

**TRANSITION PLAN FOR
THE IMPLEMENTATION OF
THE NAVIGATION STRATEGY
IN ECAC
2000-2015+**

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EXECUTIVE SUMMARY

- i. The Navigation Strategy for ECAC – EUROCONTROL Document NAV.ET16 ST16 – 001, Edition 2.1 March 1999 [ref.2] was endorsed in March 1999 in accordance with the EUROCONTROL EATMP procedures, as part of the future European ATM network strategies. At this time it was agreed that there was a requirement for a long term coherent and comprehensive transition plan to define the progressive implementation of the Strategy. This document provides the said transition plan for the period 2000 to 2015.
- ii. The main lines of action of the Navigation Strategy for ECAC are presented below:
 - achieving a total RNAV environment with defined RNP values for all operations ECAC-wide;
 - facilitating the implementation of the 'free routes' concept;
 - supporting the continued operations of aircraft with lower capabilities as long as operationally feasible;
 - supporting the continued operations of State aircraft, in line with the principles of the overall ATM Strategy for the Years 2000+;
 - implementing 4D RNAV operations, to support the transition to a full gate to gate management of flight by 2015 ;
 - providing positioning and navigation data at the required performance levels to support the various applications in the ATM/CNS environment.
 - a judicious deployment of the space-based infrastructure and a rationalisation of supporting ground-based infrastructure for all phases of flight, ensuring the transition to GNSS, in line with ICAO recommendations.
- iii. The scope of this Transition Plan is that which was defined by the Navigation Strategy for ECAC. It is applicable to General Air Traffic (GAT) operations under ICAO Instrument Flight Rules (IFR) within ECAC airspace. This includes the en-route, terminal area, approach and landing phases of flight as well as ground operations and procedures.
- iv. The main objective of this Transition Plan is to enable the implementation of the ECAC Navigation Strategy, in order to achieve a harmonised, cost-effective, and customer oriented evolution of the European navigation systems, able to support the operational improvements outlined in the ATM Strategy for the Years 2000+.
- v. The Transition Plan addresses the 16 Strategic Actions which were defined in the Navigation Strategy for ECAC. To simplify the planning process and to avoid duplication of text the Strategic Actions have been drawn together to form 11 Implementation Actions. These are :
 - Provision and Maintenance of Runway Guidance for Take-off, Final Approach, and Taxi.
 - Provision and Maintenance of Conventional & RNAV SIDs, STARs, and Holding Procedures.
 - Requirement for B-RNAV at all En-Route Flight Levels.
 - Implementation of RVSM.
 - Implementation of Free Routes
 - Support Operations by Aircraft with Lower Navigation Capability.
 - Mandate of RNP 1 RNAV Operations.
 - Implementation of 4D RNAV Operations.
 - Provision and Maintenance of All Weather Operations Capability (NPA and Cat I/II/III PA) at Airports.
 - Rationalisation of Navigation Infrastructure.
 - Support for A-SMGCS at Airports.

- vi. The planning material for each of the Implementation Actions has been developed, and agreed, in close co-operation with the internal and external specialist bodies which are working in the respective areas. The material provides a checklist of the factors which must be taken into account in order to achieve the implementation of the particular Action.
- vii. All of the Implementation Actions are closely inter-related and the degree and speed of progress made in any one area will impact on the development of the others. Consequently the overall plan must remain flexible and sensitive to change and user requirements in order to achieve a harmonised transition to the scenario envisaged by the Navigation Strategy for ECAC for the year 2015.

1. FOREWORD

1.1 About the Document

- 1.1.1 This document constitutes the EUROCONTROL Transition Plan for the Implementation of the Navigation Strategy in the European Civil Aviation Conference (ECAC) airspace.
- 1.1.2 This Transition Plan will be reviewed periodically, to ensure that the rationale for the next step forward remains valid in the light of the progress made, and to reflect the actual changes which take place in aviation. It is anticipated that the actions defined in this document will be included in the overall implementation plan for the ATM Strategy for the Years 2000 + in ECAC.

1.2 Responsible Body and Acknowledgements

- 1.2.1 This document has been developed by the EUROCONTROL Airspace Management and Navigation Team (ANT). It is expected that this plan will be endorsed in accordance with the EUROCONTROL EATMP procedures.
- 1.2.2 The EUROCONTROL Agency wishes to acknowledge the valuable assistance received from Member States, Military Representatives, the International Council of Aircraft Owner and Pilot Associations (IAOPA), the International Air Carrier Association (IACA), the International Air Transport Association (IATA), the International Civil Aviation Organisation (ICAO) and ICAO All Weather Operations Group (AWOG) in preparing this implementation plan.

1.3 Structure of the Document

Executive Summary - gives a management overview of the content and main issues of the implementation plan.

Foreword - describes the purpose of the document, its ownership and its structure.

Introduction - provides the context necessary in order to understand the contents of the Transition Plan.

Operational context - provides a summary of the planned navigation applications as defined in the Navigation Strategy for ECAC, and the ATM 2000+ operational improvements which are enabled by these applications.

Methodology – provides the template of planning considerations which was developed in order to facilitate a standardised approach to the planning for the implementation of the Strategic Actions detailed in Annexe 1 to the Navigation Strategy for ECAC.

Implementation Actions – describe the activities that have to be performed in order to implement the corresponding Strategic Actions.

Annexes - Provide additional background information (Methodology Template, RNAV and RNP operational and functional requirements, list of references, abbreviations)

2. INTRODUCTION

2.1 Need for a Transition Plan

2.1.1 The Navigation Strategy for ECAC was endorsed in March 1999 in accordance with EUROCONTROL EATMP procedures, as part of the future European ATM network strategies. As the next step, a long-term coherent and comprehensive transition plan is now required, to define the progressive implementation of the Strategy and to quantify the benefits for both service providers and airspace users. Successful implementation will depend on collaborative decision-making during system evolution especially in the light of the plurality of interests at all levels.

2.1.2 The success of this Transition Plan will depend on the commitment of all of those involved to implement the changes needed to ensure that Europe has an effective navigation system capable of meeting aviation needs for the foreseeable future. This commitment must be based on agreement between the parties concerned, include the necessary legal mechanisms, and be supported by the determination of the aviation industry to realise the benefits of change.

2.2 Scope

2.2.1 The scope of this Transition Plan is that which was defined by the Navigation Strategy for ECAC. It is applicable to General Air Traffic (GAT) operations under ICAO Instrument Flight Rules (IFR) within ECAC airspace. This includes the en-route, terminal area, approach and landing phases of flight as well as ground operations and procedures. The Transition Plan details the issues which affect the implementation of the Navigation Strategy for ECAC.

2.2.2 The time horizon of this Transition Plan is split into three phases: short-term (2000-2005), medium-term (2005-2010) and long-term (2010-2015 and beyond), and is in line with the Navigation Strategy and with related strategies for Air Traffic Management, Communications and Surveillance.



2.2.3 The ECAC area currently¹ consists of 37 Member States: Albania, Armenia, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Monaco, the Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic,

¹ At the time of the development of this Transition Plan.

Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Turkey and the United Kingdom. Of these, 28 states are EUROCONTROL members.

2.3 Objective

2.3.1 The main objective of this Transition Plan is to enable the implementation of the Navigation Strategy for ECAC [ref.2], in order to allow the achievement of its main strategic objective: a harmonised, cost-effective, and customer oriented evolution of the European navigation systems, able to support the operational improvements outlined in the ATM Strategy for the Years 2000+ [ref.1].

2.3.2 The main lines of action of the Navigation Strategy for ECAC are presented below:

- achieving a total RNAV environment with defined RNP values for all operations ECAC-wide;
- facilitating the implementation of the 'free routes' concept;
- supporting the continued operations of aircraft with lower capabilities as long as operationally feasible;
- supporting the continued operations of State aircraft, in line with the principles of the overall ATM 2000+ Strategy;
- implementing 4D RNAV operations, to support the transition to a full gate to gate management of flight by 2015 ;
- providing positioning and navigation data at the required performance levels to support the various applications in the ATM/CNS environment.
- a judicious deployment of the space-based infrastructure and a rationalisation of supporting ground-based infrastructure for all phases of flight, ensuring the transition to GNSS, in line with ICAO recommendations.

2.3.3 These lines of action are directions for change, and consist of a series of complementary and stepped operational improvements in the navigation domain. They will need to be progressed in parallel with modifications to related domains, either as a means to provide short-term and stand-alone benefits, or as a foundation for other improvements.

2.3.4 This Transition Plan is expected to result in:

- a) a work programme for the EUROCONTROL Airspace Management and Navigation Team (ANT) and its sub-groups, to enable the implementation and management of the Navigation Strategy for ECAC;
- b) guidance material for the development of National Implementation Plans in ECAC Member States.

2.4 Principles

2.4.1 ECAC is a heterogeneous area with regard to air traffic levels, demand evolution and growth, state of evolution and level of performance of the existing navigation infrastructure and economic capabilities to sustain the transition to an enhanced navigation infrastructure. These differences had to be taken into account in the development of this Transition Plan.

2.4.2 It is widely recognised that much fragmentation of systems and efforts is still apparent in Europe, despite some significant harmonisation and integration achieved during the last decade. The multiplicity of choices, fragmentation and insufficient decision-making transparency resulted in the past in a lack of long-term planning, or in low confidence in those plans which had been established. As a result, Industry was not encouraged to undertake technology and product development in a timely fashion. Industrial support and confidence are a vital factor in developing the systems needed in the future.

2.4.3 Subsequently, the following general principles have governed the development of this Transition Plan :

- to cater for sub-regional and local differences;
- to provide tangible and early benefits to the users;

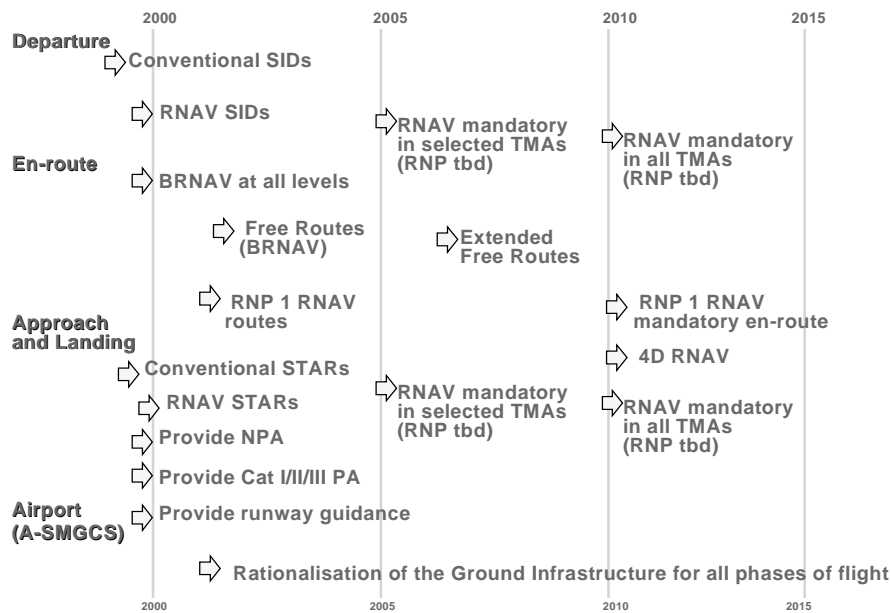
- to enable coherent development plans to be made, both within ECAC and with adjacent regions;
 - to support the continued operations of aircraft with lower capabilities as long as operationally feasible;
 - to continue to provide unrestricted access to the entire ECAC airspace to military users, and to develop procedures and maintain the supporting infrastructure to accommodate their flights, recognising that their operations may not comply with ICAO IFR or individual national aviation rules or procedures for GAT.
- 2.4.4 The evolution of the Navigation Systems must follow a benefit-driven approach. European States may need to use different transition arrangements and implement systems based on local requirements, but controlled and collaborative segmentation is needed to replace the fragmented efforts of the past.
- 2.4.5 EUROCONTROL will ensure the management of the agreed common programmes from initial development to operational implementation and will monitor the transition process. These are prerequisites for maximum efficiency in implementation, and to ensure that investments in the Navigation Domain contribute to deliver the required operational benefits.
- 2.4.6 The evolution of the ECAC navigation infrastructure will follow closely the evolution of the navigation applications. This may affect non-IFR operations, which have traditionally taken advantage of the infrastructure provided for GAT IFR operations, so that continued non-IFR operations in the future European air navigation environment may require enhanced aircraft capability.
- 2.4.7 Navigation systems, as well as communications and surveillance systems, rely heavily on the availability of a suitable frequency spectrum. Competing commercial interests outside the aviation industry are acquiring increasing allocations of this valuable resource, and there is a need to ensure that aviation interests and representation are carefully coordinated and effectively presented to those organisations responsible for spectrum management and allocation. A political initiative is needed to ensure that sufficient segments of the frequency spectrum are preserved and protected for aviation use during future frequency allocation deliberations of the International Telecommunications Union (ITU).

3. OPERATIONAL CONTEXT

This section provides a summary of the planned navigation applications as defined in the Navigation Strategy for ECAC [ref.2], and the operational improvements which are enabled by these applications as they are identified in the ATM Strategy for the Years 2000+ [ref.1].

3.1 Planned Evolution of the European Navigation System

3.1.1 Roadmap for Strategic Actions in the Navigation Domain [ref.2]



3.2 ATM Core Processes Enabled by the Navigation Systems

3.2.1 As set up in [ref.1] in the years 2000+ European ATM must simultaneously:

- generate extra capacity to meet demand while reducing unit costs;
- maintain or increase safety levels.

3.2.2 Subsequently, the lines of action focus on changing and improving the core operational processes of ATM, the services provided, and the means of application. These core processes are:

- Airspace Organisation and Management - the structure, division and categorisation of airspace, and the rules which apply;
- Flow and Capacity Management - managing the dynamic balance between capacity and demand;
- En-route & Terminal Air Traffic Control - the monitoring and separation of aircraft, traffic sequencing, and management of capacity and flexibility for en-route and terminal airspace;
- Airport Air Traffic Control - air-side traffic management, separation and sequencing of traffic on the airport and on final approach and departure, and other airport issues including environmental impacts.

3.2.3 Progressive improvements in these areas will have to be supported by the planned improvements in the Navigation domain, as well as the introduction of more sophisticated communications and surveillance capabilities and services. The following table provides a summary of those operational improvements in the four core processes of the European ATM, as identified in [ref.1] which are directly linked to planned initiatives in the navigation domain:

EATMS Core Processes	Proposed Operational Improvements	Navigation enablers		Operational Benefits
		Ground/Space	Airborne	
Airspace Organisation and Management	RVSM		RVSM MASPS altimetry system	Capacity Flight efficiency
	Continuous Route Structure Optimisation (2000-2015)	Navigation infrastructure suitable for RNAV operations	RNAV equipment	Capacity
	Optimisation of TMA Airspace and Arrival / Departure Routes			Capacity Flight efficiency Environment
	Free Routes implementation			Flight efficiency
Flow and Capacity Management	Collaborative Flight Planning (2005)	(EAD; eAIPs; revised NOTAM format)	Air/ground datalink	
En-Route and Terminal ATC	Automation of Planning Tasks	4D charting displays digital terrain data (including vertical obstruction/ obstacle) A-SMGCS (optional)	Air/ground datalink ADS (optional before 2010) 4D FMS	Capacity
	Arrival / Departure Management	Navigation infrastructure suitable for RNAV operations	RNAV equipment Air/ground datalink	Capacity Flight efficiency
	Separation Responsibility Transfer (2008+)	ADS-B	ADS-B	Flight efficiency
Airport ATC	Reduced Separation at airports All weather operations (2008+)	Navigation infrastructure suitable for RNAV operations Air/ground datalink Precision Landing Nav aids A-SMGCS (optional)	RNAV equipment Air/ground datalink Precision Landing equipment / MMR Cockpit HMI ADS-B	Capacity Flight efficiency

4. METHODOLOGY

- 4.1.1 In order to facilitate a standardised approach to the planning for the implementation of the Strategic Actions detailed in Annexe 1 to the Navigation Strategy for ECAC, the use of a template/check list of planning considerations has been adopted. A copy of the template is provided at Annexe A. It is not expected that the list will be exhaustive nor that all of the considerations will apply in every case.
- 4.1.2 The 16 Strategic Actions which were defined in the Navigation Strategy for ECAC have been drawn together to form 11 Implementation Actions, in order to simplify the planning process and to avoid duplication of text. The introductory text of each Implementation Action is adapted from the Annexe 1 of the Navigation Strategy for ECAC. This provides a clear and unambiguous statement of the objective of the action together with a review of the strategic considerations in terms of enablers and constraints. At the next step, the implementation plan for the particular Action is developed. This identifies the various tasks which must be completed in order to implement the Strategic Action and to achieve the stated objective. In all cases where specialist studies and/or work programmes (internal or external to EUROCONTROL) are being conducted (e.g. by EUROCONTROL TARA Task Force, GNSS Programme, Airport Operations Team, ICAO AWOG, etc.), the assistance, advice and input of the specialist body has been sought.
- 4.1.3 As far as possible, the definition of the different tasks include the identification of the responsible bodies and appropriate target dates for completion. The time-scales, dependencies and inter-relationships are shown in the form of Flow Charts and Gantt Charts. The target dates are still preliminary estimates based on publicly available information. It is the intention that the responsible bodies will confirm each task assigned to them and the associated target date.
- 4.1.4 Due to the dynamic nature of the implementation tasks, the Transition Plan will need to be regularly reviewed and co-ordinated with the appropriate bodies. As the EUROCONTROL Agency is responsible for the management of the EATMP in ECAC, it is anticipated that the ANT will be responsible for the maintenance of the Navigation Strategy and its Transition Plan and for managing and monitoring the progress of their implementation.

5. IMPLEMENTATION ACTION NO.1 - PROVISION OF RUNWAY GUIDANCE FOR TAKE-OFF, FINAL APPROACH AND TAXY

(Navigation Strategy for ECAC – Annexe 1 – Strategic Actions 5.1 and 5.14)

Objective: to support continued operations in low visibility conditions, maintaining capacity requirements.

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Provision and maintenance of runway guidance for take-off, final approach and taxi at airports		
RNP	tbd	tbd	tbd
Supporting Systems	ILS Cat.III (maintain as long as possible) MLS (initial use; replaces ILS Cat.III where appropriate) INS/IRS + update MMR (initial use) reduced use/availability of marker beacons, as far as feasible through the use of DME, relation with requirement for locators (NDBs)	ILS Cat.III (maintain as long as possible) MLS (increased use; replaces ILS Cat.III where appropriate) INS/IRS + update GBAS MMR (increased use)	ILS Cat.III (reduced use) MLS (continued use; replaces ILS Cat.III where appropriate; cannot evaluate ratio of replacement); INS/IRS + update GBAS (may detract from deployment of MLS at new locations) MMR (widespread use; with upgrades as required)

5.1 Strategic Considerations

Rationale:

- 5.1.1 With the increased demand for optimised runway utilisation, ATS providers and aircraft operators require lower take-off and landing minima, which can potentially improve/maintain the runway capacity for operations in low visibility conditions.

