EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

- Decisions of the Permanent Commission -

DECISION N° 95

approving the ATM Strategy for 2000+ (ATM 2000+), as amended in 2003

THE PERMANENT COMMISSION FOR THE SAFETY OF AIR NAVIGATION :

Having regard to the EUROCONTROL International Convention relating to Co-operation for the Safety of Air Navigation, as amended by the Protocol signed at Brussels on 12 February 1981, and in particular Articles 2.1, 6.1 (a) and 7.1 thereof;

Having regard to Decision N° 79 dated 23 April 1999, approving the ATM Strategy for 2000+ (ATM 2000+);

Considering that it is desirable to update this Strategy;

On the proposal of the Provisional Council,

HEREBY TAKES THE FOLLOWING DECISION :

Sole Article

The ATM 2000+ Strategy (Edition 2003) annexed to this decision, is hereby approved.

Done at Brussels on 10.04.2003

Josef TURECKÝ
President of the Commission

EUROCONTROL

ATM Strategy for the Years 2000+

2003 Edition

Volume 1

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1. Introduction

1.1. Purpose

The EUROCONTROL Air Traffic Management (ATM) Strategy for the years 2000+ (ATM 2000+ Strategy) has been developed at the request of the Transport Ministers of the European Civil Aviation Conference (ECAC), to cater for the forecast increase in European Air Traffic which will demand a quantum increase in ATM and airspace capacity. The Strategy describes the processes and measures by which the forecast demand may be satisfied while improving aviation safety. It falls within the framework of the ICAO regional and global CNS/ATM planning, the ECAC Institutional Strategy and the revised EUROCONTROL Convention.

1.2. Genesis

At the fifth meeting of ECAC Transport Ministers (MATSE/5) in Copenhagen on 14th February 1997, Ministers adopted an Institutional Strategy for Air Traffic Management (ATM) in Europe[1] and decided that the revised Convention, which was signed later in 1997[2], would be the legal instrument for the implementation of the ECAC ATM Institutional Strategy.

In addition, the Ministers requested a proposal for a comprehensive, ‘gate-to-gate’ orientated ATM Strategy for the years 2000+ as a follow-up to the En-Route and Airport Strategies for the 1990s. The ATM 2000+ Strategy follows on from the ECAC Strategies for the 1990’s.

The Strategy Proposal was developed by a Board composed of senior managers from all sectors of aviation and reviewed by the EUROCONTROL Provisional Council. On 23 April 1999, the EUROCONTROL Permanent Commission took Decision No. 79 approving the ATM Strategy for 2000+, as endorsed by the Provisional Council, and agreed that it should be presented to ECAC Ministers of Transport. The Strategy was adopted by the Ministers at their MATSE/6 meeting on 28 January 2000. The Ministers directed EUROCONTROL to put in place, as a matter of urgency, an Action Plan to implement the Strategy, and to keep it under review in the light of changing circumstances and develop consequent alternatives.

1.3. This Document

The Strategy comprises two volumes. A separate executive summary has been produced.

Volume 1 - this document - provides the basis for, and the background to, the Strategy. It describes the needs, principles and major objectives which govern the Strategy. It outlines the main conceptual changes and the general management principles to be adopted.

Volume 2 contains the detailed rationale for change, and guidance on the activities that are needed to meet the Strategy objectives.

This document is the first update of the Strategy. It takes into account the decisions, events, achievements that have happened and the progress made since January 2000. Its presentation has been improved and reorganised to allow Volume 2 to be kept more closely abreast of progress made in the execution of the Strategy.

The scope of the Strategy is focussed on the ATM service itself and its planning. It is on purpose that it excludes legislative aspects and considerations on e.g. the creation of new

[1] <European> and <Europe> are used in this document to qualify the ECAC and EUROCONTROL Member States or their airspace, but excluding Icelandic and Oceanic airspace.

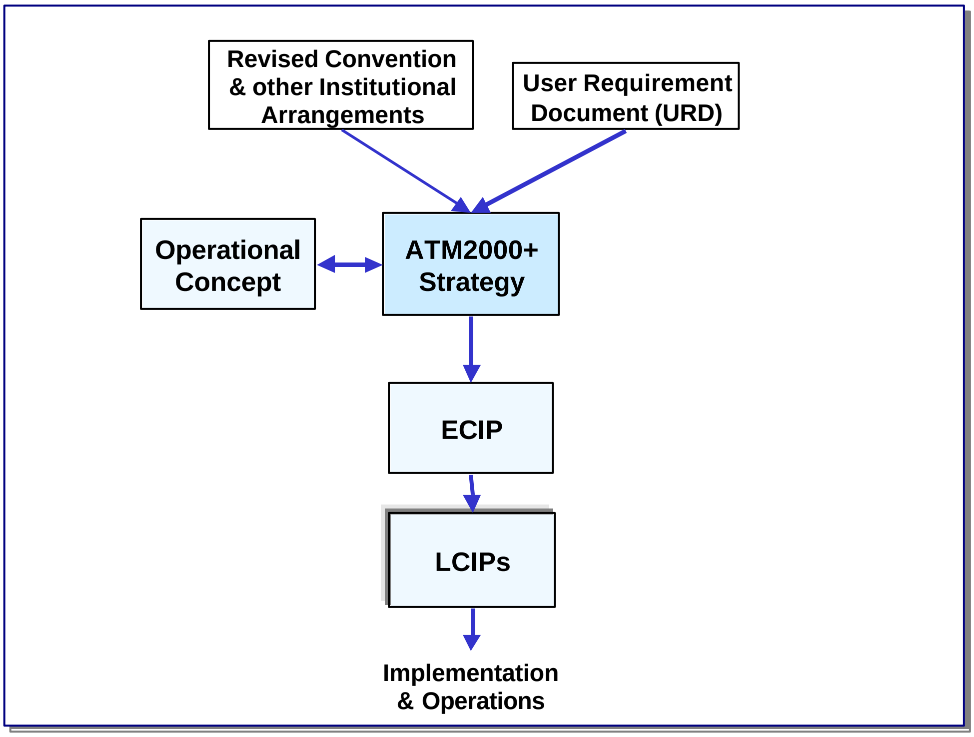
[2] The ratification process of the revised Convention is on-going. As a result of Decision No 71 of the Permanent Commission on early implementation of certain provisions of the revised Convention, the Organisation was provided with the necessary means to already, under the present amended Convention, fulfil its role and duties as foreseen in the revised Convention. While the EUROCONTROL Permanent Commission will continue to function as the sole decision making body towards its member States, the terms “Council” and “General Assembly” are used in reference to the institutional situation when the revised Convention will have come into force.

airports/runways, airport slot allocation or the organisational aspects of providing the service (numbers or status of providers, range of services they provide) when they do not directly impact the nature of ATM.

1.4. Associated Documentation

The Strategy document reflects the needs of all the users, civil and military, and the agreed institutional arrangements. It is supported by a related set of technical documents that will be revised in parallel with the Strategy to ensure that they remain in step. The Strategy defines the guiding principles and major objectives for the realisation of the European ATM network – operating to uniform principles and provides for the management of all phases of flight (gate-to-gate). The Operational Concept describes the operational vision aimed at by the Strategy. The application of the Strategy is inter-related to the operational and functional options described in the Operational Concept Document[3].

The Strategy provides the framework for the development of more detailed strategy documents for the main components of ATM, and governs European and Local Convergence and Implementation Plans. It provides the criteria for validating and selecting the most appropriate options, and the management principles needed for planning and practical implementation in terms of European ATM Programmes and projects[4]. This is illustrated by the figure below which does not display the feedback loops.



[3] The most recent document is the Operational Concept Document (OCD) version 1.1, dated January 1999 *(a more recent version currently in preparation will be referenced in final version)*.
[4] Actual implementation will have to be shown to meet as a minimum the provisions of EUROCONTROL Safety Regulatory Requirements (ESARRs). The ECIP also contains objectives related to the implementation of ESARRs.

1.5. Overview of the Strategy

1.5.1. Main Features

	DELIVERING SAFETY AND PERFORMANCE
PERFORMANCE ORIENTED, AND SAFETY COMES FIRST	• Notion of ATM performance, as the set of criteria expressing the expectations of society and airspace users. • Performance includes safety as its first element, all other criteria are always subordinated to it.
PROMOTION OF OVERALL SAFETY IMPROVEMENT AND MEASUREMENT	• Beyond the necessary introduction of safety management and safety regulatory functions in ATM • To anticipate, identify and remedy safety problems in aviation where ATM has the potential to contribute safety improvements.
A STRUCTURAL REVISION OF ATM PROCESSES, **A NEW ATM CONCEPT,** **A SYSTEMS APPROACH FOR THE ATM NETWORK**	Best use of airspace can only be achieved if the traditional Air Traffic Control (ATC) concept is replaced, in a controlled way, by a new ATM concept. A **Systems Approach** is needed, recognising the **interdependence of stakeholders' operational decisions**, encompassing the **gate-to-gate** concept, the **consistent management of all phases of flight**, the **application of uniform principles**, the **integration of airport airside**[5] **operations into ATM** and **system-wide information sharing,** thus the **notion of ATM network**. Organisational means will be introduced to manage the complexity of the traffic situation and to manage the ATM network as an integrated whole via **seamless services**
ONE AIRSPACE CONTINUUM, GATE-TO-GATE	• For ATM purposes, gate-to-gate**, not constrained by national or service provision boundaries**. • In conjunction with other measures, this should significantly improve the effective use of airspace and airports and provide the maximum freedom of movement for all airspace users, together with positive cost-benefit results and environmental benefits.
FULL CIVIL-MILITARY CO-OPERATION	Emphasis on the need for further improvements in civil-military co-ordination and co-operation to fully exploit the airspace continuum.
	A PATH FOR CHANGE
AIMED AT A SHARED VISION, **RESPONSIVE TO FUTURE SCENARIOS.**	The Strategy identifies those measures that will deliver adequate early, lasting benefits for society and the airspace users[6]. It takes account of probable changes in the aviation environment and technology during the next 15 to 20 years. This path **includes major agreed implementation programmes** for the first 5 to 10 years. It **also requires Research & Development** (R&D) activities which have to be focused on the shared future vision and which, if the validation results are positive, will allow to agree on additional programmes. The Strategy is **not a blue print fully determined for the next 20 years**.
EVOLUTIONARY, NOT REVOLUTIONARY CHANGE STEPS	To ensure effective safety and project risk management, and to protect current investments in people and systems. The aim is for a safe, cost-conscious, flexible and practicable path to the future that aids decision-making, does not rely on commitment to the unknown.
CARE ABOUT ECONOMIC & FINANCIAL IMPACT	• To support the mission and/or business requirement of the airspace users to sustain their activity and optimise the integrity and yield of their operations.

[5] <air-side> is used to denote the runways, taxiways, etc. at airports; <land-side> denotes terminal, passenger handling facilities, etc..

[6] <Airspace users> denotes all users of airspace, including State, airline, charter, other business and commercial, recreational, etc..

- Recognition that economic and financial considerations are among the main drivers for shaping the future European ATM network.

GLOBAL INTEROPERABILITY

Active contribution to the design and planning of the global ICAO CNS/ATM System and adherence to the ICAO Regional Plan to meet the airspace users' requirements on a world-wide basis, and to ensure an effective interface with neighbouring ICAO regions and adjacent States within those regions.

STRONG COMMITMENT OF ALL STAKEHOLDERS, AND BINDING COLLABORATIVE DECISIONS REQUIRED

The success of the Strategy is linked to the implementation of a judicious combination of regulatory and best practice mechanisms that encourage all stakeholders at all levels, civil and military, to be committed to efficient, timely and effective decisions, based on collaboration and co-operation, and to implement the changes needed. In order to realise the benefits of change, this commitment will come from leadership, and must be supported by the determination of the aviation industry to effect change.

BASED ON REVISED EUROCONTROL CONVENTION AND EC SINGLE EUROPEAN SKY

Commitments of the parties will be reflected in EUROCONTROL decisions, which are binding on Contracting Parties. EC Regulation will also come into play for EC member States in respect of the Single European Sky as well as further to the accession of the EC to EUROCONTROL. The revised EUROCONTROL Convention, and the ECAC Institutional Strategy, make the ATM Strategy for the years 2000+ a vital instrument for the development of a safe, efficient, and flexible European ATM network capable of responding to the demands placed on it by society and the aviation community.

1.5.2. Short-Term pan-European Actions

Concrete new pan-European actions are needed, in addition to local initiatives. For the next 5 years, they include:

- Development of an optimal airspace structure that also includes regional initiatives as an integral part of the European ATM network;
- Development of a dynamic and pro-active flow and capacity management. Steps to maximise the utilisation of the ATM network are essential;
- Continuing improvements in safety, security, capacity and environment;
- First applications of Collaborative Decision Making (CDM), principally for ATFM and at airports;
- Operational use of air-ground data communication;
- Further use of satellite navigation;
- Deployment of advanced surveillance techniques;
- Interoperability criteria and information management mechanisms, if possible at global scale, to allow system architecture convergence and seamless interfaces;
- Establishment of a common recognised repository of traffic, safety and delay data.

1.6. A Balanced and Effective Solution

1.6.1. Timely achievement of performance levels

The Strategy prescribes a new approach to solve the European ATM problems by integrating and improving the ATM-related resources and activities of all stakeholders in a performance-driven management process which will succeed only if all stakeholders fulfil their commitments to the activities decided upon to realise the Strategy.

Initial assessment of the measures proposed in the Strategy indicates that they should prove sufficient to meet the target levels of safety while also meeting the forecast traffic demand,

and provided implementation is effective and in good time. Expert opinion is that these measures offer the best practical path to the future. The implementation of some of them will be left to the provider's choice according to local needs, while maximising the interoperability and performance of the overall network.

The Strategy also emphasises the need for balanced development of en-route and airport performance. It proposes ATM solutions for the best use of the available airport infrastructure, and help to identify where shortfalls will occur at airports.

1.6.2. Affordable Costs

The Strategy will affect the procedures and investment plans of all stakeholders over many years. An initial analysis estimates the total direct costs of the changes proposed to be in the order of €20 billion over 20 years. This indicative figure has to be seen together with the long lead times necessary to achieve a full system generation change, and in contrast with the more precise assessments of costs and benefits for the short-medium term programmes made at time of decision. The benefits from the resultant improvements in capacity and efficiency of the ATM system will be made in a cost-effective manner, while also contributing to improving safety, reducing emissions and to other environmental aims[7]. The costs also have to be viewed against those needed to simply maintain the present infrastructure and replace obsolete equipment over time, as well as the inherent financial penalties associated with not adapting services in relation to the increased demand, with the overall target of an affordable system. The final assessments will consider more detailed impact, including general and military aviation, as well as the distribution between airspace users and service providers. This will also be influenced by changes in service provision organisation or financing.

1.6.3. Defending the case

The Strategy requires that safety and business cases be established for every proposed major change, before decisions are taken about their implementation. It proposes consultation and decision processes to ensure that the regulatory requirements are satisfied and to secure commitment to the implementation of agreed programmes. Some improvements may be decided for safety related needs only.

[7] Additional explanations are provided in Volume 2 and in additional reference material.

2. The Need for Change and Future Aviation Requirements

2.1. Setting the Scene

The objective of the Strategy is to ensure that European ATM is capable of providing the appropriate services in the future. The types of service to be delivered, and how they can be provided, depend on the way that the societies served by ATM develop in general, and the influence that this has on aviation activities. The Strategy must ensure that ATM not only responds to foreseeable needs, but is also able to detect, and react to, different scenarios.

2.2. The Importance of an Efficient Air Transport System

Economic growth is driving changes in the frequency and pattern of air travel within Europe. European citizens are becoming more mobile, and the number of people travelling by air for business and leisure is continuing to increase. This is leading to an expansion of the air route networks and increased traffic flows, particularly between the regional and major hub airports situated near main cities and main tourist destinations, and airlines adapt to competition from other modes of transport. Aviation contributes to economic growth, employment and trade. It is also a pre-requisite for mass tourism, one of the major factors in stimulating economies.

A steady increase in economic development in Europe is assumed, with a growing demand for safe, high-quality air transport and the continuity of military activities. This will generate increased environmental concerns and impact ATM as well. The recent ECAC Constraints to Growth study[8] has identified that such growth will only be sustainable, and the present ATM performance shortfalls resolved, if the aviation stakeholders work collectively to identify strategic solutions to current ATM problems based on a co-ordinated management of the ATM network.

