulgated for information to national AAs and ACCs concerned through national AUPs in the list “BRAVO” of Closed ATS Routes. In such cases, and considering the impact on RPL/FPL processing, the unavailability information is only for AAs and ATS units and will be handled at Level 3 which will then not require flight planning actions by AOs.

14 In the case of exceptional military activities, if this unavailability has to be applied to weekend routes, the re-routing of significant numbers of aircraft by ATC may not be feasible. In that case, AOs would be required to change their RPLs/FPLs in accordance with the CDR 1 closures published with appropriate advance AIS notice.
CDR 1 closures will therefore only be promulgated in the e-AMI as a repetition for safety of the decision already published with appropriate advance AIS notice.

When establishing CDR 1, the national high level policy body should provide the Airspace Management Cell (AMC) with clear criteria for publication of its possible unavailability especially when the consequence on ACC Sector capacity and handling is very important e.g. during Peak Hours or weekends.

When establishing a CDR 1, the national high level policy body should therefore ensure that procedures are established for the safe handling of flights which experience radio communication failure.

**CATEGORY TWO (CDR2) - Non-Permanently Plannable CDR**

Category Two CDRs (CDRs 2) is a part of pre-defined routing scenarios. CDRs 2 are established and utilised with the aim of maximising one or more of the following benefits: better traffic distribution, increase in overall ATC capacity and flight efficiency.

CDRs 2 availability can be requested to adjust traffic flow, when a capacity shortfall has been identified and after consideration of relevant ACC factors has been made by the FMPS/ACCs concerned.

Flights on CDRs 2 may be flight planned only when the CDR is made available in accordance with the appropriate AMC allocation listed in part "ALPHA" of the AUP and repeated in the e-AMI.

**CATEGORY THREE (CDR3) - Not Plannable CDR**

Category Three CDRs (CDRs 3) are those that are expected to be available at short notice. Flights will be planned on the basis of the utilisation of the permanent ATS route network around the areas.

After co-ordination with the military unit(s) in charge of the associated TRA, TSA, R or D Area(s), the GAT controller may offer an aircraft a short-notice routing through the area using a pre-defined CDR 3.

CDRs 3 can be published in AIPs as CDRs usable on ATC instructions only. CDRs 3, not being subject to allocation the day before by AMCs, are not form part of the AUP and are not notified to the aircraft operators.

**Guidelines for the Categorisation of CDRs**

When States decide on the category to be applied to a CDR they should, in addition to their foreseen availability, take due account of the:

- Possible complexity of co-ordination with the military units involved and the opening in real-time of CDR 3;
- Possible Cross-Border aspects and harmonise with their neighbours to the greatest possible extent the categorisation, Flight Levels and intended availability of such routes;
- Possible difficulties of re-routing, in real-time, all or some aircraft;
- Need for the dissemination of the CDR availability the day before operations to all ATM users (ACCs, Network Manager, AOs, ...) or to confine such information to one or several ATC sector(s) within one ACC for tactical use only;
- Possibility to form part of different routing scenarios;
- Possible complexity of being used under more than one category and in
particular harmonise with their neighbours the fixed period as Category 1 and the intended availability as Category 2;

- Expected impact on ATC sector management (grouping/de-grouping).

(19) In order to assist national ASM Level 1 Route Planners in the Categorisation of ATS Route in Permanent Route or one of the three different categories of CDRs, guidelines based on eight (8) major questions related to ATFM, ATC and ASM requirements are proposed in the figure below.

(20) A CDR can be established at ASM Level 1 in more than one of the three categories. For example, two flight planning possibilities can be defined for a particular CDR e.g. a CDR used at week-ends can be plannable during a fixed period from Friday 17.00 to Monday 08.00 (Category One), or flight planned in accordance with AUPs at other times (Category Two).
7.2.8 Guidelines for Flexible Airspace Structures Publication

General

(1) An important national task at ASM Level 1 is to publish in national AIPs the status of airspace structures and ATS routes under its jurisdiction.

(2) In order to permit airspace users to become aware of the new flexible structures implemented, the harmonisation and consistency of the publication of this information in AIPs is required.

Publication of Restriction (P, R, D)

(3) The ICAO Doc 8126 - AIS Manual recommends that AIP lists all areas through which the flight of aircraft is subject to certain specified conditions and which have some permanency, including those which are activated from time to time. Doc 8126 also requires that any such area should be designated a Prohibited Area (P), a Restricted Area (R) or a Danger Area (D).

Publication of Temporary Airspace Reservation (TRA, TSA)

(4) Article 3 d) of the ICAO Convention requires Contracting States to have ‘due regard’ for the safety of navigation of civil aircraft when issuing regulations for military aircraft. ICAO Annex 11 prescribes that any activity potentially hazardous to civil aircraft shall be co-ordinated with the appropriate air traffic services authorities. The co-ordination shall be done early enough to permit timely promulgation of information regarding the activities in accordance with the provisions of ICAO Doc 10066 PANS-AIM.

(5) In all cases, States are required to establish LoAs, if needed, with direct communication between civil and military controlling/monitoring units concerned in order to allow an efficient co-ordination process.

(6) As specified in the Doc 8126, the description and graphic portrayal of TRA or TSA should include, as appropriate:
   - identification and name (if any) - lateral limits with geographical co-ordinates;
   - upper and lower limits;
   - type of restriction or nature of hazard;
   - remarks including the period of activity if the area is only “active” during certain periods.

(7) The activation time parameters encompass “Published Hours”, “Planned Hours” and “Real Activation Time”. The Published Hours would cover the maximum possible activation and should be published in the AIP in a new column or as a specific part of the “Remarks” column. In some cases, it could also be useful to publish in the “Remarks” column the “Operating Authority” and the “Penetration Conditions”, if any.

Publication of CBA

(8) Information concerning Cross-Border Activities within a TRA or TSA established over international boundaries should be published in a similar way as a national TRA or TSA. However, such a “Cross-Border Area” must be given specific designators for publication in the AIPs of the States concerned, and the lateral limits of the area in each State.
Harmonised CBA designation

(9) In order to ensure a harmonised designation of CBA across Europe, the following principles have been approved:

(10) A group of two letters (EU); followed by

- “C” (EAD DHO-5, rule 6 for CBA); followed by
- A group of up to 7 characters (preferably digits) unduplicated within the European airspace.

(11) In order to ensure the uniqueness of the designator, a centralised management of CBA designation in Europe has been agreed, with tasking the Airspace Management Sub-Group of the Network Operations Team (ASMSG) and its Secretariat to manage the process in close coordination with the EUROCONTROL EAD.

Publication of CDR routes

(12) The possible partition of a CDR into different categories on a time and/or on vertical basis requires both the indication of the CDR category in the “Remarks” column in the AIP description of ATS routes, and the addition of an explanatory note at the front of ENR. A fictitious example of a harmonised publication of the three categories of CDRs is given in Annex B.
7.2.9 CDRs Routing Scenarios

(1) The following constitutes examples of CDR routings scenarios:

**EXAMPLE OF CDR ROUTING SCENARIO 1**

1. **C1 > C2 > C3**

   - **TSA 1 & TSA 2 non-active**
   - **C1 = ATC Capacity**
   - **Sector A + Sector B**

2. **TSA 1 non-active**
   - **TSA 2 active**
   - **C2 = ATC Capacity**
   - **Sector A + Sector B**

3. **TSA 1 & TSA 2 active**
   - **C3 = ATC Capacity**
   - **Sector A + Sector B**

**C1 > C2 > C3**
EXAMPLE OF CDR ROUTING SCENARIO 2

1. TSA 2
   - CDR A
   - CDR C
   - CDR B
   - CDR D
   - Sector H
   - TSA 3 (non-active)
   - C1 = ATC Capacity Sector (H)

2. TSA 2
   - CDR A
   - CDR C
   - CDR D
   - Sector H
   - TSA 3 (active)
   - C2 = ATC Capacity Sector (H)

C1 = C2
EXAMPLE OF CDR ROUTING SCENARIO 3

1. CDR A, CDR B, CDR C

2. C1 is ATC capacity for Sector T + Sector N
   C2 is ATC capacity for Sector (T + N)

C1 > C2
8 Route Network and Free Route airspace utilisation rules and availability

8.1 Introduction

(1) The Route Availability Document (RAD) is created based on:
   a) COMMISSION REGULATION (EU) No 255/2010 of 25 March 2010 laying down common rules on air traffic flow management, Article 4 - General obligations of Member States, paragraph 4; and

(2) The RAD is a common reference document containing the policies, procedures and description for route and traffic orientation. It also includes route network and free route airspace utilisation rules and availability.

(3) The RAD is also an Air Traffic Flow and Capacity Management (ATFCM) tool that is designed as a sole-source flight-planning document, which integrates both structural and ATFCM requirements, geographically and vertically.

8.2 Basic Principles

(1) The objective of the RAD is to facilitate flight planning, in order to improve ATFCM, while allowing aircraft operators’ flight planning flexibility. It provides a single, fully integrated and co-ordinated routeing scheme. Except where otherwise specified the RAD affects all areas where the Network Manager provides ATFCM services.

(2) The RAD enables States/FABs/ANSPs to maximise capacity and reduce complexity by defining restrictions that prevent disruption to the organised system of major traffic flows through congested areas with due regard to Aircraft Operator requirements.

(3) The RAD is designed as a part of the Network Manager (NM) ATFCM operation. It is organising the traffic into specific flows to make the best use of available capacity. Whilst, on its own, it will not guarantee the protection of congested ATC sectors during peak periods, it should facilitate more precise application of tactical ATFCM measures.

(4) The RAD should also assist the Network Manager in identifying and providing re-routeing options. Global management of the demand will, potentially, lead to an overall reduction of delays. It is important to note that to achieve this, some re-distribution of the traffic may be required through the implementation of Scenarios. This may result in modified traffic/regulations in some areas where, under normal circumstances, they would not be seen.

(5) The content of the RAD shall be agreed between the Network Manager and the Operational Stakeholders through an appropriate Cooperative Decision Making (CDM) process.
The RAD is subject to continuous review by the Network Manager and the Operational Stakeholders to ensure that the requirements are still valid and take account of any ATC structural or organisational changes that may occur.

The RAD is updated each AIRAC cycle following a structured standard process of:

a) Requirement;
b) Validation;
c) Publication by the Network Manager in cooperation/coordination with all Operational Stakeholders.

The RAD is only applicable to the IFR part of the Flight Plan.

Each State shall ensure that the RAD is compatible with their AIP with regard to the airspace organisation inside the relevant FIR/UIR.

The NM is responsible for preparing of a common RAD reference document, collating, coordinating, validating and publishing it, following the CDM process as described in this section.

It should be noted that RAD restrictions ensure predictability for ATCOs, protect congested sectors during peak periods and should facilitate more precise application of tactical ATFCM measures. Bearing in mind the NM “file it, fly it” campaign to ensure predictability, ATCOs should be encouraged, wherever possible and when the traffic situation permits, to relax RAD restrictions on a tactical basis to allow aircraft to cruise at more optimal higher levels thus enabling CDO from higher levels / top of descent. This optimises the descent profile and may allow tactical handovers at more optimum levels. Coordination with neighbouring sectors may be required to ensure that any such relaxation of RAD restrictions does not result in sector sequence changes or will not influence flow measurements or create overload situations for the remaining route of the flight concerned.

8.3 Structure

8.3.1 Document structure

The RAD document consists of:

a) General description;
b) 6 (six) Appendices:
   ➢ Appendix 2 - Area Definition;
   ➢ Appendix 3 - Flight Level Capping limits;
   ➢ Appendix 4 - En-route DCT limits;
   ➢ Appendix 5 - Airport connectivity;
   ➢ Appendix 6 - Flight Profile Restrictions;
   ➢ Appendix 7 - FUA Restrictions.

c) a Network wide Pan-European Annex;
d) if necessary, a separate Annex for special events, containing restrictions of temporary nature (i.e. European/World Sport Events, Olympic Games, large scale Military exercises, economic forums ...).
General description

(2) It defines the basic principles, general structure of the RAD, the structure of RAD restrictions, period of validity, application, amendment process, temporary changes, some flight planning issues, routeing scenarios, publication, tactical operations and RAD review process.

Appendix 2

a) It defines a number of airfields included in the RAD described by the following terms:

- “Group” - defines a number of 3 (three) or more airfields that may be subject to the same restrictions. For example a major destination may have a number of minor satellite airfields in the vicinity; this constitutes a “Group”;
- “Area” - defines as a number of airfields within the same region and may comprise several “Groups”, or individual airfields.

b) The definition of the Group or Area is the responsibility of the State/FAB/ANSP within which the Group or Area exists; however other States/FABs/ANSPs may use the definition.

c) If a State/FAB/ANSP wishes to use a defined Group or Area with the exclusion or inclusion of certain airfields, then this should be depicted as follows:

Fictitious Example

<table>
<thead>
<tr>
<th>Change record</th>
<th>ID</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A........... Group</td>
<td>E_ _ _ / E_ _ _</td>
<td></td>
</tr>
<tr>
<td>B............ Area</td>
<td>L_ _ _ / L_ _ _</td>
<td></td>
</tr>
<tr>
<td>C........... Y/Z Area</td>
<td>L_ _ _ / L_ _ _</td>
<td></td>
</tr>
</tbody>
</table>

By using the above methodology, there can only be one definition of each Group/Area, thus reducing confusion.

e) However, it is the responsibility of the State/FAB/ANSP to ensure that when corrections are made to Appendix 2 that these amendments are also applicable to any restriction using the defined Group/Area. The Network Manager will endeavour to notify relevant States/FABs/ANSPs of such changes.
Appendix 3

a) It defines FL capping limitations imposed by each State/FAB/ANSP and is applied from airport of departure (ADEP) to airport of destination (ADES).