Enablers:

- 5.1.2 Runway guidance is currently provided on Cat III PA runways by ICAO standardised non-visual systems to approach and landing, i.e. ILS and MLS. These systems can also be used for departure operations (ICAO Annex 10).
- 5.1.3 Runway guidance can also be provided by INS or IRS with update on the runway prior to departure. The costs of this equipment are still high, however it is expected to be increasingly used on RNP capable aircraft. It is expected that GBAS, as required for Cat III operations, thus providing runway guidance, may be available in the timeframe covered by the Navigation Strategy. Initially, it may not be an ECAC-wide acceptable system to replace totally ILS Cat III, but this is expected to happen towards 2010 - 2015.

- 5.1.4 Full benefits from this Implementation Action can be achieved with the integration of arrival/departure managers and better information management, which are expected to increase the throughput of aircraft on airports and in terminal airspace.

Constraints:

- 5.1.5 The required material covering the RNP concept for departure and arrival operations is expected to be completed by ICAO in the 2000-2005 timeframe.
- 5.1.6 The availability of high quality aeronautical data is critical to the successful development of Cat III systems. However, the required enhanced AIS data integrity is not expected to be widely available before the timeframe 2005-2010.
- 5.1.7 The reduction of take-off minima will have implications for ATC, which must be considered fully. Integrated arrival/departure management systems are expected to be widely available at the busier airports by 2008.
- 5.1.8 Criteria to cater for auto-land operations, when low visibility procedures are not available, are under development by AWOG. In particular where auto-land operations are conducted, ILS, MLS, GPS equipment and signals in space should have suitable frequency protection.
- 5.1.9 When new navigation aids using primary or stand-alone input devices for precision approach and landing are introduced, airborne equipment will require certification for auto-land operations.
- 5.1.10 Current working methods in CFMU procedures will need to be updated to take into account the effect on airport operations of low visibility conditions and procedures.

5.2 Implementation Planning

- 5.2.1 Since runway guidance is required on runways with Cat III PA capability, the planning considerations for this Action are addressed under Implementation Action No.9 - Provision and Maintenance of All Weather Operations Capability (NPA and Cat I/II/III PA) at Airports.

6. IMPLEMENTATION ACTON NO.2 - PROVISION AND MAINTENANCE OF CONVENTIONAL AND RNAV SIDs, STARs AND HOLDING PROCEDURES

(Navigation Strategy for ECAC – Annexe 1 – Strategic Actions 5.2, 5.3, 5.10 and 5.11)

Objective: to support the ATM 2000+ Strategy for TMA reorganisation, in order to give increased capacity, flexibility and efficiency of operations and to support continued TMA operations of aircraft with lower navigation capability

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Provision and maintenance of conventional and RNAV SIDs, STARs and Holding Procedures	Mandate of RNAV in selected TMAs	Mandate of RNAV in all TMAs
RNP	P-RNAV	P-RNAV mandated with RNP \leq 1 RNAV optional	tbd (likely RNP \leq 1 RNAV)
Supporting Systems	DME/DME (Triple coverage or double coverage with IRS required); VOR/DME (within 30 NM of airport) INS/IRS+ update; GPS+RAIM (+conventional back-up); SBAS GBAS (expected introduction towards the end of the period)	DME/DME (Triple coverage or double coverage with IRS required); VOR/DME (within 30 NM of airport) INS/IRS + update; GPS+RAIM (+conventional back-up); SBAS; GBAS (expected availability)	DME/DME (Triple coverage or double coverage with IRS required); INS/IRS + update; SBAS; GBAS; RNAV MASPS avionics

6.1 Strategic Considerations

Rationale:

- 6.1.1 The requirement is for a Strategy that takes into account all the various and contradictory needs and develops actions acceptable for all categories of users.
- 6.1.2 While physical extensions to airports, especially additional runways, may take 15-20 years, changes to TMAs may be made much more quickly. The proposed TMA reorganisation is based on current systems and on the application of P-RNAV, without major technological changes/advances.
- 6.1.3 In future, it is anticipated that environmental concerns will have to be accommodated by ensuring that all arrivals and departures follow optimal 3D routes. In the case of arrivals/approaches, this will probably mean that aircraft will have to conduct continuous

descents with engines at, or close to, idle power. Some form of automated arrival management will be necessary. Clearances may be based upon Required Time of Arrival (RTA) at specific waypoints or speed control.

Enablers:

- 6.1.4 The standardisation of RNAV procedures is being addressed by the TARA Task Force who have also produced guidance material to support RNAV operations in the TMA. This material addresses ATC, operational and procedure design requirements . It has been developed in accordance with ICAO PANS OPS criteria for VOR/DME, DME/DME and GNSS as well as JAA Guidance Material for airworthiness and operational certification for P-RNAV operations.
- 6.1.5 Increased use of RNAV in TMA will be encouraged throughout the entire period from 2000 to 2010, in order to provide benefits to capable aircraft. Evidence of achievement of these benefits may provide an incentive for re-equipment by other aircraft operators.
- 6.1.6 The development and introduction of Arrival and Departure Managers, and ultimately 4D RNAV, will enable improved sequencing of RNAV SIDs and STARs.

Constraints:

- 6.1.7 New procedures are unlikely to be introduced without adequate evidence of benefits.
- 6.1.8 The ICAO requirement to provide 7 years' advance notice of change in requirements prevents the mandatory use of P-RNAV in the TMA in the first timescale of this strategy (2000-2005). Conventional SIDs based on VOR/DME or, in extreme cases, NDB will have to continue to be supported at least until 2006-2007. The total removal of NDBs, which is an objective of many service providers, would require additional capability from on-board equipment, particularly amongst General Aviation users, which cannot be mandated within this timeframe.
- 6.1.9 A mandate for P-RNAV operations in selected TMAs by 2007 may be agreed with appropriate co-ordination and support from users and the appropriate advance notice. This would require a decision to be made by 2000 at the latest.
- 6.1.10 The ICAO manual on RNP values applicable to all phases of flight, which could support the introduction of a total RNAV environment, is still under development and it is expected to be available before 2005.
- 6.1.11 A mandatory requirement for RNP ≤ 1 RNAV operations would imply a comprehensive DME coverage at lower flight levels and RNAV MASPS-compliant avionics.
- 6.1.12 The present level of integrity associated with aeronautical data issued by the navigation database providers is insufficient to support RNP ≤ 1 operations.
- 6.1.13 Not all the aircraft that are currently certified as B-RNAV capable are expected to meet P-RNAV criteria.
- 6.1.14 Automated arrivals manager tools (AMAN) with limited functionality are already in use at a few airports. More advanced tools will be available by 2005 and will be deployed at some major airports. Improved navigation information and the use of two-way datalink will improve AMAN performance, providing the platform for automated sequencing procedures by 2008.

6.2 Maintenance of Conventional Procedures

- 6.2.1 In general, conventional SIDs, STARs and Holding Procedures will continue to be provided until at least 2006-2007. These may be based upon VORs, DMEs, radar vectors and, in extreme cases, NDBs.
- 6.2.2 ICAO SARPs are available for VOR, DME and NDB ground beacons, as are certification and operational approval standards for the corresponding airborne equipment.
- 6.2.3 ICAO PANS OPS criteria are available for VOR/DME, VOR and NDB based procedures.
- 6.2.4 The use of P-RNAV may be mandated in selected TMAs, based on local requirements. This will limit the area of operations of lower navigation capability aircraft.
- 6.2.5 National rationalisation plans for conventional infrastructure (i.e. VOR and NDB),

enabled by the increased use of RNAV, will further impact the operations of non-RNAV aircraft or lower capability B-RNAV aircraft.

- 6.2.6 Civil Aircraft with lower navigation capabilities will not be able to operate in a mandated P-RNAV environment. Procedures for accommodating State aircraft with lower navigation capabilities will have to be developed.

6.3 Provision and Maintenance of RNAV Terminal Procedures

6.3.1 Planning Assumptions

The Implementation plans are based upon the assumption that RNAV Terminal procedures will be introduced in ECAC as follows:

- a) In the period up to 2005, RNAV SIDs will be introduced for the use of appropriately equipped aircraft. There will be some new RNAV procedures but in many cases, RNAV procedures will be overlaid on existing conventional procedures.
- b) Between 2005-2010, the use of RNAV will be mandated in selected TMAs to meet Operational and User requirements. Any requirement for additional aircraft equipage would need to be supported by a cost-benefit analysis (CBA). Procedures will be developed, and the supporting infrastructure will be maintained, to accommodate State aircraft.
- c) The use of RNAV will not be mandated in all TMAs until 2010 when mandatory RNP 1 RNAV is expected to be introduced for En-route Operations. At this time, all TMA Procedures will be based upon the carriage of RNP ≤ 1 RNAV.

6.3.2 Confirm Operational Requirement

Operational Benefits

The main operational benefits expected from the introduction of RNAV Terminal Procedures are the increased operational flexibility in the TMA and the potential for reducing the ATC workload. Furthermore, cost savings can be anticipated in terms of fuel reductions through reduced track length and more consistent performance. Environmental benefits, through appreciable noise and emission reduction, are also achievable.

Cost Benefit Analysis

In the short term (2000-2005) a simple CBA should be conducted to ensure that the cost of developing and introducing new P-RNAV procedures would be justified by the anticipated operational advantages.

In the medium term (2005 - 2010), due to the significant differences between high and low density TMAs, it is important that a CBA is performed, prior to the introduction of any mandatory requirement for P-RNAV in TMA.

The cost benefit for RNAV must be demonstrated either by the reduction in infrastructure costs or the ability to make use of RNAV to effectively increase capacity/economy and/or reduce the environmental impact of operations. The cost penalties lie with the cost to Operators of equipping, or re-equipping aircraft, and to Providers in the provision of the supporting infrastructure.

Cost Benefit Studies, which will progressively address the various stages of implementation, are planned for June 2000, June 2002, June 2004.

6.3.3 **Safety**

Action must be taken to ensure that the EATMP Safety Policy requirements are satisfied.

Guidance Material for the Safety Analysis of TMA Procedures is being developed by EUROCONTROL.

6.3.4 **Prepare Business Case**

6.3.5 **Technical (Aircraft Equipment) Requirements**

Aircraft Equipment Requirements are addressed in § 6.3.7.

6.3.6 **ATM Considerations**

A document providing an ATC operational perspective to RNAV applications in terminal airspace was published in December 1999.

The Guidance Material for the Design of Terminal Procedures for DME/DME and GNSS RNAV was approved by the ANT in July 1999. A further version covering the procedures for RNAV/Baro VNAV and RNP RNAV Operations is expected to be completed by the end of 2000.

A prototype arrivals and departure manager for use with RNAV procedures is currently being developed. It is anticipated that such a system will be available for operational trials by 2005.

Amendments are required to Doc 7030 to indicate appropriate aircraft capabilities in flight plans. Currently FAA uses non-standard codes (/E and /F) in Field 10, while Europe requires /R to indicate B-RNAV capable aircraft rather than RNP capable.

6.3.7 **Navigation Requirements (See Implementation Action No 10)**

Airborne Requirements

Material relating to the airworthiness approval and operational criteria for the use of PRNAV systems in European airspace (JAA TGL-xx²) is due to be published during 2000.

This document is expected to be updated to include RNP RNAV by the end of 2001.

Infrastructure Requirements

Before RNAV Operations can be introduced in a TMA the relevant Provider State must ensure that the navigation infrastructure is capable of supporting the proposed level of operations. This will include an assessment of DME/DME and/or VOR/DME coverage down to appropriate levels and, in the event of GNSS operations, an assessment of available non-GNSS procedures (at the destination airport or the alternate) for use in case of reversion.

6.3.8 **Support for Non Compliant Aircraft (See Implementation Action No 6)**

Determine through consultation with NATO and State Authorities, the level of support necessary for operations by State Aircraft. This element of the implementation plan is addressed under Implementation Action No 6.

6.3.9 **Dependencies**

Define links to other elements of the Navigation Programme.

Define links to other Domains/Programme.

6.3.10 **Co-ordination**

Liaison with internal Domains

Liaison with external bodies

Co-ordinate activities with other Programmes.

² The number of the TGL is to be determined by JAA.

6.3.11 Define Implementation Schedule

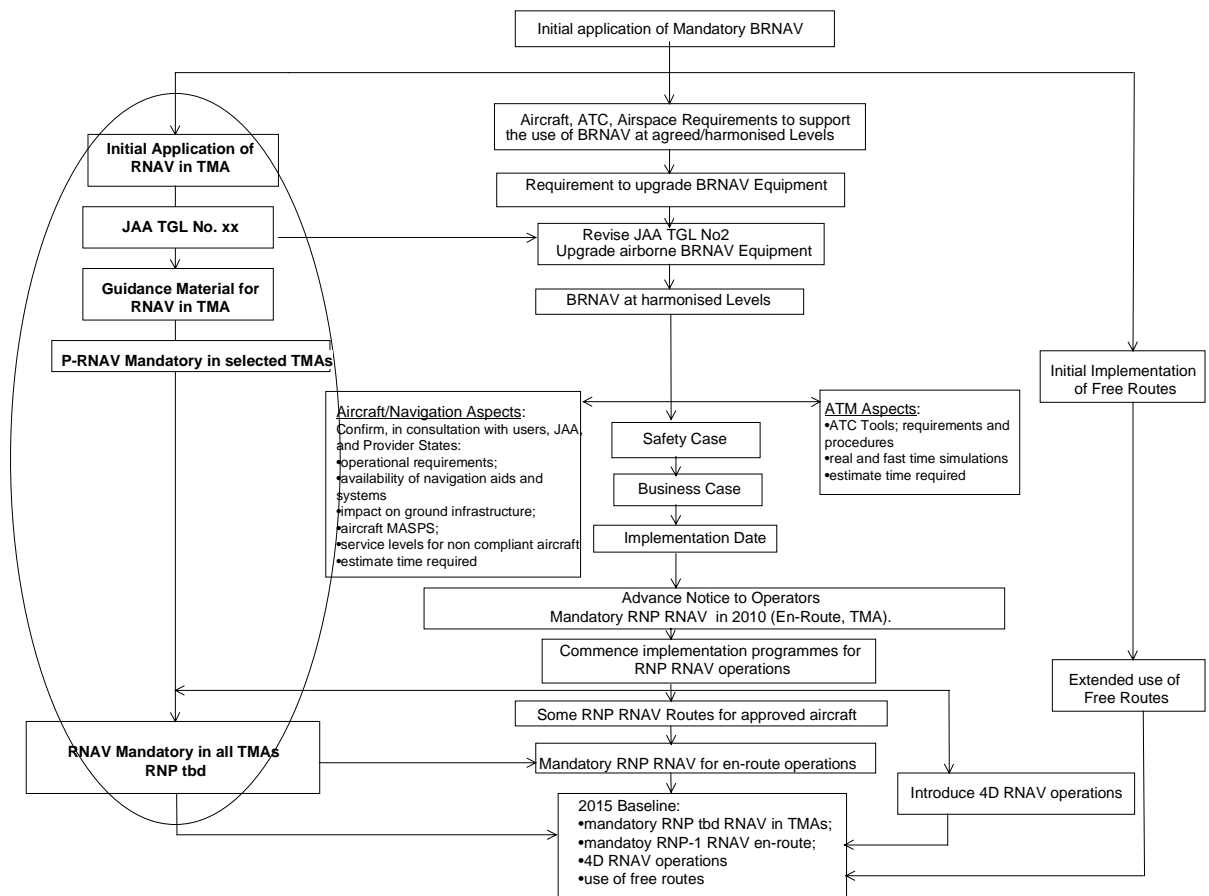
6.3.12 Notification process

ICAO Documentation
Issue Generic AIC
National Procedures

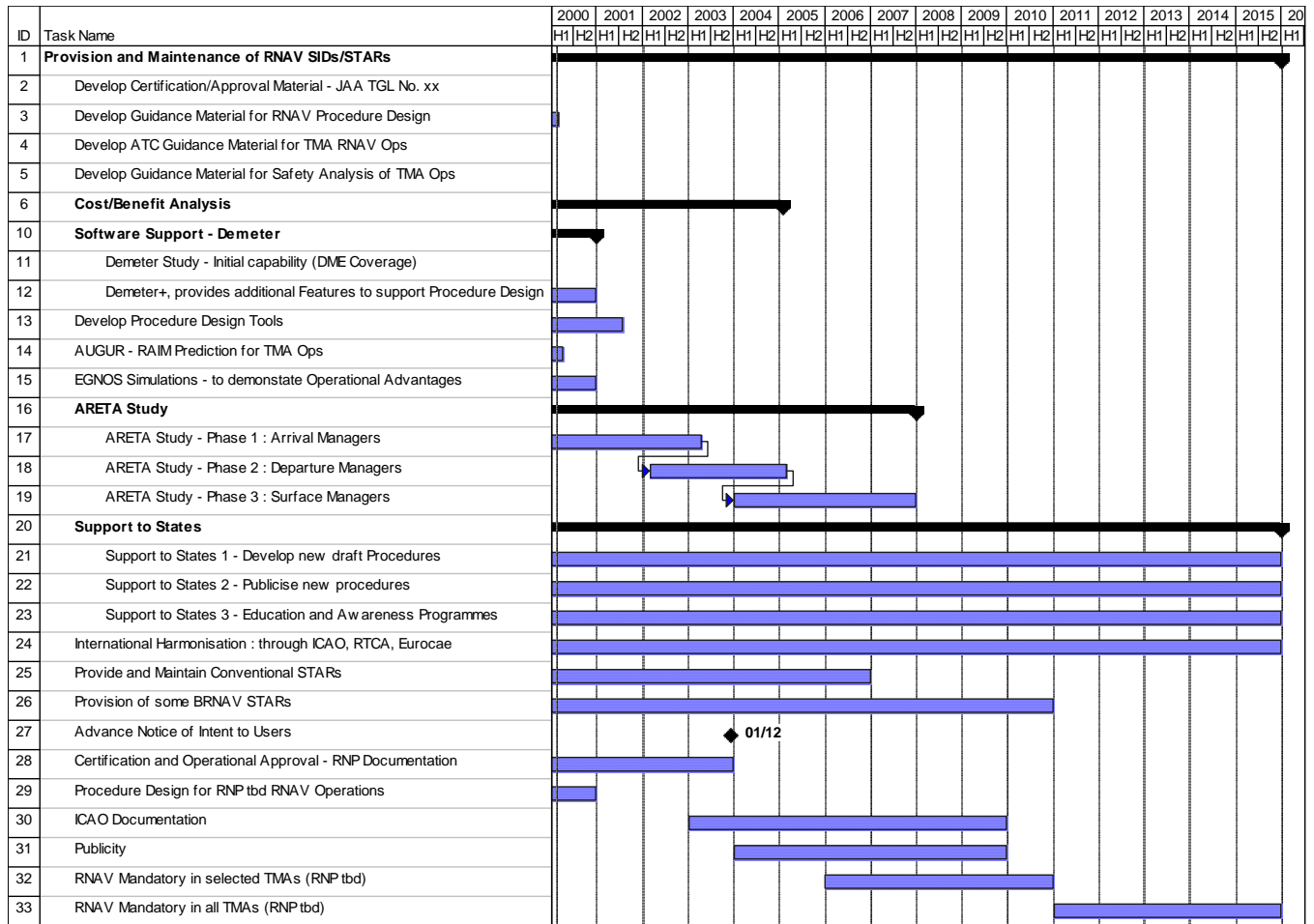
6.3.13 Publicity

Education and Awareness Material
Workshops/Seminars if required

6.3.14 Flow Chart



6.3.15 Gantt Chart



7. IMPLEMENTATION ACTION NO.3 - REQUIREMENT FOR B-RNAV AT ALL EN-ROUTE FLIGHT LEVELS

(Navigation Strategy for ECAC – Annexe 1 – Strategic Action 5.4)

Objective: to support a new route structure in both lower and upper airspace capable of providing increased airspace capacity

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Requirement for B-RNAV at all flight levels en-route	N/A	N/A
RNP	RNP-5 accuracy	N/A	N/A
Supporting Systems	VOR/DME; DME/DME (to provide adequate infrastructure and to rationalise as appropriate) INS/IRS + update GPS+RAIM (+conventional back-up) SBAS; GBAS (expected introduction towards the end of the period)		

7.1 Strategic Considerations

Rationale:

- 7.1.1 RNAV provides additional flexibility over the conventional method of navigation which can provide improved operational efficiency and potential capacity gains. This is achieved by the ability to plan the route structure to optimise the capacity of airspace without the constraints of the location of ground navigation aids.
- 7.1.2 The implementation process needs to continue until full application of B-RNAV is achieved at all flight levels for en-route operations. Specifically this will result in the extension of RNAV routes at lower flight levels than at present allowing the new route networks (e.g. ARN Version 3) to provide a complete RNAV environment in the ECAC en-route airspace.
- 7.1.3 The new route structure should be designed to make use of the RNAV and FUA concepts.