2.3. Present State

Substantial increases in capacity have been and are being delivered, thanks to national and international measures and the efforts made by all stakeholders in the last 15 years, in particular in the tactical phases by air traffic controllers. Further ATM capacity improvements are planned. However, as shown by the PRC, capacity is lagging a few years behind traffic demand and the installed capacity can not be fully exploited, in particular due to controller shortage. In addition, the present ATM organisation and infrastructure have inherent limitations, sometimes exacerbated by resources shortage and will be unable to cope with the total forecast traffic increase, which is expected to result in a doubling of aircraft movements by 2020 when compared to those in 1997[9].

Also, the airspace users, faced with greater competition as markets are de-regulated, are calling for flexible and cost-effective services, as well as economic regulation.

Airport congestion, already a problem at many major airports, will become a serious constraint, especially at the international hub airports serving major European cities and tourist destinations. Environment concerns have growing influence on ATM especially around airports. This will adversely affect airspace capacity planning.

Although airports are the points of departure and arrival of all flights, their ATM-related operations have not yet been fully integrated into the overall ATM organisation.

A seamless approach to en-route and airport operations throughout Europe, e.g. through de-fragmentation, can help to optimise resources. More use of cost-benefit analysis would also

[8] even though based on traffic forecast made in 2000

[9] Aviation growth is subject to cycles and sensitive to specific events. While specific events, such those of September 11 2001 in the US, may have an impact on passenger confidence and traffic growth in the short-term, empirical evidence is that underlying growth trends soon regain their previous levels.

help to exploit the potential for cost reduction and apply the rationalisation that normally follows such analysis.

Some ATM modernisation projects still do not meet time, budget or performance requirements, or have sometimes not been viewed as parts of an overall system.

Further action is needed to produce the required additional ATM safety and capacity, in order to satisfy the demand arising from the sustained development of air transport while keeping ATM-related delays and effects on the environment at low levels in a cost-effective system. This justify additional Pan-European actions.

2.4. Future Aviation Requirements

2.4.1. Evolution of Aircraft

Within the Strategy time-frame the operational characteristics of aircraft used in civil aviation are not expected to change significantly. Indeed, a large proportion of the present fleets will still be in use in 10 to 15 years. Larger aircraft will be introduced into service, and will impact airports although they will be a limited proportion of the aircraft fleet.

Advanced aircraft designs, such as tilt-rotor, are expected to have little impact on the overall pattern of aircraft operations within the time-frame of the Strategy. New versions of high-speed or supersonic aircraft may appear, but will operate at subsonic speeds over land.

The need is growing to develop the regulatory[10] and procedural framework for gradually increasing requests to accommodate civil and military use of Unmanned Aerial Vehicles (UAVs).

Cleaner, quieter and more efficient engines are predicted, but it is unlikely that their introduction will result in the need for significant changes in the design criteria for noise or emission abatement procedures.

2.4.2. Scheduled and Non-Scheduled Air Transport

The present hub and spoke operations of large commercial aircraft operators are expected to continue in line with the development of inter-modal transport policies, as is the increase in point-to-point operations by smaller or low-cost operators.

Policies governing deregulation and open skies in Europe should lead to continuous competition, encouraging the introduction of more low-fare carriers and further commercial alliances between airlines. High speed rail links development will capture a growing part of passengers for short journeys and create new partnership to airlines. This effect is reflected in the traffic growth figures.

The number of aircraft in commercial operation is expected to rise. European carriers expect to increase fleets by 2.3% per year raising seat capacity by 3.3% per year while the overall mix of aircraft types (narrow and wide body) in commercial fleets would remain the same.

2.4.3. Military Aviation

ATM is used by the military air, sea and ground forces according to the tasks set by government defence and foreign policies. This may necessitate the use of military power to protect sovereignty, and for military aircraft to take precedence over civil aviation in some circumstances. National security and protection of territory and airspace need to be considered by ATM more intensively in particular to fight against international terrorism, as shown by recent events.

During recent years there has been a marked reduction in the total number of military aircraft and in military aviation activity. There is now a greater emphasis on flexibility, adaptability and operations within the framework of international commitments. Common exercises are essential for the successful and safe conduct of joint peace-keeping and peace-enforcing operations. This, together with the emergence of new weapons technologies or new combat

[10] airworthiness, flight operations and ATM regulatory frameworks.

techniques, the introduction of new, more powerful and agile aircraft with new performance characteristics, and the increasing use of UAVs for military purposes, will continue to require significant volumes of airspace, some temporarily larger, for training and operations. Nevertheless, the overall impact of these changes should be able to be mitigated to a large extent through the enhanced procedures for the design and the flexible use of airspace and through the system technology being developed in particular to assist UAV operations.

Military operations are especially vulnerable to ATM-related changes that require the carriage of additional aircraft equipment that is not essential to military tasks. The cost and operational implications for military airspace users have to be the subject of particular attention, and might need the introduction of specific mitigating measures and incentives, such as refunding.

2.4.4. General Aviation

The General Aviation sector, which encompasses other commercial and business aviation activities and recreational flying, is expected to continue to grow in proportion to the economic activity.

2.4.5. Air Traffic Management

The observed corporatisation or privatisation of some ATM service provision aspects is taken into account in the Strategy. Together with the overall performance orientation, and depending on further political developments, this could create room for competition between service providers for some activities, in a progressive manner, but it should be such that it does not put neither co-operation, network capacity nor safety at risk. Whatever their status, service providers should be given the governance mechanisms and/or resources to meet their obligations and be capable to face variations in traffic demand in an effective and efficient manner. The safety management and safety regulatory functions in ATM should be clearly separated.

The co-operative development of large ATM systems, or the acquisition of services from entities such as independent enterprises providing only some elements of ATM (unbundling of services, e.g. for the provision of communications, surveillance, navigation and other parts of the ATM system), are expected to increase and require appropriate regulation.

Increasing use of new technology in ATM will bring a number of benefits, but also result in an increased complexity of the procedural, technical and legal arrangements. This is particularly true in the field of satellite technology, which involves many users and extended areas of application.

2.4.6. Airports

New ATM procedures, technologies and systems are required to provide additional network capacity by optimising the use of capacity available at airports, as well as to address safety levels enhancements, in particular for runway operations. These will also help to protect the local environment. However, there will still be a need for even more capacity in some areas than can be provided by the existing infrastructure, and this need can only be met by new runways/airports. Additionally, the air-side capacity of airports is influenced by the capacity and efficiency of the land-side (passenger handling, access, etc.). There is also a need to establish an effective operational partnership between ATM, aircraft operators and the airports as part of the gate-to-gate approach and a seamless approach to safety management and safety regulation for airport, Air Traffic Management as well as aircraft airworthiness and operations. Airports are a vital interface for gate-to-gate operations.

3. Overall Objective and Vision

3.1. Overall Objective

The overall objective of the European ATM network is:

For all phases of flight, to enable the safe, economic, expeditious and orderly flow of traffic through the provision of ATM services which are adaptable and scaleable to the requirements of all users and areas of European airspace. The services shall meet demand in a cost-effective way, be globally inter-operable, operate to uniform principles, be environmentally sustainable and satisfy national security requirements.

3.2. The Vision

The Strategy is aimed at realising the vision described below. It will fulfil the strategic performance objectives set out in Section 4; the technical aspects are further detailed in Section 5.

In the coming years, European ATM will need to accommodate twice as many flights as today and, therefore, simultaneously generate extra capacity to meet the traffic demand, increase safety levels and contribute to protect environment, in a cost-effective way.

Best use of airspace will be achieved because the traditional Air Traffic Control (ATC) concept will be replaced, in a controlled way, by a new ATM concept implying a structural revision of the ATM processes. Organisational means to manage the ATM network as a whole and the complexity of the traffic situation will be introduced, also capitalising on newly emerging technologies and fully utilising, where possible, the co-operative capabilities of both air and ground systems. This will allow the balance between humans and automation to be modified, the roles and responsibilities of people to be changed, and a redistribution of some tasks between the ground and airborne ATM systems.

A first step in the implementation of a new ATM system is the achievement of one airspace continuum for ATM purposes in Europe which encompasses the airspace at and around airports as well as en-route. This conforms to the intent of the revised EUROCONTROL Convention[11] and is compatible and in synergy with the European Commission's Single European Sky initiative. Applied in conjunction with other measures, in particular a pro-active and collaborative management of flows and capacities to optimise the use of the resulting European ATM network, it should significantly improve the effective use of airspace and airports and provide the maximum freedom of movement for all airspace users, together with positive cost-benefit results and environmental benefits.

Further improvements in civil-military co-ordination and co-operation will be introduced to fully exploit the airspace continuum.

ATM design will follow a holistic approach, encompassing the gate-to-gate concept. The improved services will support the mission and/or business requirements of the airspace users for sustaining their activity and optimising the integrity and yield of their operations.

All stakeholders at all levels, civil and military, will demonstrate strong commitment to an efficient, timely, effective and decision-making process based on collaboration and co-operation for all aspects of ATM and supported by judicious regulation. This will translate through a combination of pan-European, regional and local implementation actions.

Implementation will be facilitated by new economic and financial mechanisms, and the full use of the revised EUROCONTROL Convention. The programmes to realise the future ATM will focus on the performance output through time; actual delivery will be monitored and compared to targets to allow the Council to fulfil its planning. management and decision-making role.

[11] As well as that of the ECAC Institutional Strategy

4. The Major Strategic Objectives

4.1. General

4.1.1. Strategic Principles and Objectives

To achieve the Overall Objective and vision, certain principles shall be systematically applied throughout the European ATM network during the life-cycle of all ATM projects.

It is also essential to define clear strategic performance objectives for the ATM network. However, the airspace users have not all the same expectations; for example military are less interested in the throughput/delay aspect of capacity than in that of access to airspace volumes and need a cost-effective solution in terms of productivity, flight efficiency and mission effectiveness. In addition, traffic levels in European airspace vary from region to region and over time, creating different performance requirements. Performance indicators should be meaningful to all airspace users, as well as to service providers and regulators.

Principle All airspace users shall receive services of a nature and quality that satisfy their requirements and for which they are willing to pay. Performance targets shall be defined and monitored.

It is essential that independent bodies address the issues surrounding future safety and performance levels and set objectives and targets. The Safety Regulation Commission (SRC) and the Performance Review Commission (PRC) propose and monitor ATM performance objectives and targets for the consideration of the EUROCONTROL Council and Assembly. The strategic objectives set out in this section should therefore be considered in that context.

Targets have been set for safety and for medium-term capacity by the Provisional Council and will be progressively extended to cover the other objectives. They form the basis for establishing a strategic performance framework (see volume 2) which converts them into the stepped changes through time.

4.1.2. Trade-Offs

However, the simultaneous satisfaction of all stakeholders' requirements and fulfilment of all the strategic performance objectives involved is unrealistic. Conflicts of interest are inevitable, typically for access to the same airspace or runway at the same time, or for the service levels required, and trade-offs between the objectives will be necessary. The exception is safety, which cannot be traded beyond regulatory minima.

It is not desirable to define a single and permanent order of priority for the different objectives since it will depend on the specific situation vis-à-vis requirements.

The approach proposed in the Strategy is to make sure that the different trade-offs supported by the various classes of stakeholders are explicit, and that, wherever possible, the optimum solutions are selected for all affected stakeholders. The resolution of the issues calls for various considerations including incentives/exemption policies to facilitate transition, or care for special users, as well as socio-economic considerations which may sometimes be external to aviation.

4.2. Safety

Enhancing safety levels has an effect both on the ability to accommodate increased traffic demand and on operational efficiency since intervention of ATC is aimed at ensuring safe separation between aircraft[12]. If the increase in the number of flights is to be accommodated, the establishment of appropriately safe conditions shall precede the achievement of more capacity. In addition, the maintenance of, or improvements to, existing safety levels will require a new, top-down and rigorous system approach to safety involving harmonised safety

[12] As well as between aircraft and ground, obstacles and other hazardous objects or environments

policies and actions for both safety management and a strong safety regulation, with emphasis placed on continuous Safety Improvement and Measurement. This may include the introduction of a number of operational improvements dedicated to safety.

Principles Safety is of the highest priority in aviation, and ATM plays an important part in ensuring overall aviation safety. Uniform safety standards and safety risk management practices shall be applied systematically to the European ATM network.

Within the total aviation safety system approach, an ATM safety regulatory regime shall be established, the functions of which shall be separated from service provision at both European and national level.

ATM safety objectives shall be established. Safety performance shall be monitored and improved.

Objective To improve safety levels by ensuring that the numbers of ATM induced[13] accidents and serious or risk bearing incidents do not increase and, where possible, decrease.

The main purpose of ATM services is to ensure the safe separation of aircraft, both in the air and on the ground, while maintaining the most efficient operational and economic conditions. The formulation of the objective implies a reduction of the accident rate per operation or flight hour substantially greater than the rate of increase in traffic. In addition, key risk areas in aviation where ATM can contribute remedial measures should be identified and the subject of action.

4.3. ATM Security

Although not a new subject, recent terrorist activities have led to ATM related security issues assuming greater importance.

While ATM security remains a State responsibility, ATM must be able to assist the appropriate authorities where possible. As for safety, the security aspects related to ATM operations have to be pro-actively managed at both strategic and tactical levels and backed by the appropriate procedures and training.

Principle Appropriate ATM procedures shall contribute to the security of aviation as well as people and installations on the ground.

Objective To determine effective mechanisms and procedures to enhance the response of ATM to security threats and events affecting flights (aircraft and passengers) or the ATM system.

Security threats (intentional acts affecting aircraft or people) may be directed at aircraft or through them to targets on the ground. The ATM facilities and systems may also become threat targets. The international dimension imposes the uniform and effective application of suitable measures.

4.4. Cost-Effectiveness

Principle ATM activities and services shall meet demand in a cost-effective way and be economically viable for the users. The direct and indirect ATM-related unit costs – which include service provision, delays, flight efficiency and equipage costs - shall decrease in the future. Economic performance shall be quantified; objectives shall be established and monitored.

Objective To reduce the direct and indirect ATM-related costs per unit of aircraft operations.

[13] "ATM induced" includes those with direct and indirect ATM contribution.

Economic considerations should be an integral part of the development, implementation, operational and service charging stages to ensure prioritisation of the allocation and usage of capital and resources at each decision stage. Cost-efficiency and value-for-money must be essential elements for ATM. All direct costs of the service providers and indirect costs for airspace users, which include the costs of ATM-related delays, flight inefficiency and on-board equipment, need to be considered. In the future, other indirect costs, such as environmental costs, may also need be considered.

4.5. Capacity

Principles

ONE AIRSPACE CONTINUUM

The European airspace shall, for ATM purposes, be considered a continuum and shall not be constrained by national or service provision boundaries. Regional developments based on similar national requirements shall be encouraged.

The planning, operational division, management and use of the airspace shall reflect this principle and be done in a coherent way. The financial arrangements among service providers should reflect the operational organisation.

FREEDOM OF MOVEMENT

All airspace users shall have maximum operational freedom within the scope of the other principles and in accordance with international laws.

Objective

To provide sufficient capacity to accommodate the demand of all users in an effective and efficient manner at all times, and during typical busy hour periods without imposing significant operational, economic or environmental penalties under normal circumstances.

To enable airports to make the best use of potential capacity, as determined by the infrastructure in place (land-side and air-side), political and environmental restrictions, and the economical use of resources.

Capacity is a complex mix of access to airports, airspace and services, predictability of schedules, flexibility of operations, flight or mission efficiency, delay, timely availability of volumes of airspace, and network effects. ATM and airspace capacity-related aspects also include controller workload, weather conditions, availability of communications, navigation and surveillance systems, and other factors (e.g. radio frequency spectrum). The most visible symptom of capacity shortfall is the level of delays.

A major obstacle to producing more en-route capacity is that, despite efforts like. the introduction of the FUA concept, effective use of European airspace has not been achieved. While some States have concluded cross-border airspace agreements, the present organisation and management of airspace must be improved, used more flexibly and not constrained by boundaries. By removing the ATM constraints linked to boundaries, airspace capacity can be managed most effectively. The access to airspace by different types of airspace users also calls for more responsive airspace management processes to best match the needs of all users.

4.6. National Security and Defence Requirements

Principles

SOVEREIGNTY

Every State has complete and exclusive sovereignty over the airspace above its territory in accordance with international conventions.

NATIONAL SECURITY AND DEFENCE REQUIREMENTS

The ATM network shall satisfy national security as well as national and international defence requirements.

Objective To improve the effectiveness of existing, and develop new, mechanisms, criteria and structures to enhance civil-military co-operation and co-ordination.

To ensure access to, and availability of, airspace for military purposes through the implementation of special procedures where necessary.

ATM has to support national security in respect of the identification of flights entering a State's national territory, and Air Defence organisations have to be provided with all ATM information relevant to their task. ATM also has to support day-to-day military operations through the provision of, and access to, sufficient airspace for military needs.