Fictitious Example

<table>
<thead>
<tr>
<th>Change record</th>
<th>ID Number</th>
<th>FROM (ADEP)</th>
<th>TO (ADES)</th>
<th>Condition</th>
<th>FL Capping</th>
<th>Restriction Applicability</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>E_4001</td>
<td>A.... Group</td>
<td>B.... Group</td>
<td>Via AAAAA</td>
<td>Not above FL235</td>
<td>08:30 - 10:30 (07:30 - 09:30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E_4002</td>
<td>B.... Group</td>
<td>A.... Group</td>
<td>Via AAAAA</td>
<td>Not above FL235</td>
<td>08:30 - 10:30 (07:30 - 09:30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L_4002</td>
<td>C.... Area</td>
<td>L_... , E_...</td>
<td>Via L_... UTA</td>
<td>Not above FL315</td>
<td>04:00 - 23:00 (03:00 - 22:00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L_4003</td>
<td>L_... E_...</td>
<td>C.... Area</td>
<td>Via L_... UTA</td>
<td>Not above FL315</td>
<td>04:00 - 23:00 (03:00 - 22:00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L_4004</td>
<td>L_..._FIR</td>
<td>E_..._FiR</td>
<td>Except Type M</td>
<td>Not above FL345</td>
<td>H24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix 4

a) It defines the en-route DCT (Direct) flight plan filing limitations imposed by each State/FAB or ATC Unit in accordance with provisions of ICAO Doc 4444 PANS-ATM;

b) It contains:
   - DCT horizontal limits inside each ATC Unit;
   - Cross-border horizontal DCT limits (between ATC units);
   - Vertically defined DCTs with availability “No” or “Yes”, with certain traffic flow limitations and with defined Operational goal. Also part of these DCTs are:
     - Free Route Airspace (FRA) DCTs.

c) It should contain, for DCTs with availability YES, all possible remarks concerning the airspace crossed by the allowed DCTs. Based on relevant State AIPs AOs shall be informed for DCTs passing by: Uncontrolled classes of airspace, Danger areas, Prohibited areas, Restricted areas, TSAs, TRAs, CBAs, CTRs, TMAs etc.

d) It should not be considered as an airspace design tool creating a complimentary ATS route network in Europe;

e) Where DCT applies to Free Route Airspace (FRA) the definition of the FRA shall be found in the relevant AIP;

f) Each State shall insure that the DCTs are compatible with their AIP with regard to the airspace organisation inside the relevant ATC Units.

Fictitious Example for DCT segments

<table>
<thead>
<tr>
<th>Change record</th>
<th>FROM</th>
<th>TO</th>
<th>Lower Vertical Limit (FL)</th>
<th>Upper Vertical Limit (FL)</th>
<th>Available (Y) Not available (N)</th>
<th>Utilization</th>
<th>DCT Time Availability</th>
<th>ID Number</th>
<th>Operational Goal</th>
<th>Remark/s</th>
<th>Direction of Cruising Levels</th>
<th>ATC Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AAAAA</td>
<td>BBBBB</td>
<td>315</td>
<td>660</td>
<td>Yes</td>
<td>Only available for traffic</td>
<td>H24</td>
<td>E_5001</td>
<td></td>
<td>Night time direct route</td>
<td>Via TSAxxx</td>
<td>EVEN</td>
</tr>
<tr>
<td></td>
<td>CCCCC</td>
<td>DDDDD</td>
<td>045</td>
<td>245</td>
<td>Yes</td>
<td>Only available for traffic</td>
<td>06:00 - 22:00 (05:00 - 21:00)</td>
<td>L_5002</td>
<td>Traffic DEP...</td>
<td>Within Class G airspace</td>
<td>000</td>
<td>l_... ACC</td>
</tr>
</tbody>
</table>

Fictitious Example for DCT vertical and horizontal limits
Appendix 5

a) It defines the DCT (Direct) flight plan filing connections defined by each State/FAB/ANSP to/from the airports without SIDs/STARs or with SIDs/STARs which are not able to be complied due to certain aircraft limitations. This is done only to support/facilitate the processing of flight plans. Based on relevant State AIPs AOs shall be informed about the airspace organisation at/around the airports.

b) It contains:
- airport DCT horizontal limits;
- connecting points for ARR/DEP;
- additional compulsory FRA Departure (D) / Arrival (A) Connecting Point/s from/to a certain TMA/airport and indications on their use for departures / arrivals from / to specific aerodromes;
- information for some flight plan filing limitations with regard to last/first SID/STAR points and ATS route network, if required;
- information for AOs to comply with SIDs/STARs, if required.

Fictitious Example

Appendix 6

a) It defines the vertical profile elements of the LoAs between adjacent ATC Units. This purely operational data is not published through AIS.

b) It contains the restrictions which influence how the profile is calculated in NM systems and the Flight Plan will not be rejected (REJ) by IFPS even when there is no reference to the corresponding restriction in ITEM 15. The Operational Stakeholders are not required to file in the Flight Plan these
restrictions. In this case, it is the option of the filer to either include or exclude the restriction in the FUEL PLAN.

Note: If there is requirement to hard check any restriction, then the corresponding restriction shall be transferred to the Pan-European Annex.

Fictitious Example

<table>
<thead>
<tr>
<th>Change record</th>
<th>ID Number</th>
<th>Flow Routing</th>
<th>Utilization</th>
<th>Time Availability</th>
<th>Operational Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_8001</td>
<td>AAAA</td>
<td></td>
<td>Not available for traffic ... above FL235</td>
<td>H24</td>
<td>To comply with LoA.</td>
</tr>
<tr>
<td>E_8002</td>
<td>AAAA T1 BBBB</td>
<td>Note available for traffic DEP/ARR X group via MMM below FL075</td>
<td>00:01 - 04:50 (23:01 - 03:50)</td>
<td>To force traffic via CCCCC.</td>
<td></td>
</tr>
</tbody>
</table>

Appendix 7

a) It defines the airspace restrictions (FUA restrictions) caused by restricted airspace (RSA) activation within each State/FAB/ANSP;

b) It contains:

- coded name identification of the relevant restricted airspace;
- information that restriction is valid only, when the airspace is allocated at EAUP/EUUP;
- specific conditions for the utilization of FRA Intermediate Point/s (I).

Fictitious Example

<table>
<thead>
<tr>
<th>Change record</th>
<th>AIP RSA ID</th>
<th>CACD RSA ID</th>
<th>Restriction Applied during times and within vertical limits allocated at EAUP/EUUP</th>
<th>ID Number</th>
<th>Operational Goal</th>
<th>Affected ATS route/s / DCT/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_R24</td>
<td>L_R24</td>
<td></td>
<td>Not available for traffic.</td>
<td>L_R24R</td>
<td>Traffic is not allowed to flight plan across active military area.</td>
<td>AAA L1 BBBB CCCCC M1 DDDDD DCT EEE - FFFF</td>
</tr>
<tr>
<td>E_TRA51</td>
<td>E_T51</td>
<td></td>
<td>Only available for traffic: 1. DEP/ARR E _ _ 2. Military GAT 3. Via AAAA N3 BBBB 4. Via CCCCC N3 DDDDD</td>
<td>E_T51R</td>
<td>Traffic is not allowed to flight plan across active military area except specified flows. For avoidance nearby FRA (I) point/s is/are: ZZZZZ, FFFF, MMMMM.</td>
<td>AAA L1 BBBB CCCCC M1 DDDDD GGGGG N1 HHHHH DCT RRRRR - TTTTT DCT NNNNN - LLLLL</td>
</tr>
</tbody>
</table>
Network wide Pan-European Annex

a) The Annex contains a list of restrictions valid for each States/FABs/ANSPs on specific:

- Significant point/s; or
- ATS route segment/s; or
- Airspace volume/s (ATC Unit, AoR of relevant ATC Unit - CTA/UTA, TMA, CTR or individual control sector/s within an ATC unit).

b) The Annex also contains the relevant restrictions included in Letters of Agreement (LoA) between adjacent ATC Units requested to be “H” Hard checked. These restrictions are named “Cross-border”.

Fictitious Example

<table>
<thead>
<tr>
<th>Change record</th>
<th>Airway</th>
<th>FROM</th>
<th>TO</th>
<th>Point or Airspace</th>
<th>Utilization</th>
<th>Restriction Applicability</th>
<th>ID Number</th>
<th>Operational Goal</th>
<th>Remark/s</th>
<th>ATC Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA</td>
<td>BBBBB</td>
<td></td>
<td></td>
<td></td>
<td>H24</td>
<td>L_E_1001</td>
<td>To segregate traffic</td>
<td></td>
<td>ACC</td>
</tr>
<tr>
<td>UL1</td>
<td>CCCCC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23:00 - 03:00 (22:00 - 04:00)</td>
<td>E_1_2033</td>
<td>To dualise the traffic</td>
<td>FRA application</td>
<td>ACC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Airspace E_ _ _ES</td>
<td>Compulsory for traffic DEP/ARR</td>
<td>06:00 - 22:00 (05:00 - 21:00)</td>
<td>E_2002</td>
<td>To force traffic</td>
<td>ACC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.3.2 Restriction Structure

1. Each restriction is hierarchical and specific and has been arranged to facilitate parsing of the information into computer systems.

2. For the usage of the restricted object (significant point, ATS route segment, defined DCT, airspace volume (ATC Unit, AoR of relevant ATC Unit - CTA/UTA, TMA, CTR or individual control sector/s within an ATC unit, etc.) there are 3 (three) main types of restrictions:

   a) **Not available for** ...

      Flight planning via restricted object is forbidden for described flow(s).

   b) **Only available for** ...

      Flight planning via restricted object is allowed exclusively for described flow(s).

   c) **Compulsory for** ...

      Flight planning via restricted object is the only valid option for described flow(s).
(3) For the combination of elements that define the flow of traffic, there are 2 (two) types of restrictions - inclusive and exclusive:

a) **INCLUSIVE restriction** - traffic must meet ALL of the conditions to be subject to the restriction. The implicit logical operator between the listed conditions is an “AND” - Logical Conjunction.

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBBB</td>
<td>Not available or Only available or Compulsory for traffic Above FL275 With DEP ... With ARR ...</td>
</tr>
</tbody>
</table>

b) **EXCLUSIVE restriction** - traffic only needs to meet ONE of the numbered sub-conditions to be subject to the restriction. The implicit logical operator between the numbered conditions is an “OR” - Logical Disjunction.

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBBB</td>
<td>Not available or Only available or Compulsory for traffic 1. ARR ..... 2. Via ... Except a. ARR ...... b. DEP..... 3. Via ... with .....</td>
</tr>
</tbody>
</table>

(4) Usage of combinations and terms in utilization expression

(5) If circumstances allow or if it is required for better expression of the utilization, the 3 (three) usage types can be combined as follows:

a) “Only available” and “Compulsory” might be used in combination, resulting in “Only available and Compulsory”.

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBBB</td>
<td>Only available and Compulsory for traffic ARR .....</td>
</tr>
</tbody>
</table>

b) “Only available …” together with “Not available …”, are combined by using the formula:
"Only available for ...
Except ..."

**Fictitious Example**

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBB</td>
<td>Only available for traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ARR ....</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Except Via...</td>
</tr>
</tbody>
</table>

c) Combining "Compulsory... " with "Not available... " is NOT POSSIBLE. The TWO independent numbered expressions shall be given within the same box.

**Fictitious Example**

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBB</td>
<td>1. Compulsory for traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ARR ....</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Via...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above FL245 at...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Not available for traffic DEP</td>
</tr>
</tbody>
</table>

d) term "Except" to define usage:

The expression "Not available for traffic except ..." shall be avoided, "Only available for traffic..." shall be used instead.

**Fictitious Example**

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBB</td>
<td>Not available for traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Except DEP ....</td>
</tr>
</tbody>
</table>

It is the same as below which is clearer.

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
</table>
| UL1    | AAAAA - BBBB| Only available for traffic DEP...

e) The expression "Only available for traffic except" shall be used only if the combination of elements is inclusive.