Enablers:

- 7.1.4 The equipment needed on the aircraft remains unchanged from the existing B-RNAV requirement. The rules (including ICAO Doc 7030) and guidance and regulatory material are therefore already available. The majority of aircraft are also already equipped.

Constraints:

- 7.1.5 This Implementation Action will include aircraft not presently affected by the B-RNAV equipage requirement.
- 7.1.6 The supporting infrastructure will need to be provided ensuring adequate coverage for RNAV routes at lower flight levels.

7.2 Implementation Planning

7.2.1 Planning Assumptions

In the development of this Transition Plan it has been assumed that the requirement relates to the harmonised application of B-RNAV at/above all en-route flight levels.

7.2.2 Confirm Operational Requirement

Operational Benefits

Operational benefits derived from the application of RNAV in the upper airspace can be extended into the lower airspace.

The extension of RNAV requirements will allow the efficient connection of the Terminal Procedures with the en-route structure.

The demonstration of these benefits will form part of the Airspace Organisation and Management programme and will normally make use of fast and real time simulations.

Cost Benefit Analysis

The cost benefit analysis will need to take into account:

- the provision, by some States, of additional navigation aids;
- the additional equipage required by aircraft presently not affected by the B-RNAV programme;
- the ability to commence the rationalisation of navigation infrastructure needs to be investigated to establish whether some infrastructure costs can be reduced.

7.2.3 Safety

Ensure that the EATMP Policy requirements are satisfied.

Review existing B-RNAV safety studies against EATMP Policy to confirm that they are still applicable. Examples to be considered are expected to include:

- Implications specific to additional aircraft (types, number, RNAV for single pilot operation, etc);
- Coverage of reversionary navigation aids at lower levels;
- impact that the application of B-RNAV operations might have on the minimum en-route altitude.

Complete Safety Case if required from above considerations.

7.2.4 Prepare Business Case

Prepare Business Case based upon:

- Technical capability;
- Cost benefit considerations;
- Overall aims and direction of the future navigation plans.

Develop and gain acceptance of business plan by all stakeholders.

7.2.5 Technical (Aircraft Equipment) Requirements

This project will not impose any additional requirements for the majority of Operators, in terms of aircraft equipment. The majority of aircraft (except State Aircraft) are already required to be B-RNAV compliant in accordance with the requirements of JAA TGL No. 2 (Rev 1). However a number of aircraft, operating only in the lower flight levels, will be required for the first time to carry RNAV equipment.

The parallel development of requirements for TMA RNAV operations may result in the need for review of RNAV equipage on the basis of the totality of requirements rather than for en-route alone.

7.2.6 ATM Considerations

Determine optimum time-scale for the implementation of the agreed changes to B-RNAV airspace.

7.2.7 Navigation Requirements (See Implementation Action No 10)

States should ensure that ground navigation aids provide adequate coverage to support B-RNAV operations at the minimum usable level of the airspace for which they are responsible.

Estimate time and cost of provision of additional ground navigation aids (if required).

7.2.8 Support for Non Compliant Aircraft (See Implementation Action No 6)

Determine, through consultation with NATO and State Authorities, the level of support necessary for operations by State Aircraft.

Support will not be necessary for civil aircraft as the carriage of BRNAV equipment is mandatory for operations in designated BRNAV airspace by civil aircraft

7.2.9 Dependencies

Define links to other elements of the Navigation Programme, e.g. TMA RNAV projects

Define links to other Domains/Programme.

7.2.10 Co-ordination

Liaison with internal Domains

Liaison with external bodies

Co-ordinate activities with other Programmes.

7.2.11 Define Implementation Schedule

Timescales have to be defined on the basis of the CBA which in turn depends upon the expected applications set out in the EATMP ASM projects/programmes.

Note:

1. There is a need to provide sufficient notice to allow installation of air and ground systems. However, notice has already been given of the intent for RNAV requirement for all en-route operations and so a further 7 years advance notice of the implementation is not required.

2. The CBA will be influenced by the timescales, an excessive delay in implementation of this B-RNAV extension together with a decision for an early implementation of P-RNAV application in terminal airspace may negate the benefit of an extension of B-RNAV when compared with the cost and benefits to be gained by a step directly from the present B-RNAV application to P-RNAV.

7.2.12 Notification process

ICAO Documentation – no additional ICAO documentation needed as Doc 7030 already covers all FIRs/UIRs.

Issue Generic AIC - AICs to be issued detailing lower flight level of B-RNAV applicability

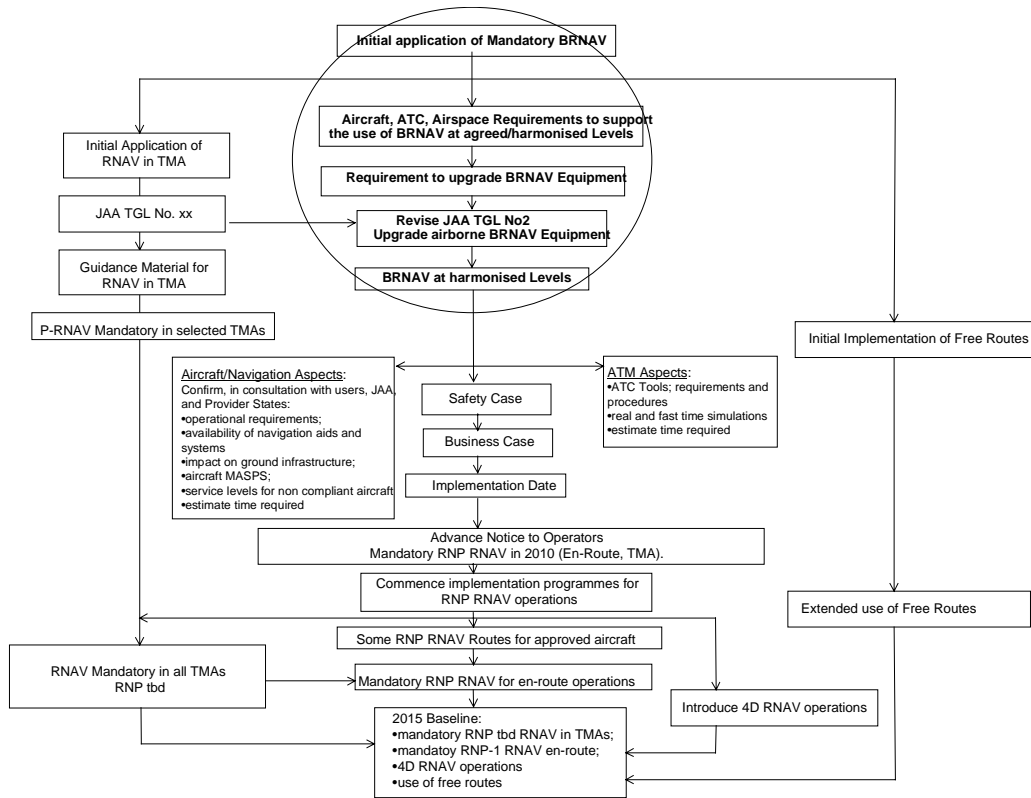
National Procedures - update as required

7.2.13 Publicity

Education and Awareness Material

Workshops/Seminars if required

7.2.14 Flow Chart



7.2.15 Gantt Chart

ID	Task Name	Qtr 1, 2000			Qtr 2, 2000			Qtr 3, 2000			Qtr 4, 2000			Qtr 1, 2001		
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	Requirement for B-RNAV at all en-route FLs	[Task bar spanning from Jan 2000 to Mar 2001]														
2	Confirm existing B-RNAV capability	[Task bar from Jan to Feb 2000]														
3	Determine type and cost of B-RNAV upgrade	[Task bar from Jan to Mar 2000]														
4	Define service levels for non-BRNAV aircraft	[Task bar from Jan to Mar 2000]														
5	Identify any additional facilities required (ATC, navigation aids, etc.)	[Task bar from Jan to Feb 2000]														
6	Safety Case	[Task bar from Jan to Jun 2000]														
7	Business case	[Task bar from Mar to Aug 2000]														
8	Consultation / Notice to users	[Task bar from Jan to Feb 2000]														
9	Agree optimum date for implementation	[Task bar from Jan to Feb 2000]														
10	Provision of aircraft / ground / ATC requirements	[Task bar from Jan to Oct 2000]														
11	Awareness and education programmes	[Task bar from Jan 2000 to Mar 2001]														
12	Implementation	[Task bar from Jan 2001 to Mar 2001]														

8. IMPLEMENTATION ACTION NO.4 - IMPLEMENTATION OF RVSM

(Navigation Strategy for ECAC – Annexe 1 – Strategic Action 5.5)

Objective: to increase en-route airspace capacity by providing additional flight levels

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Support the Implementation of RVSM	N/A	N/A
RNP	N/A	N/A	N/A
Supporting Systems	RVSM MASPS compliant altimetry systems		

8.1 Strategic Considerations

Rationale:

- 8.1.1 The application of RVSM is considered the most cost-effective means of providing increased ECAC airspace capacity. RVSM will provide six additional flight levels for use in the highly congested airspace between FL 290 to FL 410 inclusive, which will provide the additional en-route capacity needed to support the demand over the next 8-10 years, reduced in-flight delays and fuel economies for the users.

Enablers:

- 8.1.2 The airspace users support almost unanimously the implementation of RVSM. The RVSM CBA demonstrated a positive benefit-to-cost ratio over a wide range of assumptions regarding future developments within the European aviation environment.
- 8.1.3 Aircraft height keeping performance (including altimetry system accuracy) will have to meet specific RVSM criteria (MASPS-compliant altimetry and height-keeping systems), which may require re-equipage and/or fuselage treatment.
- 8.1.4 Some changes will be required to ATC systems.
- 8.1.5 A monitoring system to confirm RVSM height keeping performance will be applied to support a safe introduction of RVSM.
- 8.1.6 RVSM will be introduced after a thorough assessment of the safety implications, with safety evaluations before and after RVSM implementation as established within the EATMP Safety Policy and in accordance with ICAO Guidance Material.

Constraints:

- 8.1.7 Due to the aircraft height keeping performance requirements, which enable the safe operation in the RVSM airspace, the overall height keeping accuracy of aircraft flying in European airspace will increase. Safety assessments for horizontal separation minima, especially for (reduced) minimum route spacings, apply aircraft height keeping accuracy as one of the parameters which influences the horizontal risk. In general the risk models assume that the better the vertical accuracy, the higher the collision risk in the horizontal plane. Therefore, when considering the safety of separation minima on the basis of (improved) horizontal navigation performance (RNP), it will be necessary to take into account the effect of increased vertical accuracy, as brought about by RVSM requirements.
- 8.1.8 The introduction of RVSM and the resulting availability of more flight levels above FL290 may require some ATC re-sectorisation. This requirement has to be taken into account considering re-sectorisations in the context of route-structure changes. Therefore, the navigation infrastructure, as required to support en-route route structures and the associated airspace (sectorisation) structures, may need to take into account RVSM airspace requirements.
- 8.1.9 Other key elements in the implementation of RVSM relate to ATC issues (e.g. airspace requirements, ATC operational procedures, ATC system support, etc.), which are not

covered by the Navigation Strategy and this Transition Plan.

8.2 RVSM Implementation Planning

- 8.2.1 The Master Plan of the European RVSM Programme, dated 31 March 1999, sets out the scope of the work needed to safely implement RVSM at the earliest realistic date and in an efficient manner. It identifies the key activities of stakeholders within the Programme and the scale of commitment to be made by EUROCONTROL and the participating States.
- 8.2.2 The Master Plan has been developed in consultation with National RVSM Programme Managers, ICAO, JAA, Airspace User Associations, Agency staff and other RVSM Stakeholders.
- 8.2.3 This material in this document is limited to a list of the main aspects, which are addressed in the RVSM Master Plan, and a copy of the structure and implementation schedule of the RVSM programme.

8.2.4 Main Aspects of the RVSM Master Plan

- Safety
- Airspace Aspects
- ATC Procedures
- ATC Systems
- Aircraft Requirements
- Monitoring

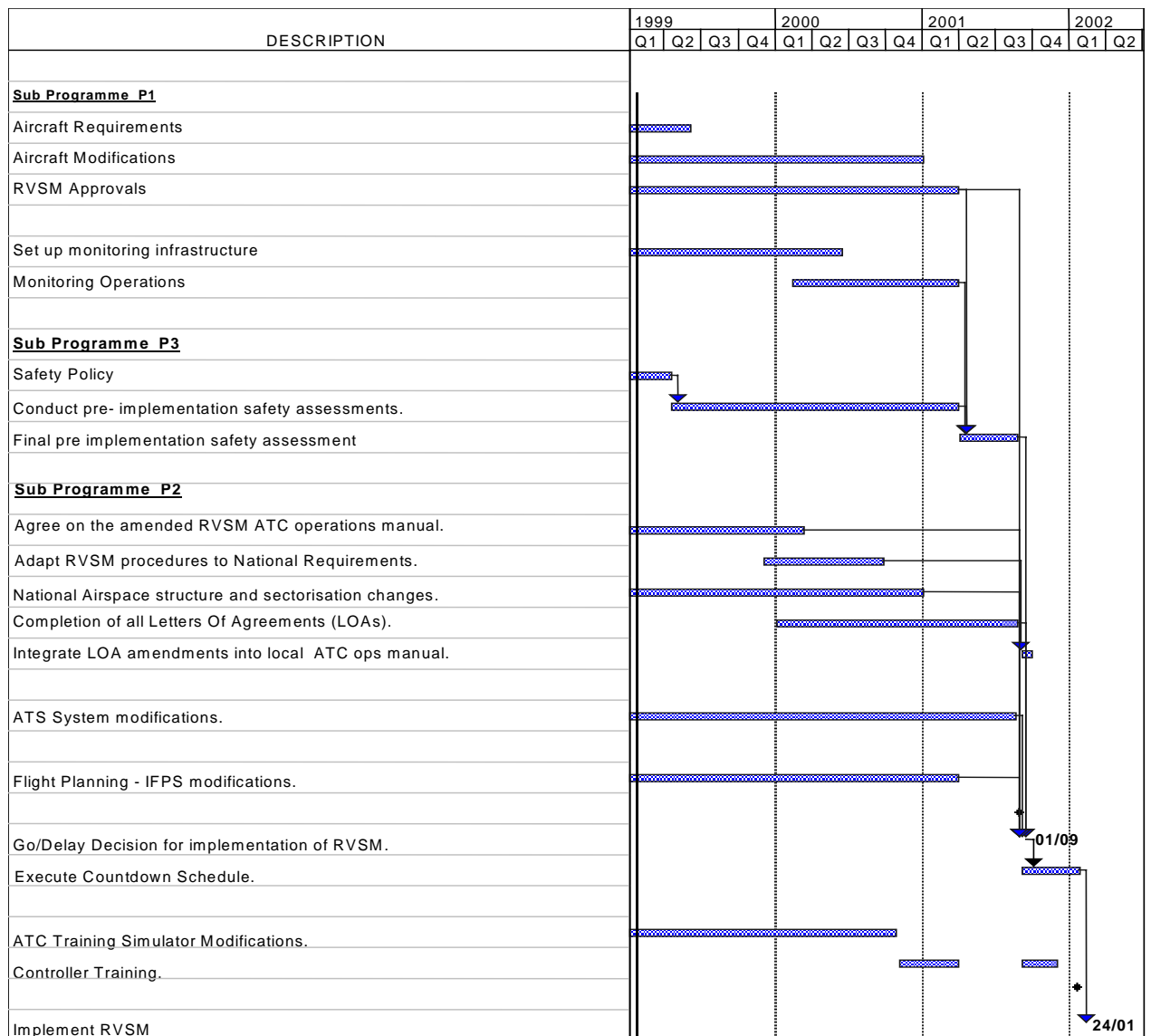
8.3 RVSM Programme Structure

- 8.3.1 The three Sub Programmes P1-P3 represent the main workload of the RVSM Programme.
- 8.3.2 Sub Programme P1, "Airspace User Preparation & Performance Verification", will ensure that the technical, operational and regulatory means will be available for airspace users and States to enable RVSM approvals. Sub Programme P1 will also assist and monitor the approval process. Aircraft height keeping accuracy will be verified through the operation of a height-monitoring infrastructure. The monitoring programme will provide the technical data to confirm that safety objectives are met (see Sub Programme P3).
- 8.3.3 Sub Programme P2, "ATM Preparation", will ensure all ATS provider units are well prepared and ready for the introduction of RVSM on the agreed date. To this end, Sub Programme P2 identifies the tasks which should allow States, inter alia, to make airspace changes, if required; introduce RVSM related ATC procedures; modify ATC systems; provide ATC training; and resolve legal issues.
- 8.3.4 Sub Programme P3, "RVSM Safety Assurance", constitutes the safety assessments necessary prior to implementation, just after implementation and at the end of the RVSM Programme to ensure that the agreed Safety Objectives are met. Sub Programme P3 includes the development of an agreed RVSM Safety Policy, and also identifies the possible need for States to prepare RVSM Safety Cases.
- 8.3.5 Project P4, "Awareness and Marketing", caters for awareness activities undertaken by EUROCONTROL and each State. Increasing the levels of awareness throughout the Industry and within each State will reduce risk of the programme failing to attain its objectives.