The exchange of information between civil and military Air Navigation Service providers is essential for civil-military co-ordination, and can only be achieved if civil and military systems are interoperable.

4.7. Environment

Environmental concerns about gaseous emissions and noise is an increasingly important economic, social and political issue in aviation. As aviation activity in Europe increases, the pressure on airlines, airports and ATM to increase capacity will intensify the debate on the environmental impact of aviation activities and lead to give preference to certain operational concepts. In particular, gains in flight profile efficiency translate directly into environmental benefits.

Aircraft noise is expected to remain the major perceived cause for community opposition to airport construction and capacity expansion. Improvements in the present flight procedures at and around airports, and in airport infrastructure (runways, taxi-ways, aprons and gates) to enhance capacity will have to take care of the environment.

Principle The environmental impact of aircraft noise and gaseous emissions shall be taken into account when defining operational ATM improvements. Their implementation should provide environmental benefits wherever possible.

Objective To work with ICAO and its Member States to obtain improvements in ATM, in particular the accelerated implementation of those CNS/ATM concepts, procedures and systems which help to mitigate the impact of aviation on the environment.

Goals of the Strategy are to, on a network-wide basis, accommodate environmental considerations, identify and tackle environmental problems posed by traffic growth, and progressively improve environmental performance. In some cases, the result may be the forced under-utilisation of available capacity.

4.8. Human Involvement and Commitment

Traditional ATC processes rely heavily on the cognitive skills of the air traffic controller, who acquires and processes data and makes decisions in real-time. These processes are based on innovations introduced in the past to manage the levels of traffic then experienced, and are now testing the limits of the people involved in their operation. Helping the human element with automated tools will allow to improve efficiency for a few years, but the processes themselves will need to be reviewed. Change management requires a particular attention to ensure acceptance and success.

The flight deck already participates and will be more and more involved in the ATM process. The impact of changes on the workload, roles and human factors aspects of pilots has also to be addressed.

Objective To ensure human involvement and commitment to support the change to future ATM so that operational, technical and support staff can operate effectively, efficiently and safely within their capabilities and obtain challenge and job satisfaction.

ATM systems are expected to remain human-centred for the foreseeable future, and people will play a key role in achieving system safety and capacity enhancements. People are therefore an essential element in the ability to deliver ATM services, and their co-operation and involvement (qualitative and quantitative) in developing and effecting change is essential. All consequences of new roles and changes to responsibilities will require to be well defined

4.9. Uniformity

Objective To ensure that ATM operations are compliant with ICAO CNS/ATM plans and global interoperability requirements, provide a seamless service to the user at all times throughout Europe.

Uniformity embodies the application of harmonised ATM safety regulatory requirements, common ATM rules and procedures across all European airspace, and the use of interoperable, common core technical functionality in the systems used, rather than an all-embracing requirement for identical equipment or systems.

Uniformity also includes close co-operation and consistent approaches between ATM and aircraft safety regulatory organisations, both at national and European level. Agreed minimum requirements in respect of aircraft equipment, performance and ATM system capabilities will also be matched by defined levels of service.

4.10. Quality

Objective To develop a common framework that leads to Continuous Improvement by means of a structured approach to Excellence.

To foster, promote and enhance the use of recognised quality management standards, systems and continuous improvement methodologies in the provision of gate-to-gate ATM services, products and processes.

To promote exchange of views and information which will lead to transfer of Best Practice.

Quality management systems promote business excellence by ensuring a balanced satisfaction of all stakeholders. In a world of permanent development like ATM, this requires a continuous improvement to always meet these requirements.

5. Directions for Change

5.1. Path for Change and Network Effects

The directions for change comprise the series of complementary and stepped operational improvements in the ATM processes to achieve the target[14] operational concept and satisfy the strategic objectives. The operational improvements will need to be progressed in parallel with the modification of airspace control sectors, which is currently the primary method of enhancing capacity. This re-sectorisation of airspace will continue in many areas, either as a means to provide short-term and stand-alone benefits, or as an enabler for further improvements.

Not all of the changes will need to be applied in all areas or at the same time. Some of the measures proposed will need to be focused, either initially or primarily, in the most challenging environments that contain the more complex traffic flows and patterns and the highest concentration of flights, while ensuring that the overall network functions with adequate performance and interoperability levels. The implementation dates must reflect operational needs, be economically viable and based on effective implementation paths.

ATM is a complex integrated network of organisations, information and processes. The weakest element adversely affects the whole system, and the directions for change must therefore:

- Address the weakest points in the network and give priority to improving them;
- Promote those actions that provide network-wide advantages;
- Ensure that equipment change and transition periods are as short as possible.

This requires to better understand the issues, uncertainties and processes involved, the causes and their effects, and to define and standardise interfaces. The directions for change must also remain flexible to cater for new measures when needed. In particular, the introduction of some Operational Improvements may induce new and unanticipated safety problems which must be identified and addressed efficiently. Related remedial actions will stand as a continuous source of Operational Improvements.

5.2. New Concepts for a structural revision of the ATM process

The core ATM 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 the capacity and flexibility of 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.

The processes will become increasingly dependent upon the efficiency of supporting processes and services in particular the system-wide management of information, integrating the air and ground systems, and including meteorological and aeronautical information services, .

[14] 'target' refers to the ideal state that would be achieved at the time horizon of the Strategy, currently 2020.

The target operational concept embodies a new approach in the way ATM services are applied in order to obtain network-wide benefits and transform the ATM processes into co-operative services to air traffic, based on the management of the flight trajectory.

The principal characteristics governing the new concepts and their main advantages are described below.

STRATEGIC ORGANISATION AND ENHANCED PREDICTABILITY	The achievement of capacity and safety gains will primarily come from the introduction of organisational means such as strategic traffic de-confliction or traffic flow smoothing, supported by the improvement of data exchange between ground units and the use of consistent flight trajectory data. The complexity of the congested traffic situations and of the procedures will be reduced and will allow the proper exploitation of computer assistance tools based on high quality trajectory prediction, data communications and other technical developments.
FLIGHT MANAGEMENT FROM GATE-TO-GATE	Flights will be managed continuously within the ATM network throughout all phases of flight from flight planning to actual flight execution and post-flight activities. This will improve planning and reactions to real-time events and make better use of resources, including those at airports.
ENHANCED FLEXIBILITY AND EFFICIENCY	The trajectory of a flight will be managed to best meet at any moment the aircraft operators' needs subject to the prevailing flight or ATM circumstances. This will enhance the efficiency of both individual flights and total fleet utilisation, while improving the management of traffic and respecting the responsibilities of the air traffic service organisations.
COLLABORATIVE DECISION-MAKING	Improved information management will provide the foundation for a more extensive and comprehensive exchange of real-time information between ATM, the aircraft operators and airports during all phases of flight, including the planning phases. Decision-making will be based on the sharing of real-time data about actual events that incorporate preferences and constraints. Decisions will be of better quality allowing more flexible responses and enabling greater efficiencies on both a network-wide and individual flight basis. Military will also be involved in the CDM process.
RESPONSIVE CAPACITY MANAGEMENT TO MEET DEMAND	Flexible management, based on the best possible division of air traffic control centre responsibilities, and responsive allocation of their resources in line with traffic variations, will be applied to ensure that demand can be handled safely and efficiently with minimum delay. This will provide operational and cost efficiencies by matching resources to fluctuations in traffic levels
COLLABORATIVE AIRSPACE MANAGEMENT	A collaborative airspace planning and management mechanism based on the flexible use of airspace, and involving both civil and military authorities will be established. This will ensure that airspace is managed and used as a pan-European continuum in a flexible and dynamic way.

5.3. Operational Improvements

The operational improvements are described in Volume 2 and summarised below. They constitute the individual steps to realise a new ATM operational concept

5.3.1. Airspace Organisation and Management

The main actions will be to simplify the airspace organisation, improve airspace management and civil-military co-ordination, optimise the route network, ATC sector design and terminal airspace organisation, allow maximum use of user-preferred trajectories and optimise the airspace procedures. Airspace design (flight information regions, centres, sectors, routes) will be prepared with the participation of all stakeholders under the auspices of EUROCONTROL.

Airspace management will move to a regime whereby airspace boundaries are adjusted dynamically to particular traffic flows and peaks in demand, thanks to collaborative European airspace management. Flexible route and airspace structures will be implemented where possible and traffic organised when necessary. This will provide the most efficient and cost-effective solutions with regard to safety, capacity, productivity, flight efficiency and mission effectiveness for the benefit of Europe as a whole, while lessening the environmental impacts, and taking into account the needs of all airspace users, civil and military.

Advances in avionics, the development of Area Navigation (RNAV) techniques, advanced ATC decision supporting tools and improved navigation systems, will be the main enablers.

5.3.2. Flow & Capacity Management

Flow and Capacity Management is necessary from strategic planning to tactical execution of flights to optimise the use of available ATC capacity. Improvements will be based on a gradual shift from managing the demand to collaboratively and pro-actively managing the capacity of the ATM network, through increased overall responsiveness by real-time and optimised tactical procedures, and pro-active and informed collaborative decisions on alternatives.

Flow and Capacity Management will remain a preventive mechanism, primarily for:

- Tactical management of arrival and departure flows – since airport capacity will be a major limiting factor in the ATM network;
- Residual en-route problems, peak periods and exceptional circumstances;
- Management of traffic densities to support enhanced flexibility in airspace use.

Enhanced Central Flow Management Unit (CFMU) services, improved ATFM techniques and tools based on the capture and integration of current traffic, airspace management and capacity data will help to further enhance safety and the utilisation of capacity through the avoidance of potential ATC overloads.

5.3.3. En-Route & Terminal Air Traffic Control

Safety-net tools assist in reducing the risk of aircraft collisions and will be used to monitor the traffic situation and trigger alarms when safety parameters are likely to be infringed.

In addition to the strategic organisation of traffic and the further automation of routine tasks, productivity will be increased through:

- Use of automated tools to assist the controller in planning and tactical decision-making and communications in all phases of flight;
- Redistribution of control tasks within sector teams or between controllers within a control centre, using the flexibility provided by data communications;
- Co-operative air traffic services based, initially, on greater situational awareness and controller pilot data communications, and then delegation of separation tasks to the flight crew in well defined and duly regulated circumstances. Agreed 4D trajectory contracts between the air and the ground will also enhance their co-operation.

The procedures, capacity gains, costs and other requirements associated with the delegation of separation tasks will be evaluated, and safety and human factors analyses undertaken, both to verify the feasibility of such operations and to define their conditions of applicability .

These changes depend on the provision of accurate real-time data on aircraft position and intent, and improvements in flight data processing systems and in CNS systems, in particular mobile data communications, increased surveillance efficiency, and navigation system performance. These improvements and the related data semantics and quality requirements call for extended criteria and new forms of interoperability.

5.3.4. Airport Air Traffic Control

Improvements will be brought to the management of arriving and departing aircraft, and of aircraft on the movement area, as well as to runway capacity and utilisation, and airport operations efficiency in all weather conditions within the limits imposed by political/environmental restrictions. They will be accompanied by, and integrated with, better management of the land-side infrastructure as the airport is a key stone in the realisation of a gate-to-gate network. Operational and strategic co-ordination between aircraft operators, airports and ATM, based on CDM applications, will allow to resolve conflicting goals.

The Airport operational environmental protection will address procedures for minimising the impact of aircraft noise and of gaseous emissions, the application of, and compliance with, pan-European harmonised environmental standards and regulations, and the management of noise capacity.

ATM operational initiatives at airports and efficient use of the available movement areas and associated infrastructure will bring capacity, efficiency and environmental gains in terms of reduced airborne delay and ground waiting times, and also enhance the safety of aircraft and other traffic on the airport manoeuvring area.

Changes to procedures will be enabled by runway management tools, arrival/departure management systems, and advanced surface movement guidance and control systems.

These measures will allow to optimise the use of available infrastructure, but are not a substitute to the ultimate need for more runways.

5.3.5. Information Management

ATM will increasingly depend on system-wide information management, and on efficient, high-quality services such as Aeronautical Information Services (AIS) and aviation meteorological services (MET). ATM activities, such as trajectory prediction, traffic sequencing and collaborative decision-making, require that all parties have the same accurate information on the operational environment and rules. Similarly, the operation of the supporting CNS services will require timely, accurate and high-integrity data.

AIS will be improved and developed to provide a harmonised, co-ordinated service delivering quality-assured most up-to-date information for all phases of flight and all users.

The safety and efficiency of air traffic relies upon the timely and accurate and up-to-date availability of MET information to pilots, controllers, and planners, in particular information on adverse weather conditions.

Post-flight activities include the monitoring of performance and require the development of one recognised, impartial repository of traffic, delays and incidents for the whole of Europe.

Information sharing and collaborative decision-making, will rely on an integrated and networked environment. Proper protection will be required for some data, for legitimate reasons related to security or commercial sensitivity, nevertheless possibly resulting in less than optimum decisions.

5.3.6. Human Resource Management and Human Factors Issues

Changes in ATM procedures and technology in the period covered by the Strategy will be a major human resources challenge. In order to ensure that new operational procedures and technologies will provide the expected benefits from the moment of implementation, it is of high importance that all human-related issues are sufficiently addressed as part of a systematic approach and managed as early as possible.

The two main lines of action will be to ensure:

- Timely availability of the required suitable people.
- Pro-active management of human performance.

This includes specific actions to address related issues, in particular roles and responsibilities of staff, staff adaptation and buy-in to change, staff ageing or the long term future of jobs.

5.4. Supporting Infrastructure

Supporting infrastructure should be developed to timely enable the operational changes required to meet the performance objectives, or to improve its own cost-effectiveness. Deployment of air and ground infrastructure elements should be synchronised to the implementation of the operational applications they serve. These main elements cover Flight Data Processing Systems, Flight Management Systems and Communication, Navigation and Surveillance (CNS) systems. It is essential that ground infrastructure is compatible with, and exploits the capabilities of, modern aircraft and systems.

An increasing use of non-ATM specific information technologies will be made, based on satellite technology – in particular for navigation services with the advent of GALILEO and shorter-term GPS augmentation solutions –, mobile data-link communications and advanced computer technology.

5.4.1. Integration

The ECAC Strategies for the 90’s achieved significant harmonisation and integration of ATM, and further measures to overcome the past fragmentation of systems are being progressed.

Driven by Operational Improvements, new ATM and CNS infrastructure will tend to integrate different elements. This requires, as a minimum, the establishment of safety requirements and the definition of interoperability criteria and information management mechanisms, if possible at global scale, to allow system architecture convergence. A particular attention will be paid to security aspects of the signals and information processed and transmitted.

All stakeholders must make transparent cohesive benefit-driven technical choices from a global perspective and backed by realistic investment plans and political commitment.

A co-ordinated and strengthened long-term planning process and means to increase Industry involvement will be developed to handle the multiplicity of choices and increase industrial support and confidence. The rule-making process will help in this respect and assist in obtaining commitment to change by the stakeholders. Incentives for investment should be defined to provide accompanying or alternative means to obtain that commitment.

5.4.2. Investments

Means of ensuring that all areas of aviation are able to benefit from the choices made shall be developed to facilitate investment by the airspace users and Air Navigation Service providers. This approach will help to achieve an optimum balance between private and public funding, and assist private investors in identifying suitable areas of opportunity.

To ensure that investments in infrastructure programmes help to deliver the required operational benefits, while making best use of the available financial resources, improved programme management is needed within the EUROCONTROL Organisation to co-ordinate interdependent actions from initial development to operational implementation.

European States or service providers may, in some cases, need to use different transition arrangements and implement systems based on local requirements, but a controlled and collaborative segmentation is needed to replace the fragmented efforts of the past and determine which aspects should be centralised or de-centralised for maximum efficiency.

5.4.3. Frequency Spectrum

CNS systems rely heavily on the availability of a suitable frequency spectrum and is vulnerable to competing commercial interests of, and decisions made by, organisations which are not part of the aviation industry. The political initiative was taken by MATSE/6 to ensure that the available spectrum is used efficiently, and 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). It requires continuous attention and support to make sure that the aviation requirements remain fulfilled. Key to success in this area is the ongoing development of a spectrum strategy to accompany this Strategy and its implementation plans, and the recent European Common Aviation Position on spectrum needs.

6. Management Considerations

6.1. Purpose and Scope

The purpose of the management considerations is to convert the ATM Strategy for the years 2000+ into practical implementation actions in conformance with the strategic principles. Since the adoption of the Strategy in January 2000, all management actions are focused on, and support, the Strategy objectives and associated programmes.