**Fictitious Example**

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBB</td>
<td>Only available for traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ARR ....</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Via...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above FL245 at...</td>
</tr>
</tbody>
</table>
f) If the combination of elements is exclusive, it can lead to two different ways of interpretation. To have the required effect TWO (or more) independent numbered expressions shall be given within the same box.
Fictitious Example

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBB</td>
<td>Only available for traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Except DEP ....</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. ARR ....</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Via...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. ARR...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Via...</td>
</tr>
</tbody>
</table>

**Shall be expressed as:**

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBB</td>
<td>1. Only available for traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. ARR ....</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Via...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. ARR...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Via...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Not available for traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEP ....</td>
</tr>
</tbody>
</table>

**g)** Word “except” in expression of utilization can also be used in between brackets to exclude relevant destinations from Area/Group definitions; FIR/UIR; ACC/UAC; etc. used as terminal conditions.

Fictitious Example

<table>
<thead>
<tr>
<th>Airway</th>
<th>From - To</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL1</td>
<td>AAAAA - BBBB</td>
<td>Only available for traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ARR nnnnnn Group (except nnaa)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Via...</td>
</tr>
</tbody>
</table>

**h)** The 2 (two) combination of elements types might also be used alone or in combination.

(6) The term Requested FL (RFL) is used for RAD purposes and refers to the actual requested cruising level as specified in the ICAO flight plan field 15. Where it is used it shall be applied only to the State/FAB/ANSP in question unless otherwise specified. If a restriction specifies FL that is understood to be the flight level measured against IFPS calculated profile and is checked accordingly.

(7) Restrictions for the same restricted object (significant point, ATS route segment, defined DCT, airspace volume (ATC Unit, AoR of relevant ATC Unit - CTA/UTA, TMA, CTR or individual control sector/s within an ATC unit), etc.) may be identified by more than one unique identifier. Single restriction should aim at containing all the flow elements that concerns a single operational goal, or closely related operational goals.

(8) State/FAB/ANSP restrictions shall be uniquely identified by a 6 digit alpha/numeric identifier which comprises the ICAO nationality letters for location indicators assigned to the State of origin or 2 letter Regional / FAB
naming convention prefix code, together with a 4 digit number (LF2016, DU2001, RE2001). Exception from above rules is allowed for DCT identification in Appendix 4 where a maximum 9 digit alpha/numeric identifier containing 5 digit number might be used (LF50001, DU52345, RE54999, DSYX50000) and FUA restrictions in Appendix 7.

**Cross-border (RAD) restrictions**

**Definition**

(9) RAD restrictions, except if otherwise mutually agreed by the States/FABs/ANSPs, shall be categorized as being cross-border when they are referenced to:

a) boundary significant point;

b) ATS route segment or DCT starting from or ending at boundary significant point;

c) cross-border ATS route segment via boundary significant point or cross-border DCT.

(10) The referenced significant point shall be located on common boundary between two adjacent airspaces. The concerned airspaces might be FIRs / UIRs or ACCs / UACs or CTAs / UTAs or FABs or combination of them. These airspaces shall not be inside the same FAB, if FAB prefix code is used in identification.

(11) Cross-border restrictions might be or might not be part of the relevant LoA. Clear explanation for that shall be given by the appropriate National RAD Coordinator (NRC) in Column “Operational Goal”.

(12) For any State/FAB/ANSP restriction, not defined as cross-border and considered that has impact on adjacent State/FAB/ANSP clear explanation for that shall also be given by the appropriate National RAD Coordinator (NRC) in Column “Operational Goal”.

**Identification**

(13) Cross-border restrictions shall be identified with an 8 digit alpha/numeric identifier as follows:

a) twice ICAO nationality letters for location indicators assigned to the State followed by 4 digit number (EGEB1009); or

b) twice 2 letter Regional / FAB naming convention prefix code followed by 4 digit number (DUBM1001); or

c) ICAO nationality letters for location indicators assigned to the State and 2 letter Regional / FAB naming convention prefix code or vice-versa followed by 4 digit number (LWBM1001, DULY1001).

(14) First two letters are identifying the State / FAB / ANSP performing the ATC action, while the second two letters - State / FAB / ANSP affected by that action.

(15) The Maastricht UAC restrictions are considered as cross-border and shall be identified as follows:

a) inside AoR: ICAO nationality letters for location indicators assigned to the relevant State (EB, EG or EH) and 2 letters “YX” followed by 4 digit number (EBYX1009);

b) outside AoR: 2 letters “YX” and ICAO nationality letters for location indicators assigned to the neighbouring State or 2 letter Regional / FAB
naming convention prefix code followed by 4 digit number (YXED1001, YXIU1002).

**Coordination**

(16) Cross-border restrictions shall be coordinated between the NRCs of the States/FABs/ANSPs concerned BEFORE submission for inclusion in the RAD.

(17) Any cross-border restriction discovered by the NM RAD Team that has not been coordinated will be removed from the RAD until the coordination process has been completed.

**FUA restrictions Identification**

(18) The FUA restrictions shall be identified as follows:

- Restricted Airspaces Identifier (RSA ID) as published in State AIP followed by 1 letter R, S, T, U, V, W, X, Y (LBTSA11R); or

Note: In case of more than 8 FUA restrictions per RSA the NM RAD Team in coordination with relevant NRC/s and/or other NMOC Team/s is authorised to use other letters starting with Q on reversed order (Q, P, N, M, etc. with no use of letters “O” and “I”).

(19) When more than one FUA restriction is used for same RSA, the last letter shall be assigned based on the following rules:

- R - describes the most restrictive limitation/s in RSA availability;
- S - describes the less restrictive limitation/s different from those under letter “R”;
- T, U, V, W, X, Y - same descending logic as for letter “S”.

(20) Identifiers shall be assigned at RAD document as per tables below:

<table>
<thead>
<tr>
<th>Group ID</th>
<th>Origin ID</th>
<th>Restriction type</th>
<th>Restriction subtype</th>
<th>Publication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 99</td>
<td>Country code or ATC Units or Regional / FAB ID</td>
<td>DCT</td>
<td>DCT limit inside ATC Units</td>
<td>Appendix 4</td>
</tr>
<tr>
<td>400</td>
<td>Country code or ATC Units or Regional / FAB ID</td>
<td>DCT</td>
<td>Cross-border DCT limit</td>
<td>Appendix 4</td>
</tr>
<tr>
<td>1000 - 1499</td>
<td>Country code or Regional / FAB ID(s)</td>
<td>Traffic Flow</td>
<td>Cross-border restrictions</td>
<td>Pan-European Annex</td>
</tr>
<tr>
<td>2000 - 3999</td>
<td>Country code or Regional / FAB ID(s)</td>
<td>Traffic Flow</td>
<td>State / FAB / ANSP restrictions</td>
<td>Pan-European Annex</td>
</tr>
<tr>
<td>4000 - 4999</td>
<td>Country code or Regional / FAB ID(s)</td>
<td>Traffic Flow</td>
<td>City pair level capping</td>
<td>Appendix 3</td>
</tr>
<tr>
<td>5000 - 5499</td>
<td>Country code or Regional / FAB ID(s)</td>
<td>Traffic Flow</td>
<td>Conditions on DCT segments Point-to-Point</td>
<td>Appendix 4</td>
</tr>
<tr>
<td>5000 - 5499</td>
<td>Country code or Regional / FAB ID(s)</td>
<td>Traffic Flow</td>
<td>Conditions on DCT segments to/from airfields</td>
<td>Appendix 5</td>
</tr>
<tr>
<td>6000 - 6099</td>
<td>Country code or Regional / FAB ID(s)</td>
<td>Traffic Flow</td>
<td>Plain text notes</td>
<td>Whole document</td>
</tr>
<tr>
<td>6100 - 6499</td>
<td>Country code or Regional / FAB ID(s)</td>
<td>Traffic Flow</td>
<td>Conditions on consecutive DCT segments Point-Point</td>
<td>Appendix 4</td>
</tr>
<tr>
<td>7000 - 7499</td>
<td>Country code or Regional / FAB ID(s)</td>
<td>Traffic Flow</td>
<td>Military restrictions</td>
<td>Whole document</td>
</tr>
<tr>
<td>8000 - 8999</td>
<td>Country / FIR code or Regional / FAB code ID</td>
<td>Traffic Flow</td>
<td>Flight Profile Restrictions</td>
<td>Appendix 6</td>
</tr>
<tr>
<td>R, S, ..., Y</td>
<td>RSA ID as per AIP</td>
<td>FUA</td>
<td>FUA</td>
<td>Appendix 7</td>
</tr>
</tbody>
</table>
Prefix code | Region / FAB / ANSP (State / ANSP)
--- | ---
BL | BALTIC FAB (Poland, Lithuania)
BM | BLUE MED FAB (Italy, Greece, Cyprus, Malta)
CE | FAB CE - FAB CENTRAL EUROPE (Austria, Czech Republic, Croatia, Hungary, Slovakia, Slovenia, Bosnia and Herzegovina)
DU | DANUBE FAB (Bulgaria, Romania)
DS | DENMARK / SWEDEN FAB (Denmark, Sweden)
EC | FABEC - FAB EUROPE CENTRAL (France, Germany, Switzerland, Belgium, Netherlands, Luxembourg, Maastricht UAC)
NE | NORTH EUROPEAN FAB (Estonia, Finland, Latvia, Norway)
PE | SOUTH WEST FAB (Spain / Portugal)
IU | UK / IRELAND FAB (United Kingdom, Ireland)
YX | Maastricht UAC
RE | Regional / Pan-European / Axis

(21) Where date/time ranges are used these shall be considered as INCLUSIVE. When time periods are expressed in column "Restriction" or column "Utilization", restrictions are not applied outside those published times unless otherwise specified.

(22) A restriction shall not qualify for inclusion in the RAD unless it has a FLOW ELEMENT attached to it. A FLOW ELEMENT is defined as affecting either:
   a) Departures from an Airfield/Group/Area;
   b) Arrivals to an Airfield/Group/Area;
   c) Traffic flying between Airfields/Groups/Area;
   d) Overflying traffic.

Time periods

(23) The time periods are in Co-ordinated Universal Time (UTC) used by air navigation services and in publications issued by the AIS. The expression “summer period” indicates that part of the year in which “daylight saving time” is in force. The other part of the year is named the “winter period”. Times applicable during the “summer period” are given in brackets. Daylight saving time is UTC plus 1 hour. The “summer period” in Europe is introduced every year on the last Sunday in MAR at 01:00 UTC and ceases on the last Sunday in OCT at 01:00 UTC. For detailed description in each State the relevant AIP shall be checked.

(24) Details of weekend periods, if and when used are included where relevant. The start and end time of the periods relates to the entry to the segment concerned.

(25) Additional periods can be declared as weekends (e.g. Busy Fridays, Nights, Bank Holidays), refer to national publication and relevant annex for the details.

(26) To access data regarding Public Holidays pertinent to each State, refer to GEN 2.1 of the respective AIP.

Definition of limits expressed by FL

(27) The vertical limits shall be expressed as follows (ref. ERNIP Part 1):
   a) above the lower limit or minimum en-route altitude and below FL290 - VFR flight levels in accordance with ICAO Annex 2, Appendix 3, page 1 (e.g. FL035 or corresponding altitude ... FL285);
b) above FL290 and below FL410 in RVSM areas - number representing the layer/intermediate level between IFR flight levels ending on ..5 (e.g. FL295 ...FL405);

c) above FL410 or above FL290 in non RVSM areas - number representing the layer/intermediate level between IFR flight levels ending on ..0 (e.g. FL420 ...FL500 ...).

**Expression of abbreviated words meaning Departure and Destination**

(28) In all Appendixes and Pan-European Annex, if and when used and required the expression of abbreviated words meaning Departure and Destination from/to certain airport/s or in/outside FIR/UIR / ACC/UAC/ ATC Units shall be used based on ICAO Doc 8400 PANS-ABC Abbreviations and Codes as follows:

a) **DEP** - code meaning “Depart” or “Departure”;

b) **ARR** - code meaning “Arrive” or “Arrival”.
8.4 Period of Validity

The routeing organisation is permanently effective and applies daily H24, except where otherwise specified. When it can be identified that capacity is surplus to demand the RAD restrictions may be relaxed from the H24 time constraints.

The RAD may be suspended, or temporarily relaxed, in cases where it has an abnormally adverse impact upon the traffic flows. This action will always be co-ordinated through the CDM process between the Network Manager and its Operational Stakeholders.
8.5 Application

(1) The RAD will be fully integrated into the Network Manager Operational systems, including IFPS, through the Route Restrictions computer model. Any changes to the Pan-European Annex will automatically be checked provided the relevant notification period has been observed.

(2) Changes agreed outside the AIRAC cycle will not be handled automatically by IFPS until such time as the system can be updated at the appropriate AIRAC date.
8.6 CDM Process

(1) Amendments to the General Description of the RAD, or the period of validity, shall be co-ordinated between the Network Manager and the Operational Stakeholders via the RAD Management Group (RMG) and approved by NETOPS team. Inclusion or withdrawal of additional Annexes or Appendixes shall follow the same process.

(2) The Operational Stakeholders shall provide their request for changes to the NM RAD Team, taking into account agreed publication and implementation dates, in accordance with AIRAC procedures and Handbook Supplement for the Provision of Environment data.