8.4 RVSM Programme Schedule

8.4.1 The schedule, which has been developed in close consultation with national RVSM Programme Managers, contains the following significant dates:

Activity	Month of Completion
Provisional Council approval of Master Plan	April 1999 (completed)
Monitoring Infrastructure Fully Operational	September 2000
Sufficient Aircraft Approved	March 2001
Pre-Implementation Safety Assessment	July 2001
Go/Delay Decision	September 2001
Implementation Date	January 2002
Initial Post implementation Safety Assessment	December 2002
Final Post Implementation Safety Assessment	December 2004



9. IMPLEMENTATION ACTION NO.5 - IMPLEMENTATION OF FREE ROUTES

(Navigation Strategy for ECAC – Annexe 1 – Strategic Action 5.6)

Objective: to support increased flexibility of en-route operations and to provide greater opportunity for ATC to approve user-preferred trajectories

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Implementation of free routes	Extended implementation of free routes	Extended implementation of free routes
RNP	RNP 5 accuracy (B-RNAV)	RNP 5 accuracy and RNP 1 accuracy	RNP 1 could be expected as infrastructure will automatically provide this capability if RNP-1 RNAV becomes mandatory in the TMA and/or VOR are decommissioned
Supporting Systems	as for B-RNAV comprehensive navaid coverage is required DME/VOR/GPS adequate ATC tools	as for B-RNAV and/or P-RNAV comprehensive navaid coverage is required DME/DME supported by GNSS providing together an adequate reversionary capability adequate ATC tools	as for RNP 1 RNAV Comprehensive navaid coverage is required GNSS supported by DME/DME providing together an adequate reversionary capability adequate ATC tools

9.1 Strategic Considerations

Rationale:

- 9.1.1 The Free Routes Airspace Concept (FRAC) will provide additional capacity increase, expected to be required in the time frame 2003-2006, after the RVSM implementation. This concept allows aircraft with RNAV capability to plan flights between en-route points at the beginning/end of the Terminal Procedures (SIDs / STARs) or the entry/exit points to the Free Routes airspace. This concept is expected to contribute to the flexibility of en-route operations, to give capacity increases, and to allow fuel and time efficient operations with the minimum of ATC constraints. It is expected to offer an increase in en-route capacity in the timeframe 2003-2006/8, by allowing aircraft to benefit from the improved on-board capabilities and by enabling selectable user operational preferences.

Enablers:

- 9.1.2 Initial studies and simulations (EUROCONTROL) have indicated a reduction of approximately 33% in conflicts in a Free Routes environment, primarily from the dispersion of tracks. This in turn could allow a greater proportion of aircraft to receive the requested flight level and a reduction in controller intervention. This may to some extent be reflected in increased sector capacity. If feasible, the two factors would significantly increase the effective system efficiency and capacity and would become an important step towards the future European ATM system.
- 9.1.3 The Free Routes Project is currently under development within EATMP. Its initial

application from 2003 is based on B-RNAV capability. No additional airborne equipment fit will be required and the requirements for navigation infrastructure remain unchanged by reason of this Implementation Action.

Constraints:

- 9.1.4 The initial simulations retained the control function of the ground system, but with flexibility being offered to aircraft to follow their optimum profile. The studies underway have demonstrated the need for adequate controller support due to the complexity of the interaction between these "ideal" routings and the resulting spread of conflict points. The required enhancements in ATC tools are yet to be determined and are expected to be the most costly element of the implementation.
- 9.1.5 There will be a need for the controller tools to support the application of the Free Routes to specific parts of the airspace (e.g. higher flight levels or areas with less dense traffic). An additional requirement for comprehensive navigation coverage with appropriate infrastructure may arise when the effective implementation area is defined (EATMP).
- 9.1.6 The feasibility of implementing free routings ECAC-wide in the timeframe 2005-2010 is under consideration within EATMP. Issues being addressed include the relative roles of ATC and aircraft systems for separation assurance, management of the converging traffic around the terminal airspace and the concentration of traffic likely to occur in the proximity of an active restricted area. The main areas of development required in such an environment might involve vertical and time profiles (4D RNAV). Some options studied under the EUROCONTROL PHARE programme using this concept demonstrated that RNAV and FMS, together with a ground-based ATC function, could play an important role in future developments.
- 9.1.7 The period to 2005 is likely to see only the very first stage of the 'free routes' implementation process, or more likely an experimental stage. The ability to use the navigation capability will increasingly require further development of ATS and airborne systems. It is expected that free routes operations will be gradually extended throughout the upper and lower airspace, as the support tools become available. However timescales are uncertain.

9.2 Implementation Planning

9.2.1 Background

A Draft Project Management Plan (PMP) aimed at implementation of Free Routes in the Upper Airspace of 8 European States (Belgium, Denmark, Finland, Germany, Luxembourg, Netherlands, Norway, Sweden) was initiated by the EUROCONTROL Agency in November 1998. It is anticipated that this 8-States pilot project can form the basis for wider implementation in ECAC, to adjoining States and to other States in Europe, for example to the CEATS States. The general objective of the project is to provide an implementation strategy, plan and business plan for the introduction of Free Route Airspace across the eight ECAC member States by 2003. It is foreseen that an expanded application of the Free Routes Airspace (FRA) will occur in 2007, leading to the application in all ECAC States in 2010.

Definition

Free Route Airspace is defined as specific airspace within which users shall freely plan their routes between an entry point and an exit point without reference to the ATS route network. In this airspace flights will remain subject to Air Traffic Control.

(Note: ATC retain responsibility for the separation of aircraft and this characteristic distinguishes the proposed Free Route Airspace from "Free Flight" Concept.)

Aircraft Navigation

A fundamental principle of the initial implementation of the Free Routes Concept is that there will be no requirement for any airborne equipment additional to that necessary for B-RNAV operations in compliance with JAA TGL No 2. However it will be necessary during the Project Phase P3 - Post Implementation Monitoring and Development - to establish a study to:

- confirm adequacy of B-RNAV to meet requirements of Free Route Airspace.

- consider impact on future expansion of Free Route Concept.
- recommend remedial measures.
- consider impact of aircraft with a higher navigation performance (i.e. P-RNAV or RNP 1 RNAV) in Free Route Airspace.
- define MASPS to support operations in totally Free Route environment. (i.e. RNP 1 RNAV, 4D capability).
- ensure that the navigation infrastructure will support the envisaged operations in the airspace for which they have responsibility.
- define, and ensure provision of, the necessary support tools for ATC.

9.2.2 **Confirm Operational Requirement**

Operational Benefits

Operational benefits derived from the application of Free Routes are to be demonstrated. This is to consider the benefits to be derived from the application of BRNAV capability available from the start of the programme as well as extensions of the application which might be made possible in the period 2010-2015 if 4D RNAV were to be available.

The demonstration of these benefits will form part of the Airspace Organisation and Management programme and will normally make use of fast and real time simulations.

Cost Benefit Analysis

The cost benefit analysis will need to take into account:

- the provision, by some States, of additional navigation aids;
- the ability to commence the rationalisation of navigation infrastructure needs to be investigated to establish whether some infrastructure costs can be reduced;
- Provision of ATC support tools;
- Increase efficiency of operations where user preferred trajectories are more readily available;
- Benefits to be derived from different on-board capabilities (B-RNAV/P-RNAV/RNP 1 RNAV/4D RNAV).

9.2.3 **Safety**

Ensure that the EATMP Safety Policy requirements are satisfied.

The Navigation programme will support the overall safety analysis required for Free Routes which will involve Airspace Management, Navigation and ATC & DP issues.

Typically the navigation aspects will include the:

- Implications on aircraft equipage
- Coverage of reversionary navigation aids in Free Route airspace
- impact that different RNAV capabilities might have on the system safety

Complete Safety Case

As required from above considerations.

9.2.4 **Prepare Business Case**

Support the overall Business Case preparation to cover the navigation issues derived from:

- Technical capability
- Cost benefit considerations
- Overall aims and direction of the future navigation plans

Develop and gain acceptance of Business Case by all stakeholders

9.2.5 **Technical (Aircraft Equipment) Requirements**

Initially, this project will not impose any additional requirements for the majority of Operators, in terms of aircraft equipment. The majority of aircraft (except State Aircraft)

will already be required to be B-RNAV compliant in accordance with the requirements of JAA TGL No. 2 (Rev 1).

The parallel development of requirements for TMA RNAV operations may result in the need for review of RNAV equipage on the basis of the totality of requirements rather than for en-route alone.

The longer term requirements of Free Routing environment may require a 3D and, ultimately, 4D capability.

9.2.6 **ATM Considerations**

Determine optimum time-scale for the implementation of the agreed changes to airspace.

Determine the RNAV capability needed to meet the ATM requirements

9.2.7 **Navigation Requirements (See Implementation Action No 10)**

States should ensure that ground navigation aids provide adequate coverage to support RNAV operations at the minimum usable level of the airspace for which they are responsible.

Estimate time and cost of provision of additional ground navigation aids (if required).

9.2.8 **Support for Non Compliant Aircraft (See Implementation Action No 6)**

Determine, through consultation with State Authorities and NATO (if required), the level of support necessary for operations by State Aircraft.

Where only B-RNAV is required, support will not be necessary for civil aircraft as the carriage of B-RNAV equipment is mandatory for operations in designated B-RNAV airspace. Where additional capability is required (e.g. 3D/4D/P-RNAV), implementation timescales may be shortened if mixed mode operation is possible with adequate support by ATC to non-compliant civil aircraft.

9.2.9 **Dependencies**

Define links to other elements of the Navigation Programme.

Define links to other Domains/Programmes.

9.2.10 **Co-ordination**

Liaison with internal Domains

Liaison with external bodies

Co-ordinate activities with other Programmes.

9.2.11 **Define Implementation Schedule**

Timescales have to be defined on the basis of the CBA which in turn depends upon the expected applications set out in the ASM projects/programmes.

Note: 7 years advance notice should be planned for any implementation resulting in a change of mandatory equipage (where only B-RNAV is required this is not applicable)

9.2.12 Notification process

ICAO Documentation: Doc 7030 - No changes are required for BRNAV applications, but that changes may be required for other applications

Issue Generic AIC: AICs to be issued detailing RNAV requirements

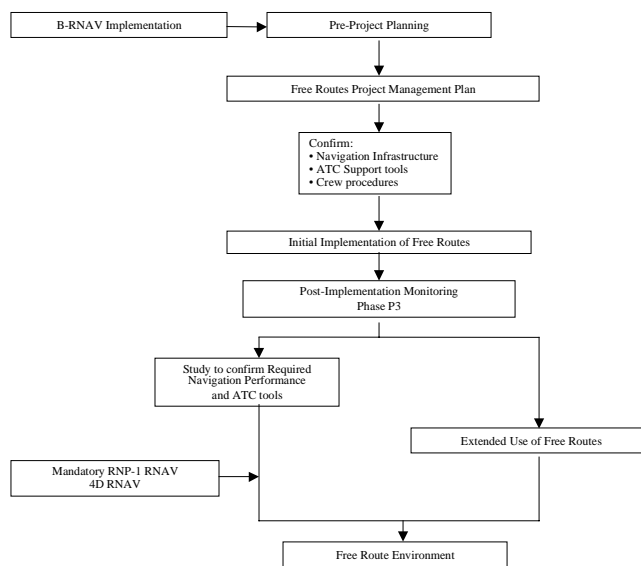
National Procedures: update as required

9.2.13 Publicity

Education and Awareness Material

Workshops/Seminars if required

9.2.14 Flow Chart



9.2.15 Gantt Chart

ID	Task Name	2000		2001		2002		2003		2004		2005		2006		2007	
		H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
1	Implementation of Free Routes	[Thick black bar spanning all years]															
2	Prepare Free Route Airspace Project Plan	[Thin blue bar spanning 2000 H1 to 2000 H2]															
3	Approve Free Route Airspace Project P1- Development Phase	[Thin blue bar spanning 2000 H1 to 2000 H2]															
4	Conduct Feasibility Assessment	[Thin blue bar spanning 2000 H2 to 2001 H1]															
5	Produce Feasibility Assessment Report	[Thin blue bar spanning 2001 H1 to 2001 H2]															
6	Produce Implementation Plan	[Thin blue bar spanning 2001 H1 to 2001 H2]															
7	Produce Draft Safety Case	[Thin blue bar spanning 2000 H2 to 2001 H1]															
8	Steering Group Approves 8-States Implementation Plan, Safety Case, and Implementation Documents	[Milestone diamond at 2001 H1, labeled 03/09]															
9	Approve Free Route Airspace Project P2 - Implementation Phase	[Milestone diamond at 2001 H2, labeled 27/09]															
10	Conduct Demonstrations	[Thin blue bar spanning 2001 H2 to 2002 H1]															
11	Each State Approves Its Local State Implementation Plan, Safety Case, and Implementation documents	[Thin blue bar spanning 2002 H1 to 2002 H2]															
12	Steering Group Confirms all State Approval Signatures	[Thin blue bar spanning 2002 H1 to 2002 H2]															
13	Implement Free Route Airspace in 8-States	[Thin blue bar spanning 2002 H2 to 2003 H2]															
14	Post-Implementation Monitoring and Development - P3	[Thin blue bar spanning 2003 H2 to 2004 H2]															
15	Implement Free Route Airspace in ECAC (Not part of 8-States Project)	[Thin blue bar spanning 2005 H1 to 2007 H2]															

10. IMPLEMENTATION ACTION NO.6 - CONTINUE TO SUPPORT OPERATIONS OF AIRCRAFT WITH LOWER NAVIGATION CAPABILITY

(Navigation Strategy for ECAC – Annexe 1 – Strategic Action 5.7)

Objective: to support continued en-route operations of Civil aircraft equipped with lower capability systems and State aircraft

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Continue to support operations of aircraft with lower capability		N/A
RNP	RNP 5 accuracy (B-RNAV)		RNP1 RNAV mandated ECAC wide
Supporting Systems	NDB VOR DME	VOR/DME; INS/IRS + update; GPS+RAIM (+ conventional back-up)	

10.1 Strategic Considerations

Rationale:

- 10.1.1 It is a User Requirement that civil aircraft which are equipped with lower capability B-RNAV equipment are provided with support to enable them to continue their operations for as long as feasible.
- 10.1.2 State aircraft are not subject to ICAO requirements. Special arrangements may be required to provide the support necessary for them to continue their operations. Military Authorities may consider that specific military equipment meets the respective civil navigation requirement when certifying military aircraft for IFR GAT operations.

Enablers:

- 10.1.3 Although the carriage and use of B-RNAV systems is expected to progressively reduce due to the evolution of the air navigation environment, the Navigation Strategy for ECAC does not anticipate the mandatory implementation of RNP 1 RNAV until 2010. Furthermore, due to the continued need to support conventional procedures in TMAs (Implementation Action No.2 - § 6.2), the rationalisation and/or withdrawal of conventional supporting infrastructure (mainly VOR and NDB) is not expected to be completed before 2010.
- 10.1.4 In line with international agreements, State aircraft have unrestricted access to the entire airspace and appropriate infrastructure support for their operations has to be maintained. Military Authorities are expected to upgrade navigation equipment in line with developing technology which should satisfy GAT IFR requirements.

Constraints:

- 10.1.5 Throughout the period 2005-2010 the requirement to accommodate a number of aircraft equipped with lower capability B-RNAV systems will impose restrictions on the majority of aircraft, which have higher RNAV capabilities. This will delay the benefits to be derived from an RNAV environment with increased performance requirements (e.g. RNP 1). RNP 1 RNAV is expected to be mandated ECAC-wide from 2010 for all phases of flight.
- 10.1.6 Some military GAT operations may still require conventional infrastructure support beyond 2010. On a national basis, authorities may decide to continue the provision of conventional services for military use.

- 10.1.7 For en-route operations, NDBs and VORs are expected to be completely withdrawn before or by 2010. VOR services may continue to be required at a limited number of airports to support TMA operations beyond 2010, but not ECAC wide and the system is expected to be completely withdrawn by 2014-2015. The further developments in GNSS may accelerate VOR withdrawal for all phases of flight.

10.2 Implementation Planning

10.2.1 Planning Assumptions

It is assumed that the harmonised implementation of B-RNAV at agreed flight levels throughout ECAC airspace has been completed.

Civil aircraft considered to have a “lower capability” are assumed as a minimum to be in compliance with the requirements of JAA TGL No.2 (Rev 1).

State aircraft will continue to require access to all airspace (e.g. RVSM, B-RNAV, Free Routes).

After 2010, the majority of Military GAT operations are expected to use advanced navigation systems meeting GAT IFR requirements

10.2.2 Operational Benefits and Cost Benefit Analysis

The Operational Benefit and Cost Benefit Analyses of all Implementation Actions will be required to reflect support to lower capability and State aircraft, as this support adds constraints on ATM and in particular on ASM.

10.2.3 Safety Requirements

Ensure that the EATMP Safety Policy requirements are satisfied.

Safety analysis for the introduction of all Implementation Actions should include the requirement to continue to support operations of aircraft of lower capability and State aircraft.

10.2.4 Business Case

Business Cases for the introduction of all Implementation Actions should include the requirement to support operations of aircraft of lower capability and State aircraft.

10.2.5 Technical (Aircraft Equipment) Requirements

Civil Aircraft must satisfy the requirements of JAA TGL No. 2 (Rev 1) for operations in the designated B-RNAV airspace.

There are no commonly agreed minimum equipment requirements for State aircraft. However, Military Authorities may consider that specific military equipment meets the respective civil navigation requirement when certifying military aircraft for IFR GAT operations.

10.2.6 ATM Considerations

All Implementation Actions should include procedures for handling lower capability BRNAV aircraft in the event of a failure of their single BRNAV system and non RNAV capable State aircraft.

10.2.7 Navigation Requirements (See Implementation Action No 10)

Low Navigation Capability Civil Aircraft

Up until 2010 it is envisaged that sufficient conventional navigation aids will remain to provide support to lower capability B-RNAV aircraft. After 2010, with the introduction of mandatory RNP 1 requirements, such support will no longer be required

State Aircraft

Determine, through consultation with NATO and State Authorities, the level of support necessary for operations by State Aircraft.

State Aircraft are assumed, as a minimum, to be capable of navigating utilising conventional navigation aids. Up until 2010 it is envisaged that sufficient conventional navigation aids will remain to provide the necessary level of support required.

After 2010, the majority of Military GAT operations are expected to use advanced navigation systems meeting GAT IFR requirements. Some military GAT operations may require navigation assistance.

10.2.8 **Dependencies**

The requirement to support low capability civil aircraft and State aircraft should be reflected in respective Implementation Actions.

10.2.9 **Co-ordination**

To facilitate the handling of State aircraft it will be important to develop close co-operation and consultation with the relevant National Military Authorities and NATO, in order to :

- Define navigation capabilities of State aircraft
- Define navigation assistance required to support State operations

Liaison with internal Domains.

Liaison with external bodies

Co-ordinate activities with other Programmes.

10.2.10 **Define Implementation Schedule**

No separate implementation schedule is necessary. This will be part of the individual Implementation Actions.