The guidelines for a management geared to the effective development of the future European ATM network in accordance with the Strategy are set out below.

6.2. Institutional Framework

The revised EUROCONTROL Convention[15] provides the institutional framework for the ATM Strategy for the years 2000+ and the division of responsibilities in the Organisation. It is the legal instrument of the ECAC ATM Institutional Strategy.

The airspace users and service providers are responsible for their timely and effective response to agreed plans, programmes and projects.

6.2.1. Decision-Making, Commitment and Follow-up

Decisions taken at the EUROCONTROL General Assembly and Council levels are made on majority voting and are binding on the contracting parties and the EUROCONTROL Agency with a possibility of temporary derogation, for national reasons.

For the non-EUROCONTROL ECAC States to which the Strategy will apply, a method for ensuring the rights, obligations and commitments of those States should be established.

Experience shows that a decision is not automatically translated into the full, timely commitment and follow-up needed at all levels in all States. To obtain commitment, a convincing case must be presented to those who are empowered to make binding decisions and good communication and collaboration must be maintained with all parties involved. Initial and continued commitment to an activity requires each step to be accompanied by evidence, including cost-benefit analysis, which motivates the airspace users and service providers to make the necessary investments. It is vital to the success of projects that the commitments made are known and accepted at all levels by the stakeholder(s) involved.

With its accession to EUROCONTROL, and in accordance with proposals of the "Single European Sky Initiative", the European Commission will play a role in the EUROCONTROL decision-making process; it may propose Community legislation and, when Community Competence applies, will enforce EUROCONTROL decisions on European Union Member States.

6.3. Rule-Making and Regulation

6.3.1. Common Rule-Making

The successful realisation, maintenance, and continued development of a safe and efficient uniform ATM network requires all parties to fulfil the commitments which they have accepted to achieve performance objectives and implementation targets. This also requires the various stakeholders to ensure that their actions will not be delayed by logistic problems. An important mechanism to achieve strengthened commitment is through rule-making.

[15] See footnote 2 above.

6.3.2. The Rule-Making Process

The rule-making process needs to be improved to help promote transparency, trust, confidence and consensus on change among all major stakeholders (national and European authorities, Air Navigation Service providers, Airspace Users and Manufacturing Industry).

The recent creation of the EUROCONTROL Regulatory Committee and its supporting Regulatory Unit allows the separation of the regulation and service provision functions of the Organisation and is an important contribution to the independence and transparency of the improved rule-making process.

One measure to achieve this is the upcoming adoption[16] of the EUROCONTROL Notice of Proposed Rule-Making (ENPRM) process to assist in obtaining commitment by stakeholders to proposed rules.

The EUROCONTROL Organisation should develop proper processes for declaring that agreed important products/systems are compliant with a standard. The scope of these proposals will be defined in the near future.

EUROCONTROL's General Assembly and Council will make binding decision, in accordance with the revised Convention. All regulatory and rule-making activities must be proportional to the objectives to be realised, and be consistent with safe, expeditious and economic operation.

6.3.3. Regulation of Safety

Within the EUROCONTROL Organisation, ATM safety regulation is approved by the Council with the Safety Regulation Commission as the highest level advisory body. The SRC is responsible for advising the Council with respect to the development and harmonisation of an ECAC-wide ATM safety regulatory regime, through co-ordination and harmonisation of States' safety regulatory approaches and requirements, ensuring their effectiveness through the measurement of ATM safety performance. SRC develops EUROCONTROL Safety Regulatory Requirements (ESARRs) and associated material, using ENPRM rulemaking principles, as part of national harmonisation activities in the safety regulation field. ESARRs, further to their adoption by the Council, are binding on the EUROCONTROL contracting parties. The entry into force of the EC Single European Sky regulations will also result in the strengthening of the ESARRs' enforcement.

In addition, the SRC is developing and reporting to the Council harmonised safety regulatory views[17] on the acceptability of the proposed changes to the European ATM system being co-ordinated within the Agency. This activity aims at facilitating and harmonising the subsequent approvals of those changes when implemented at national level.

The European Aviation Safety Authority (EASA) is under development, focusing on airworthiness and aircraft operations.

6.4. Liability of personnel

The Strategy envisages a series of changes concerning the level of automated assistance, the roles and responsibilities of air traffic management personnel and pilots, and the distribution of functions within the system. Their actual implementation by the service providers and their acceptance by personnel is dependent on the proper resolution of the new legal consequences and liability issues they may entail at the place of application. These questions must be addressed explicitly during the development phases and with participation of interested parties.

6.5. Economics and Financial Arrangements

To ensure more responsiveness of service providers to the needs of the users, direct control of costs and improved efficiency of operations ANSPs will need to address two main issues:

[16] still to be confirmed by one of the EUROCONTROL Member States
[17] based on an assessment of the safety deliverables developed for each OI

the governance and the charging mechanism.. As pointed out in the Performance Review Report PRR5, the current full cost recovery system provides little incentives to ANSPs to control their costs and to adjust to demand conditions in a timely and appropriate manner. In addition, the lack of financial buffers pushed them to increase charges to deal with the recent unanticipated shortfalls in demand.

In addition to the performance-driven approach which builds on existing structures and procedures in the EUROCONTROL Organisation, improved governance arrangements[18], resulting in greater accountability of ANSPs could result in allowing ANSPs to create financial buffers to deal with shocks in the future. This business-driven approach requires economic regulation.

Both may co-exist and the performance-driven approach can be supplemented with a business-driven approach if so decided by individual States.

The PRC and other EUROCONTROL bodies work on this subject and are addressing issues that require further study, such as:

- Pricing mechanisms, possible as an alternative option to the cost recovery concept; when there is an independent economic regulator in the State concerned;
- Facilitating financing of investments, in particular through incentives for investment; or
- Financial reserves for service providers.

The requisite studies, when considered in the context of the work of the PRC, will result in proposals to be put to the EUROCONTROL Council. The shortage of research in the economic field in comparison to other areas emphasises the need for such studies being given sufficient work priority within the EUROCONTROL Organisation. Future financial arrangements should, in line with ICAO, reflect cost transparency and support the principle that, in case of delegation of services among services providers, they should reflect the operational agreements.

6.6. Maintenance of a Dynamic Strategic Planning Process

The implementation and maintenance of the Strategy, regulatory issues and common policy-setting, requires an agreed strategic planning process, performance oriented, which takes account of air transport needs, technological evolution, national security and environmental constraints.

A strategic performance framework is used to identify future ATM system requirements in the various operational environments, based on forecast future demand and strategic performance requirements set by the EUROCONTROL Council. This analysis, as well as the identification of key safety risk areas result in a set of operational improvements and the determination of when and where they are needed over time.

Specific short and medium-term targets are derived from the strategic performance requirements. The agreed targets, together with commonly agreed implementation objectives for applying the operational improvements to the European ATM system, are set out in the European Convergence and Implementation Plan (ECIP) that has a rolling 5 to 7 year medium-term look-ahead period. These objectives describe the actions needed from each involved stakeholder, and by when, to realise the objective. At this stage, the common supporting programmes are also identified and included in the European ATM Programme (EATMP) portfolio.

The ECIP objectives provide the building blocks for national Local CIP (LCIP) documents that set out the national plans to deliver local performance improvements.

The performance planning process is both cyclic and iterative, and the performance gains achieved in the past year, together with the results of Research and Development activities, are used to refine future plans in the next planning cycle. This allows control of the change process, with timely validation that expectations can be met, and improvements delivered, and planning of decision points at key steps.

[18] For more information see the chapter on Governance in the Performance Review Report (PRR5)

The EUROCONTROL Agency acts as the managing agent for the ECIP and co-ordinates consultation with all stakeholders before consolidating and validating proposals for submission to the EUROCONTROL Council[19]. The EUROCONTROL General Assembly[20] will decide high-level strategic issues. In addition, the SRC develops and reports to the EUROCONTROL Council harmonised safety regulatory views on the acceptability of proposed ATM changes.

The time-frame of the Strategy stretches to 2020. This time-frame is not intended to signify an end to the strategic process, and future strategic planning will continue on a rolling 15 to 20 years basis.

6.6.1. General Guidelines

The use of the following guidelines, together with better management structures and practices, will improve the process of change and reduce risks:

- Each project must fit within the overall network, and the total life, requirements and consequences of each project must be identified and evaluated as early as possible;
- Every phase of the development shall be monitored to provide a basis for decisions on continuation, redirection or cut-off;
- All partners shall be involved in the process in good time;
- Technical and operational solutions, resources and priorities must be determined on the basis of delivering early benefits as well as on cost and safety grounds;
- The level of sophistication must not exceed that which is necessary for meeting the relevant performance targets;
- Within areas where common performance target levels apply, uniformity shall be applied in defining implementation objectives and the functionality and solutions for equipment, procedures and training wherever operationally or cost beneficial;
- The development, implementation and regulation[21] of changes to equipment and/or procedures in the respective space, air and ground-based elements of the network shall be synchronised, and be organised to limit the number of required interventions in aircraft, by designing, where possible, packages able to fulfil the requirements of a series of changes.

6.7. Enlarged Partnership

The systematic approach of the Strategy, and the variety of different stakeholders in the network, demand an enhanced involvement of all stakeholders in the decision-making process.

The aviation community is faced with common challenges and problems. It needs to plan collaboratively and take common actions where air and ground measures, regulation and industrial development work to synchronised schedules. This implies that all involved in agreed changes must fulfil their responsibilities and actively contribute to their timely implementation. It also means that the aviation community needs to share information amongst of the partners to underpin effective collaborative decision making.

6.7.1. Partnership

This section is focused on collaboration of the EUROCONTROL Organisation with other stakeholder groups, but initiatives should also be developed by between individual members within a particular group or across groups, in particular a strong co-operation between providers of adjacent airspace volumes.

[19] Provisional Council until the establishment of the revised Convention
[20] permanent Commission until the establishment of the revised Convention
[21] Rule making and approval

Besides its relations with member States, agreements and memoranda of co-operation should be established by the EUROCONTROL Organisation with all parties whose decisions, activities and/or services affect the realisation of ATM programmes/projects. These will provide the platform for collaboration and include the following arrangements:

Collaboration with Airspace Users: The future prevention of shortcomings requires a close collaboration, including clear lines of communication and the exchange of all relevant information between the EUROCONTROL Organisation and airspace users.

Collaboration with Air Navigation Service Providers: The Strategy will affect the operation and management of Air Navigation Service providers. Although the final authority rests with the States, it is essential, besides the national internal co-ordination, to improve the involvement of ATM service providers in the EUROCONTROL Organisation's decision-making process. The recently established Chief Executive Officers Standing Conference (CESC) contributes to this goal.

Collaboration with Airports: The benefit of integrating airports into the ATM network requires the establishment, as a matter of urgency, of a collaboration arrangement between the EUROCONTROL Organisation and the airports which ensures commitment by all parties to agreed ATM programmes and projects.

Civil-Military Collaboration: The ECAC ATM Institutional Strategy and the revised Convention highlight the importance of close civil and military co-operation and co-ordination, and recognises that military authorities are airspace users, service providers, airport operators and regulators. The measures taken to enhance this co-operation - EUROCONTROL Civil-Military Interface Standing Committee (CMIC) and EUROCONTROL Agency Military Expert Unit - should be further strengthened by the ratification of a Memorandum of co-operation between the EUROCONTROL Organisation and NATO.

Collaboration with Manufacturing Industry: Suppliers and service providers need to develop procedures for the best use of their respective expertise and ensure that requirements and products can rapidly converge, e.g. by high level standards to be applied to all ATM systems. In addition, the EUROCONTROL Organisation will conduct an analysis of the ATM rule-making, standardisation, operational requirement determination and contractual specification processes, and industry's involvement in those processes to identify past problems and effect measures to share best practice as a matter of urgency. This will help to shorten the transition periods and bring cost-effectiveness. Collaboration with Industry is required also to prepare the future systems, and should cover strategic research, as well as a master plan for validation and system implementation.

Collaboration with Safety Regulators: The establishment of the Safety Regulation Commission within the EUROCONTROL Organisation has enabled national safety regulators in ATM to increasingly harmonise their positions at European level. There is a need to improve the involvement of ATM safety regulators in the EUROCONTROL Organisation's decision-making process by systematically requesting their conclusions and views on the acceptability of proposed changes to the ATM system. The SRC input to the EUROCONTROL Council contributes to this goal. In order to support a total system approach to the safety regulation of ATM/CNS, co-operation with aircraft regulatory [22] authorities will need to be strengthened and enlarged.

Collaboration with the European Commission: The role of the EU in the EUROCONTROL consultation and decision-making process derives from the Accession Protocol. Further detailed practical arrangements will be defined in a memorandum of co-operation between the two organisations in order to use as much as possible the existing arrangements and expertise at EUROCONTROL level and create synergies.

6.7.2. Projects of Common Interest

The extent of the commonality adopted for ATM projects may vary considerably, and must be managed according to the nature and scale of the different actions and expected benefits. In addition to pan-European functions and services (e.g. CFMU or Central Route Charges Office – CRCO -, three main categories of projects of common interest are identified:

[22] Airworthiness and operational approval authorities

- Projects which may affect all European States, e.g. the Reduction of Vertical Separation Minima (RVSM),
- Projects which involve several States or service providers working together (e.g. CEATS);
- Projects aimed at the common application of elements of the ATM infrastructure that will enhance the inter-operability of systems at ATM network-level (e.g. for flight data processing).

The benefits of adopting a common project approach include:

- Cost savings and efficiency through shared research, development, validation, trials, evaluation, procurement and life-cycle support;
- A smoother profile of expenses for individual States and Air Navigation Service providers;
- Increased consistency in national safety regulatory approval processes and conclusions;
- Wider application of agreed standards and protocols, system interoperability and transparent interfaces;
- Ensuring the requirements of all States, Air Navigation Service providers and airspace users are balanced.

States have recognised these benefits and, through the revised Convention, have committed themselves to identifying opportunities for adopting a common project approach wherever this is feasible and beneficial. The EUROCONTROL Organisation will analyse the possibilities of new financing mechanisms which could assist in timely implementation of common agreed projects.

6.7.3. International Collaboration

European ATM will strengthen its contribution to the design and planning of the ICAO CNS/ATM System. European ATM will also remain aligned with ICAO Regional ATM plans to meet the airspace users' global requirements and to both strengthen co-operation and provide an effective interface with adjacent States and ICAO regions.

Because of the particular similarity in the development, problems and solutions of the ATM of North America and Europe, and the mutual benefits to be gained, co-operation with the authorities of North America and NATO shall be strengthened.

6.8. Research and Development, and Validation

ATM Research and Development (R&D) must focus its activities on supporting the Strategy's major areas of development concerning new procedures, new technologies and how humans (controllers and pilots) will adapt to the changes, as well as the need to validate the overall system and concept and their individual components.

ATM R&D should place greater emphasis on applications that improve ATM operations, while ensuring proper development of the necessary CNS technologies.

ATM R&D related activities, including their funding, should be co-ordinated and directed at European level by an aviation Strategic R&D Agenda developed in co-operation with the European Commission. This agenda will be used to support the Strategy within the framework of the revised Convention and provides for co-operation with European and international R&D activities.

In implementing the Strategic R&D Agenda one should make sure that the activities also encompass:

- Clear identification of the technical and human factor issues and the efforts and time needed to solve them;
- Efficient use of resources through collaborative projects;
- Effective exchange of appropriate R&D information;

- Involvement of Air Navigation Service providers, Manufacturing Industry, Airports Airspace Users and/or safety regulatory authorities from an early stage;
- Validation and quantification of related economic benefits to facilitate economic analysis;
- Assessment of related safety impact to facilitate feasibility and safety analysis.
- Adequate balance between shorter and longer term needs, and effective transition from R&D to implementation.

All aspects are to be validated using a structured approach, with transparency of results, to allow decisions to be made with confidence.