(3) All new RAD restrictions, amendments and changes will be checked by the NM RAD Team versus airspace organisation in the area. Any possible discrepancies will be notified to the States/FABs/ANSPs concerned as soon as possible.

(4) Suspension of NAVAIDs, and/or replacement by temporary mobile units will be promulgated via the Pan-European Annex. States should ensure that the NM RAD Team is notified of these changes.

(5) The final content of any amendment to the RAD shall be positively agreed between the NM RAD Team and State/FAB/ANSP concerned. This agreement shall be reached in a form of e-mail confirmation, meeting report/minutes or any other means reflecting final mutual agreement for change. These agreements will be properly recorded by the Network Manager.

(6) Amendments will be published by the NM RAD Team as follows:

a) 34 days in advance of the relevant AIRAC cycle;

b) Until establishment of automated RAD process amendments will be highlighted in RED / BLUE BOLD lettering and will be annotated by abbreviation NEW / AMD;

c) Restrictions that have been removed will be annotated by abbreviation DEL;

d) “Last minute” changes:

- are changes required due to exceptional circumstances and/or only when they have a significant impact on operational requirements;
- shall be:
  - announced by the NRCs as ordinary amended (AMD / DEL) or new RAD requirements (NEW);
  - exceptionally annotated as such;
  - sent via e-mail to the NM RAD Team in accordance with ERNIP Part 4;
- will be promulgated on the NM NOP portal via the “Increment File”.

8.7 Temporary changes

(1) Temporary changes due to exceptional circumstances (e.g. major equipment failure, industrial action or large-scale military exercises) may necessitate the suspension of part of the RAD for specified periods, and additional routeings will be activated where possible following co-ordination with the relevant FMPs and AOs.

(2) Temporary changes will be published by AIM giving details of the traffic affected, the period of activation and the corresponding routeings.
8.8 Flight Planning

(1) The RAD defines restrictions on routes/points, through specified areas during the published period of validity. Aircraft operators planning flights through these areas must flight-plan in accordance with these route restrictions, taking into account any change of validity.

(2) When a route is restricted between two points it must be understood that all segments, between the recorded points, are included in the restriction.

(3) An operator who has submitted a flight plan for a route and wishes to change to another route must either; send a CHG (Change) message giving the new route or; cancel the existing flight plan and submit a new flight plan following the replacement flight plan procedure. This applies equally to re-routeing proposed by the Network Manager and to changes made at the initiative of the AO.

(4) When filing flight plans, AOs must comply with any flight level limitation published in the RAD. AOs shall be aware that when receiving the confirmed FPLs the FLs used are NOT checked against the Flight Level Orientation Scheme (FLOS) applied by the State concerned.

(5) AOs shall also be aware that when receiving the confirmed FPLs using DCT options from Appendixes 4 and 5 these flight plans are NOT checked against Minimum Sector Altitudes (MSA) or Minimum En-route Altitudes (MEA) published by the States in the relevant parts of their AIPs. In accordance with provisions of ICAO Doc 4444 PANS-ATM AOs remains responsible with the checking of MSA and/or MEA.

Note: (Refer to IFPS Users Manual for full details)
8.9 Routeing Scenarios

(1) For each area expected to be critical, a number of flows could be identified, for which other routeings are available, that follow the general scheme, but avoid the critical area. These are known as routeing scenarios.

(2) When, during the planning phase, the Network Manager identifies the risk of major imbalance between demand and capacity, it may be decided, after agreement with all FMPs concerned, to make part (or all) of the alternative routeings mandatory for the period expected to be critical.

(3) Scenarios may be identified which require the temporary suspension of route restrictions within the RAD for a particular traffic flow.

(4) The list of available scenarios is promulgated on the NM NOP portal.
### 8.10 Publication

(1) The RAD is created in accordance with ICAO publication procedures and is published on the NM NOP website, 34 days prior to the relevant AIRAC cycle.

(2) Each State may promulgate the RAD by any one of the following methods:

   a) Publish the RAD in its entirety as an AIP Supplement (the onus is on the State to ensure that the RAD is kept up to date);
   b) Publish relevant Appendices and State/FAB/ANSP part of the Pan-European Annex of the RAD as an AIP Supplement;
   c) Publish reference to the NM NOP website in the AIP, in accordance with Annex 3.

<table>
<thead>
<tr>
<th>DAY</th>
<th>PROCESS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-63</td>
<td>Notification to States/FABs/ANSPs &quot;One week to Cut-off&quot;.</td>
<td>NM</td>
</tr>
<tr>
<td>D-56</td>
<td>Finalisation of States/FABs/ANSPs requirements. Cut-off date. States/FABs/ANSPs provide amendments to NM.</td>
<td>States/FABs/ANSPs</td>
</tr>
<tr>
<td></td>
<td>Three weeks to compile the RAD and to resolve errors/conflicts.</td>
<td>NM</td>
</tr>
<tr>
<td>D-34</td>
<td>Publication. Two weeks to assess impact of new restrictions.</td>
<td>NM</td>
</tr>
<tr>
<td>D-14</td>
<td>Results of impact assessment of new restrictions. Changes/amendments to be promulgated via the &quot;Increment File&quot; on the NOP Portal.</td>
<td>NM</td>
</tr>
<tr>
<td>D-10</td>
<td>Freeze of ENVironment tape for AIRAC.</td>
<td>NM</td>
</tr>
</tbody>
</table>

(3) Where applicable, publication of route availability in national aeronautical information publications shall be fully consistent with this common reference document.
8.11 Tactical Operations

(1) The Network Manager in conjunction with the FMPs will monitor the actual situation during the day of operation to ensure the RAD is achieving the balance of traffic required.

(2) During periods of unanticipated high demand the Network Manager may co-ordinate an extension to the period of validity of routeing scenarios with the relevant FMPs. This will be published by AIM, giving at least three hours notice.

(3) During periods of significant improvement to the ATFCM situation, the Network Manager will co-ordinate with the relevant FMP, a reduction in the period of validity of scenarios. This will be published by AIM.

(4) If, due to a major unexpected event, there is a significant disturbance to traffic patterns, after co-ordination with the relevant parties (FMPs and AO’s), the Network Manager may suspend part of the RAD and provide alternative routeings.

(5) With effect from AIRAC -6 day (D -6), implemented RAD data is considered as Operational. Management of such changes to the RAD is the responsibility of the NRC of the originating State.

(6) If, after AIRAC -6 day (D -6), a State discovers an error or omission to the RAD that is SAFETY RELATED, then it is the responsibility of the NRC to contact the NM RAD Team to request a live update of the NM CACD in order to correct the problem. The safety related RAD error or omission shall be exceptionally annotated as such and shall be sent via e-mail to the NM RAD Team in accordance with ERNIP Part 4. The NM RAD Team will only act after consultation with the NRC or his designated Deputy. Following the consultation process the NM RAD Team shall create the necessary DMR and the change shall be promulgated via the “Increment File”. During the weekend, the ACC shall contact the Current Operations Manager and the matter shall be handled MANually. A second alternative is to request that the restriction in question be DISABLED in ENVironment so that there will not be a check at IFPS.
8.12 RAD Review

(1) The NM RAD Team is responsible for coordination of the entire RAD review process.

(2) The RAD review is required to ensure that all data contained within the RAD is current and correct. The review is also the opportunity to ensure that any modifications, within the incremental update to the Network Manager Operational systems, are reflected in the construction of RAD restrictions.

(3) A RAD review for each and every Annex/Appendix, including cross-border restrictions, shall be completed annually during designated meetings and as a rolling process by the NM RAD Team. The existing South West, South East, North West, North East or Ski - Airspace or ATFCM meetings could be used for RAD review purposes. Additional ad-hoc RAD review meetings could be organised in case of any urgent issues to be discussed.

(4) The outcome of each RAD review shall be properly documented through the report or minutes. The reports/minutes will be stored by the NM RAD Team.

(5) Each State/FAB/ANSP shall convene an internal RAD review with the airlines concerned. Such an internal review shall be announced to the NM RAD Team and shall cover as minimum the validity of all restrictions; the timeliness of restrictions; the completeness of all restrictions. The NM RAD Team may offer items to be covered. The results of such an internal review shall be passed to the NM RAD Team as soon as possible.

(6) For each cross-border RAD review the NM RAD Team shall perform a RAD impact assessment on each relevant restriction. This analysis shall be carried out together with the Operational Stakeholders.

(7) The NM RAD Team shall maintain a List of proposed/requested by the AOs RAD restrictions for consideration by the States/FABs/ANSPs. The List shall contain the restrictions traceability and shall record the proposal’s status as change/removal/update till RAD restriction resolution or deletion.
8.13 Additional airspace utilisation rules and availability

INTRODUCTION

(1) Additionally to the RAD airspace utilisation rules and availability the NM also maintains other airspace utilisation rules (restrictions) which might impact the traffic flows at Network level.

(2) These additional airspace utilisation rules are not part of the RAD as they are not qualified for inclusion by not having a flow element attached to them. They shall not be categorized as one of the three inclusive or exclusive or compulsory RAD restrictions (the description of flow element and RAD restriction types is given in section 8.3. above).

BASIC PRINCIPLES

(3) The content of each restriction and its implementation shall be agreed between the NM and the Operational Stakeholders through an appropriate cooperative decision making (CDM) process.

(4) All additional restrictions are implemented in the NM CACD and are maintained by the NM.

(5) All additional restrictions are also subject to continuous review, as minimum 2 (two) times per year, by the NM and the Operational Stakeholders to ensure that the requirements are still valid.

RESTRICTION DEFINITION AND PURPOSE

1) EU / EURO restrictions

(6) A temporary (duration of few hours, daily, weekly) or seasonal airspace related information and/or other information influencing the air navigation is considered either as “EU” or “EURO” restriction.

(7) These restrictions are marked as Forbidden (F), Mandatory (M) or Closed (C) and could also be considered as Active and non-Active, which are live updated, based on sources received by the States/ANSPs (NOTAM, AIP SUP, AUP/UUP etc.)

(8) “EU” restriction can be implemented for:
   a) Major Military exercise/s;
   b) Special event/s;
   c) Industrial action/s;
   d) AIP Supplement/s;
   e) Aeronautical Information Circular/s (AIC/s);
   f) NOTAM/s;
   g) Contingency plans;
   h) Crisis management.

(9) “EURO” restriction can be implemented for Traffic Flow Restrictions published in AIP (ENR part).

(10) For flight plan processing purposes “EU” and “EURO” restrictions are technically qualified as “Hard Traffic Flow Restrictions”. Flight plan checking against “EU” and “EURO” restrictions is handled in the same way as against RAD restrictions.

(11) These types of restrictions are used to generate valid route/s.
2) **Profile Tuning Restriction (PTR)**

(12) Profile tuning restriction is influencing the flight profile calculation in order to be correctly counted in certain operational airspace/s. At a later stage this flight profile is checked against the RAD.

(13) Additionally this restriction might also be used to allow correct addressing in IFPS.

(14) The ETFMS will in all cases try to avoid a PTR by applying profile banding/adapting the profile in climb or descend phases. If a PTR is incoherent with other data then a message shall be generated and logged.

3) **Aerodrome Flight Rule Restriction**

(15) Aerodrome Flight Rule Restriction defines that arrivals to or departures from the aerodrome reference location must be conducted under VFR.

(16) Departing from and/or arriving at an aerodrome, which has no IFR equipment, must be done under VFR. States/ANSPs require that this information is present in the FPL ITEM 15. IFPS shall invalidate a FPL if it does not reflect the correct flight rules on the last segment before the aerodrome of destination or first segment after the aerodrome of departure e.g. if the flight is not conducted under VFR, an error message is generated.

(17) This type of restriction has no impact on ETFMS.

4) **Flight Property Restriction on Terminal Procedures**

(18) The use of terminal procedures is often restricted to given flight property conditions such as aircraft type/classification (e.g. “propellers only” or “jet only”), type of flight (e.g. military), aircraft equipment (e.g. ILS).

(19) Defining restriction of this type shall allow IFPS to select more accurately the most suitable Terminal Procedure for a flight and invalidate those FPLs containing a wrong Terminal Procedure.

(20) This restriction has an impact on the Terminal Procedure selected by ETFMS, based on the specific properties of the restriction.

5) **DCT Limitation Restriction**

(21) The general en-route DCT distance limits and cross-border DCT distance limits defined in the RAD at operational level will serve to invalidate FPLs that contain too long DCT segments. Individual DCT segments which are longer but nevertheless allowed can be defined as exceptions to this rule. Also there will be individual DCT segments that are shorter but not-allowed neither. The latter will be expressed as secondary restriction to the primary restriction which reveals the actual DCT distance limit.

(22) Secondary en-route DCT limitations can be defined to express deviating DCT limits on particular airspaces and/or specific type of flights such as military.

(23) Similarly aerodrome departure and arrival DCT distance limits will be defined in a restriction. Such a restriction will also contain the allowed DCTs that are the aerodrome connecting points as defined in the RAD.