10.2.11 **Notification process**

This will be part of the individual Implementation Actions.

10.2.12 **Publicity**

This will be part of the individual Implementation Actions.

11. IMPLEMENTATION ACTION NO.7 - MANDATE OF RNP 1 RNAV OPERATIONS

(Navigation Strategy for ECAC – Annexe 1 – Strategic Action 5.8)

Objective: to support additional capacity gains through the provision of closely-spaced parallel routes, the application of RNP-1 RNAV functionality and performance; to optimise navigation infrastructure

Note: the application of RNP 1 RNAV might be made possible through the requirement for RNAV in the TMA even where a Business Case could not be made for the application of RNP 1 RNAV only for en-route operations.

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Implementation of dedicated RNP 1 RNAV routes on an opportunity basis	More widespread introduction of RNP 1 RNAV routes	Mandate of RNP 1 RNAV operations
RNP	RNP 1 accuracy	RNP 1 accuracy	RNP 1
Supporting Systems	DME/DME (comprehensive coverage desirable) INS/IRS + update; GPS+RAIM (+conventional back-up); SBAS (expected introduction towards the end of the period); GBAS; adequate database integrity	DME/DME (comprehensive coverage desirable) INS/IRS+ update; Full GNSS (i.e. GPS + RAIM, SBAS and GBAS)	DME/DME (comprehensive coverage); INS/IRS+ update; GNSS (National Authorities may retain a VOR infrastructure for domestic/State flights, but ECAC wide VOR no further required) RNAV MASPS avionics

11.1 Strategic Considerations

Rationale:

- 11.1.1 RNP 1 RNAV is expected to enable a reduction in route spacing and separation criteria and provide increase functionality which together provide the opportunity for increased system capacity and reduced controller workload.

Enablers:

- 11.1.2 It is possible to require this performance on a limited basis for dedicated routes between 2000-2010, where the need for additional capacity is stringent and no other means of providing additional capacity is available. In this timeframe RNP 1 operations can be performed with dual/multi DME and GNSS based RNAV systems. A comprehensive DME coverage is required and is expected to be available throughout the timeframe, due to the requirements to enhance coverage to support B-RNAV operations.
- 11.1.3 Global standards are available for RNP x RNAV systems. They relate presently to plan navigation (2D RNAV) but work is underway to extend the standards to vertical (3D) requirements, as well as time (4D). It is expected that suitable standards will be available before 2005.
- 11.1.4 Rationalisation of ground navigation aids (VOR, NDB) will be possible from 2000

onwards on an opportunity basis. The increase in RNP 1 and even RNP<1 RNAV-equipped aircraft, due to the more stringent demands of terminal airspace operations, will lead to the mandatory requirement for a (baseline) RNP 1 RNAV requirement en-route from 2010 onwards.

- 11.1.5 This will allow further rationalisation towards a total removal of VOR. Since the ability to revert to non-RNAV operations will no longer be available, the removal of VOR would imply a requirement for an increased quality of performance offered by RNAV equipment. This could only be achieved if all aircraft satisfied the full RNP RNAV MASPS. If this was necessary/required before 2005, it could imply considerable expense to operators for those aircraft, which have to be retrofitted. After 2010, however, it is expected that RNP 1 RNAV MASPS will be the common level of aircraft capability.
- 11.1.6 The DME infrastructure will continue until at least 2015, and will support RNP 1 RNAV operations adequately. Dual/multi DME and GNSS based RNAV systems and INS/IRS with update, will provide the required performance.

Constraints:

- 11.1.7 Before new avionics requirements are set it is important that the benefit arising from their implementation can be quantified and a positive CBA can be demonstrated. Existing RNAV systems have a continuity of service and integrity level significantly below that of VOR transmitter/receiver combinations. Indeed, many of the current RNAV systems that meet RNP 1 accuracy cannot provide the required continuity of service and in many cases cannot meet the integrity requirements.
- 11.1.8 Constraints upon route spacing arise from both navigation capability and radar separation minima, the provision of improved navigation may not alone enable reduced route spacing without suitable support tools and/or enhanced surveillance.
- 11.1.9 Further constraints in requiring more stringent RNP values are the present CFMU and ATC systems. These currently have no means of distinguishing between aircraft with mixed capabilities and this facility has to be provided if different requirements are imposed. Handling traffic with mixed capabilities will be a drawback to implementing such a requirement, due to the possible decrease in capacity through increased controller workload as well as the need for costly enhancements or changes to ATC systems. Studies and simulations have demonstrated that potential capacity gains from a mixed capability environment are limited and could result in reduced ATC sector capacity.

11.2 Implementation Planning

11.2.1 Confirm Operational Requirement

Operational and Cost Benefits

The envisaged implementation time-scale for the evolutionary progression to a mandatory RNP 1 RNAV environment in the ECAC airspace must be confirmed by a comprehensive study which takes due account of the operational and cost aspects of :

- user requirements;
- need for, and use of RNP 1 RNAV capability in TMAs;
- need for, and use of, RNP 1 RNAV capability for en-route operations i.e. as basis for a reduced lateral separation minimum and/or a new route structure;
- need for RNP 1 RNAV capability to support the FUA and/or the extended use of the Free Route concept;
- the future requirement for 4D Navigation capability;
- increased operational efficiency/tactical flexibility;
- the potential to provide an increase in the airspace system capacity;
- the use of a airspace environment with a mixture of RNP 1 RNAV and B-RNAV equipped aircraft;
- the ability to identify aircraft navigation capability to ATC;
- need for additional ATC tools and new procedures;
- avionics requirements.

11.2.2 **Safety**

Action must be taken to ensure that the EATMP Safety Policy requirements are satisfied.

Complete Safety Case.

11.2.3 **Prepare Business Case**

Prepare Business Case for the various options for use of RNP 1 RNAV, as determined by the proposed study.

11.2.4 **Technical (Aircraft Equipment) Requirements**

Confirm, in consultation with JAA, the minimum system performance specifications (MASPS) necessary to support the agreed RNP ≤ 1 /P-RNAV Operations:

- Aircraft MASPS;
- Airworthiness certification requirements;
- Accuracy, availability, integrity and reliability of Navigation Aids/Systems;
- Requirements for the certification of Navigation Aids/Systems;
- Certification procedures and documentation;
- Time necessary to approve all aircraft.

11.2.5 **ATM Considerations**

Conduct ATC Simulations of the proposed RNP 1 RNAV Operations.

Identify, in consultation with Provider States, any additional ATC Facilities, Tools, Procedures, Route structures necessary to support the foreseen RNP 1 RNAV Operations.

Estimate time to meet these requirements.

11.2.6 **Navigation Requirements (See Implementation Action No 10)**

Confirm, with Service Providers and JAA, that the Navigation Aids/Systems meet the specified accuracy, availability, integrity, and reliability requirements to support RNP 1 RNAV Operations.

Rationalise need for existing ground navigation aids (VOR) in an RNP 1 RNAV environment.

11.2.7 **Support for Non Compliant Aircraft (See Implementation Action No 6)**

Determine service level, and available options, necessary to support operations by non-compliant civil aircraft.

Determine, through consultation with NATO and State Authorities, the level of support and available options necessary for operations by non-compliant State aircraft.

Determine operational, safety and cost implications of providing support to non compliant aircraft.

11.2.8 **Dependencies**

Define links to other elements of the Navigation Programme.

Define links to other Domains/Programme.

11.2.9 **Co-ordination**

- Ongoing consultation with User Organisations
- Liaison with internal Domains
- Liaison with external bodies
- Co-ordinate activities with other Programmes.

11.2.10 **Define Implementation Schedule**

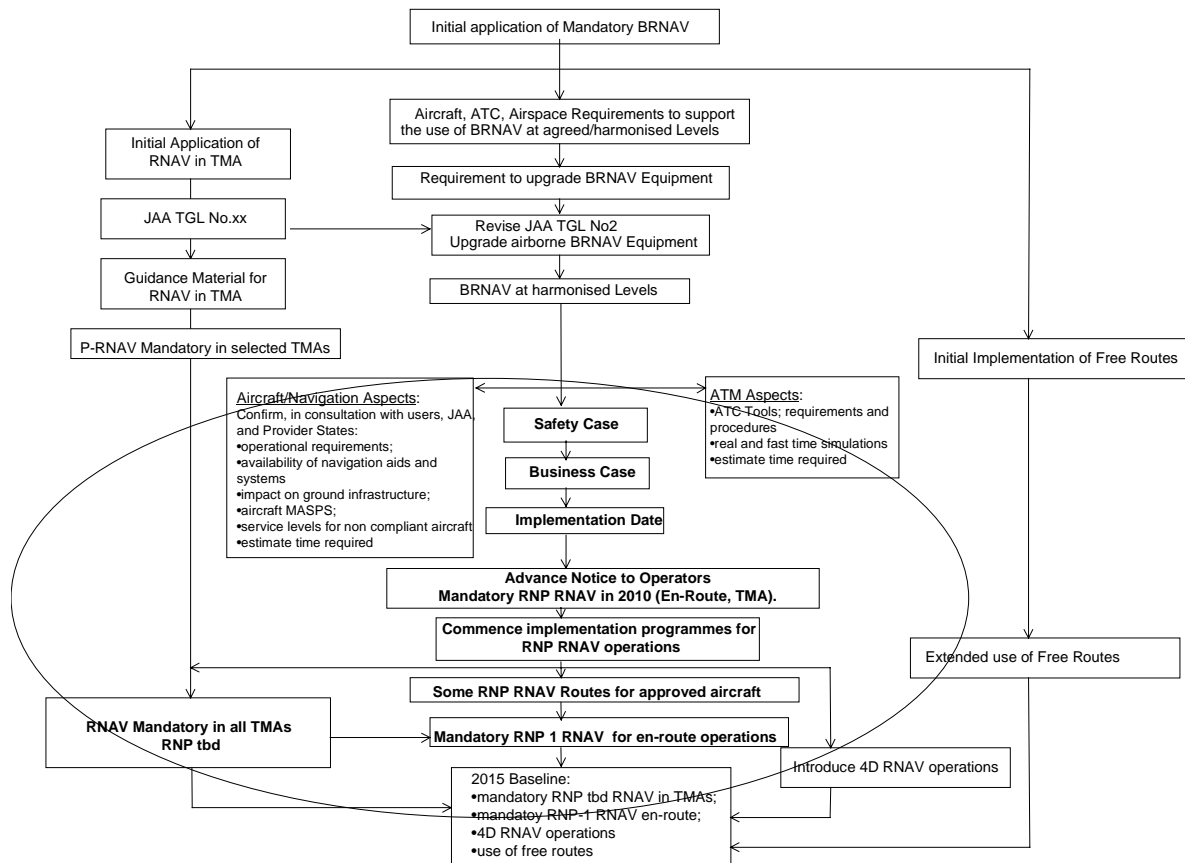
11.2.11 **Notification process**

- ICAO Documentation - Doc 7030 Regional Supplementary Procedures
- Issue Generic AIC
- National Procedures
- Guidance Material
- JAA TGL or equivalent

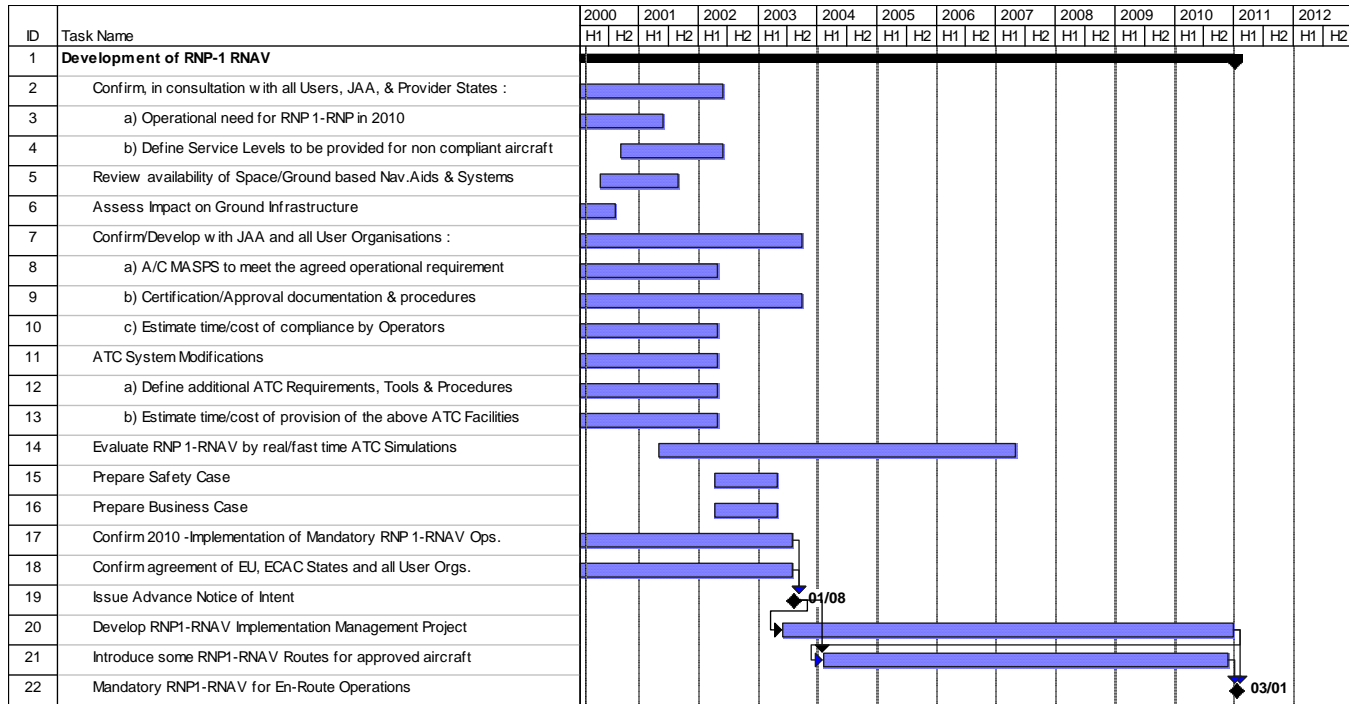
11.2.12 **Publicity**

- Education and Awareness Material
- Workshops/Seminars if required
- User Support Cell

11.2.13 **Flow Chart**



11.2.14 Gantt Chart



12. IMPLEMENTATION ACTION NO.8 - IMPLEMENTATION OF 4D RNAV OPERATIONS

(Navigation Strategy for ECAC – Annexe 1 – Strategic Action 5.9)

Objective: to exploit the advanced navigation capability in four dimensions in order to maximise freedom of movement, efficiency and flexibility of operations

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	N/A	N/A	Implementation of 4D RNAV operations
RNP			tbd
Supporting Systems			advanced aircraft systems capable of 4D RNAV (MASPS); ATC tools: integrated arrival/ departure managers, datalink DME/DME (comprehensive coverage) INS/IRS+ update; GNSS

12.1 Strategic Considerations

Rationale:

- 12.1.1 In the period 2010-2015, 4D RNAV operations by capable aircraft may offer significant capacity and efficiency of operation benefits. It might also allow a redistribution of responsibilities between aircraft and ATC.

Enablers:

- 12.1.2 Extending the capability of RNAV to accurate time control (4D RNAV) will allow the arrivals management concept to advance to the level of individual trajectory management. 4D-capable aircraft systems certified against 4D RNAV MASPS, could support such advanced operations. Global standards could be available in the proposed timeframe (2010-2015), and action is underway (EUROCAE/RTCA) to extend the existing 2D RNP RNAV MASPS [ref.7] to 4D RNP RNAV.
- 12.1.3 The EUROCONTROL PHARE programme has demonstrated the feasibility of 4D operations. A follow-up project is focused on implementation issues, with the aim of achieving operational benefits by making best use of available technology.

Constraints:

- 12.1.4 R&D studies have to be initiated, in order to identify and thoroughly explore all issues related to the complex application of 4D navigation. In an increasingly business-orientated environment for air navigation, any effective development plans will have to be based on sound business cases, where CBA results play an important part.
- 12.1.5 An international standard for the PHARE compatible RNAV systems needs to be agreed and cost benefit assessments of alternative infrastructure to be performed. Controller support tools such as trajectory prediction, conflict resolution and arrival/departure managers must be in place to support 4D applications and datalink must be available to permit the ATM system capacity to approach more closely and consistently the system optimum. These imply a complex integration of all system components into a cohesive whole and close relationships and co-ordination with developments in other domains (e.g. Surveillance, Communications). If tackled inappropriately or late, it may delay the benefits of such systems.
- 12.1.6 It is expected that the concepts of an integrated air/ground ATM with precise 4D trajectory-following will become the standard by 2015 [ref.1]. For such operations to be undertaken, increased availability of planning tools and accurate short-term

meteorological forecasts will be required. Operations are expected to be based upon preferred trajectories and will take account of any active airspace restrictions and the sequencing requirements necessary to optimise the airspace capacity.

12.2 Implementation Planning

12.2.1 Planning Assumptions

In the development of this transition plan it has been assumed that:

- RNP 1 RNAV MASPS will be mandatory post 2010;
- A regional gate-to-gate RNAV environment will be implemented in ECAC from 2010, with defined RNP values for each phase of flight,
- Conditional RNP RNAV approval anticipated to be necessary during the transition period from present to 2010 capability, which imply operational restrictions or limitations for operations in RNP RNAV airspace, will be removed from the certification requirements [ref.7]
- An increasing number of aircraft will be suitably equipped for 4D operations.

12.2.2 Confirm Operational Requirement

Operational Benefits

The extent of application will be determined based upon operational requirements identified during the EUROCONTROL Arrival Management Programme using RNAV (ARETA). 4D RNAV is a complex application, which requires coordinated and extensive R&D studies, in order to identify and thoroughly explore all issues related to this type of operations. 4D RNAV capability will enable the implementation of advanced free routes applications (directed towards free flight operations) and the gate-to-gate management of flight, main components of the target operational concept [ref.3] towards which the ATM 2000+ planned operational improvements are oriented.

Benefits are expected to result initially from increased tactical flexibility and efficiency of operations, maximised freedom of movement and potentially subsequent capacity gains. In the end it will allow a redistribution of responsibilities between air and ground in the planning, conduct and management of flights. However these can only be achieved through synchronised developments in all ATM areas.

Cost Benefit Analysis

The Cost Benefit analysis will need to consider:

- The airborne and ground developments needed to enable 4D RNAV application (RNAV equipment and ground planning tools);
- The CBA will be influenced by the potential to support a phased implementation thereby avoiding the need for mandatory equipage.

12.2.3 Safety

Safety studies will represent a significant part in the R&D studies. Action must be taken to ensure that the EATMP Safety Policy requirements are satisfied.

Complete Safety Case

The advanced 4D RNAV application, expected to be possible beyond 2015, will allow a redistribution of responsibilities between air and ground, with significant implications in the safety related aspects. The advance to this stage will require prior to implementation the development of a complete safety case, in which 4D RNAV will be only one of the components. The complexity of the safety case will require a collaborative and coordinated approach, which goes far beyond the Navigation domain responsibility.