7. Acronyms, Abbreviations and Definitions

7.1. Acronyms and Abbreviations

ACC . . . . Area Control Centre
AECMA . . . . European Association of Aerospace Industry
AIS . . . . Aeronautical Information Services
ANS . . . . Air Navigation Services
ANSP . . . . Air Navigation Services Provider
APATSI . . . . Airport/Air Traffic System Interface
ASAS . . . . Airborne Separation Assurance System
ATC . . . . Air Traffic Control
ATFM . . . . Air Traffic Flow Management
ATM . . . . Air Traffic Management
ATS . . . . Air Traffic Services
CDM . . . . Collaborative Decision Making
CEATS . . . . Central European Air Traffic Services
CESC . . . . Chief Executive Officers' Standing Conference
CFMU . . . . Central Flow Management Unit
CMIC . . . . Civil-Military Interface Standing Committee
CNS . . . . Communications, Navigation and Surveillance
CRCO . . . . Central Routes Charges Office
EASA . . . . European Aviation Safety Authority
EATCHIP . . . . European Air Traffic Control Harmonisation and Integration Programme
EATMP . . . . European Air Traffic Management Programme
EC . . . . European Commission
ECAC . . . . European Civil Aviation Conference
ECIP . . . . European Convergence and Implementation Plan
ENPRM . . . . EUROCONTROL Notice of Proposed Rule-Making
ESARR. . . . . EUROCONTROL Safety Regulatory Requirement
EU . . . . European Union
EUROCAE . . . . . European Organisation for Civil Aviation Equipment
EUROCONTROL . European Organisation for the Safety of Air Navigation
FAA . . . . Federal Aviation Administration
FUA . . . . Flexible Use of Airspace (Concept)
GDP . . . . Gross Domestic Product
GPS . . . . Global Positioning System
ICAO . . . . International Civil Aviation Organisation
IFALPA . . . . International Federation of Airline Pilots' Associations
ISO . . . . International Organisation for Standardisation
ITU . . . . International Telecommunications Union
JAA . . . . Joint Aviation Authorities
LCIP . . . . Local Convergence and Implementation Plan
MATSE . . . . ECAC Transport Ministers' meeting on the Air Traffic System in Europe
MET . . . . Meteorology
NATO . . . . North Atlantic Treaty Organisation
OAT...................Operational Air Traffic
OCD . . . . Operational Concept Document
PRC . . . . Performance Review Commission
R&D . . . . Research and Development
RNAV . . . . Area Navigation
RVSM . . . . Reduced Vertical Separation Minima
SRC . . . . Safety Regulation Commission
TMA . . . . Terminal Control Area
UAC . . . . Upper Airspace Area Control Centre
UAV . . . . Unmanned Aerial Vehicle

7.2. Definitions

The following general definitions are used in this document:

Certification	A process by which an authorised body, acting within a legislative framework gives formal recognition that a product, process or service conforms to applicable safety regulatory requirements.
Collaborative Decision-Making	Collaborative decision-making refers to a set of applications aimed at improving flight operations through the increased involvement of airspace users, ATM service providers, airport operators and other stakeholders in the process of air traffic management. Collaborative decision-making applies to all layers of decisions, from longer-term planning activities through to real-time operations, and is based on the sharing of information about events, preferences and constraints.
Information Management	The timely distribution of relevant, up-to-date and validated data to those who have the necessary authorisation to access it.
Gate-to-Gate	The 'gate-to-gate' scope is considered to start at the moment the user first interacts with ATM and ends with the switch-off of the engines, including also the processes of charging users for ATM services. The scope does not encompass ATM processes only.
Harmonised	Comparable levels of performance.
Integrated	Systems or procedures which are, or which appear to the end user to function as, a single entity.
Qualification	The process of demonstrating whether an entity is capable of fulfilling specified requirements.
Regulation	The adoption, enactment and implementation of rules for the achievement of stated objectives by those to whom the regulatory process applies.
State aircraft	For ATM purposes and with reference to article 3(b) of the Chicago Convention, only aircraft used in military, customs and police services shall qualify as State Aircraft. This includes: Aircraft on a military register, or identified as such within a civil register, thus considered to be used in military service; Civil registered aircraft used in military, customs and police service. This excludes Civil registered aircraft used by a State for other than military, customs and police service.
Safety Nets	A Safety Net is an airborne and/or ground based function within the ATM System whose sole purpose is to alert aircrew/ATCO of the imminence of a hazardous situation (e.g., risk of aircraft collision, terrain collision, or airspace penetration) so that it can be resolved in a timely manner.
Uniform	Without variation and appearing the same to the end user regardless of location.
Validation	Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled (usually used for internal validation of the design).
Verification	Confirmation by examination of evidence that a product, process or service fulfils specified requirements.

EUROCONTROL

ATM Strategy for the Years 2000+

2003 Edition

Volume 2

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1. Introduction

1.1. This Document

The Air Traffic Management (ATM) Strategy for the years 2000+ (ATM 2000+ Strategy) document comprises two volumes:

- **Volume 1** provides the basis for, and the background to, the Strategy. It describes the Overall Objective, the high-level principles and major objectives that govern the Strategy, an outline of the main lines of action to effect change, and the general management principles to be adopted.

- **Volume 2** - this document - contains the more detailed rationale for change and guidance on the activities that are needed to meet the Strategy objectives.

The principles and major objectives set out in Volume 1 provide the main framework for the Strategy and will remain generally stable during its lifetime. However, the content of Volume 2 requires periodic updates to reflect shifts in the priorities and scope of activities to be undertaken resulting from experience and knowledge gained, as well as reflecting changing circumstances in the aviation environment.

Additionally, the measures set out in the Steps for Change, particularly in the medium to longer term, should be seen as providing guidance as to the most likely path to realise the future European ATM network rather than as a rigid blueprint. They will need to be reviewed and revised over time. Likewise, a number of the operational improvements proposed will need validation and cost-benefit analysis to determine the potential benefits to be gained, and how and where they might be best applied.

The content of Volume 2 is set out as follows:

Chapter 1 - provides a short introduction to the document and summarises the main decisions, events, achievements and progress since MATSE/6 that shape this updated edition.

Chapter 2 - explains why the Strategy and a new approach to providing ATM services are needed.

Chapter 3 - expands on the major objectives described in Volume 1 and provides details of the supplementary objectives associated with each of the major objectives. It also presents the strategic performance requirements.

Chapter 4 - explains the performance oriented approach used to link strategic objectives and implementation steps.

Chapter 5 - introduces the overall road map of change through time.

Chapter 6 - sets out the details of the main directions for change in the ATM processes and supporting technical functions. It also outlines the steps for improving performance.

Chapter 7 - details the progressive changes needed to meet the Strategy objectives for the periods – up to 2004, 2005 to 2007, 2008 to 2011 and beyond 2012.

Chapter 8 - introduces additional considerations related to the validation and development of the measures proposed in the Strategy.

Chapters 9 and 10 - provide details of the reference documents and list the acronyms and definitions used in the document.

Appendix 1 - provides descriptions of the operational improvements

Appendix 2 - describes the main characteristics of the target operational concept towards which the Strategy is aimed.

Appendix 3 - lists possible economic studies.

The relationship between the Volume 1 chapters and the additional material contained in Volume 2 is shown in the following table

Volume 1	Related Volume 2 Chapters
Chapter 1	Chapter 1
Chapter 2	Chapter 2
Chapter 3	Chapter 3
Chapter 4	Chapter 3

Chapter 5	Chapter 6, 7 and App. 1 and 2
Chapter 6	Chapters 4, 5, 8 and App. 3
Chapter 7	Chapter 9 and 10

1.2. Progress made since the first edition

The first edition of the ATM 2000+ Strategy was adopted by the ECAC Transport Ministers at their MATSE/6 meeting on 28 January 2000. This second edition takes into account the decisions and events that have occurred since that meeting, together with the achievements and progress made in applying the Strategy measures to date. The main changes involved and their impact can be summarised as:

Implementation of a number of Operational Improvements and Enablers listed in the Strategy, such as ACAS, RVSM and ARN-V4, has been achieved successfully. Their introduction is the fruit of widespread co-operation in Europe and with its neighbouring States, and marks the first steps forward along the roadmap of change presented in the first Strategy edition.

Technical progress to prepare for the next change steps has been intense. Detailed descriptions of domain strategies that discuss and document the vision, concepts and expertise in the different ATM areas are now available. Their development has allowed work to be streamlined and additional knowledge gained. The progress made in specific operational and technical areas now needs to be reflected in the overall Strategy. One such example is the nature and conditions for the potential delegation of some tasks to the flight deck.

Collaborative Decision Making (CDM) has been confirmed as a key theme for the further development of ATM. The potential applications have been identified and are starting to materialise, in particular in the field of airport ATC and ATFM.

Air Traffic Flow Management (ATFM) has been the subject of special attention, and an independent "Enhanced ATFM Study" was carried out in 2000 into how to optimise the use of existing capacity, and improve the ATFM strategy, as well as its processes and operation. The recommendations from this study, which are consistent with the Strategy, have provided the basis for an "ATFM Action Plan" that was approved by the EUROCONTROL Provisional Council in 2001. That Plan proposes concrete actions to expand the role of ATFM beyond slot allocation; optimise the use of available capacity for the European network; provide more optimum co-ordination of relevant information between ATC, Airspace Users, Airports and ATFM systems; and to define ATFM performance indicators and their monitoring.

Particular attention has been paid to **Civil-Military co-operation** in ATM. A joint study by the Performance Review Unit and the EUROCONTROL Agency, made at the request of the Provisional Council. This assessed the actual status of the civil-military co-ordination in ATM, including the implementation status of Flexible Use of Airspace Concept, with a view to launching a programme in the near future to ensure best practice and foster the integration of civil and military ATS.

The **performance planning process** necessary to realise the measures proposed in the Strategy has been established. This includes the reform and issue of the European Implementation and Convergence Plan (ECIP) as the common implementation planning vehicle for European ATM - recognised by ICAO - and the development of a Strategic Performance Framework (SPF), the first results of which have been used in the updating of this Strategy edition.

ECAC Constraints to Growth study: MATSE/6 requested a detailed study to establish the implications and consequences – with particular regard to safety, the environment, inter-modality, cost, financing and practical issues – of continuing to increase ATM capacity in line with forecast demand, including consideration of the requirement for sustainable development.

The key messages arising from that study are:

- A growing mismatch between supply and demand, already significant in 2005, and the criticality of airport constraints before 2005, in particular due to environmental concerns and increasing ATM constraints.
- The strategic need for the integrated management of the European air transport network (airline, airport or ATM) capacity for both en-route sectors and airport nodes.
- The urgent need for stakeholders to identify together strategic measures and solutions if the anticipated air traffic demand is to be accommodated.

The **separation of regulation and service provision** has been adopted in a growing number of States. Concrete proposals have been made for its implementation within the EUROCONTROL Agency through a combination of a functional and organisational/structural reform, and this has led to the creation of a Regulatory Unit which became effective on 1 January 2002.

A **harmonised European ATM safety regulatory framework** has been developed by the Safety Regulation Commission and already resulted in the approval by the Permanent Commission of a number of EUROCONTROL Safety Regulation Requirements (ESARRs), associated advisory material and guidance for implementation.

European Notice of Proposed Rule Making (ENPRM): The introduction of a EUROCONTROL Notice of Proposed Rule Making process and associated advisory material has been agreed by the EUROCONTROL Permanent Commission subject to receiving a last confirmation from one member State (which until now has maintained its reservation).

The ENPRM process is seen as a major step forward in the enhancement of the existing EUROCONTROL regulatory process. Its application, including safety regulation and at first within the CNS/ATM area, , will allow the unambiguous identification of all mandatory requirements placed upon Air Navigation Services stakeholders. The clear knowledge of these requirements should create the conditions for a quicker and easier implementation of the major Programmes agreed at European level. It will also allow a clear distinction to be made between mandatory provisions and complementary and voluntary ones that support the implementation of rules. This distinction, as well as the commonality of rules at European level, will support the implementation of “One Sky for Europe”.

To reflect their **commitment to help safeguard the environment**, EUROCONTROL Member States unanimously approved the EUROCONTROL Environmental Policy and Strategy (April, 2001), which states that consideration of environmental implications will be an essential part of the entire ATM decision-making process. The recent European Commission (EC) Communication on Air Transport and the Environment defines clear actions for EUROCONTROL to enhance the environmental efficiency of ATM, including market-based measures.

A number of other **measures** proposed in the Strategy have also been **implemented**, in particular in the field of **safety management**, and **enlargement of the partnership** of the EUROCONTROL Organisation.

The EC High Level Group and the Single European Sky initiative have increased the political momentum for the resolution of ATM problems. These have focused particularly on the conditions to achieve a “seamless ATM system” across Europe, and highlighted four main orientations: effective regulation, constructive involvement of all stakeholders, coherent airspace design and institutional framework. This work was accompanied by the preparation of European regulations on the “provision of air navigation services in the Single European Sky”, “the organisation and use of the airspace in the Single European Sky”, and “the Interoperability of the European Air Traffic Management Network”, respectively. These have a strong impact on the Strategy as they will create new conditions and mechanisms to accelerate the pace and expand the scope of change.

The **Co-ordination of ATM R&D at European level** has been reinforced through several initiatives, which aim at better preparing the longer-term evolution of ATM and creating a partnership for research and innovation between all stakeholders. The Advisory Council for Aeronautics Research in Europe (ACARE) has been established to define a strategic research agenda. Based on the needs to be covered, ACARE will be a vehicle to guide the definition of the EC’s next framework programmes on research and technological development, as well as those of the EUROCONTROL Agency.

The tragic events of September 11th 2001 in the US have had a major impact on the aviation industry and led to a re-examination of the contribution that ATM can make to overall aviation security. As a consequence, the security and contingency aspects of the Strategy have been reinforced. In addition to the measures foreseen for the shorter term, the orientation of the target operational concept also contains a number of inherent elements than will help to enhance the ATM contribution to security (information management, consistent description of flight trajectories, or use of flight intent), which can be summarised under the general formula of “management by trajectory”.

The Director General EUROCONTROL has also launched a Safety Initiative aimed at reinforcing EUROCONTROL’s contribution to aviation safety improvement; and comprising notably the implementation of a formal Agency Safety Management System. In addition, following recent accidents, a High Level Safety Action Group (AGAS) has been created and will deliver recommendations to the PC in 2003.

The Protocol for the accession of the European Community to the EUROCONTROL Convention has been signed on 8 October 2002.

In addition, **feed back** received from users and readers of the first edition of the Strategy documents was taken into account and used to improve some of the descriptions. In particular, the roadmap of change through time should be easier to find and interpret, and there should now be no ambiguity on the primacy of safety in relation to the more advanced concepts proposed in the longer-term, particularly those involving the redistribution of tasks and responsibilities.

2. Challenges and Need for Change

2.1. Past and Current Problems

The ECAC En-route and Airport Strategies for the 1990s led to the introduction of the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP) and Airport/Air Traffic System Interface (APATSI). These, together with the implementation of the Central Flow Management Unit (CFMU), have helped to provide a steady improvement in ATM capacity and efficiency. In addition, following the completion of EATCHIP and APATSI in 1998, a number of measures were implemented by the ECAC States within the framework of the European ATM Programme (EATMP) or directly at national level, thereby allowing the enhancement of the European ATM system to continue. However, the capacity of the ATM system continues to lag behind the demand in a number of States, and the pressures on the ATM system are increasing.

The improvements realised thus far to the ATM network have been largely overtaken by the increase in the number of flights and, while there has been a fall in flight numbers following the terrorist attack in 2001,air traffic levels are expected to recover and then continue to rise again in the foreseeable future. The traffic increase and other factors imply that further substantial gains have to be found in safety levels in the whole of Europe, and in ATM capacity in much of the European airspace that already experience capacity shortfalls, or which is likely to do so in the future.

Whilst the delay issue has been widely discussed, it should be remembered that the primary purpose of ATM is safety, and it is for safety reasons that capacity is limited to prevent overloading of the ATM system. Any attempt to accommodate higher levels of traffic will have to be accompanied by even more stringent safety requirements. This, however, should not mask the need to identify safety issues in the current system, and to devise measures to remedy them. This task is made more difficult due to the current lack of, and difficulty in collecting, comprehensive and consistent safety data to identify safety issues. ATM improvement measures also have the potential to reduce the wider aviation risks.

Air traffic planning and management processes needs to be strengthened to ensure that the ATM system is able to provide timely responses to the expanding calls on its services. Also that these are based on sustainable investment plans and system upgrade paths. Additionally, air traffic processes have to become more efficient and dynamic if they are to meet the Airspace Users requirements for more cost-effective and flexible operations that are responsive to their business needs .

While the tragic events of 11 September 2001 have had a profound impact on passenger confidence and the aviation industry in general, the main effects are mostly likely to be concentrated in the shorter-term. The fall in air passenger numbers and slow down in traffic growth provides an opportunity for ATM to close the present gap between the capabilities and demands made on the ATM network, but does not obviate the need for the changes that are necessary to meet the challenges that ATM will face over the life time of the Strategy.

These changes require the progressive introduction of new operational and technical solutions based on an overall top-down and performance-driven system approach that will support sustained aviation growth and meet both the Airspace Users business needs and the travelling public's expectations for safe, reliable, punctual services that offer value for money.

These changes call for a European ATM strategy, based on a consensus within the aviation community on a common goal and evolution path.