(24) This type of restriction is used to generate valid route/s.
6) **FRA DCT Restriction**

(25) This restriction defines rules for flying direct (DCT) in the Free Route Airspace (FRA). They have the same features as a conventional DCT limitation restriction, extended with the possibility to define the entry/exit points and the intermediate points for the FRA.

(26) This type of restriction is used to generate valid route/s in FRA.

7) **SSR Code Allocation Restriction**

(27) This restriction is used to define which flights can be allocated which range of SSR codes by the NM Centralised Code Assignment and Management System (CCAMS).

(28) This type of restriction has no impact on ETFMS.
Appendix

A. ANT Airspace Classification Toolbox

Attachment A to ANT/50 WP09

Airspace Classification Toolbox v 28/09/09

1. Tools that if applied by a member State would require that State to notify a difference to ICAO

1.1 IFR flights in Class G airspace at and below 900 m (3000 ft) AMSL, or 300 m (1000 ft) AGL - Tool 1

Annex 2, Table 3.1

Rationale:

ICAO permits IFR flight in Class G airspace at all levels. Most member States are content with this accommodation, but some member States have a safety concern over its application in their airspace at and below 3000 ft AMSL or 1000 ft above the ground. An independent safety and impact analysis was conducted in 2007 - 2008. The principal issue of concern among some member States relates to the less prescriptive VMC minima in this level band whereby, in airspace classes F and G, VFR flights are merely required to remain clear of cloud and in sight of the surface. In all other airspace classes a minimum distance from cloud, both horizontally and vertically, is specified.

Member States would appear to have four options in respect of the integration of IFR and VFR flights in Class F or G airspace in this level band:

a) A member State is satisfied with the level of safety of this integration in a particular operating environment, with or without mitigations, or

b) A member State is not satisfied with the level of safety of this integration in a particular operating environment, with or without mitigations, and does not allow IFR flights in this level band, or

c) A member State is not satisfied with the level of safety of this integration in a particular operating environment, with or without mitigations, and amends the VMC minima to overcome the safety concern, or

d) A member State is not satisfied with the level of safety of this integration in a particular operating environment, with or without mitigations and applies a different airspace classification, e.g. A - E.
1.2 CTR VMC criteria - Tool 2

Annex 2, Chapter 4, Paragraph 4.1:
Except when operating as a special VFR flight, flights shall be conducted so that the aircraft is flown in conditions of visibility and distance from clouds equal to or greater than those specified in Table 3-1, viz. for airspace classes A-E, 1500 m horizontally and 300 m (1000 ft) vertically clear of cloud.

In airspace classes E, F and G at and below 3000 ft AMSL or 1000 ft above ground, whichever is the higher, clear of cloud and in sight of the surface is permitted for VFR flights. This also applies in these airspaces where IFR flights are operating even though all aircraft and ATC do not know of all of the aircraft operating in that airspace. In the CTR environment, the airspace is fully controlled, ATC have issued clearances to all aircraft, know of their position and intentions, and provide separation as necessary between them. It is argued that this in significantly safer and more manageable by ATC than outside controlled airspace. Therefore, to permit more flexibility within a CTR, since VMC minima is reduced in Class F & G airspace, it is proposed to introduce a similar reduced criteria for VMC criteria in a controlled environment of a CTR.

Rationale:

The main reason for this difference from ICAO is to provide more flexibility to control VFR flights by removing the need to remain “1000 ft distance from cloud” in a CTR together with other restrictions that would otherwise have to be applied to special VFR flights in this circumstance.
The advantages of this difference are:
- more than one VFR flight can operate within a CTR without the need for IFR separation;
- managing the interaction between VFR flight and IFR flights.

Tool 2 - CTR VMC Criteria

Within a control zone, when traffic conditions permit and a clearance is obtained from an air traffic control unit, VFR flights permitted to remain clear of cloud and in sight of the surface provided that:

a) they maintain a flight visibility of at least 5 km, and 
b) the cloud ceiling is at least 1500 ft.

Classes affected: A, B, C, D

Note: Tool 2 would constitute a Category C ICAO difference.

2. Tools that standardise parameters left by ICAO to the discretion of the appropriate ATS authority and do not require the notification of a difference to ICAO

2.1 VMC minima for class F and G airspace at and below 900 m (3000 ft) AMSL - Tool 3

Annex 2, Table 3:

At and below 900 m (3000 ft) AMSL, or 300 m (1000 ft) above terrain, whichever is the higher; "When so prescribed by the appropriate ATS authority".

Rationale:

ICAO provides the opportunity for an appropriate ATS authority to prescribe a number of VMC options in respect of lower level and/or lower performance aircraft, including helicopters. A number of States have variously interpreted this option, particularly with respect to being more specific with the speed criteria. ICAO provides for "at speeds".

A number of States have been more specific and stipulated a maximum speed, i.e. at 140 kts or less, at which that particular provision is acceptable.

Equally, in the case of helicopters, whilst accepting the possibility of a lower visibility of "not less than 1500 m, a number of member States see the need to apply an absolute minimum visibility, the majority of whom stipulate not less than 800 m.
Tool 3 - VMC Criteria in class F and G airspace at and below 900 m (3000 ft) AMSL or 300 m (1000 ft) above terrain, whichever is the higher

For VFR flight during daylight hours, when operating in airspace classes F or G, at and below 900 m (3000 ft) AMSL or 300 m (1000 ft) above terrain, whichever is the higher, and when so prescribed by the appropriate ATS authority, flight visibility reduced to not less than 1500 m may be permitted for flights which are clear of cloud and in sight of the surface and operating:

- (Aircraft other than helicopters) at 140 kts IAS or less that, in the prevailing visibility, will give adequate opportunity to observe other traffic or any obstacles in time to avoid a collision; or

- in circumstances in which the probability of encounters with other traffic would normally be low, e.g. in areas of low traffic volume and for aerial work at low levels.

- HELICOPTERS may be permitted to operate in less than 1,500 m but not less than 800 m flight visibility, if manoeuvred at a speed that will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision.

2.2 Special VFR - Tool 4

Annex 2, chapter 4.1:

Except when operating as a special VFR flight, VFR flights shall be conducted so that the aircraft is flown in conditions of visibility and distance from clouds equal to or greater than those specified in Table 3-1

PANS-ATM chapter 7.14.1 Authorisation of Special VFR flights:

7.14.1 When traffic conditions permit, special VFR flights may be authorised subject to the approval of the unit providing approach control service and the provisions of 7.14.1.3

7.14.1.2 Requests for such authorisation shall be handled individually.

7.14.1.2 Separation shall be effected between all IFR flights and special VFR flights in accordance with separation minima in Chapters 5 and 6 and, when so prescribed by the appropriate ATS authority, between special VFR flights in accordance with separation minima prescribed by that authority.

7.14.1.3 When the ground visibility is not less than 1500 m, special VFR flights may be authorised to: enter a control zone for the purpose of landing, take-off and departing from a control zone, cross a control zone or operate locally within a control zone.
Rationale:

Special VFR criteria are not stipulated by ICAO. Consequently, historically member States have devised their own criteria. Special VFR represents the widest diversity or extent of criteria applied by member States. In order to propose standardisation the most widely used and/or those same as or closest to ICAO VMC minima were chosen in order to provide a coherent set of criteria. Whilst most member States make provision for special VFR by day, very few States appear to permit special VFR flights at night, therefore no tool is offered. A visiting pilot cannot inadvertently contravene that State’s regulations because an ATC clearance is required which would not be given.

Tool 4 - SVFR in a CTR

When so prescribed by the appropriate ATS authority special VFR flight may be authorised to operate within a control zone, subject to an ATC clearance, under the following conditions:

- during daylight hours
- the ground visibility is at least 1500 m
- the ground visibility is not less than 800 m for helicopters
- the cloud ceiling is at least 600 ft
- clear of cloud and in sight of the surface
- the flight visibility is at least 1500 m
- the flight visibility is not less than 800 m for helicopters
- at a speed that, in the prevailing visibility, will give adequate opportunity to observe other traffic and any obstacles in time to avoid a collision.
- The appropriate ATS authority may effect separation between special VFR flights with a separation minima prescribed by that authority.
2.3 VFR at night - Tool 5

Annex 2 chapter 4.3:

"VFR flights between sunset and sunrise, or such other period between sunset and sunrise as may be prescribed by the appropriate ATS authority, shall be operated in accordance with the conditions prescribed by that authority."

Rationale:

Not all member States permit VFR flight at night. Of those that do most adhere to ICAO daytime VMC criteria although not permitting the reduced VMC minima applicable at and below 3000 ft AMSL or 1000 ft above ground, whichever is the higher. Even so there is concern amongst some stakeholders as to the practicality of a pilot being able to judge his compliance with these criteria at night.

Tool 5 - VFR at night

When so prescribed by the appropriate ATS authority, when operating VFR flight at night in airspace classes B, C, D, E, F or G, such flights shall be conducted under the following conditions:

a) At and above FL100
   - flight visibility at least 8 km
   - distance from cloud: 1,500 m horizontally, 1,000 ft vertically

b) Below FL100, above 3,000 ft AMSL
   - flight visibility at least 5 km
   - distance from cloud: 1,500 m horizontally, 1,000 ft vertically

c) At and below 3,000 ft AMSL
   - flight visibility at least 5 km*
   - minimum cloud ceiling 1,500 ft
   - clear of cloud and in sight of the surface
   - * 3 km for helicopters in class F and G, provided the pilot maintains continuous sight of the surface and if manoeuvred at a speed that will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision.

d) File a flight plan, when flights are leaving the vicinity of the aerodrome

e) Establish and maintain two-way communication on the appropriate frequency with ATS where required

Note: Higher minima for mountainous terrain may be prescribed by the appropriate authority
2.4 Optional additional VFR communications requirement - Tool 6

Annex 2, chapter 4.9:

A VFR flight operating within or into areas, or along a route, designated by the appropriate ATS authority in accordance with 3.3.2.2 c) or d) shall maintain continuous air-ground voice communication watch on the appropriate communication channel of, and report its position to, the air traffic services unit providing flight information service.

References to paragraphs 3.3.2.2 c) and d) concern the need or otherwise to file a flight plan when so required by the appropriate ATS authority.

Rationale:

A number of member States stipulate the requirement for VFR flights to establish and maintain two-way communications with ATS under certain circumstances. This is particularly so for some remote aerodromes in class G airspace where there is an occasional IFR arrival or departure such that it does not warrant the provision of an Air Traffic Control Service but more usually an Aerodrome Flight Information Service. In addition, a number of member States currently have the requirement for mandatory carriage two-way communications with ATS for all aircraft in all airspace classes at night.

This tool seeks to standardise those circumstances

Tool 6 - Optional additional VFR communications requirement

a) When operating in airspace classes E, F or G, mandatory two-way communication or continuous listening watch may be required for VFR flights on the appropriate ATS radio frequency in designated airspace.

Note: 1. Awaiting clarification from ICAO. If considered a difference from ICAO, would constitute a Category C difference.

2. See also VFR at night (Tool 5)

2.5 Optional relaxation of requirement for mandatory two-way RT Communications for IFR flights in class F & G airspace - Tool 7

Annex 2, chapter 5.3.2:

An IFR flight operating outside controlled airspace but within or into areas or along routes, designated by the appropriate ATS authority in accordance with 3.3.1.2 c) or d) shall maintain an air-ground voice communication watch on the appropriate communication channel and establish two-way communication, as necessary, with the air traffic services unit providing flight information service.

References to paragraphs 3.3.1.2.c) and d) concern the need or otherwise to file a flight plan when so required by the appropriate ATS authority.
Annex 11, Appendix 4, ATS airspace classes - services provided and flight requirements:

Classes F and G, IFR flights radio communication requirement - continuous two-way.

Rationale:

ICAO provides for some relief from the requirement for IFR flights to maintain continuous two-way communication with ATS. This tool seeks to clarify and standardise the application of this provision. The most common application is where radio coverage provided by ATS is affected by terrain such that it cannot provide the continuity of radio coverage to make this requirement possible. The tool is designed to ensure that the obligation of the IFR flight to be suitably equipped with radio communication and ATS frequencies is maintained even though two-way communications may not always be established.

Tool 7 - Optional relaxation of requirement for mandatory two-way RT Communications for IFR flights in class F & G airspace

When operating in airspace classes F or G, although IFR flights are required to carry and operate a radio on the appropriate ATS frequency, IFR two-way communication may only be required above an altitude prescribed by the appropriate ATS authority. Consequently FIS would only be provided above an altitude prescribed by the appropriate ATS authority.
2.6  Mandatory carriage of SSR - Tool 8

ICAO Annex 11, Chapter 2, paragraph 2.26

States shall establish requirements for carriage and operation of pressure-altitude reporting transponders within defined portions of airspace.