12.2.4 Prepare Business Case

12.2.5 Technical (Aircraft Equipment) Requirements

It has to be confirmed, in consultation with JAA, the minimum requirements for 4D RNAV operations:

- Accuracy, integrity, reliability of navigation systems;
- Aircraft navigation equipment ;
- Certification requirements, procedures and documentation

Most modern RNAV systems have limited 4D capability at present, e.g. meeting a single time constraint to within 30 seconds. 4D RNAV requires specific additional capability of aircraft systems, such as trajectory prediction, etc. ARINC 702A standard (Advanced FMS) specifies the required functionality.

Global standards should be available in the timeframe 2010-2015. The existing 2D RNP RNAV MASPS are currently being extended (by EUROCAE/RTCA) to encompass 3D and 4D requirements.

12.2.6 **ATM Considerations**

Determine the necessary ATM tools to support 4D RNAV operations (link in the ATM 2000+ Strategy and other enablers):

- Increased availability of planning tools;
- Controller support tools such as trajectory prediction, conflict resolution and arrival/departure managers;
- Datalink;
- Integrated air/ground ATM systems with precise 4D trajectory following;
- accurate short term meteorological forecasts.

Estimate time necessary to meet these requirements.

4D RNAV capability will impact both on ASM and airspace design. Associated requirements for controller support tools on trajectory prediction and conflict resolution will benefit ASM Level 3 operations by facilitating civil/military real-time coordination.

These imply a complex integration of all system components into a cohesive whole and close relationships and co-ordination with developments in other domains (e.g. Surveillance, Communications). If tackled inappropriately or late, the benefits of such systems may be delayed.

12.2.7 **Navigation Requirements (See Implementation Action No 10)**

4D RNAV operations will not imply supplemental requirements for the navigation infrastructure that is expected to be available from 2010 onward. However, it has to be confirmed, with ECAC Member States participating in the application, that the coverage provided by that infrastructure, both satellite and ground-based is adequate. In those areas where problems are identified, the time necessary to provide the required coverage has to be determined. Identification of gaps is expected to be an exceptional case, as the level of coverage for ECAC is quite advanced at present and is expected to be completed during the following decade (2000-2010) to support operations ECAC wide.

12.2.8 **Support for Non Compliant Aircraft (See Implementation Action No 6)**

Determine level of support necessary for operations by State Aircraft, in consultation with NATO and State Authorities. Since 4D RNAV will not be a mandatory requirement within the timeframe of this Transition Plan, State Aircraft will most probably only require minimum support through specific procedures, to avoid operations on routes and in areas where 4D RNAV will be implemented.

Determine level of support necessary for operations by non-compliant civil aircraft where 4D RNAV operations are mandated.

12.2.9 **Dependencies**

Define links to other elements of the Navigation Programme:

- Advanced navigation database and AIS performance requirements will have to be defined and implemented, to enable 4D RNAV operations. Navigation coordinates will have to be published in the WGS84 reference system both in horizontal and vertical components.

- Specific procedures and appropriate crew training requirements will need to be defined and implemented.

Define links to other Domains/Programme.

- Airspace management should be able to allow the implementation of 4D RNAV operations and advanced free routes [ref.12].
- The datalink implementation planning should be coordinated with that of 4D RNAV applications [ref.4].
- The required ATC support tools will have to be in place before the implementation of 4D RNAV in the TMA . Specific procedures will need to be defined and appropriate controller training implemented.
- These imply a synchronised development and complex integration of all system components into a cohesive whole. If tackled inappropriately or late, the benefits of such systems may be delayed.

12.2.10 **Co-ordination**

Liaison with internal Domains

Liaison with external bodies

Co-ordinate activities with other Programmes.

12.2.11 **Define Implementation Schedule**

12.2.12 **Notification process**

Since 4D RNAV operations are not expected to be implemented earlier than 2012-2015, the Notice of Intent to airspace users will probably not be issued before 2008-2009.

ICAO Documentation

Issue Generic AIC

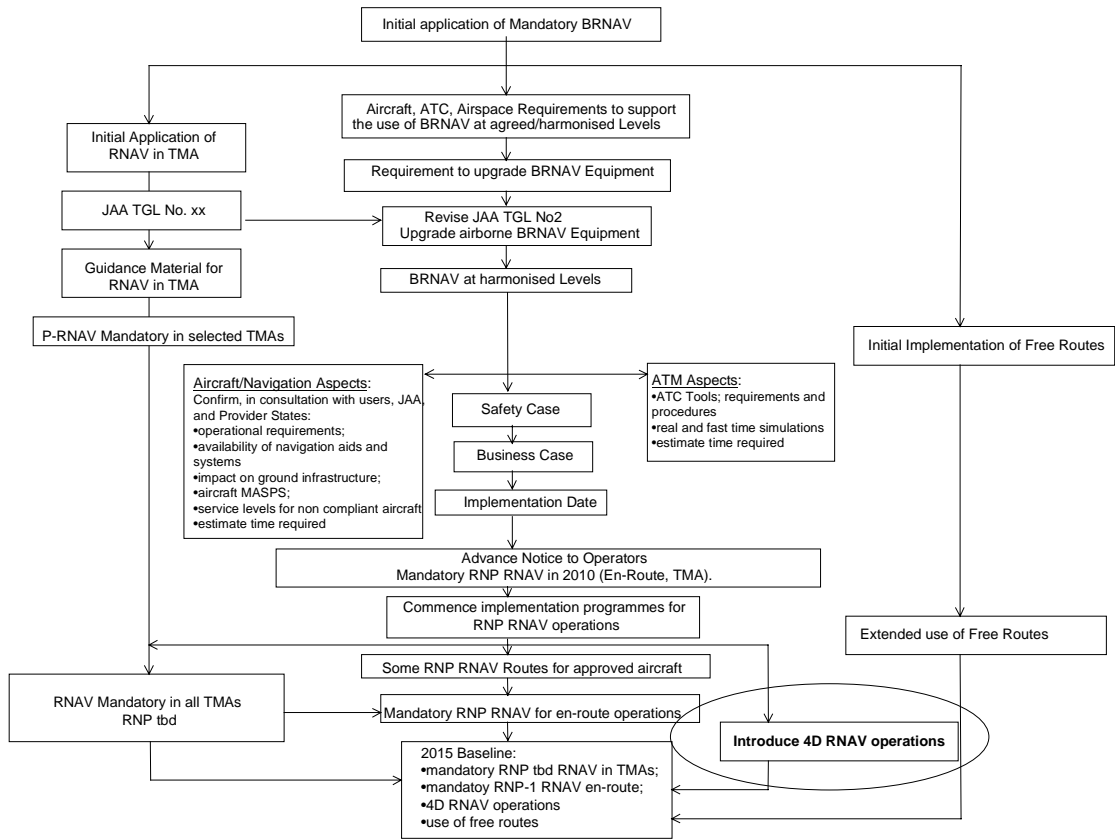
National Procedures

12.2.13 **Publicity**

Education and Awareness Material

Workshops/Seminars if required

12.2.14 Flow Chart



13. IMPLEMENTATION ACTION NO.9 - PROVISION AND MAINTENANCE OF ALL WEATHER OPERATIONS CAPABILITY (NPA AND CAT I/II/III PA) AT AIRPORTS

(Navigation Strategy for ECAC – Annexe 1 – Strategic Actions 5.12 and 5.13)

Objective: to maintain capacity levels and support continued all weather operations in low visibility conditions at airports

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Provision and maintenance of NPA, and Cat I/II/III PA Capability at airports (Cat.III including roll-out guidance)		
RNP	tbd	tbd	tbd
Supporting Systems			
for NPA	NDB; VOR; GPS+RAIM + conventional back-up;	NDB; VOR; GPS+RAIM + conventional back-up;	SBAS GBAS
for Cat I	some use of SBAS and/or GBAS by end of period	expected availability of SBAS; GBAS as possible option to replace ILS Cat I.	SBAS and GBAS will continue to replace ILS Cat I when appropriate
for Cat II/III	ILS Cat.II/III (continue wide spread use/ maintain service level	ILS Cat.II/III (continue wide spread use/ maintain service level as long as possible);	ILS Cat.II/III (diminished use/ maintain service level as long as possible);
		GBAS (possible introduction, subject to constraints) for ILS Cat II/III.	GBAS (further introduction to replace ILS Cat II/III). Note -cannot evaluate ratio of replacement of ILS by MLS or GBAS.
	MLS (initial introduction to replace ILS Cat II/III)	MLS (further use; replaces ILS CatII/III as appropriate; cannot evaluate ratio of replacement);	MLS (further introduction to replace ILS Cat II/III);
airborne	ILS MLS MMR	ILS MLS MMR (increased use)	ILS MLS MMR (widespread use; with upgrades as required)

13.1 Strategic Considerations

Rationale:

13.1.1 In ECAC, the forecast traffic increase will create major operational constraints at all airports, in particular in low visibility conditions. This problem will be felt equally at all categories of airports, from those with NPA facilities to those offering Cat III precision approach facilities. The number of airports with Cat III capabilities is expected to increase in future both in high-density traffic and medium/low-density traffic areas.

Enablers:

- 13.1.2 The development and application/introduction of ICAO RNP concept to precision approach operations is a main enabler for increased efficiency in a gate-to-gate perspective. The applicable RNP value is under consideration in various bodies, e.g. EUROCONTROL TARA Task Force, ICAO OCP, etc.
- 13.1.3 Non-precision approach (NPA) procedures based on GNSS and/or DME/DME (with IRS) are expected to replace many NDB and VOR/DME procedures before 2005. This will allow for a progressive rationalisation and withdrawal of NDB before 2010. VOR will continue to support certain non-precision approach operations until 2010. Its use is expected to decrease progressively, allowing for VOR decommissioning by 2010. It is anticipated that NPA will be superseded by NPV by 2010. These operations will be performed with GNSS and/or DME/DME RNAV systems.
- 13.1.4 ILS Cat I is expected to remain in use until the end of its service life at locations where there is no stringent requirement for upgrading or replacing. It is expected that ILS Cat I will be progressively replaced by SBAS or GBAS, allowing for ILS Cat I decommissioning by 2015.
- 13.1.5 Cat III PA capability is provided by ICAO standardised non-visual systems to approach and landing, i.e. ILS and MLS. These can also be used for departure operations (ICAO Annex 10).
- 13.1.6 It is expected that GBAS, as required for Cat III operations, may be available in the timeframe covered by this Navigation Strategy. Initially, it may not be an ECAC-wide acceptable system to replace totally ILS Cat III, but this is expected to happen towards 2010 - 2015.
- 13.1.7 Due to the necessity of interoperability between Regions and States, the ICAO Global Strategy identified the ultimate need for a multi mode airborne capability. This can be achieved either by the use of a Multi-Mode Receiver (MMR) or by a number of stand-alone receivers.
- 13.1.8 MMR, also known as multi-mode avionics landing system (MMALS), can provide the means for flexible transition. MMR has been developed as a single box which uses ILS, MLS or GNSS signals (as required and/or available) to provide ILS like guidance and other critical landing functions. MMR with high integrity datalink could support GNSS operations. Differential GNSS could also be integrated into MMR.
- 13.1.9 The development and availability of MMR is critical for maintaining full interoperability in the field of landing systems. This equipment is expected to be available by 1999 and its progressive implementation on board aircraft is recommended.

Constraints:

- 13.1.10 The ICAO RNP Manual Document will have to be amended or a separate manual on RNP for departure and arrival to be produced. The required material is under development and a document is expected to be ready in the 2000-2005 timeframe.
- 13.1.11 Cat I/II/III operations at European airports are currently supported by ILS. The continued use of ILS to support these operations is recommended for as long as it is economically beneficial and operationally acceptable (ILS Cat III will continue to be in use for the following 8-10 years, see ICAO Annex 10, Volume 1). However, the technical limitations of ILS will be a major constraint to its continued use.
- 13.1.12 ILS signal quality is likely to be threatened by:
 - VHF interference (ILS operates in the VHF band and from 1998 onwards increasing the power of FM broadcast stations in the same band is permitted)
 - multipath effects which can be caused by new building works at and around airports
 - ILS channel limitations.
- 13.1.13 In addition, operational limitations on the use of ILS, due to the decreased capacity of runways during low visibility conditions are a very important factor for consideration. The threats that cause the ILS signal degradation can partially be solved by having new generation receivers on board aircraft. These have increased filtering capabilities, which would solve the interference problem from the increased power of the FM-broadcast

stations. The possibility of maintaining the required ILS service level is the deciding factor when the development of replacement/transition plans is considered.

- 13.1.14 Frequency issues will become stringent during the transition period. Moreover, frequency allocation cannot be achieved by a simple transfer and, in addition, several systems (ILS, MLS, GBAS) will need to be supported at the same time.
- 13.1.15 Where the levels of service of ILS Cat III cannot be maintained, MLS is considered the best candidate to replace ILS Cat III in the timeframe 2000-2015 [ref.10]. Plans are on going at some major European airports (e.g. London Heathrow, Amsterdam Schiphol).
- 13.1.16 The main constraints related to GBAS for Cat III operations are associated with technical, operational and institutional issues involved in the development of sole means satellite navigation systems for civil use. However it is expected that satellite technology could provide the required level of service sometime by 2015.
- 13.1.17 Considerations regarding integrated arrival/departure managers and A-SMGCS with datalink are applicable. The enhanced AIS data integrity necessary to support these advances is not expected to be available before 2005.

13.2 Implementation Planning

13.2.1 Planning Assumptions

The transition methodology outlined below is based upon the ICAO AWOOG Roadmap [ref.10]. This recognises the need to meet local requirements, which should be presented in the form of an Aerodrome Business Plan. This Business Plan should be produced by an airport operator in close co-ordination with the State Authority and users.

13.2.2 Planning Considerations

The European Strategy for the planning of All Weather Operations, based on the ICAO Global Strategy, is to:

- a) continue ILS operations to the highest level of service as long as operationally acceptable and economically beneficial;
- b) implement MLS where operationally required and economically beneficial;
- c) promote the use of the MMR or equivalent airborne capability to maintain aircraft interoperability;
- d) validate the use of GNSS, with such augmentations as required, to support approach and departure operations, including Cat. I operations, and implement GNSS for such operations as appropriate;
- e) complete feasibility studies for Cat II and III operations, based on GNSS technology, with such augmentations as required. If feasible, implement GNSS for Cat II and III operations where operationally acceptable and economically beneficial.

The transition Methodology contains four subsequent phases:

- i. Requirements phase
- ii. Planning phase
- iii. Implementation phase
- iv. Operational phase

Requirements phase

It is recommended as a first step that aerodromes clearly define the local operational requirements in terms of capacity and capability level (NPA, Cat I, II or III PA). These requirements will have to be defined in close co-ordination with the operators at a particular aerodrome. Also environmental conditions may play a role of importance in the assessment of the local operational requirements.

Related to the **requirements phase**, there are three tasks to be initiated:

- Task 1.1: Determine the status of the installed navigation aids
- Task 1.2: Initiate the user consultation
- Task 1.3: Determine the local aerodrome requirements

Planning phase

The second step concerns the development of a planning for AWO. First the current and expected level of service of the existing non-visual aids for approach and landing should be analysed. Subsequently, the assessment of the implemented non-visual aids against the user requirements and the status of other non-visual aids should be made. This should result in a planning for the forthcoming period on the introduction of new systems.

If the decision taken into the second step was not to implement new landing systems and to stay with the existing equipment, an iteration process starts. This process involves States progressing through the requirements and planning phase preferably on a two-yearly basis.

Related to the **planning phase**, the following tasks can be identified:

- Task 2.1: Required background
- Task 2.1.1: ILS sustainability: determine the ILS lead time and the cost/benefit analysis
- Task 2.1.2: MLS introduction: determine the MLS implementation lead time, the related aspects and the cost/benefit analysis
- Task 2.1.3: GNSS availability: determine the best estimate of the availability of GNSS signals for approach and landing
- Task 2.2: Development of local ILS/MLS/GNSS transition plan, to be published in an **Aerodrome Business Plan**
- Task 2.3: Consult with Users on the Aerodrome Business Plan

Implementation phase

If the decision is to implement new non-visual aids, then the implementation phase starts. In this phase the new systems will be ordered, installed, tested and certified. Also attention should be given to proper ATC and operator training programs.

Within the **implementation phase**, the following tasks can be identified:

- Task 3.1: Distribution of information:
 - to the users through the user consultation group
 - through the appropriate international announcements
- Task 3.2: Development of operational procedures to allow early benefits
- Task 3.3: Assign a contract to the system provider
- Task 3.4: Installation and calibration of the required navigation equipment
- Task 3.5: Training of ATC controllers to use new procedures
- Task 4.1: Gathering statistics for the full range of AWO to reach certification of MLS/GNSS.
- Task 4.2: Evaluation of the gathered statistics for certification of MLS/GNSS

Operational phase

In the final step, the certified equipment is ready for operational use. The focus within this phase will be on the operation and maintenance of the equipment.

Related to the **operational phase**, the following tasks can be identified:

- Task 4.3: Maintenance

13.2.3 **Safety**

Due to the foreseen pressure to continue ILS-based AWO and to introduce new technologies for AWO at the same time, the proper, safe introduction of new technology, based on known criteria, should be safeguarded. This is especially true for the most critical operations known in aviation, namely Cat II/III PA operations. Criteria to design aircraft operations shall be developed and agreed.

A standard needs to be developed with which regulators must be able to judge whether specific operations meet a pre-determined Target Level of Safety (TLS).

ICAO AWOG has identified EUROCONTROL as responsible for producing this TLS as soon as possible.[ref.10]

Action must be taken to ensure that the EATMP Safety Policy requirements are satisfied.

13.2.4 **Technical (Aircraft Equipment) Requirements**

Due to the necessity of interoperability between Regions and States, the Global Strategy identified the ultimate need for a Multi Mode Airborne Capability. This can be achieved either by the use of a Multi-Mode Receiver (MMR) or by a number of stand-alone receivers. The availability and implementation of the MMR are critical and need to be ensured for maintaining full interoperability in the field of landing navigation systems.

JAA Guidance on Airworthiness and Approval Criteria will be required.

13.2.5 **ATM Considerations**

ATS and aerodrome operational aspects are identified in the ICAO AWOG Roadmap [ref.10]. These should be addressed in the Aerodrome Business Plan.

The increased number of airports remaining open in low visibility conditions in high-density/medium traffic areas will offer extra capacity in the ASM domain.

13.2.6 **Navigation Requirements (See Implementation Action No 10)**

The infrastructure issues should be addressed in the Aerodrome Business Plan.

13.2.7 **Dependencies**

Define links to other elements of the Navigation Programme.

Define links to other Domains/Programme.

13.2.8 **Co-ordination**

In determining the requirements for the provision of the All Weather Operations capability at a particular airport, close co-operation will be required between ICAO, EUROCONTROL, State authorities, Airport Authorities and Users.

Liaison with internal bodies

Liaison with external bodies: ICAO, EUROCAE, JAA, State Authorities, Airport Authorities, European Commission, etc.

Co-ordinate activities with other Programmes.