2.1.1. Limitations of the Present System

The current ATM concepts and systems have a number of shortcomings. Particular limitations are:

- disparate services and procedures resulting from differing systems, and limited system-support for tools for the controller;
- a reliance on increasingly congested voice radio communications for air-ground exchanges;
- rigid airspace divisions and route structures which are often predicated on national needs, and which do not utilise the totality of European ATM resources to the best effect;
- a lack of collaborative planning and limited facilities for real-time information exchange between ATM, airport operating authorities and Airspace Users, as well as between civil and military, resulting in inflexible responses to real-time events and changes to users' operational requirements and less than optimum use of scarce airport air-side capacity;

- the inability to fully exploit the potential for efficiency and capacity gains offered by aircraft avionics capabilities;
- a severe shortage of controlling staff in a number of States stemming from national financial constraints and the absence of validated planning data at the European ATM network level;
- the long lead-times involved in developing and deploying improved systems in aircraft fleets or in the ground infrastructure which, in turn, result in complex transition planning and high costs. This is exacerbated by the delays encountered in many ATM projects.

One of the major operational problems is the current means of airspace sector operations and resultant Air Traffic Control (ATC) workload. An essential component of that workload is the volume of routine air-ground radio communications messages, which in peak traffic conditions can approach saturation point.

Traditionally, capacity gains have been obtained by dividing airspace into smaller and smaller control sectors to offset the increases in workload generated by additional flights, and this will remain the primary means to increase capacity in the shorter-term. However, this technique follows a law of diminishing returns, as it generates additional co-ordination workload and reduces the ability of sectors to handle traffic situations independently. It is reaching its useful limit in some of the busier airspace areas and other, additional, means have to be found to enhance capacity in the medium to longer-term. While advances in technology will provide a platform for future safety, capacity and efficiency gains and cost savings, they have to be accompanied by operational, organisational and institutional changes before these benefits can be realised. The best practical path is therefore to introduce new concepts and procedures, supported by technical improvements and improved management and regulatory processes to create a safer environment and thus provide the types and standards of ATM services that the Airspace Users require.

2.1.2. Performance Shortfalls and Delays

The most visible aspect and measure of the shortfall in ATM capabilities in relation to the demand for its services are the delays imposed on flights to ensure that the ATM system can continue to function safely.

The question of delays in air transport is a complex one. More than 70 causes have been identified, of which ATM is just one of a number (airlines, airport, meteorological conditions, etc.). Given that the demand for air travel will continue to grow, both the number of flights subject to ATM delay, and the total ATM delay experienced, will increase unless there is a corresponding expansion in the capacity of the present ATM network, including that of the airports and their surrounding airspace.

Nevertheless, aviation is a dynamic process and it is not possible to eliminate all causes of delay entirely. Neither would it be cost-effective to build an ATM network capable of handling abnormal or infrequent peaks in demand. While it is therefore natural to plan the ATM system so that it still generates a certain amount of delay, the long lead-times needed to implement improvements mean that increases in ATM capacity have to be planned to anticipate the growth in traffic if delays are to be contained at, or below, economically optimum levels.

ATM is in essence a network using a number of resources of limited capacity for which the Airspace Users compete. To accommodate increasing levels of traffic demand, it has to evolve to make better use of scarce resources, or to generate more resources, or increase its use of resources that are less subject to congestion. As a result, ATM performance, is very sensitive to whether or not the network functions close to, or at, its congestion ceiling. ATM delays tend to grow exponentially when the network is approaching saturation. The preparation of future plans, and the consideration of what would need to be changed or improved, has to take account of:

- the potential performance shortfall that would develop if the network was not, or was insufficiently, adapted to the growing traffic demand;
- analysis of the causes of these potential shortfalls and when and where they materialise to help eliminate them as far as possible.

Several specific analysis methods are available or are being developed, including simulations, macro-economic modelling and analytical work. The work conducted so far, although it has not yet addressed all of the issues because of the complexity of the problem, leads to a number of converging results that:

- confirm the exponential character of ATM delays when accommodating increasing traffic at constant capacity;

- show how all improvements, current and past, progressively increased capacity, but have left a chronic overall under-capacity;
- show that, in Europe, en-route ATM is currently the root cause of a majority of the ATM delays, but that delays at and around airports are already an increasing fraction, and would grow more rapidly becoming predominant once en-route problems were solved;
- indicate that the optimum functioning point of the network in terms of costs is achieved when the capacity offered is slightly higher than demand, and that costs increase more rapidly when capacity is insufficient rather than more than sufficient. In periods of increasing traffic, this leads to a definite advantage in allowing capacity to grow ahead of demand;
- show that the situation at the ATC centres is not uniform; some still have capacity margins, while severe potential shortfalls are predicted for others;
- indicate that the further use of the technique of splitting sectors to increase capacity (although still a key for the shorter term and a technique that will accompany other improvements) will not accommodate future traffic demand, and that significant changes in ATM concepts are required to enable phased sector productivity gains (i.e. number of flights that an en-route sector would be able to manage) have to be achieved by 2015.

2.2. Market Evolution

The aim of this section is to complement the descriptions in Chapter 3 of Volume 1. In general terms, ATM should, like the aircraft manufacturers, develop a strategic market outlook that addresses the evolution of the global aviation market together with the role of the various sectors of aviation, and provides data on aviation developments and the long term traffic forecast. Traditionally performed at European level within the scope of the STATFOR activities for traffic statistics and forecast aspects, the production of a more comprehensive planning outlook has recently been undertaken by the Agency. In the interim, the available material is being exploited as far as is possible.

The ECAC Constraints to Growth Study was mentioned briefly in Chapter 1, together with its main findings. The traffic projections undertaken in the study have also been used to derive the requirements that are presented in Chapter 3. The rest of this section therefore concentrates on the overall traffic demand forecast and on discussion of the scenarios that could affect that forecast.

2.2.1. Traffic Demand

The expansion of air transport has been accompanied in the last ten years by harmonisation and integration of ATM systems in Europe and, depending on the areas or time periods concerned, has allowed the European ATM network to absorb a yearly traffic increase of between 3% and 10%, while reducing or stabilising flight delays due to ATM. The world economic slow down in 2001/02 combined with the events of 11th September, broke that trend.

Nevertheless, available information indicates that, overall, this is a temporary setback, and that the traffic increase will be sustained in the longer-term. The current medium term forecast is that traffic will increase by around 30% between now and 20109. Extrapolation of this forecast indicates that traffic movements will nearly double by 2022 when compared with those for 2002. Although these increases may not necessarily occur uniformly across all States, they remain the best assumption for the longer-term despite the short-term uncertainty as to the exact moment and way in which the recovery will take place.

Despite the recent implementations of continuing improvements, and the measures already in hand to provide further enhancement, the current ATM systems and procedures have inherent constraints and will need to be changed to be able to cope with traffic increases of this magnitude.

2.2.2. Planning risks and uncertainties

Future planning is by its very nature an inexact science. Volume 1 describes the likely development of aviation in Europe in the next decades on which the basis of the Strategy has been built. However, it does not address the issues of uncertainty and risk that are inherent in such planning, and this short section discusses briefly the validity of the chosen scenario in relation to the more apparent risks that surround it.

The primary issue is what is the chance of the projected aviation scenario described in Volume 1 actually happening; what other scenarios could occur; and how would the envisaged ATM network be able to adapt to these other scenarios? Classical techniques for future planning usually define the two most extreme scenarios that lie at each end of the range of the identified possibilities, and then try to determine the most likely point between those extremes to situate likely future events based on observed trends and past experience.

In terms of the development of European aviation, the range of possibilities lies between severe economic recession leading to a reduction in passenger numbers and flights, and accelerating growth leading to greater mobility and rapid aviation expansion.

The scenario proposed in Volume 1 falls almost centrally between the two extremes. It expresses confidence in the sustainable development of air transport, and assumes realistic rather than over-optimistic economic growth rates in Europe over the lifetime of the Strategy. Additionally, both of the extreme scenarios point to the common requirement, included in the Strategy, to contain costs and provide services that are responsive to customer needs.

Recent analysis, by the PRC, of the economic optimum in the European ATM network also supports the Strategy scenario in terms of the need for the capacity of the ATM system to slightly exceed the projected air traffic demand. This analysis indicates that there is an economic advantage in operating with a small excess of capacity, rather than a shortfall. The PRC investigation shows that the time required to effect change in ATM is inherently longer than for the rest of the aviation industry, and that a surplus of capacity is necessary to prevent performance gaps when demand rises rapidly. The importance of this point has been underlined by the Airspace Users, who have stressed the need to maintain efforts to expand the capacity of the ATM network despite current economic difficulties, both to help contain the cost of flight delays, and to ensure that ATM can respond effectively when passenger number begin to rise again.

Although economies are subject to cycles, the scenario described in Volume 1 is generally consistent with current observed levels of economic activity and growth rates, and does not incorporate any greater degree of risk than any other possible scenarios. While the validity of the Strategy predictions will continue to be monitored against events, current indications are that the scenario described in Volume 1 should be retained as the central assumption for sizing the future ATM network.

In any case, the Strategy is not a blueprint on which stakeholders would be required to commit for the next 15 years, and it is its purpose to set a line and be a tool to monitor assumptions and, in the light of national programmes, to allow ATM to react and adapt.

Another important issue is the risks associated with the non-availability of technology, change in policy and/or regulation, and in the level of participation of stakeholders. These risks may affect the envisaged directions of change or timings. The technological risk is mitigated by both the R&D conducted in support of ATM and the fact that ATM is not using leading edge technology; nevertheless, special attention has to be paid to the ability of humans to use it in the safety critical environment. The policy/regulations change risk e.g. in the field of environmental protection, is likely to affect transport and in particular air transport rather than ATM only and would likely not create imbalance for ATM compared to the industry it serves. Finally, stakeholders participation is seen as a vital ingredient in achieving the changes that are needed. If it does not materialise, the resultant sub-optimal efficiency would penalise the overall transport sector and likely mobilise the political level to find regulatory solutions to solve the issue.

3. Strategic Objectives and Performance Requirements.

The strategic objectives that the future ATM network will have to meet are described in Volume 1. This chapter presents them in more detail and, for some of them, introduces additional objectives to facilitate their understanding and scope, and provide more specific strategic initiatives to be pursued for the achievement of the objectives. The objectives will need to be accompanied by more specific indicators and targets that can be associated with aspects of the services to be delivered and that can be measured and monitored.

These descriptions are aimed at supporting and not at replacing the specific targets proposed by the Safety Regulation Commission (SRC) and the PRC, as approved by the EUROCONTROL Council and General Assembly.

As stated in Volume 1, traffic levels in the ECAC area vary, and not all airspace areas have the same needs or performance requirements. The strategic performance requirements are also outlined in this chapter principally through the requirements for the most challenging environments (MCEs). These requirements are a first quantification of the strategic objectives for safety, capacity and economics objectives and have provided the means for producing and assessing the proposed roadmap of change.

3.1. Strategic performance requirements / Most challenging environments

Three performance objectives have been considered so far in terms of defining quantified performance requirements: safety, capacity and economics. The other Strategy objectives will be addressed more comprehensively at a later stage .Nevertheless, a first qualitative judgement of these objectives has been incorporated in the roadmap described in Chapter 8.

The primary objective of ATM is to provide safety, and in the context of increased traffic levels. It is emphasised that **the individual operational changes will need to first create safer new conditions for other benefits to then materialise**. However, the level of safety is discussed in relation to the volume of traffic demand that has to be accommodated when the operational change is able to be fully exploited.

The need for change will be generated in the first instance by the MCEs. These environments illustrate the typical operating conditions that are likely to be the first locations where finding additional performance will require the deployment of new ATM techniques. They are situated almost exclusively in the core area of Europe adjacent to the main industrial and commercial centres served by major international airports, where many of the main traffic flows converge and there is a high incidence of climbing and descending traffic.

However, while such areas may need tailored solutions, the notion of a gate-to-gate interoperable network still needs to be retained, and consideration of the MCEs should not be confused with the planning needed for the facilities that serve the corresponding airspace.

In a similar way, consideration of the MCEs does not preclude the requirement for new or possibly alternative solutions for those areas that have lower traffic densities and complexities. This is particularly relevant where new techniques could provide cost-effective performance enhancement without such areas having to adopt the same successive ATM change steps that the MCEs would have already applied.

A selection of MCEs has been made in each of the main operational segments (en-route, terminal airspace and aerodrome), based on anticipated busy-hour IFR traffic. In order to allow for a plausible link with the operational improvements, in particular those related to airspace organisation and traffic handling within sectors, the MCEs have been adjusted to the current boundaries of existing ACCs, TMAs and Airports.

3.2. Safety

3.2.1. General Objective

To improve safety levels by ensuring that the numbers of ATM-induced[1] accidents and serious or risk bearing incidents do not increase and, where possible, decrease.

[1] "ATM induced" includes those with direct and indirect ATM contribution.

Safety is of the highest priority in aviation. The main purpose of ATM services is to ensure the safe separation of aircraft, both in the air and on the ground, while maintaining the most efficient operational and economic conditions.

The safe separation of aircraft is fundamental to ATM and public confidence in aviation. Empirical evidence shows that the aviation industry has maintained a good safety record in the past, and that commercial air transport is one of the safest means of public travel.

European ATM must maintain high levels of safety in the face of increasing demand. This will require improvements in safety management methods.

To achieve this, safety must be pro-actively managed and form an integral part of both planning and tactical operations. Improvements will be needed at the strategic level as well as the operational level, and these will have to be underpinned by clear and unambiguous procedures backed by training for all those involved. Safety management and monitoring processes will need to be strengthened, and applied consistently throughout the ATM network.

3.2.2. Strategic Safety Requirements

The safety requirements are based on:

- the Strategic Safety Objective, as described in Volume 1;
- a policy[2] from the SRC, the current version of which develops the accident target of the Strategic Safety Objective into quantitative safety minima, together with the associated rationale.

It should be noted that the SRC policy does not yet include quantified targets for ATM induced incidents[3]. The targets will be developed at appropriate juncture, when the level of reporting of ATM incidents in ECAC will have been considered as being stable and reliable enough to allow trends in incidents to be meaningful.

Once fully developed, those Safety Minima for ATM in the ECAC region are intended to be used:

- as a baseline which takes into account the actual traffic levels and trends, and against which the achieved ATM safety levels in ECAC can be monitored, thus identifying the need to initiate research to develop safety improvement measures in aviation (refer to following diagram);
- as an historical baseline providing justifications for the quantified elements contained in ESARR 4 “Risk Assessment and Mitigation in ATM”, i.e., to be used as an order of magnitude of ATM safety against which the design of proposed changes to the ATM system ought to be assessed4.

The strategic safety requirement for the Strategy uses the so-called monitoring safety requirement with a progressive reduction of the tolerable probability to take into account traffic variations over the years, and is depicted in the following diagram:

[2] Refer to SRC POLICY DOC 1, Ed. 1.0
[3] This is mainly due to the lack of reliable historical baseline on which to base expert judgement.
[4] ESARR 4 refers to 1,55 10^{-8} per flight hour (“maximum tolerable probability of ATM directly contributing to an accident of a Commercial Air Transport aircraft”) as being the order of magnitude of ATM safety against which the design of proposed changes to the ATM system ought to be assessed. This figure has been defined to maintain the absolute number of accidents induced by ATM at or below the identified historical level. It corresponds to the probability of accidents with ATM direct contribution at a volume of traffic forecast for 2015.