Note: This provision is intended to improve the effectiveness of air traffic services as well as airborne collision avoidance systems

Rationale:

In order to achieve a “known traffic environment” especially in Class E airspace. It provides an additional protection for departing and arriving IFR flights outside a CTR or TMA. It has a particular application at aerodromes where the traffic volume or complexity is not considered sufficient for the application of class C or D airspace. In addition, a number of member States currently have the requirement for mandatory carriage of SSR for all aircraft in all airspace classes at night.

The establishment of a TMZ may also enable controllers to detect inadvertent penetration of controlled airspace, which could enable controllers to initiate appropriate avoiding action, and also enable additional safety nets such as traffic collision avoidance system (TCAS) to assist with the resolution of potential conflicts arising from inadvertent penetrations of controlled airspace.

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**Tool 8 - Mandatory Carriage of SSR**

Mandatory carriage of SSR modes A & C, or mode S may be required as follows:

a) in designated airspace (CTR, TMA, TMZ, MSSRA, etc.)

b) at night
B. Harmonized CDR AIP publication

FICTITIOUS EXAMPLE OF CDR EXPLANATORY NOTES

The times and conditions when CDRs are available for flight planning are described in remarks column in the Tables below.

<table>
<thead>
<tr>
<th>Purpose of CDRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Conditional Routes&quot; (CDRs) complement the permanent ATS route network. The purpose of CDRs is to allow flights to be planned on and to use ATS routes, or portions thereof that are not always available.</td>
</tr>
<tr>
<td>CDRs are established:</td>
</tr>
<tr>
<td>- through any potential areas of temporary segregation identified under the generic term “AMC Manageable Areas” (TRAs, TSAs or R or D Areas), with CDR opening/closure resulting from associated military activities and/or</td>
</tr>
<tr>
<td>- to address specific ATC conditions (e.g. traffic restrictions or ATC sectorisation compatibility), with CDR opening/closure resulting from purely civil needs.</td>
</tr>
<tr>
<td>The conditions for the use of CDRs will be daily published in the national Airspace Use Plan (AUP), Updated Airspace Use Plan (UUP) and notified to the Operational Stakeholders via European AUP/UUP (EAUP/EUUP).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Categories of CDRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>As described in the ERNIP Part 1, CDRs are divided into three different categories according to their foreseen availability and their flight planning potential. A CDR can be established in one or more of the three following categories:</td>
</tr>
<tr>
<td><strong>Category One (CDR 1)</strong></td>
</tr>
<tr>
<td>- Permanently Plannable;</td>
</tr>
<tr>
<td>- Expected to be available for most of the time;</td>
</tr>
<tr>
<td>- Flights will be planned in the same way as planned for all permanent ATS routes;</td>
</tr>
<tr>
<td>- In the event of a short notice unavailability of a CDR 1, aircraft will be tactically handled by ATC;</td>
</tr>
<tr>
<td>- For the calculation of fuel consumption, alternate routes are published in the “Remarks” column.</td>
</tr>
<tr>
<td><img src="image" alt="UL1 (CDR 1)" /></td>
</tr>
<tr>
<td><strong>Category Two (CDR 2)</strong></td>
</tr>
<tr>
<td>- Non-Permanently Plannable;</td>
</tr>
<tr>
<td>- Part of pre-defined routing scenarios which respond to specific capacity imbalances;</td>
</tr>
<tr>
<td>- Flights will be planned only in accordance with conditions daily published in the EAUP/EUUP.</td>
</tr>
<tr>
<td><img src="image" alt="UL2 (CDR 2)" /></td>
</tr>
<tr>
<td><strong>Category Three (CDR 3)</strong></td>
</tr>
<tr>
<td>- Not Plannable;</td>
</tr>
<tr>
<td>- Published as usable on ATC instructions only;</td>
</tr>
<tr>
<td>- Flights will be re-routed on ATC instructions as short notice routing proposals.</td>
</tr>
<tr>
<td><img src="image" alt="UL3 (CDR 3)" /></td>
</tr>
</tbody>
</table>
## FICTITIOUS EXAMPLES OF CDR PUBLICATION

In relevant AIP sub-section remarks column

<table>
<thead>
<tr>
<th>CDR 1 H24</th>
<th>CDR 1 Mixed Time Categories (daily base)</th>
<th>CDR 1 Mixed Time Categories (weekly base)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDR 1 H24</td>
<td>CDR 1 23:00 - 05:00 (22:00 - 04:00)</td>
<td>CDR 1 MON - FRI 23:00 - 05:00 (22:00 - 04:00)</td>
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<tr>
<td></td>
<td>NOT AVBL or PERM or CDR 2 or CDR 3</td>
<td>FRI 14:00 (13:00) - MON 06:00 (05:00)</td>
</tr>
<tr>
<td></td>
<td>and/or all other possible combinations</td>
<td>NOT AVBL or PERM or CDR 2 or CDR 3</td>
</tr>
<tr>
<td></td>
<td>05:00 - 23:00 (04:00 - 22:00)</td>
<td>and/or all other possible combinations</td>
</tr>
<tr>
<td></td>
<td>or Rest of the day time</td>
<td>Time period</td>
</tr>
<tr>
<td></td>
<td>TEMPO CLSD on ACC/UAC instructions</td>
<td>or</td>
</tr>
<tr>
<td></td>
<td>ALTN route: AAAAA M1 BBB N1 CCCCC</td>
<td>Rest of the week</td>
</tr>
<tr>
<td></td>
<td>Route extension MAX ... NM (optional)</td>
<td>TEMPO CLSD on ACC/UAC instructions</td>
</tr>
<tr>
<td></td>
<td>FREQ: ...</td>
<td>ALTN route: AAAAA M1 BBB N1 CCCCC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Route extension MAX ... NM (optional)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FREQ: ...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CDR 1 Mixed Vertical Categories</th>
<th>CDR 2 Category</th>
<th>CDR 3 Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDR 1 FL285 - FL325 MON - FRI 08:00 - 10:00 (07:00 - 09:00)</td>
<td>CDR 2 H24</td>
<td>Only by ATC</td>
</tr>
<tr>
<td>Outside the described period and FLs</td>
<td></td>
<td>TEMPO OPN on ACC/UAC instructions</td>
</tr>
<tr>
<td>NOT AVBL or PERM or CDR 2 or CDR 3</td>
<td></td>
<td>NML route: L2</td>
</tr>
<tr>
<td>and/or all other possible combinations</td>
<td></td>
<td>FREQ: ...</td>
</tr>
<tr>
<td>TEMPO CLSD on ACC/UAC instructions</td>
<td></td>
<td>FREQ: ...</td>
</tr>
<tr>
<td>ALTN route: AAAAA M1 BBB N1 CCCCC</td>
<td></td>
<td>FREQ: ...</td>
</tr>
<tr>
<td>Route extension MAX ... NM (optional)</td>
<td></td>
<td>FREQ: ...</td>
</tr>
<tr>
<td>FREQ: ...</td>
<td></td>
<td>FREQ: ...</td>
</tr>
</tbody>
</table>

**Note:** All CDR 1 mixed fictitious examples shall be also applied in CDR 2 or CDR 3 publications.
C. Annex C

Each State may promulgate the RAD by publishing the following text and reference to the NM NOP website in the National AIP, sub-section ENR 1.10.

**ENR 1.10 FLIGHT PLANNING**
(Restriction, limitation or advisory information)

1. Procedures for the submission of a flight plan

*(Add new sub-paragraph)*

**Adherence to Airspace Utilization Rules and Availability**

No flight plans shall be filed via the airspace of .......... FIR/UIR or ACC/UAC or CTA/UTA deviating from the State restrictions defined within the Route Availability Document (RAD). This common European reference document contains all airspace utilisation rules and availability for .......... FIR/UIR or ACC/UAC or CTA/UTA and any reference to them shall be made via https://www.nm.eurocontrol.int/RAD/index.html.

Each State is encouraged to publish only the above reference instead of republishing the required RAD information as per Chapter 8, paragraph 8.10, second sub-paragraphs a. / b. as an AIP Supplement.
D. No Planning Zone (NPZ) - AIP Publication

I. Description

Description, supplemented by graphic portrayal where appropriate, of No Planning Zones together with information regarding their establishment and activation, including:

1) identification, name and geographical coordinates of the lateral limits in degrees, minutes and seconds;
2) upper and lower limits;
3) time of activity; and
4) remarks.

II. AIP placeholders

ENR 1.10 FLIGHT PLANNING
(Restriction, limitation or advisory information)

1. Procedures for the submission of a flight plan
(Add new sub-paragraph)

No Planning Zones (NPZ) unavailable for flight planning

This section includes a description of the concept of the NPZ and the applicable rules for IFR flight planning, such as the following examples:

- No Planning Zone/s (NPZ/s) is/are published within the airspace of ........ FIR/UIR or ACC/UAC or CTA/UTA or FRA area.
- A No Planning Zone (NPZ) is a defined airspace volume within which the planning of FRA DCT trajectories is either not allowed or allowed only for exceptions as described.
- Airspace users can avoid these areas by planning via appropriate significant points around the NPZ or according to described conditions. Flight planning through the published NPZ will cause a reject message by IFPS except where the set conditions are met.

ENR 2.2 OTHER REGULATED AIRSPACE

(Add new sub-paragraph 'No Planning Zone')

Lateral and vertical limits of No Planning Zones are published in ENR 2.2 (Other regulated airspace)
ENR 6 EN-ROUTE CHARTS

NPZ is graphical portrayed on a dedicated ENR 6. EN-ROUTE CHART (ENR 6.x).

NPZ borders are depicted by using the ICAO Annex 4 symbol for restricted airspace (prohibited, restricted or danger area).

Information of the area identification and name is accompanying the NPZ symbol on the chart.

Necessary information to serve the understanding of the location of the NPZ is included in the chart, such as intersections of relevant airspace and the airspace identification (e.g. FIR/UIR, CTA/UTA, sector names), and the significant points facilitating appropriate flight planning.

III. Publication Guidelines

Each NPZ shall be published based on the following rules:

Identification:   LENPZ1 or EFNPZ999 or ECNPZ123 (fictitious examples)

Rules:

Up to 8 (eight) characters composed by:

- 2 (two) nationality letters for location indicator, if zone is located entirely in one State, or
- 2 (two) letters “EC”, if zone is located across two or more State borders, followed by
- 3 (three) letters: abbreviation “NPZ”, followed by
- 1 (one) - 3 (three) digits: a number/s from 1 to 999.

Notes:

1. Nationality letters are those contained in Location Indicators - ICAO Doc 7910.
2. For ECNPZ, a unique Europe wide number shall be used monitored by NM. Despite the limit of 1000 cross-border NPZs in Europe, it is believed that the amount cannot be reached but in case of reaching it additional 9th character can be considered for use, when required.
3. NPZ is signified in GEN 2.2 and annotated as national abbreviation that is different from those contained in ICAO Doc 8400 PANS-ABC.
4. Number/s shall not be expressed with leading “0” or “00”.
5. No type of sign or space to separate the elements comprising the identification.

Name (if applicable): LENPZ1 SUKOM or EFNPZ999 MIC or ECNPZ123 MIC
(fictitious examples)

Rules:
- Identification and Name shall be separated by only one “space”;
- Normally the name might be the name-code (3 or 5 letters) of the relevant significant point around which the zone is located or the closest one but any free name is also allowed;
- To support flight planning, the significant point as the name may be the significant point that shall be used to avoid the area;
- Name composition is free and it is not part of the 8 characters rule applied for the identifier;
- Only upper cases shall be used.

Area definition:

Rules:
- Geographical coordinates defining the lateral limits of an area shall be enumerated in clockwise order. The first and the last published geographical coordinates defining the lateral limits shall be the same and term “to point of origin” shall not be used;
- Upper and lower limits shall be as specified in ERNIP Part 1, paragraph 7.2.8 under Publication of vertical limits;
  - Use the abbreviation GND, SFC, AGL, AMSL, MSL, UNL, ALT, FL or any other abbreviation (e.g. LAL) signified in State AIP, GEN 2.2 and annotated as national abbreviation that is different from those contained in ICAO Doc 8400 PANS-ABC to indicate the reference datum, as appropriate;
  - Indicate the units of measurement used (metres or feet) by placing the appropriate abbreviation after the figure;
- Time of activity shall be presented in a commonly agreed AIS time format expressing hourly or daily or weekly or monthly or yearly or seasonally applicability.
E. Identification of Control Sector

Each Control Sector (Area or Approach) shall be identified based on the following rules:

Identification: **EADDSOUTH1** (fictitious examples)

Composition: ID with maximum **10 (ten) characters** composed by:

- 4 (four) nationality letters for location indicator of the relevant FIR and/or ATC unit (EADD), followed by
- 6 (six) alpha-numeric: random use of digits and/or letters, depending on States decisions for combination or rules for coding, unique for the relevant ATC unit (SOUTH1).