13.2.9 **Define Implementation Schedule**

13.2.10 **Notification process**

ICAO Documentation

Issue Generic AIC

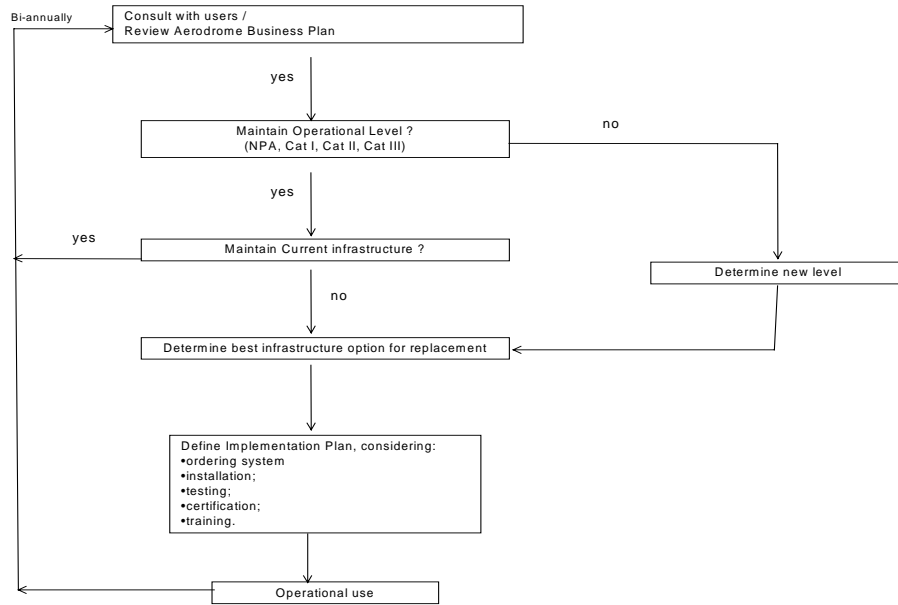
National Procedures

13.2.11 **Publicity**

Education and Awareness Material

Workshops/Seminars if required

13.2.12 Flow Chart



13.2.13 Gantt Chart

To be developed as part of the Aerodrome Business Plan.

14. IMPLEMENTATION ACTION NO.10 - RATIONALISATION OF THE NAVIGATION INFRASTRUCTURE

(Navigation Strategy for ECAC – Annexe 1 – Strategic Action 5.15)

Objective: to increase the cost efficiency of flight operations through a judicious deployment and use of supporting infrastructure for all phases of flight

Implementation Period	2000-2005	2005-2010	2010-2015
Strategic Step	Rationalisation of the Navigation Infrastructure		
RNP	tbd	tbd	tbd
Supporting Navigation Systems			
Departure and Arrival	NDB (rationalisation)	NDB (withdrawal before 2010);	VOR (finalise withdrawal) DME infrastructure maintained GPS + Galileo
	VOR (initial rationalisation)	VOR (withdrawal by 2010);	
	DME (improved coverage)	DME infrastructure improved	
	GPS	GPS + EGNOS	
En-route	NDB (rationalisation)	NDB (withdrawn before 2010)	GPS + Galileo
	VOR (rationalisation)	VOR (withdrawn by 2010)	
	DME (comprehensive coverage)	DME (comprehensive coverage)	
	GPS	GPS + EGNOS	
Approach and Landing	As presented in Section 13 – Implementation Action No.9		

14.1 Strategic Considerations

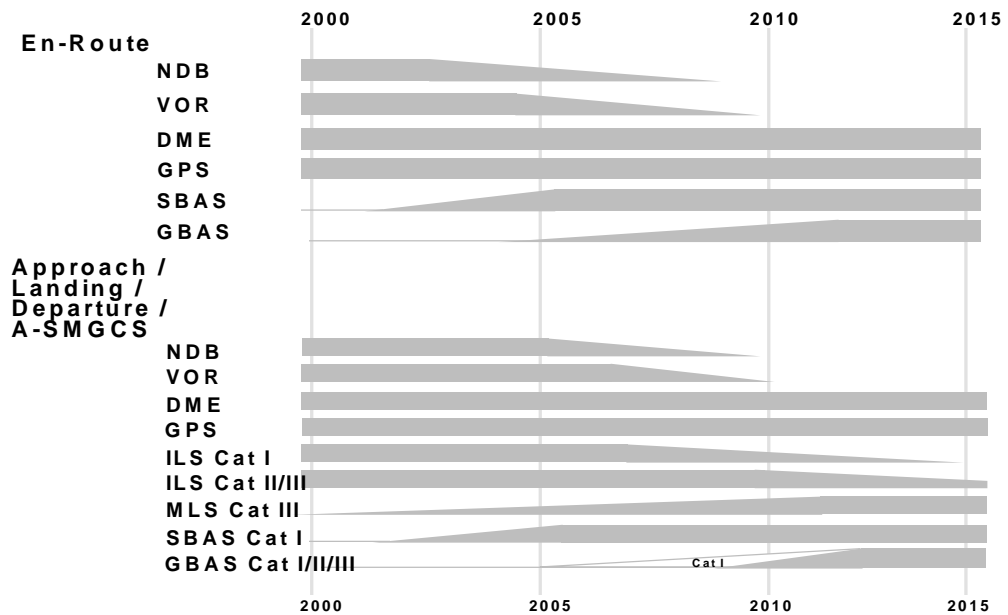
Rationale:

- 14.1.1 The airborne requirements for navigation systems are dependent on the area or airspace in which an aircraft operator wants to fly and/or which service he wants to use. Any reduction in the ground-based navigation infrastructure through decommissioning plans and/or its replacement with new technology has implications in aircraft systems, which need to be assessed with priority. RNAV systems are designed such that neither the pilot nor the controller necessarily knows which particular elements of infrastructure are used to determine the navigation solution. The current trend is towards defining performance requirements in terms of RNP values, without prescribing any particular combination of equipment .

Enablers:

- 14.1.2 The main triggers for rationalisation plans are high maintenance costs for service providers and the impact on charges to users (aircraft operators). Rationalisation plans for the ground-based navigation infrastructure are equally needed to allow full benefits from the satellite systems to be achieved.
- 14.1.3 In most parts of ECAC there is coverage with high redundancy provided by VOR and DME for en-route operations (i.e. at higher flight levels).
- 14.1.4 It is expected that the actions described in the Navigation Strategy for ECAC and in this Transition Plan will allow for the development of transition/ rationalisation/ withdrawal plans for the existing navigation aids, ensuring the transition to the GNSS in the long term, as recommended by ICAO. All considerations made throughout the Navigation

Strategy, regarding supporting infrastructure for each phase of flight, are applicable. A graphic illustration is provided below.



Constraints:

- 14.1.5 The shared use of most of the current systems for both en-route and terminal operations creates rationalisation planning difficulties for most of the conventional infrastructure. It also creates problems for the aircraft, which are equipped with a large variation of system mixes, with different levels of capabilities, and different, even contradictory, operational interests. Performance requirements have to be set to the lowest level (of the ‘small’ users), which may not find the rationalisation/withdrawal plans acceptable. Conversely, the larger operators require a system that allows them to collect benefits.
- 14.1.6 GPS stand-alone equipment is an acceptable system for B-RNAV operations, provided that the particular aircraft also carries conventional back-up equipment (e.g. VOR, DME, ADF).
- 14.1.7 The need for a comprehensive coverage to support various RNAV operations at all applicable flight levels requires an assessment to be made of the coverage provided by the ground-based infrastructure. Some uncertainties still remain concerning the number of DMEs that would be needed to obtain the required comprehensive coverage at lower levels. For TMA operations the shared use of navigation aids may solve the problems in some areas, but some States have reservations in sharing agreements, mainly due to liability issues.
- 14.1.8 The relaxation of integrity and continuity requirements associated with B-RNAV and P-RNAV is only applicable as long as reversion to conventional navigation using VOR/DME and NDB remains available. Once the VOR and NDB infrastructure starts to be decommissioned, operations on RNP 5 and RNP 1 routes will require conformance to the requirements for RNP 5 RNAV and RNP 1 RNAV (MASPS) equipment respectively.
- 14.1.9 This Navigation Strategy recognises the emergence of satellite technology and its future role in the global navigation environment. However, it is expected (based on current knowledge) that the rate of technological development of the system and the time needed for the resolution of institutional limitations will result in the need for a ground-based back-up system for GNSS for the foreseeable future.

14.2 Planning Considerations

14.2.1 NDBs and VORs

The existing requirement for NDBs and VORs is derived from the need to support :

- Conventional SIDs, STARs, Holding Procedures and Non Precision Approaches at some airfields;
- Operations by non-B-RNAV equipped aircraft;
- Reversionary capability of aircraft in the event of a failure of B-RNAV equipment.

The strategy foresees the rationalisation of NDBs commencing in the period 2000 – 2005 and the withdrawal of all installations being completed before 2010. The withdrawal of VORs is expected to commence in the period 2005 – 2010 but it is considered to be unlikely that the process will be completed before 2010.

14.2.2 DMEs

It is not anticipated that any DMEs will be withdrawn from service before 2015. However some DMEs may have to be re-sited, or additional ones introduced, in order to support :

- a) the rationalisation of NDBs and VORs;
- b) the use of B-RNAV at all en-route flight levels; and
- c) the extended use of P-RNAV and/or RNP 1 RNAV.

14.2.3 Satellite Navigation Services

Satellite navigation services are provided today by GPS, which is used in European airspace, in conjunction with the existing ground based infrastructure, to support B-RNAV operations. It is also used for non-precision approach operations and is expected to support RNAV operations in the TMA.

When EGNOS, the European Satellite Based Augmentation system (SBAS), becomes operational in 2004 the performance of GPS will be enhanced to a level where it will allow users to meet the navigation performance requirements for all phases of flight down to Category 1 precision approach. However, before operational use can be made of this enhanced navigation performance there are many tasks that need to be completed. These would include the following:

- Development of Avionics standards (MASPS and MOPS) by /EUROCAE/RTCA.
- Publication of JAA Technical Standards Orders (TSO) and Temporary Guidance Leaflets (TGL).
- Operational procedures and relevant ICAO documentation to support them must be developed.
- ICAO SARPs for GPS and SBAS must be published.
- The EGNOS and GPS signals-in-space must be validated against the ICAO SARPs.
- The AIS requirements for NOTAMs and database issues must be developed.

Ground Based Augmentation Systems (GBAS) are also under development to support the approach and landing phase of flight. The similar list of tasks as above will need to be completed before these GBAS systems can be introduced operationally. The technical development of GBAS systems is running behind SBAS, however it is expected that the implementation of GBAS will be more straightforward as it can be done at a local level. Category 1 GBAS systems are likely to be available around 2002 with Category 2 and 3 systems planned for the 2007/8 timeframe.

In the period between 2005 and 2015 GPS is going to be gradually improved to include more satellites and different transmissions on three separate frequencies. The performance of stand-alone GPS will therefore improve dramatically. Also in this timeframe, currently planned to be operational in 2008, the European satellite navigation system called Galileo will be introduced. The navigation performance to be expected from Galileo is not yet defined but it can be assumed that it will be at least as good as that provided by the future GPS. With GPS and Galileo available the GNSS infrastructure will be very robust and will allow the removal of ground infrastructure to be considered. In this context it should be noted that in view of the European Commission

EGNOS has to be considered as the first step in the Galileo development. At the present time it has not been decided whether the provision of only a satellite navigation infrastructure would ever be acceptable. Alternative navigation facilities may always be necessary.

14.2.4 Rationalisation Considerations

During the rationalisation phase the decision to withdraw, relocate or add a particular facility will be the responsibility of the Service Provider(s) and/or Airport Authority in consultation with State Authorities, Users and Military Authorities (if required). The factors which will need to be addressed, should include:

- a) A review of the operational impact of the planned change with respect to the ability to meet the existing requirements and the availability of, and coverage provided by, other existing navigation systems (VOR, VOR/DME, DME, DME/DME, or GNSS);
- b) Cost/Benefit Assessment in terms of the cost savings (maintenance and refurbishing) resulting from the withdrawal of a facility, or the enhanced operational effectiveness of relocated or additional facilities, against the possible costs to Users (e.g. additional aircraft equipment, increased User Charges);
- c) Technical Aircraft Equipment Requirements;
- d) Assess impact on ASM;
- e) Safety Case (where necessary); action must be taken to ensure the EATMP Safety Policy Requirements are met;
- f) Dependencies
 - Define links to other elements of the Navigation Programme.
 - Define links to other Domains/Programmes.
- g) Business Case (where necessary);
- h) Coordination
 - between navigation infrastructure/service providers, State authorities, Airport Authorities, Users, ICAO, EUROCAE, JAA, EUROCONTROL, etc.
- i) Period of notification required for the planned change;
- j) Legal implications of the planned change;
- k) Development of new/revised ATC Procedures;
- l) Effective date of change;
- m) Amendment and publication of Documentation, e.g. ICAO Regional Air Navigation Plan, AICs, National AIPs, En-Route Charts and Terminal Procedures.

15. IMPLEMENTATION ACTION NO.11 - SUPPORT FOR ADVANCED SURFACE MOVEMENT GUIDANCE AND CONTROL SYSTEMS (A-SMGCS) AT AIRPORTS

(Navigation Strategy for ECAC – Annexe 1 – Strategic Action 5.16)

Objective: to support A-SMGCS at airports in order to help maintain capacity and continued operations in low visibility conditions

15.1 Strategic Considerations

Rationale:

- 15.1.1 Surface Movement Guidance and Control operations in low visibility conditions may become a major constraint to the overall system capacity. New technologies for A-SMGCS may have a significant impact on aerodrome operations. These could have an effect on the approach and landing as well as for the ground operations.
- 15.1.2 A-SMGCS must provide more precise guidance for all aircraft and vehicles on the movement area, between the runway(s) and the stands. It must also be able to ensure separation between all moving aircraft and vehicles in conditions when their speed prevents such separation being maintained visually. To compensate for a lack of visual capability, A-SMGCS must be able to provide situational awareness not only to ATC but also to all those aircraft and vehicles that may come in proximity with each other. An A-SMGCS will need to interface with (the rest of) the ATM system, and will support gate-to-gate operations, rather than merely serving to provide guidance and control to individual aircraft and vehicles.

Enablers:

- 15.1.3 The integration of A-SMGCS with combined arrivals and departures management systems, the use of RNAV techniques, the gradual introduction of GNSS for precision approach operations, optimised traffic routes around airports and more integrated schedule planning between adjacent airports will provide the foundation for progressive improvement in all weather operations by 2010. Arrival and departure rates in poor visibility conditions will be improved and capacity will begin to match that for operations in good visibility conditions [ref.1].
- 15.1.4 Several tasks related to the optimisation of aerodrome operations have been taken into consideration in the APATSI Programme.
- 15.1.5 The developments for approach and landing operations should be well co-ordinated and in line with the developments for ground operations. Special attention is necessary on the interface of landing operations and ground operations. Improving airport capacity in low visibility conditions is strongly dependent on improving the runway occupancy times, which in turn is dependent on guidance functionality for ground operations.
- 15.1.6 An apparent relationship exists between A-SMGCS and the runway guidance function, as well as many relationships with domains other than Navigation (e.g. Surveillance). Studies are underway (in EUROCONTROL as well as in some European States) and their results, when available, will in future be considered in the Navigation Strategy for ECAC [ref.2].

Constraints:

- 15.1.7 Currently there is no appropriate ICAO body studying navigation requirements for A-SMGCS [ref. 10]. Further development of technical and operational requirements for such systems that concern the approach and landing phases of flight are addressed by ICAO AWOG.
- 15.1.8 Enhancements to the A-SMGCS to allow the maintenance of optimal airport capacity under reduced visibility conditions have to take into account cost/benefit considerations.
- 15.1.9 The navigation system requirements for A-SMGCS can be driven by requirements for ATC surveillance and control systems, when the latter systems are based on some form

of ADS. Related navigation system requirements may include, for example, navigation data, RNP, the availability of other navigation-related parameters (ground speed, intentions, distance to stop), as (uplinked) input into the ATC surveillance and control systems. These requirements will be determined through the EATMP Surveillance Strategy and will be taken into account by the Navigation Strategy for ECAC, as soon as they become available.

15.2 Implementation Planning

15.2.1 Background

The considerations outlined below are based upon the ICAO AWOG Manual on Advanced Surface Movement Guidance and Control Systems (A-SMGCS) [ref. 13] and on Eurocontrol Studies [ref. 14, 15]. The ICAO document has been developed taking into account the most demanding conditions at an airport, but it recognises the need that A-SMGCS should be developed and introduced depending upon traffic density, local weather conditions, aerodrome layout and other local circumstances and taking into account global interoperability requirements for international civil aviation operations.

It is recognised that the current SMGCS at airports, as described in ICAO Doc 9476-AN/927, are not always capable of providing the necessary support to aircraft operations in order to maintain the required capacity and safety levels, particularly under low visibility conditions. An A-SMGCS is expected to provide adequate capacity and safety in relation to the specific aerodrome conditions by use of modern technologies and a high level of integration between the various functionalities. An A-SMGCS has to be designed in a modular manner to adapt to the needs of different aerodromes and be open to be capable of interfacing with other systems and exchange information with all parties concerned.

The main benefits to be accrued from the implementation of A-SMGCS are associated with, but not limited to, low visibility surface operations. Significant improvements of aerodrome capacity can also be achieved under good visibility conditions. A-SMGCS increases surface guidance aids and reliance on avionics in the cockpit to help guide the pilot to and from the runway, and can thus contribute to reduce voice communications workload, and improve ATC surveillance of aircraft and vehicles by electronic means. Automation also plays a greater role to assist in monitoring the dynamics of the surface operations.

The following planning considerations relate only to the navigation functions of an A-SMGCS. The Communications and Surveillance functions will be addressed within the relevant domains.

15.2.2 Planning Considerations

The planning for the upgrading of an existing SMGCS, or the upgrading of an A-SMGCS, should be undertaken by means of a consultative process involving the Airport Operator or responsible Authority, the State Aviation Authority, and representatives of the Airport User Organisations. The planning should be conducted in accordance with the material contained in the ICAO European Manual on Advanced Surface Movement Guidance and Control Systems (A-SMGCS). The main principles of this material are summarised below.

An A-SMGCS is a system providing routing, guidance, surveillance and control to aircraft and affected vehicles in order to maintain movement rate under all local weather conditions within the Aerodrome Visibility Operational Level (AVOL) whilst maintaining the required level of safety. The AVOL is the minimum visibility at or above which the declared movement rate can be sustained. When visibility conditions drop below AVOL or when traffic exceeds the specified traffic density; an A-SMGCS should provide for reduction of surface movement of aircraft and vehicles to a level acceptable for the new situation.

The main A-SMGCS objective is to assist aircraft and authorised vehicles to manoeuvre safely and efficiently on the movement area, in order to support optimised "gate to gate" operations.

Due to availability and development of new technologies, including automation capabilities, it is already possible to increase aerodrome capacity in low visibility and on

complex and high density aerodromes. In order to avoid a technology driven approach, the aerodrome specific operational requirements are recommended to be considered in the process of selection, development and introduction of A-SMGCS where current SMGCS needs to be upgraded, or on aerodromes which currently have no SMGCS, but where the traffic density and/or aerodrome layout requires so.