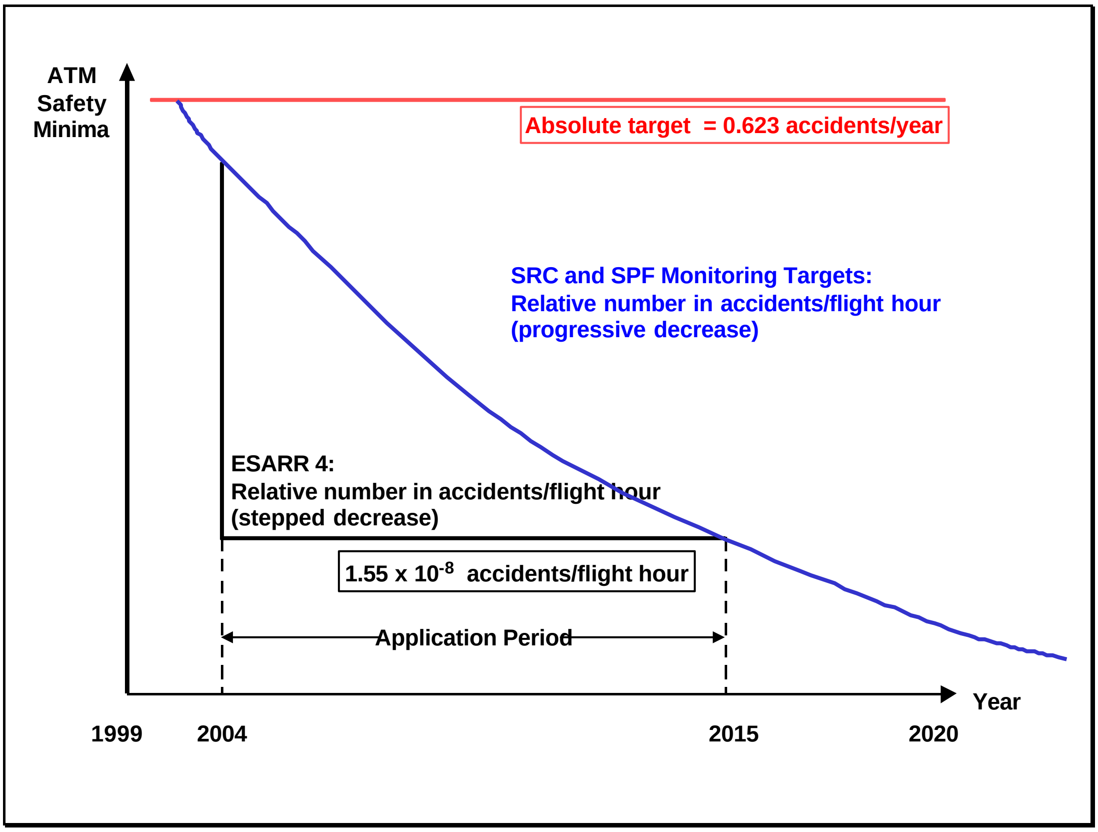


Figure 1: Safety requirement over time

A tool to assess safety in a prospective way is being considered as part of the SPF.

3.2.3. Enhancing the Safety Management Methods

To ensure safety objectives can be achieved in the most efficient and economic way with minimum adverse effect on operational conditions.

Achieving an increase in the level of safety will present a major challenge for ATM. Assuming that other conditions remain unchanged, the probability of aircraft colliding rises proportionally faster than the increase in the number of flights. This is particularly true at airports and in terminal control area airspace where the traffic is more concentrated. The introduction of more automated functions and integrated networks will place greater emphasis on the safety criticality of their software, Human Machine Interface (HMI) and procedures.

Safety objectives must be realistic and take account of the operational requirement. For the purposes of prioritisation and cost-effective application, the methods by which they are achieved must be subject to cost-benefit analyses.

Seamless safety regulatory and safety management processes should be implemented across the ATM and airport communities.

3.2.4. Participating in Global Safety Objectives

To introduce safety tools which encompass all phases of flight from gate-to-gate in line with ICAO policy.

ATM must benefit the framework of global air traffic operations and contribute to the reduction of air transport hazards in line with the ICAO Safety Initiative. Where they provide significant safety benefits, improvements must include measures that address not only collision prevention, but also other significant aviation hazards, such as controlled flight into terrain (CFIT).

While operational and economic factors are often the main drivers behind the introduction of new ATM systems, some procedures and equipment can also make a major contribution to improving safety. Assessment of safety benefits should, therefore, form an integral part of any implementation decision-making process.

3.2.5. Improving the Assessment of the Actual Safety Levels Within Europe

To introduce harmonised ATM safety policy, performance assessment and evaluation methodologies within the ECAC States.

The SRC through the application of ESARR 2 collects on an annual basis national statistics about ATM induced incidents, ATM incidents and other precursors to accidents. Those national statistics are analysed and aggregated in ECAC wide safety indicators which are the reported together with conclusions and recommendations to he PC. The current lack of reliable and consistent data across ECAC makes it difficult to achieve a consistent assessment or establish common policy.

There is a need to define common safety indicators for use by all States. Safety data should be recorded, processed and analysed centrally within the EUROCONTROL Organisation, taking into account the experience of existing national confidential incident reporting schemes to make a harmonised safety culture, with a non-punitive confidential analysis of safety related incidents.

3.2.6. Harmonising Safety Regulations

To ensure the clear and separate definition of the respective functions of air traffic service provision and safety regulation by each State at National level;

and

To harmonise the air traffic service regulatory regime at European level within the total aviation system approach to air safety required by the ECAC Institutional Strategy for ATM.

Achieving a harmonised level of safety on the basis of common analysis criteria requires that ATM safety in Europe be regulated and managed in a consistent way, with clearly defined and separate functions responsible at national level for safety regulation and service provision, including safety management. There is also a need to adopt an approach that is in line with ICAO global safety policies. The growing inter-dependency of air and ground systems make it essential that States adopt an approach to safety which is more closely co-ordinated between air and ground than has previously been necessary.

Harmonised safety regulations are a pre-requisite for the introduction of new systems such as satellite applications. The trend towards commercial operation of air traffic services in several States also demands an approach that separates safety regulation from other ATM functions, especially service provision. Both these factors were taken into account and have resulted in the creation of institutional arrangements designed to cater for such developments in the future.

3.2.7. Safety at airports

To introduce procedures and tools to reduce runway incursions and other safety occurrences at airports involving aircraft and/or vehicles and objects, and the use of the airport surface, in particular runways.

A particular effort is required at airports where the incidents and accidents are increasing, in particular those due to runway incursions. Action is needed to address the following aspects: reduction of the rate and severity of runway incursions; enhancement of the error tolerance of the aviation operations; refinement of the runway safety benchmarks and metrics; and, promotion of best practices.

Seamless safety regulatory and safety management processes should be implemented across the ATM and airport communities.

Ways should also be found to guarantee safety when more environmentally friendly procedures are used without reducing support to navigation and surveillance of traffic. Additional considerations will be needed to comply with the Certification of Aerodromes as in ICAO Annex 14, and to address the airport safety management issues across the airside/landside interface.

3.2.8. Contingency Planning

To ensure safety, security and a continuous operation, the European ATM network must be able to deal with different contingencies at all levels of operation.

The objective of contingency planning is to prepare for uninterrupted operations at all times regardless of technical or catastrophic failures, as well as temporary unavailability of resources, unsafe flight environment or unlawful acts, be it a breakdown of a radio frequency at a small airport or a major international crisis. This will be achieved by developing contingency plans at all levels and co-ordinating the plans. At times of contingency, the nominal performance may not be achievable in parts of the airspace; the plans will privilege the establishment of a safe traffic situation and consider the cost-effectiveness of the contingency measures.

3.3. ATM Security

3.3.1. General Objective

To determine effective mechanisms and procedures to enhance the response of ATM to security threats and events affecting flights (aircraft and passengers) or the ATM system.

The growing threat to the aviation industry from terrorist acts means that the security of passengers, aircraft and even ATM facilities is assuming greater importance. While the levels of threat are not related to traffic volumes, preventive and recovery measures become more complex when traffic density and complexity are increased.

Security threats (intentional acts affecting aircraft or people) may be directed at aircraft or through them to targets on the ground. The ATM facilities and systems may also become threat targets. Although ATM cannot by itself address all issues, it nevertheless has to provide responsible authorities with the requested help in all phases of the security occurrence in accordance with national, ICAO and other relevant international rules. The international dimension imposes the uniform and effective application of suitable measures.

The ATM system shall take the necessary protective measures in order to minimise the effectiveness of acts against ATM facilities, systems and data and the undue dissemination of data. For example, the identification of aircraft and the diversion of other flights away from particular aircraft or airspace. It will also need to ensure the security of air traffic information and data systems from outside interference. In this respect, it will be essential to guard against so-called cybercrime. Particular attention will need to be paid to the preparation of contingence plans designed to handle degradations of the ATM system and security-related emergency situations.

In close consultation with, among others, Member States, ICAO, ECAC and the European Commission, EUROCONTROL has identified four strategic initiatives, namely:

- Establish processes to optimise the sharing of Civil Air Traffic Control (ATC) and Military (ATC/Air Defence) surveillance information;
- Create a European Regional Focal Point for Air Traffic Management information, involving civil and military interests.
- Give priority to the validation of a high capacity air-ground communications capability for the transmission of encrypted cockpit voice, flight data and on-board video information.
- Ensure that both civil and military ATC procedures and training, relating to hijack and other emergency situations, are reviewed and harmonised.

Particular attention will need to be paid to the preparation of contingency plans designed to handle degradations of the ATM system and security-related emergency situations.

Specific additional measures include the maintenance of efficient communications between the aircraft and the ground, the provision of information on the traffic situation to the authorities in charge of security and the development of suitable contingency plans.

3.4. Cost-Effectiveness

3.4.1. General Objective

To reduce the direct and indirect ATM-related costs per unit of aircraft operations

Cost-effectiveness encompasses aircraft operation and service provision, where service provision covers all gate-to-gate air navigation services. It should be considered in each of the ATM decision-making processes covering the development, implementation, operational and service invoicing stages, to ensure choices and prioritisation of allocation and best usage of capital and resources.

Costs are of major importance, and cost reduction and value-for-money must be essential elements in the provision of ATM, while still ensuring that levels of safety are maintained. When costs are considered, all component costs should be included. From a service provider perspective, the unit cost is the operations' cost base divided by traffic units serviced by the operations. Only direct costs of operation are included in the cost base. However, to this must be added the indirect costs, which include the cost of delays due to ATM and flight inefficiency. In future, other indirect costs, e.g. environmental costs, may also have to be considered.

The reduction of ATM-related costs, which represent a significant component of aircraft operators operating costs, coupled with the provision of extra capacity, is a key factor to air traffic growth. The expected growth also depends on the ability of aircraft operators to reduce their costs, allowing competitive fares and thus attracting new demand.

There are two approaches for supporting the primary economic objective of reducing the ATM-related costs per unit of aircraft operation. There are also some additional policies that support direct control of costs and improved efficiency of current operations.

3.4.2. Strategic Economic Requirements

The economic requirements are based on the strategic economics objective, as described in Volume 1.

The overall target is that of a **decrease in the total unit cost** for Airspace Users. Combining the expected traffic forecast and the current volume of route charges, a "virtual budget upper band" is created, that should not be exceeded by the total ECAC-wide ATM related investments and operating costs required to meet the capacity and safety needs. This virtual budget upper band has been used as the economic requirement. In reality, the balance is more likely to be positive, since operational effects such as increased flight efficiency and reduced delay have not been taken into account.

Using the overall economic objective of the Strategy, an estimate of what categories of users could afford the changes in the period can be derived and compared to potential costs and benefits.

3.5. Capacity

The en-route ATM issues represent a challenge that should not be underestimated. Unless a new concept for ATM operations is introduced, supported by the full exploitation of existing and emerging technologies, it will not be possible to accommodate the current forecast en-route traffic growth. The new concept will allow ATM to make more efficient and flexible use of finite airspace and human resources, and produce the additional capacity needed to cope with en-route air traffic demand under normal conditions.

The situation is different at airports. Airport congestion is already a growing problem. While there are over 800 airports in the ECAC region, 15% of these account for 85% of all commercial traffic. Many of themajor airports are already operating at their maximum throughput for longer and longer periods of the day, and some have already reached their operating limits as determined by the political and environmental constraints in force.

The forecast increase in air traffic demand will exacerbate the problem, and future traffic distribution patterns are likely to spread congestion to other airports that currently do not experience capacity problems at the moment. The ECAC Constraint to Growth Study has already identified that un-accommodated demand has been increasing over the past years.

European and national inter-modal transport policies may influence airport usage patterns, but their impact on the traffic growth rate depends on a variety of issues, such as the completion of trans-European transport networks and environmental parameters and policies. For example, the goal of ECAC Member States is to reduce the overall number of people affected by aircraft noise by 2002, following the completion of the ICAO, Annex 16 Chapter 2 aircraft phase-out arrangement, and thereafter to stabilise it or preferable reduce it further (ECAC Environmental Policy, 1996).

New technology, concepts, procedures and systems should be used wherever possible to provide additional air-side capacity and lessen the environmental impact of aviation at airports. However, complementary actions such as airlines diversifying their use of airports, or the building of new airports or runways, will inevitably be required in some parts of Europe if airport capacity is to match the expected passenger demand and resulting aircraft operators schedules. There also have to be parallel improvements in the landside infrastructures (terminals, etc) and services (passenger and baggage handling, etc) if airside capacity gains are to be fully realised.

The current observed trend towards private ownership of airports is expected to continue, and to result in a greater emphasis being placed on the commercial aspects of airport operations.

3.5.1. General Objective

To provide sufficient capacity to accommodate the demand of all users in an effective and efficient manner at all times, and during typical busy hour periods without imposing significant operational, economic or environmental penalties under normal circumstances.

Capacity is a complex mix of access to airports, airspace and services; predictability of schedules, flexibility of operations, flight efficiency, delay, and network effects. ATM and airspace capacity-related aspects also include controller workload; weather conditions; availability of communications, navigation and surveillance systems, and other factors (e.g. radio frequency spectrum). The most visible symptom of capacity shortfall is the level of delays.

At present capacity in Europe is provided on an individual basis by airports and Air Navigation Service providers, based on capacity planning profiles co-ordinated at network level. The objective set by the PC for 2006 is an average delay of one minute per flight.

3.5.2. Strategic Capacity Requirements

The capacity requirements are based on:

- the Strategic Capacity Objective, as described in volume 1;
- traffic data derived from 1 year of CFMU data year 2000and the STATFOR high growth rate 3.7% average per year. Even under the current market situation, an annual average growth rate over 20 years of 3% to 4% is felt to be justified.

Capacity requirements have been analysed by considering those parts of ECAC airspace which have today or will have the highest traffic densities in the future. These are situated exclusively in the core area. Care was also taken to select a representative sample of airspace to include a variety of traffic pattern and operating environments.

In order to anchor the analysis on tangible examples, a number of the existing ACC and TMA boundaries, and existing airports were retained, and no assumption were made regarding possible future changes to the current areas of unit responsibility.

Traffic forecast for these MCEs reflect the latest available information and include the assumptions and analysis made in the ECAC Constraint to Growth study. It is particularly noticeable, that although an overall doubling of traffic is forecast over the next two decades, the traffic increase in the MCEs will be significantly lower than in other areas, particularly at the airports.

The strategic objective refers to satisfying the demand of typical busy hour periods. After an analysis of the shape of the hourly distributions of the demand over individual sectors and aerodromes, the assumption has been made to retain the level of traffic at or above 98% of the operating hours of the units considered. This is equivalent to an average over the year of less than 30 minutes per day where the demand would be greater than the declared capacity. This approach models the medium-term PC target of one minute average delay per flight. In addition to hourly demand data, information on the time and vertical distribution of traffic, the type of movements and traffic (arrivals, departures, transit, flight duration, weight, and engine class) and the sector information was also considered.

The results of the analysis identified that the capacity of the ACCs in the busiest MCEs would need to increase between 80% and 100% during the period out to 2020 Also, in a number of instances, increases of between 25% and 50% are needed by 2007 to meet the forecast demand. Similar increases also apply to the busiest TMAs in the core area, where the additional capacity required ranges from 35% to around 90% by 2020, with an average increase of about 40% being needed by 2007.

3.5.3. Airport Capacity

To enable airports to make the best use of potential capacity, as determined by the infrastructure in place (land-side and air-side), political/environmental restrictions, and the economical use of resources.

Airport capacity is the product of a number of strategic and tactical processes. These include:

- capacity planning, harmonisation of operating practices, and infrastructure balance to meet the demand for both passenger and flight movements as long-term issues;

- airport capacity targets, implementation of operational systems and 'best practice' as line management issues.

Good practice for maximising airside airport capacity must be used systematically across Europe.

Airport airside capacity indicators must be used more uniformly than at present. Regular comparisons must be made between the traffic demand, declared capacity and the unconstrained airside capacity.

New tools providing decision-making support to all parties in the slot planning process must be developed.

Systems and procedures for improving runway capacity management, in the context of the constraints imposed by the en-route, TMA, ground movement and gate environments are required.

All-weather capacity requires particular attention and the application of new measures, concepts and procedures that make best use of emerging technologies.

There is a need for work to be done on assessing the impact of landside considerations in relation to ATM as applied at airports. Interfaces will have to be defined and the impact of CDM/Gate to Gate will have to be investigated.

3.5.4. Access

To enable all users a fair access to airspace, airports and required ATM services.

Access to airspace, airports and ATM services is the first condition to realise a flight. Access to the whole of the airspace under jurisdiction of a State is of vital interest for military or national security missions.

Access can be measured by reference to un-accommodated demand and access denials. The first is not directly accessible to ATM services since it is often, de facto, hidden in airport slot allocation mechanisms and flight scheduling. The second relates to flight cancellations, but also to restrictions on access to some portions of the airspace and airports by certain categories of users, permanently or at specified times. This may also be tied to the carriage of minimum airborne equipment.