Notes:
1. Nationality letters are mandatory.
2. Nationality letters are those contained in Location Indicators - ICAO Doc 7910.
3. No type of sign or space to separate the elements comprising the identification.
4. As the Control Sector is a subdivision of a designated control area in case of publication in State AIP the lateral limits shall be defined in accordance with Doc. 10066 PANS-AIM in degrees, minutes and seconds.
References

EU Legislation

- “Performance Scheme Regulation”: Regulation 691/2010 - Performance Scheme for Air Navigation Services and Network Functions in Europe
- Regulation 730/2006 on airspace classification and access of flights operated under visual flight rules above flight level FL195

ICAO Documentation

- Annex 2 Rules of the Air
- Annex 4 Aeronautical Charts
- Annex 11 Air Traffic Services
- Annex 15 Aeronautical Information Services
- Doc 4444 PANS - ATM Procedures for Air Navigation Services - Air Traffic Management
- Doc 7030/EUR (European) Regional Supplementary Procedures
- Doc 9426 Air Traffic Services Planning Manual
- Doc 9554 Manual Concerning Safety Measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations
- Doc 9689 Manual on Airspace Planning Methodology for the determination of Separation Minima
- Doc 10066 PANS-AIM Procedures for Air Navigation Services - Aeronautical Information Management
- EUR Doc 001, RNAV 5 - European Region Area Navigation (RNAV) Guidance Material

EUROCONTROL Documentation

- ERNIP Part 3 - ASM Handbook
- ARN V7
- EUROCONTROL Airspace Concept Handbook for the Implementation of PBN
- Advanced Airspace Scheme Concept Document
- Terminal Airspace Design Guidelines
- Template Common Format Letter of Agreement
- Focus Group on Spacing report and documentation
- Free Route Airspace Workshop report and documentation
- RAD (Route Availability Document)
- EUROCONTROL ANT Airspace Classification Toolbox
- ESARR4 - EUROCONTROL Safety Regulatory Requirement 4 Risk Assessment and Mitigation in ATM
- EUROCONTROL B-RNAV route spacing study
Definitions

The terms used in the ERNIP document have the following meanings:
The ICAO definitions are identified with an (I) at the end of the text.

Some terms may have an explanatory note in italics.

A

Active Mode of Real Time Civil/Military Coordination is the communication mode in real
time between civil and military units which results from an action by the
tocontroller(s).

*It encompasses both “Verbal” coordination by speech only, and “Silent”
coordination, the communication process by manual input only.*

Ad hoc Structures refer to airspace structures, whether routes or areas, required to
meet operational needs at shorter notice than ASM Level 1 process. The
establishment of such ad hoc structure at ASM Level 2 or ASM Level 3
should follow the general design and safety management criteria.

Aerial Work is an aircraft operation in which an aircraft is used for specialised services
such as agriculture, construction, photography, surveying, observation and
patrol, search and rescue, aerial advertisement, etc. (I)

Aeronautical Information Publication (AIP) is a publication issued by or with the
authority of a State containing aeronautical information of a lasting character
essential to air navigation. (I)

Aeronautical Information Service (AIS) A service established within the defined area
of coverage responsible for the provision of aeronautical information/data
necessary for the safety, regularity and efficiency of air navigation. (I)

Such information includes the availability of air navigation facilities and services
and the procedures associated with them, and must be provided to flight
operations personnel and services responsible for flight information service.

Aircraft Operating Agencies (AOs) are the person, organisation or enterprise engaged
in, or offering to engage in, an aircraft operation. (I)

In the context of the FUA Concept, “AOs” encompass all aircraft operations other
than aerial work operations, that is to say commercial air transport operations
and general aviation operations.

Airspace Configuration refers to the predefined and coordinated organisation of ATS
Routes of the ARN and/or Terminal Routes and their associated airspace
structures (including temporary airspace reservations, if appropriate) and
ATC sectorisation.

Airspace Management (ASM) is a planning function with the primary objective of
maximising the utilisation of available airspace by dynamic time-sharing and,
at times, the segregation of airspace among various categories of users
based on short-term needs. In future systems, airspace management will also
have a strategic function associated with infrastructure planning. (I)

In the context of the FUA Concept, airspace management is a generic term
covering any management activity at the three Strategic, Pre-tactical and
Tactical Levels, provided for the purpose of achieving the most efficient use of airspace based on actual needs and, where possible, avoiding permanent airspace segregation.

**Airspace Management Cell (AMC)** is a joint civil/military cell responsible for the day-to-day management and temporary allocation of national or sub-regional airspace under the jurisdiction of one or more ECAC State(s).

**Airspace Reservation** is a defined volume of airspace temporarily reserved for exclusive or specific use by categories of users.

**Airspace Restriction** is a defined volume of airspace within which, variously, activities dangerous to the flight of aircraft may be conducted at specified times (a ‘danger area’); or such airspace situated above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions (a ‘restricted area’); or airspace situated above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited (a ‘prohibited area’).

**Airspace Structures** are specific portions of airspace designed to accommodate the safe operation of aircraft.

*In the context of the FUA Concept, “Airspace Structures” include Controlled Airspace, ATS Route, including CDRs, ATC Sectors, Danger Area (D), Restricted Area (R), Prohibited Area (P), Temporary Segregated Area (TSA), Temporary Reserved Area (TRA), Cross-Border Area (CBA)…*

**Airspace Use Plan (AUP)** is an ASM message of NOTAM status notifying the daily decision of an Airspace Management Cell on the temporary allocation of the airspace within its jurisdiction for a specific time period, by means of a standard message format.

**Air Traffic** encompasses all aircraft in flight or operating on the manoeuvring area of an aerodrome. (I)

**Air Traffic Control Clearance** is an authorisation for an aircraft to proceed under conditions specified by an Air Traffic Control unit. (I)

*For convenience, the term “Air Traffic Control Clearance“ is frequently abbreviated to “ATC Clearance” or “Clearance“ when used in appropriate contexts. (I)*

*The abbreviated term “Clearance“ may be prefixed by the words “taxi“, “take-off“, “departure“, “en-route“, “approach“ or “landing“ to indicate the particular portion of flight to which the Air Traffic Control Clearance relates. (I)*

**Air Traffic Control Service** is a service provided for the purpose of:

a) preventing collisions:
   1) between aircraft, and
   2) on the manoeuvring area between aircraft and obstructions, and

b) expediting and maintaining an orderly flow of air traffic. (I)

**Air Traffic Flow [and Capacity] Management (ATF[C]M)** is a service established with the objective of contributing to a safe, orderly and expeditious flow of air traffic by ensuring that ATC capacity is utilised to the maximum extent possible, and
that the traffic volume is compatible with the capacities declared by the appropriate ATS authority.

Note: The above-mentioned is the ICAO definition of the ATFM. ATFCM is EUROCONTROL term that includes process that ensures better realisation of the ATM capacity towards the traffic demand.

Air Traffic Flow Management Notification Message (ANM) is the official medium for the notification of ATFCM measures. It is produced by the NM the day before the day of operation to provide a summary of planned ATFCM measures and to promulgate any specific instructions or communications requirements associated with those measures.

Air Traffic Management (ATM) is the dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management - safely, economically and efficiently - through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions. (I)

The general objective of ATM is to enable aircraft operators to meet their planned departure and arrival times and to adhere to their preferred flight profiles with the minimum constraints, without compromising agreed levels of safety.

Air Traffic Services (ATS) is a generic term meaning variously, Flight Information Service, Alerting Service, Air Traffic Advisory Service, Air Traffic Control Service (Area Control Service, Approach Control Service or Aerodrome Control Service). (I)

Air Traffic Services Unit (ATSU) is a generic term meaning variously, air traffic control unit, flight information centre or air traffic services reporting office. (I)

Airway (AWY) is a control area or portion thereof established in the form of a corridor. (I)

AMC-Manageable Area is an area subject to management and allocation by an AMC at ASM Level 2.

Under the TAA Process, these manageable areas are either formal structures entitled "TRAs or TSAs" or R and D Areas that are manageable at ASM Level 2 in the same way as TRA/TSAs.

Approved Agencies (AAs) are units, which are authorised by a State to deal with an Airspace Management Cell for airspace allocation and utilisation matters.

Area Control Centre (ACC) is a unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction. (I)

Area Navigation (RNAV) is a method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these. (I)

ATC Clearance (see Air Traffic Control Clearance)

ATC Coordination is the process of communication between ATC units, or controllers within such units, of the necessary flight plan data, radar data and control information with a view to reaching an agreed course of action as the controlled flight(s) progress(es).
**ATC Instructions** are directives issued by air traffic control for the purpose of requiring a pilot to take a specific action. (I)

**ATC Unit** is a generic term meaning variously, area control centre, approach control office or aerodrome control tower. (I)

**ATS Unit** is a generic term meaning variously, air traffic control unit, flight information centre or air traffic services reporting office. (I)

**ATS Airspaces** are airspaces of defined dimensions, alphabetically designated, within which specific types of flights may operate and for which air traffic services and rules of operation are specified. (I)

*ATS airspaces are classified as Class A to G (I).*

**ATS Reporting Office (ARO)** is a unit established for the purpose of receiving reports concerning air traffic services and flight plans submitted before departure. (I)

**ATS Route** is a specified route designed for channelling the flow of traffic as necessary for the provision of air traffic services. (I)

*The term “ATS route” is used to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure route, etc.*

*An ATS route is defined by route specifications which include an ATS route designator, the track to or from significant points (waypoints), distance between significant points, reporting requirements and, as determined by the appropriate ATS authority, the lowest safe altitude.*

**B**

**B2B** is **Business to Business**; means that the services are offered via a programmatic interface; this implies that the customer has to develop software that uses that interface in order to access our services; this is the case of the NOP B2B web services.

**B2C** is **Business to Client**; means that the services (the business) are offered via client interface that are property of the NM (CHMI, Portal); this implies that the customer does not need to develop any software to access the offered services.

**C**

**Centralised Airspace Data Function (CADF)** is an ASM function entrusted to the NM by the ECAC States for consolidating national AUPs/UUPs to be published on the NOP Portal as EAUP and EUUP.

**Changed Airspace Restriction (CAR)** concerns any Danger or Restricted Area not suitable for Pre-Tactical management, but for which a change in its use, either in time or size, could be notified to AMC the day before activity for publication in the List "DELTA" of AUP/UUP.

**Civil/Military Coordination** is the communication between civil and military elements (human and/or technical) necessary to ensure safe, efficient and harmonious use of the airspace.

**Clearance** (see Air Traffic Control Clearance) (I)

**Cleared Flight Level (CFL)** is the flight level at or to which an aircraft is authorised to proceed under conditions specified by an ATC unit.
Conditional Route (CDR) is an ATS route that is only available for flight planning and use under specified conditions.

A Conditional Route may have more than one category, and those categories may change at specified times:

a) Category One - Permanently Plannable CDR:

CDR1 routes are in general available for flight planning during times published in the relevant national Aeronautical Information Publication (AIP). Updated information on the availability in accordance with conditions published daily in EAUP/EUUPs.

b) Category Two - Non-Permanently Plannable CDR:

CDR2 routes may be available for flight planning. Flights may only be planned on a CDR2 in accordance with conditions published daily in the EAUP/EUUPs, and

c) Category Three - Not Plannable CDR:

CDR3 routes are not available for flight planning; however, ATC Units may issue tactical clearances on such route segments.

Control Area (CTA) is a controlled airspace extending upwards from a specified limit above the earth. (I)

Control Sector is a subdivision of a designated control area within which responsibility is assigned to one controller or to a small group of controllers. (I)

Note: For the ERNIP purpose, the terms used “ATC Sector” or “Sector” or “ATC Sectorisation” or “Sectorisation” shall be referenced to the term “Control Sector”.

Control Zone (CTR) is a controlled airspace extending upwards from the surface of the earth to a specified upper limit. (I)

Controlled Airspace is airspace of defined dimensions within which air traffic control services are provided to IFR flights and to VFR flights in accordance with the airspace classification. (I)

Controlled Airspace is a generic term, which covers ATS airspace classes A, B, C, D & E.

Controlled Airspace includes Control Area (CTA), Terminal Control Area (TMA), Airway (AWY) and Control Zone (CTR).

Controlled Flight is any flight, which is subject to an ATC clearance. (I)

Controller’s Intentions are updated flight data, which shall be exchanged, as laid down in LoAs, either simultaneously with or before, the corresponding ATC clearance is issued.

Controlling Military Unit (CMU) means any fixed or mobile military unit handling military air traffic and/or pursuing other activities which, owing to their specific nature, may require an airspace reservation or restriction.

Cross-Border Area (CBA) is an airspace restriction or reservation established over international borders for specific operational requirements. This may take the form of a Temporary Segregated Area or Temporary Reserved Area.

Current Flight Plan (CPL) is the flight plan, including changes, if any, brought about by subsequent clearances. (I)
When the word “message” is used as a suffix to this term, it denotes the content and format of the current flight plan data sent from one unit to another. (I)

D

Danger Area (D) is an airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times. (I)

In the context of the FUA Concept, some Danger Areas subject to management and allocation at ASM Level 2 are established at ASM Level 1 as “AMC-Manageable Areas” and identified as such in AIP.

E

eAMI or electronic ASM Information is an electronic message containing all airspace allocations (ASM Level 1 and ASM Level 2) and the derived opening/closure of CDR2/CDR1/ATS routes published daily in EAUP/EUUPs.