A-SMGCS should evolve from an SMGCS by progressive enhancements to match the desired level of operations. The airport operator or the competent authority will determine, in consultation with the users, whether existing SMGCS needs to be upgraded to A-SMGCS. The analysis and development of specific local requirements (irrespective of the available technology) should be presented in the form of a Business Plan, produced by the airport operator or the competent authority in close co-ordination with the State Authority and users.. Concise statements of operational requirements should be provided and substantiated by explanatory texts.

The design principle of an A-SMGCS should be modularity, thus being able to provide the required level of service to different areas of an aerodrome, and also permitting modular enhancements. The level of service provided by an A-SMGCS should be consistent from the runway to the stand and vice-versa.

An A-SMGCS should support the following primary functions:

- a) surveillance;
- b) routing;
- c) guidance; and
- d) control;

Note 1: Communication is considered to be an integral part of each of the primary functions.

Note 2: Only the routing and guidance functions impose navigation requirements.

An A-SMGCS requires the development of integrated Human Machine Interface (HMI) suitable for such a function and reducing workload on controllers, pilots and vehicle drivers by using computer facilities and the appropriate automation, but retaining a manual control capability.

Additional planning considerations for A-SMGCS should be as follows:

- a) An A-SMGCS should support operations involving all aircraft types;
- b) An A-SMGCS should be capable of adaption to cater for future aircraft types;
- c) An A-SMGCS should be capable of being used by appropriately equipped vehicles operating within the movement area

15.2.3 Transition Methodology

Because of mutual inter-dependence of the All Weather Operations capability of, and the requirement for A-SMGCS at an airfield, the transition methodology for the introduction of, or transition to A-SMGCS should be is similar to that described for AWO. This consists of four phases:

- i. Requirements phase
- ii. Planning phase
- iii. Implementation phase
- iv. Operational phase

Requirements phase

It is recommended as a first step that aerodromes clearly define the local operational requirements in terms of capacity and capability level. These requirements will have to be defined in close co-ordination with the operators at a particular aerodrome.

Planning phase

The second step concerns the development of a planning for A-SMGCS. First the current and expected level of service of the existing and planned non-visual aids for approach and landing as well as for (A-)SMGCS should be analysed. Subsequently, the assessment of the implemented systems against the user requirements and the status of other available technologies should be made. This should result in a planning for the forthcoming period on the introduction of new systems.

If the decision taken in this phase was not to implement new systems and to stay with the existing equipment, an iteration process starts. This process involves States progressing through the requirements and planning phase preferably on a two-yearly basis.

The planning phase, should result in the development of a local A-SMGCS transition plan, to be published in the Aerodrome Business Plan, or added to the aerodrome transition plan for AWO (if the latter exists). A consultation with Users should follow the publication of the transition plan.

Implementation phase

If the decision is to implement a new A-SMGCS, or new modules to the existing (A-)SMGCS, then the implementation phase starts. In this phase the new systems (modules) will be ordered, installed, tested and certified. Attention should be given to proper ATC and operator training programs.

Within the implementation phase, the following tasks can be identified:

- Task 3.1: Distribution of information:
 - to the users through the user consultation group
 - through the appropriate international announcements
- Task 3.2: Development of operational procedures to allow early benefits
- Task 3.3: Assign a contract to the system provider(s)
- Task 3.4: Installation and calibration of the required equipment
- Task 3.5: Training of personnel to use new equipment and procedures
- Task 4.1: Gathering statistics for the full range of aerodrome operations based on the newly installed A-SMGCS to reach certification.
- Task 4.2: Evaluation of the gathered statistics for certification.

Operational phase

In the final step, the certified equipment is ready for operational use. The focus within this phase will be on the operation and maintenance of the equipment.

Related to the operational phase, the following tasks can be identified:

- Task 4.3: Maintenance

15.2.4 **Safety**

The introduction of an A-SMGCS should not result in an overall level of risk in excess of the probability of one fatal accident per 107 operations [ref. 13].

15.2.5 **Technical (Aircraft Equipment) Requirements**

Requirements on the airborne capability to support the navigation function(s) within an A-SMGCS should be established in consultation with the operators and should take due account of the necessity of interoperability between aerodromes, States and Regions.

Some A-SMGCS functions may have significant impact on navigation performance and cockpit display requirements, e.g. the provision of taxi guidance in visibility condition 4. However this condition may occur for a very limited period of time. Therefore the confirmation of the need for such functions is important, as the benefit of the additional requirements may be questioned [ref. 14].

Once the requirements on the airborne capability are agreed, JAA Guidance on Airworthiness and Approval Criteria will be required.

The issues should be addressed in the Aerodrome Business Plan.

15.2.6 **ATM Considerations**

ATS and aerodrome operational aspects are identified in the ICAO Manual for A-SMGCS [ref.13]. These should be addressed in the Aerodrome Business Plan.

15.2.7 **Navigation Requirements (See Implementation Action No 10)**

The infrastructure issues should be addressed in the Business Plan.

The certification of an A-SMGCS should address the total system. An A-SMGCS total system includes sub-systems, equipment and other components necessary for it to

perform its functions as well as operational procedures, the identification of responsibilities, management functions and system support facilities.

The addition of, or upgrading of existing modules will require an analysis to ensure that they do not affect the continued validity of the original certification. Where the continued validity of the original certification cannot be assured, a new certification of the complete system will be required.

15.2.8 **Dependencies**

Define links to other elements of the Navigation Programme.

Define links to other Domains/Programme.

15.2.9 **Co-ordination**

In determining the requirements for the provision of an A-SMGCS on a particular airport, close co-operation will be required between Airport Authorities and Users, State authorities, Eurocontrol, ICAO.

Liaison with internal bodies

Liaison with external bodies: ICAO, EUROCAE, JAA, State Authorities, Airport Authorities, European Commission, etc.

Co-ordinate activities with other Programmes.

15.2.10 **Define Implementation Schedule**

15.2.11 **Notification process**

ICAO Documentation

Issue Generic AIC

National Procedures

15.2.12 **Publicity**

Education and Awareness Material

Workshops/Seminars if required

16. ANNEXES

Annex A - Planning Template

Objective

Strategic Considerations

Rationale

Enablers

Constraints

Implementation Planning

Planning Assumptions

Confirm Operational Requirement

Operational Benefits

Cost Benefit Analysis

Safety

Ensure that the EATMP Safety Policy requirements are satisfied

Complete Safety Case

Prepare Business Case

Technical (Aircraft Equipment) Requirements

ATM Considerations

Navigation Requirements

Support for Non Compliant Aircraft

Determine level of support necessary for operations by State Aircraft

Consultation with State Authorities

Determine level of support necessary for operations by non-compliant civil aircraft

Dependencies

Define links to other elements of the Navigation Programme

Define links to other Domains/Programmes

Co-ordination

Liaison with internal Domains

Liaison with external bodies

Co-ordinate activities with other Programmes

Define Implementation Schedule

Notification process

ICAO Documentation

Issue Generic AIC

National Procedures

Publicity

Education and Awareness Material

Workshops/Seminars if required

Annexe B - Explanation of RNAV and RNP Requirements

Required Navigation Performance (RNP)

- B 1. Traditional regional regulations apply for the carriage of specific airborne navigation equipment. ICAO has endorsed the concept of Required Navigation Performance (RNP), which is a statement of the aircraft navigation performance defined in terms of accuracy, integrity, availability and continuity of service necessary for operations within a defined airspace, without requiring specific navigation equipment [ref. 11].
- B 2. For en-route purposes currently four RNP “types” have been defined (RNP 1, RNP 4/5, RNP 12.6/10, RNP 20), where the type number indicates the containment value in miles. The containment value is the distance from the intended position within which flights would be found for at least 95% of the total flying time. The extension of the RNP concept to the precision approach and landing phase and the corresponding RNP “types” are currently under development.
- B 3. States must ensure that the navigation infrastructure provided supports adequately the prescribed RNP type in a specific area or on a specific route. RNP is only one parameter in the determination of separation standards.

Area Navigation (RNAV)

- B 4. RNAV is a method of navigation, which permits aircraft operation on any desired flight path within the coverage of referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these. 2D RNAV relates to RNAV capabilities in the horizontal plane only; 3D RNAV includes a guidance capability in the vertical plane and 4D RNAV provides an additional timing function. The RNP determines the accuracy with which the RNAV system is required to determine the aircraft absolute geographical position (instead of only in terms of its position relative to a navaid, as is the case with conventional VOR/DME display instruments). As from 1998 the carriage of RNAV equipment capable of RNP 5 accuracy (B-RNAV) is mandatory in the ECAC area.
- B 5. The RNAV concept represents a fundamental change in navigation philosophy. Traditionally aircraft used to fly to and from specific navaids, using each navaid as a source of data. An RNAV-capable aircraft can automatically determine its position, from one or more of a variety of inputs, e.g. VOR, DME, GNSS, INS. Single-sensor RNAV systems only use one source of navigation data, such as DME stations, while multi-sensor RNAV systems monitor a number of navaid systems to determine the best source of navigation data.
- B 6. The RNAV system has access to a sophisticated on-board navigation data base containing details of the pre-programmed routes, the airspace through which the routes pass, the navaids servicing this airspace and the departure, destination and planned diversion aerodromes. The system identifies the next waypoint on the planned route, selects the most appropriate navaids to determine the aircraft position and usually provides steering inputs to the autopilot.
- B 7. An RNAV route can be flown automatically, with the autopilot coupled to the RNAV system, or manually, with the RNAV system outputs displayed on the flight director/course deviation indicator, with adequate warning of speed, altitude and track changes being provided to allow the pilot time to respond and follow the required track.

Standards

- B 8. The Eurocontrol RNAV Standard [ref.9] defines operational and functional requirements for RNAV equipment meeting RNP 5 and RNP 1 accuracy (B-RNAV and P-RNAV respectively). These requirements are taken into account in the TGL-2 published by JAA in 1997 for certification and airworthiness approval of aircraft for B-RNAV operations in ECAC [ref.8].
- B 9. Global specifications for RNAV systems are contained in the RNAV MASPS [ref.7]. These standards are intended for designers, manufacturers and installers of avionics equipment, service providers and users of these systems for worldwide operations. The MASPS requirements, formulated as RNP- (x) RNAV, are intended to meet the ICAO

definition of RNP while providing increased integrity with repeatable and predictable navigation. RNAV MASP demands increased functionality and, in particular, define system integrity requirements enabling removal of conventional navigation aids.

- B 10. The minimum requirements set out in the Eurocontrol Standard for B-RNAV and P-RNAV systems [ref.9] represent a subset of the total system requirements, which have been defined in the MASP on the basis of global requirements. A relaxation of integrity and continuity values is associated with B-RNAV and P-RNAV. This relaxation is applicable only so long as reversion to conventional navigation using VOR and NDB remains available. Once the VOR and NDB infrastructure starts to be decommissioned, operation on RNP 5 and RNP 1 routes will require conformance to the RNAV MASP.
- B 11. The following tables summarise the correspondence between the performance requirements set out in the Eurocontrol Standard and the RNAV MASP:

ROUTE FUNCTIONS

Function	B-RNAV	P-RNAV	RNP 5 RNAV	RNP 1 RNAV
Flight Crew Waypoint Entry (En-Route)	R	R	R	R
Terminal Leg Data Type Entry from Data Base	O	R	R	R
Flight Crew Manual Terminal Leg entry	P	P	P	P
Flight Crew Manual Terminal Leg modification	O	R	R	R
Navigation Data Base for en-route operations	O	R	R	R
Navigation Data base for TMA operations	O ³	R	R	R
Flight Plan Entry	R	R	R	R
Minimum number of waypoints	4	10	*	*
Flight Plan whole Route used in TMA	R	R	R	R
In Flight Modification	R	R	R	R

* sufficient for the route to be flown

R = required; P = preferred; O = optional

NAVIGATION FUNCTIONAL PERFORMANCE

Function	B-RNAV	P-RNAV	RNP 5 RNAV	RNP 1 RNAV
Operation with WGS 84 Datum	R	R	R	R
Ground Aid Selection	O	R	R	R
Manual Inhibit of aids where aid selection automatic	R	R	R	R
Ground Aid Tuning	O	R	R	R
Position Initialisation	R	R	R	R
Inflight Manual Position Update	O	P	O	P
Indication of Navigation Mode for multiple input sources	R	R	R	R
Navigation accuracy annunciation	O	O	R	R

R = required; P = preferred; O = optional

³ If a data base is not provided it will be necessary to demonstrate that the required flight plan integrity can be provided by the alternative means of route definition

SYSTEM FUNCTIONAL PERFORMANCE

Function	B-RNAV	P-RNAV	RNP 5 RNAV	RNP 1 RNAV
95% Containment	5 NM	1 NM	5 NM	1 NM
System Integrity (per Flight Hour)	-	-	10 ⁻⁵	10 ⁻⁵
Continuity of Function (failure per flight Hour) ⁴	10 ⁻⁴	10 ⁻⁵	10 ⁻⁵	10 ⁻⁵
Cross Track Deviation Display or Output	R	R	R	R
AFCS Output	O	R	R	R
Waypoint Sequencing	R	R	R	R
En-route Fly Over Turn Anticipation	P	P	P	P
En-Route Fly By Turn Anticipation	R	R	R	R
En-Route Fixed Radius turn	O	O	O	R
TMA Fly Over Turn Execution	R	R	O	O
TMA Fly By Turn Anticipation	O	R	R	R
TMA Defined Radius turn	O	O	R	R
Parallel Offsets	O	R	R	R
"Direct to" Function	R	R	R	R
Holding Procedure (RNP)	O	O	R	R
Holding Procedure (conventional)	O	O	O	O
Display Bearing Distance and Time to Waypoints	R	R	R	R
Self Monitoring	R	R	R	R
Sensor Monitoring	R	R	R	R
Alert Outputs	R	R	R	R

R = required; P = preferred; O = optional

⁴ a lower level of performance is permissible while VOR is available and VOR equipment is carried.

Annexe C - References

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- [2] Navigation Strategy for ECAC, Version 2.1 / March 1999
- [3] Operational Concept Document (OCD) Ed.1.1/August 1998
- [4] EATCHIP Communications Strategy, V2.1/June 1998
- [5] EATCHIP Surveillance Strategy, V1/January 1998 (Draft)
- [6] EUR ANP - European Air Navigation Plan, ICAO Doc 7754
- [7] Minimum Aviation System Performance Specification (MASPS) for RNP RNAV - RTCA Do 236/EUROCAE ED 75
- [8] JAA TGL-2 Temporary Guidance Leaflet No.2, Rev.1/June 1997
- [9] EUROCONTROL Area Navigation Equipment - Operational Requirements and Functional Requirements Ed.2/Doc 003-93
- [10] ICAO AWOG - Road Map for All Weather Operations in the European Region, May 1999
- [11] ICAO Doc 9613 - Manual on Required Navigation Performance
- [12] ECAC Airspace Strategy, V1.0 / October 1999
- [13] ICAO European Manual on Advanced Surface Movement Guidance and Control Systems (A-SMGCS), Draft 02
- [14] Review of Navigation Requirements at airports - EUROCONTROL/NLR, March 1999
- [15] Functional Requirements and Implementation Options to Support Navigation at airports - EUROCONTROL/NLR, October 1999

Annexe D - Abbreviations

For the purposes of this Strategy, the following abbreviations shall apply:

ADF	Automatic Direction Finder
ADS (-B)	Automatic Dependent Surveillance (-Broadcast)
AEEC	Airlines Engineering Electronics Committee
AIC	Aeronautical Information Circular
AIS	Aeronautical Information Services
AMAN	Arrival Manager
ANT	Airspace And Navigation Team
APATSI	Airport ATS Interface
ARINC	Aeronautical Radio Incorporated
ARN	ATS Route Network
ASM	Airspace Management
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
AWO	All Weather Operations
AWOG	ICAO All Weather Operations Group
B-RNAV	Basic Area Navigation
CBA	Cost Benefit Analysis
CEATS	Central European Air Traffic Services
CFMU	(EUROCONTROL) Central Flow Management Unit
CNS	Communications-Navigation-Surveillance
DME	Distance Measuring Equipment
DP	Data Processing
eAIP	Electronic Aeronautical Information Publication
EAD	European AIS Database
EATCHIP	European Air Traffic Control Harmonisation And Integration Programme
EATMP	European Air Traffic Management Programme
EATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
EUROCAE	European Organisation for Civil Aviation Electronics
FAA	Federal Aviation Administration (USA)
FDPS	Flight Data Processing Systems
FIR	Flight Information Region
FL	Flight Level
FM	Frequency Modulation
FMS	Flight Management System
FRAC	Free Routes Airspace Concept
FUA	Flexible Use Of Airspace
GAT	General Air Traffic
GBAS	Ground Based Augmentation System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HMI	Human Machine Interface
IACA	International Air Carrier Association
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System

IRS	Inertial Reference System
ITU	International Telecommunications Union
JAA	Joint Aviation Authorities
MASPS	Minimum Aviation System Performance Specification
MLS	Microwave Landing System
MMR	Multi-Mode Receiver
NATO	North Atlantic Treaty Organisation
NDB	Non-Directional Beacon
NOTAM	Notice to Airmen
NPA	Non Precision Approach (procedure) (without vertical guidance)
NPV	Non Precision Approach (procedure) with Vertical Guidance
OCP	(ICAO) Obstacle Clearance Panel
PA	Precision Approach
PANS OPS	(ICAO) Procedures for Air Navigation Services - Aircraft Operations
PHARE	Programme for Harmonised ATM Research in EUROCONTROL
P-RNAV	Precision Area Navigation
RAIM	Receiver Autonomous Integrity Monitoring
R&D	Research and Development
RNAV	Area Navigation
RNP	Required Navigation Performance
RTCA	Radio Technical Commission for Aeronautics
SARPs	(International) Standards and Recommended Practices
RVSM	Reduced Vertical Separation Minimum
SBAS	Satellite Based Augmentation System (
SID	Standard Instrument Departure
(A-)SMGCS	(Advanced-) Surface Movement Guidance And Control Systems
STAR	(Terminal) Standard Instrument Arrival (Route)
TARA	(EUROCONTROL) Terminal Airspace RNAV Applications Task Force
tbd	to be determined
TGL	Temporary Guidance Leaflet
TLS	Target Level of Safety
TMA	Terminal (Control) Area
UIR	Upper Flight Information Region
VHF	Very High Frequency
VOR	Very High Frequency Omni-directional Radio Range
WGS	World Geodetic System
4D	Quadri-dimensional
RNAV Overlay Procedures	RNAV SIDs / STARs which replicate the published conventional procedures (SIDs/STARs)
State aircraft	Aircraft operating on military, customs or police activities shall be deemed to be State Aircraft (ICAO Chicago Convention)
Vertical guidance	The guidance in the vertical plane relative to the path defined by a ground-based navigation aid (i.e. ILS or MLS) or computer generated from a database

END