F

Filed Flight Plan (FPL) is the flight plan as filed with an ATS unit by the pilot or a designated representative, without any subsequent changes. (I)

When the word “message” is used as a suffix to this term, it denotes the content and format of the filed flight plan data as transmitted. (I)

Flexible Use of Airspace (FUA) Concept is based on the fundamental principle that airspace should not be designated as either pure civil or military airspace, but rather be considered as one continuum in which all user requirements have to be accommodated to the extent possible.

Flight Data Operation Division (FDOD) is the NM unit responsible for the collection, updating, processing and dissemination of data on flight operations and on the air navigation infrastructure. This includes the running of, amongst other systems, the Integrated Initial Flight Plan Processing System (IFPS) and the Environment Data Base.

Flight Information Region (FIR) is airspace of defined dimensions within which flight information service and alerting service are provided. (I)

Flight Management System (FMS) is an integrated system, consisting of airborne sensor, receiver and computer with both navigation and aircraft performance databases, which provides performance and RNAV guidance to a display and automatic flight control system.

Flight Plan contains specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft. (I)

Flow Management Position (FMP) is a working position established within an ACC to ensure the necessary interface with the CEU on matters concerning the provision of the ATFCM Service and the interface with national AMCs on matters concerning the ASM Service.

Free Route Airspace (FRA) is a specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control.
**FUA Temporary Instruction (FTI)** is a temporary instruction published by the NM and agreed/applied by appropriate AMCs and the NM/CADF for all or for a part, of the FUA area.

**G**

**General Air Traffic (GAT)** encompasses all flights conducted in accordance with the rules and procedures of ICAO and/or the national civil aviation regulations and legislation.

*GAT can include military flights for which ICAO rules and procedures satisfy entirely their operational requirements.*

**General Aviation** encompasses an aircraft operation other than a commercial air transport operation or an aerial work operation. (I)

**I**

**Integrated Initial Flight Plan Processing System (IFPS)** is the NM system receiving and processing the GAT IFR flight plan data and associated update messages for the area covered by the participating States. It subsequently distributes these messages in a format, which can be received and processed automatically by ATC Flight Plan Processing Systems (FPPS) and the CEU (West) without further intervention. The IFPS is installed at two geographical sites.

**K**

**Known Traffic Environment (KTE)** is the environment within which all traffic is known to ATS.

**L**

**Level 1 - Strategic ASM** is the act of defining and reviewing, as required, the national airspace policy taking into account national and international airspace requirements.

**Level 2 - Pre-Tactical ASM** is the act of conducting operational management within the framework of pre-determined existing ATM structure and procedures defined in ASM Level 1 and of reaching specific agreement between civil and military authorities involved.

**Level 3 - Tactical ASM** is the act, on the day of operation, of activating, deactivating or real time reallocating of airspace allocated in ASM Level 2, and of solving specific airspace problems and/or of individual OAT/GAT traffic situations in real time between civil and military ATS units and/or controlling military units and/or controllers, as appropriate. This coordination can take place either in active or passive mode with or without action by the controller.

**M**

**Manoeuvring Area** is that part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons. (I)

**N**

**Network Manager** means the entity established under Article 6 of regulation (EC) No 551/2004 (the Airspace regulation) to perform the duties provided for in that
Network Management Directorate (NM) is a EUROCONTROL Directorate nominated by the EC as European Network Manager to perform the network functions under the conditions defined in regulation (EU) 677/2011 (the ATM Network Functions regulation).

Network Manager Environment Data Base (NMEDB) is a specific part of the NM Data Base containing all environment data concerning airspace organisation and structure, ACC operational organisation and ATC capacities. The Environment Data Base is used by the NM systems for the calculation of flight profiles taking account of all airspace constraints.

Network Manager Operations Centre (NMOC) is a Network Manager Unit being the operational component of the Network Manager, established in accordance with the applicable regulations and requirements to provide the ATFCM and Initial Flight Planning Service, on behalf of the participant States.

No Planning Zone (NPZ) is an airspace of defined dimensions within which the planning of flight trajectory is either not permitted or allowed under certain specified conditions.

Notice to Airmen (NOTAM) is a notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations. (I)

Off-Route Traffic encompasses all GAT flying outside the published ATS Routes Network.

On-Route Traffic encompasses all GAT flying along the published ATS Routes Network.

Operational Air Traffic (OAT) encompasses all flights which do not comply with the provisions stated for GAT and for which rules and procedures have been specified by appropriate national authorities.

OAT can include civil flights such as test-flights, which require some deviation from ICAO rules to satisfy their operational requirements.

Passive Mode of Real Time Civil/Military Coordination is the system-supported communication mode of information in real time between civil and military units without any action by the controller(s).

Permanent ATS Route is a permanently designated ATS route which is not subject to daily management at ASM Level 2 by AMCs.

Pre-Tactical Civil/Military Coordination - (see definition of ASM Level 2 - Pre-Tactical ASM).

Prior Coordination Airspace (PCA) is a portion of airspace of defined dimensions within which individual GAT is permitted to fly "off-route" only after prior coordination initiated by controllers of GAT flights with controllers of OAT flights.

Prohibited Area (P) is airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited. (I)
**R**

**Real-Time Civil/Military Coordination** - (see definition of ASM Level 3 - Tactical ASM).

**Reduced Coordination Airspace (RCA)** is a portion of airspace of defined dimensions within which GAT is permitted to fly “off-route” without requiring controllers of GAT flights to initiate coordination with controllers of OAT flights.

**Restricted Area (R)** is airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions. (I)

In the context of the FUA Concept, some Restricted Areas are subject to management and allocation at ASM Level 2 are established at ASM Level 1 as “AMC-Manageable Areas” and identified as such in AIP.

**Route Availability Document (RAD)** is a strategically planned routing system for the NM area agreed at the annual meeting. The RAD is designed as a part of the NM ATFCM operation to make the most effective use of ATC capacity while allowing aircraft operators’ flight planning flexibility. The RAD enables ATC to maximise capacity by defining routings that provide an organised system of major traffic flows through congested areas and reduce the crossing of major flows at critical points.

**S**

**Silent Coordination** (see definition of Active Mode of Real Time Coordination)

**Standard Instrument Arrival (STAR)** is a designated instrument flight rule (IFR) arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach procedure can be commenced. (I)

**Standard Instrument Departure (SID)** is a designated instrument flight rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a flight commences. (I)

**Strategic Civil/Military Coordination** - (see definition of ASM Level 1 - Strategic ASM).

**T**

**Tactical Civil/Military Coordination** - (see definition of ASM Level 3 - Tactical ASM).

**Temporary Airspace Allocation Process** consists in the allocation process of airspace of defined dimensions assigned for the temporary reservation/segregation (TRA/TSA) or restriction (D/R) and identified more generally as an “AMC-manageable” area.

**Temporary Reserved Area (TRA)** is a defined volume of airspace normally under the jurisdiction of one aviation authority and temporarily reserved, by common agreement, for the specific use by another aviation authority and through which other traffic may be allowed to transit, under ATC clearance.

In the context of the FUA Concept, all TRAs are airspace reservations subject to management and allocation at ASM Level 2.

**Temporary Segregated Area (TSA)** is a defined volume of airspace normally under the jurisdiction of one aviation authority and temporarily segregated, by
common agreement, for the exclusive use by another aviation authority and through which other traffic will not be allowed to transit.

*In the context of the FUA Concept, all TSAs are airspace reservations subject to management and allocation at ASM Level 2.*

**Terminal Airspace** is a generic term encompassing Terminal Control Area (TMA), Control Area (CTA), Control Zone (CTR), Special Rules Zone (SRZ), Aerodrome Traffic Zone (ATZ), or any other nomenclature, such as Traffic Information Area (TIA) or Traffic Information Zone (TIZ), used to describe the airspace around an airport.

**Terminal Control Area (TMA)** is a control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes. (I)

**Updated Airspace Use Plan (UUP)** is an ASM message of NOTAM status issued by an AMC to update and supersede AUP/previous UUP information.

**Verbal Coordination** (see definition of Active Mode of Real Time Coordination)
## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Approved Agency</td>
</tr>
<tr>
<td>AAS</td>
<td>Aerodrome Advisory Service / Airborne Approach Spacing</td>
</tr>
<tr>
<td>ACAS</td>
<td>Airborne Collision Avoidance System</td>
</tr>
<tr>
<td>ACC</td>
<td>Area Control Centre</td>
</tr>
<tr>
<td>ACFT</td>
<td>Aircraft</td>
</tr>
<tr>
<td>ACP</td>
<td>Airspace Crossing Acceptance Message</td>
</tr>
<tr>
<td>ADR</td>
<td>Airspace Data Repository</td>
</tr>
<tr>
<td>ADS-B</td>
<td>Automatic Dependent Surveillance-Broadcast</td>
</tr>
<tr>
<td>ADT</td>
<td>Approved Departure Time</td>
</tr>
<tr>
<td>AFTN</td>
<td>Aeronautical Fixed Telecommunications Network</td>
</tr>
<tr>
<td>AIM</td>
<td>Air Traffic Flow Management Information Message</td>
</tr>
<tr>
<td>AIP</td>
<td>Aeronautical Information Publication</td>
</tr>
<tr>
<td>AIRAC</td>
<td>Aeronautical Information Regulation and Control</td>
</tr>
<tr>
<td>AIS</td>
<td>Aeronautical Information Service</td>
</tr>
<tr>
<td>AIXM</td>
<td>Aeronautical Information Exchange Model</td>
</tr>
<tr>
<td>AMA</td>
<td>Airspace Manageable Area</td>
</tr>
<tr>
<td>AMAN</td>
<td>Arrival Manager Tool</td>
</tr>
<tr>
<td>AMC</td>
<td>Airspace Management Cell</td>
</tr>
<tr>
<td>AMDT</td>
<td>Amendment (ICAO)</td>
</tr>
<tr>
<td>AME</td>
<td>ATM Message Exchange</td>
</tr>
<tr>
<td>AMSL</td>
<td>Above Mean Sea Level</td>
</tr>
<tr>
<td>ANM</td>
<td>ATFCM Notification Message</td>
</tr>
<tr>
<td>ANSP</td>
<td>Air Navigation Service Provider</td>
</tr>
<tr>
<td>ANT</td>
<td>Airspace &amp; Navigation Team</td>
</tr>
<tr>
<td>AO</td>
<td>Aircraft Operator</td>
</tr>
<tr>
<td>AOLO</td>
<td>Aircraft Operation Liaison Officer</td>
</tr>
<tr>
<td>AOWIR</td>
<td>Aircraft Operator What if Re-routing (NM Function)</td>
</tr>
<tr>
<td>AR</td>
<td>Air Route</td>
</tr>
<tr>
<td>ARINC</td>
<td>Aeronautical Radio Incorporated (US)</td>
</tr>
<tr>
<td>ARO</td>
<td>ATS Reporting Office</td>
</tr>
<tr>
<td>ARN</td>
<td>ATS Route Network</td>
</tr>
<tr>
<td>ASM</td>
<td>Airspace Management</td>
</tr>
<tr>
<td>ASMSG</td>
<td>Airspace Management Sub-Group (Sub-Group of NETOPS Team)</td>
</tr>
<tr>
<td>Acronym</td>
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<td>LoA</td>
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<td>(5LNC) - unique five-letter pronounceable &quot;name-code&quot;</td>
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NAVAID  Navigational Aid
NETOPS Team  Network Operations Team
NEST  Network Strategic Tool
NM  Nautical Mile
NM  Network Manager
NMD  Network Management Directorate
NOP  Network Operations Portal
NOTAM  Notice to Airmen
NPZ  No Planning Zone
OAT  Operational Air Traffic
OEM  Original Equipment Manufacturer
OLDI  On-Line Data Interchange
OPS  Operations
OPSD  Operations Division (NM)
PA  Prohibited Area
PANS-AIM  Procedures for Air Navigation Services - Aeronautical Information Management (ICAO Doc 10066)
PANS-ATM  Procedures for Air Navigation Services - Air Traffic Management (ICAO Doc 4444)
PANS-OPS  Procedures for Air Navigation Services - Aircraft Operations (ICAO Doc 8168)
PBN  Performance Based Navigation
PCA  Prior Coordination Airspace
PRISMIL  Pan-European Repository of Information Supporting Military
PSSA  Preliminary System Safety Assessment
PTR  Profile Tuning Restriction
RA  Restricted Area
RAD  Route Availability Document
RCA  Reduced Coordination Airspace
RDP  Radar Data Processing
RDPS  Radar Data Processing System
RJC  Airspace Crossing Reject Message
RNAV  Area Navigation
RNDSG  Route Network Development Sub-Group
RNP  Required Navigation Performance
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<td>RVSM</td>
<td>Reduced Vertical Separation Minima</td>
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<td>System for Assignment and Analysis at a Macroscopic level</td>
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<td>Very High Frequency Omnidirectional Radio Range</td>
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