Conversely, undue access may be a safety issue, and users should adhere to the rules.

Airport access conditions will remain a local issue.

3.5.5. Delay

To increase overall ATM network capacity in line with traffic demand, to ensure that ATM-induced delays are not a significant constraint, and that the percentage of traffic delayed by ATM is less than today.

Delay is the most visible symptom of capacity shortfall. Good performance indicators are provided by the CFMU. For ATM-related delay, the two indicators useful to Airspace Users are the average delay per flight and the percentage of delayed flights. The average delay per delayed flight is a parameter to monitor the overall ATM network.

In addition to the ATFM indicators supplied by the CFMU, the Central Office for Delay Analysis (CODA) has defined indicators covering the different sources of delays, to give a European view of all the components of the air transport delays.

3.5.6. Predictability

To improve the predictability of flight operations by reducing ATM-related variations in gate-to-gate transit times.

Predictability is essential to build and maintain flight schedules. An ATM capacity shortfall has two effects: systematic delays extend artificially the flight duration and require additional aircraft for the same programme; while variance on the day disrupts schedules. The airlines incorporate "padding" for systematic delays in their flight schedules to minimise the effects of the variance on the day. Hub operations are particularly sensitive to predictability problems.

Predictability can be measured in terms of variance/slippage from expected schedule times due to operational, weather, ATM, etc. Indicators are available from airlines; the variance factor is measurable using delay distribution data.

3.5.7. Flexibility

To increase the responsiveness of ATM services to real-time changes in airspace users´ needs.

Flexibility is the ability of ATM to accommodate changing user needs in real time (e.g. leave late, change aircraft, substitute slots). It often equates to operational freedom, and is a means for applying short-term action to keep flight schedules predictable, whereas predictability is seen as covering longer-term flight scheduling requirements (e.g. crew/resource rostering).

Collaborative decision-making between ATM and Airspace Users is a potential key to optimal fleet control.

Lack of flexibility translates into a "substitution penalty", measurable via delay data, and the number of denials.

3.5.8. Flight Efficiency

To enable all airspace users to operate as efficiently as possible while accommodating both civil and military operators' needs.

Flight efficiency can be measured as a factor of deviations from the preferred 4D-flight trajectory. For OAT, this consideration is enlarged to encompass the notion of mission effectiveness.

Optimisation can relate to sets of flights and individual flight optimum is not the top priority for Airspace Users, except for flights that are performed close to the aircraft's operating range or payload.

3.6. National Security and Defence Requirements

To improve the effectiveness of existing, and determine new, mechanisms, criteria and structures to enhance civil-military co-operation and co-ordination.

To ensure access to, and availability of, airspace for military purposes through the implementation of special procedures where necessary.

As a principle, every State has complete and exclusive sovereignty above its territory in accordance with international conventions. In order to safeguard sovereignty, States maintain and develop their individual and collective capacity to resist armed attack.

National security encompasses the maintenance of internal order, measures necessary for the promotion of National interests and, where necessary, deterring or defending against external aggression. Defence, on the other hand, can be defined as the military contribution to National security, including activities in support of international law and treaties and alliances with other States.

States will continue to attach importance to the need for their National security and defence requirements to be safeguarded and improved, whatever the planned developments in ATM. In addition, States may join together and operate to international defence agreements and procedures.

ATM has to support National security in respect of the identification of flights entering a State's National territory; the implementation of air safety measures at all times and under all circumstances in the airspace above a State's National territory and the ability, in times of crisis, for military authorities to resume responsibility for ATM. In addition, ATM also has to support day-to-day military operations, the services for a number of which do not differ significantly from those provided to other Airspace Users, through the provision of and access to airspace for the military that is sufficient for their needs. It will sometimes be necessary to find compromises to satisfy as far as possible the interests of both civil and military users.

The exchange of both strategic and real-time information between civil and military ANS providers is essential for civil-military co-ordination, and can only be achieved if civil and military systems are compatible or inter-operable.

The institutional arrangements contained in the ECAC ATM Institutional Strategy stress the need to strengthen civil-military co-operation. The resultant EUROCONTROL revised Convention provides for a number of instruments to achieve this.

The military require sufficiently large areas in which their units can train and make efficient use of their modern weapons systems. Dynamic airspace management using suitable tools must be put in place for the benefit of all civil and military users and simulations are required to validate their efficiency. The concept of the flexible management of airspace is one such tool, which must be progressively improved as new technology becomes available.

The utilisation of ATM information will be one of the keys to success, and the various objectives can only be achieved by organising the management of the available information within the framework of the defined procedures. In their triple capacity as ATS providers, Airspace Users and administrators, as well as the body responsible for the security of their National territory, the military must have access to any information they might require. Certain protected data will nevertheless need to remain confidential. Such inter-operability has been only partially achieved within each State or between States thus far.

ATM information could be used, in some circumstances, against own Military Forces; therefore provisions to prevent the wrong dissemination of ATM data shall be taken.

Improvements to civil-military co-ordination have the potential to provide a number of benefits:

- an improved and faster decision-making process in areas involving national and international civil-military interests;
- improved abilities to meet the legitimate requirements of both civil and military service providers;
- compatibility of future civil and military programmes through agreed standards and protocols.

  New mechanisms, criteria and structures should be devised.

- Particular measures to achieve this objective are to:
- Allow States which so request under predetermined conditions to temporarily resume responsibility for all or part of the provision of ATM services in the airspace under its jurisdiction;
- Reliably provide all necessary data for both Air Defence and Operational Air Traffic needs;
- Provide sufficient airspace for day-to-day military operations;
- Enhance and fully apply the Flexible Use of Airspace (FUA) concept:
- Maintain or improve the services provided to the Ministries of Defence and North Atlantic Treaty Organisation (NATO) and other relevant international organisations;
- Provide capacity to handle crisis situations (contingency plans);
- Ensure inter-operable civil and military systems.

3.7. Environment

To work with ICAO and its member States to obtain improvements in ATM, in particular the accelerated implementation of those CNS/ATM concepts, procedures and systems that help to mitigate the impact of aviation on the environment.

Environmental considerations are another area where deciding how and when change should be applied will become increasingly important. The aviation industry has consistently tried to lessen the impact of its operations on the environment, particularly by reducing noise and some gaseous emissions. This momentum needs to be maintained and accelerated, so that future growth in aviation remains acceptable to the citizens of Europe. Improvements in ATM can make a significant contribution through the application of common ATM solutions that deliver reduced delays, shorter and more fuel-efficient routes, more optimum flight profiles and, where possible, a reduction in the noise impact around airports.

As aviation in Europe is expected to continue to grow, the pressure upon airlines, airports and ATM to increase capacity will intensify the potential environmental impact of aviation operations and lead to some forms of operational concept becoming more acceptable than others. There will, therefore, be a need for measures to manage and mitigate the environmental impact at global, regional and local levels.

At the global and regional levels there will be a need to reduce gaseous emissions according to international agreements, European (EU) and national legislation. At the local level, both the air pollution and noise impact will have to be kept at negotiated limits, thus constraining the potential airside capacity of key airports even further than at present.

The environmental effects of aviation are an increasingly important political, economic and social issue and for that reason the Strategy is aiming at the following with no degradation of safety:

- accommodating environmental considerations in an integrated and expanded European ATM network :

- identifying and tackling environmental problems posed by traffic growth, and
- progressively improving environmental performance on a network-wide basis.

To promote the use of new ATM technologies, systems and procedures which benefit the environment or mitigate impact at global, regional and local levels.

To accelerate the implementation of systems improvements that lessen aviation's environmental impact.

To ensure that development and implementation of the Strategy reflects ICAO environmental policies.

It is important to promote the use of new ATM concepts, procedures, systems and best practices that bring environmental benefits. This may require improvements to existing environmental assessment methodologies and inventories. Operational measures taken to increase capacity will help to reduce delays and fuel consumption, thereby reducing emissions and noise.

There is broad consensus that there are fuel savings and other positive benefits (such as improved safety, reliability and efficiency) associated with ATM and CNS improvement. ICAO resolutions A32-8 and A33-7 directs the ICAO Council through ICAO Committee on Aviation Environmental Protection (CAEP) to study policy options to limit or reduce the greenhouse gases from civil aviation, taking into account the Kyoto Protocol and the findings of the IPCC Special Report. Work of CAEP WG/4 Emissions and Operational Issues resulted in the development of a methodology and tool to initiate global analysis of the environmental benefits arising from the implementation of planned ATM/CNS systems. This WG/4 study was a co-operative effort of both the FAA and EUROCONTROL. The study showed that ATM/CNS systems, when implemented in the North American and European regions could provide a reduction of approximately 5% in fuel burn by 2015. This number represents a reduction in total fuel usage even with forecast growth.

Furthermore, ATM has a key role to play in reducing the ATM-related noise impact. Effective ATM should contribute to achieving the overall noise objectives set for aviation and aiming to reduce noise. This has to be achieved in close co-ordination with ICAO, ECAC, EU and other relevant stakeholders.

Local noise and emission pollution at airports is a highly political issue and will be subject to the principle of subsidiarity.

3.8. Uniformity

To ensure that ATM operations are compliant with ICAO CNS/ATM plans and global interoperability requirements, provide a seamless service to the user at all times, and operate on the basis of uniformity throughout Europe.

Uniformity embodies both the applications of common ATM rules and procedures across all European airspace, and the use of interoperable, common core technical functionality in the systems used. It is not an all-embracing requirement for identical equipment or systems, and related implementation actions remain subject to meeting applicable safety levels.

Agreed required minimum levels of aircraft equipment, performance and ATM network capabilities will be matched by defined levels of service.

Common rules are an essential feature in meeting the aim of efficient airspace use and managing airspace as a continuum for ATM purposes. There is also a need for uniformity of procedures within ECAC as the basis for, and a means of meeting, service objectives.

Likewise, uniformity of equipage and procedures in Europe cannot be viewed independently from those in the rest of the world. There is also a requirement to harmonise and ensure uniformity in homogeneous regions with similar functionality requirements, and to ensure a smooth transition of flights at ECAC borders. This calls for inter-operable systems and common standards, and for these to be applied extensively to core functions such as flight and radar data processing and communications. Measures of the degree of convergence to be applied have to be developed.

An agreed minimum level of aircraft equipment will be required to enable a satisfactory service to be delivered.

3.8.1. Ensure the Availability of Common Standards

To provide timely standards, specifications and procedures for ATM, CNS and associated avionics requirements.

The achievement of the general objective of uniformity needs to be supported by the timely availability of a number of standards beyond the Standards And Recommended Practices (SARPs) set by ICAO. The scope and management of these standards must be tailored to the service requirements, and to the capability of the market to organise itself to elaborate and implement them. Common core equipment functionality based on agreed specifications will help ensure interoperability of systems and provide safety and cost advantages. These need to be supported by agreed procedures.

3.8.2. Ensure Cost Effective System Inter-Operability and Evolution

To enable inter-operability between the different elements (aircraft, airport and ATM systems) together with their seamless integration, development and upgrading to new technology.

New ATM concepts will require greater inter-operability between the systems of aircraft, Airspace Users, Airport Operators and ANS providers both on the ground and in the air. These systems will evolve at different rates and be replaced or upgraded at different times, but will need to progressively support increasing traffic levels. For a system of a typical life cycle of 15 years, this means being able to support a doubling of traffic through the smooth evolution of its capabilities.

A key requirement is to specify interface requirement changes well in advance to prevent individual projects being delayed by or being dependent upon these changes. (Interface requirements apply at both the system module level and between national ATM systems.) The specifications must reflect that each service provider will also have systems in place that may continue in service and operate alongside the new systems for many years, and must therefore cater for the transition periods.

3.9. Quality

To develop a common framework that leads to Continuous Improvement by means of a structured approach to Excellence.

To foster, promote and enhance the use of recognised quality management standards, systems and continuous improvement methodologies in the provision of gate-to-gate ATM services, products and processes.

To promote exchange of views and information which will lead to transfer of Best Practice.

ANSP organisations have many different issues to deal with when addressing the key Management Responsibilities of Safety, Capacity, Cost, Environment and Security etc. In a world of constant change and development like ATM, this situation calls for ANSPs to set up approaches to Quality Management and Excellence with systematic Continuous Improvement processes to ensure that stakeholder requirements are met.

To do all of this successfully requires a common structured approach and framework, so that all aspects of Management Responsibility are addressed, reviewed and **continuously improved**. In addition, it will be appropriate to be able to benchmark activities with external comparable organisations.

The need to drive towards customer satisfaction is a key challenge.

The Single European Sky initiative of the European Commission will require harmonised certification/authorisation conditions for ANSPs e.g. Regulators' assessment of Quality Management performance.

To deliver on all of these requirements demands that an holistic approach is taken, to address all aspects of Management and ensure that Continuous Improvement is also practised. This approach is provided by the use of the European Foundation for Quality Management (EFQM) Excellence Model or ISO 9004:2000 (Guidelines for Performance Improvements) which also provide a common framework for measuring achievements.

In addition, the use of the EFQM Excellence Model (or ISO 9004:2000) helps to support continuous learning and improvement of the Safety Objective of this Strategy.

To be able to move forward and deliver on all of these requirements, it is necessary to develop and implement a comprehensive EUROCONTROL Excellence Policy and Strategy.

3.10. Human Involvement and Commitment

To ensure human involvement and commitment in making possible the changes in future ATM, so that operational, technical and support staff can operate effectively, efficiently and safely within their capabilities, and obtain challenge and job satisfaction.

ATM systems are expected to remain human-centred in the foreseeable future, and people will play a key role in achieving system safety and capacity enhancements. People are an essential element in the ability to deliver ATM services, and their co-operation and involvement in developing and effecting change is essential. Of course it should not be forgotten that the flight deck will become more and more integrated into the ATM environment. Increased use of data link and delegation of responsibility, to name but two factors, will have an impact on working methods, and possibly workload.

There is a need for the timely availability of suitable numbers of people with the right skills, knowledge, attitude and motivation, to assure the expected ATM performance, and who are committed to delivering the best possible services.

This requires, firstly, suitable and efficient strategies, policies, methodologies, and integrated procedures, together with the requisite tools, for manpower planning, personnel budgeting and recruitment, the selection and training and, if necessary, the licensing of all of the types of staff involved in ATM. Secondly, it requires the extensive and intensive use of human factors principles throughout the whole life cycle of ATM systems. Finally, it involves the enhancement of human capabilities in terms of flexibility, motivation, and commitment through the application of suitable human resource management to ensure that careers in ATM are sufficiently rewarding to attract and retain high-quality staff.

At the same time, human resource measures must be aligned with the strategic principles and other major objectives; this requires the means to measure and monitor parameters such as productivity, cost-effectiveness and efficiency.

The concept of Human Resources is concerned with improving the understanding of human activity and integrating it into the evolving ATM network. It is one of the crucial factors that will enable future operational improvements to be implemented and is a key to commitment for any change and transition. Human Resources activities and projects embrace human resource management, human factors studies and human/technology integration to provide proactive and holistic strategies for the improved use of human resources and evolving technology.

Investment in human resources activities and projects is essential in order to realise the full benefit of human activity in future ATM. The aviation community needs an improved understanding of the added value that this approach provides to encouraging common developments and operational applications. Identification and sharing of best practices in the human resources activities that are available in Europe, or elsewhere, are vital to the completion of the initiatives and programmes.

The development and implementation of human resources programmes in ATM are sensitive issues, and specific cultural and organisational characteristics and differences need to be taken into consideration by involving stakeholders at an early stage to build confidence and keep commitments. Nevertheless, implementation of common licensing and standards as a means of aiding mobility, and thus meet local shortfalls in staffing, should be encouraged.

This implies wider participation of operational staff in defining and validating of new procedures/tools. It must also address the clarification of the possible liability issues that the new roles/regulations could entail

Integration of human activity in ATM development is often seen as increasing costs and time. Measures are needed to integrate human activity throughout the life cycle of technical systems, both to contribute to implementation within planned time scales and cost, and to increase the acceptability and usability of the evolving technology.

In this respect, the following should be addressed:

- Development of human factors programmes for individual and team resource management to improve human related safety issues in ATM;
- Analysis of current and emerging forms of error, and the development of means to mitigate their impact;
- Analysis of human workload and stress, and the development of related strategies to cope with increasing traffic demand;
- Analysis of the relationship between human factors and human system integration and safety;

- Recurrent analysis of operator tasks, functions and cognitive abilities to prepare for enhanced automation and new forms of task sharing.

Future work in the human resources area will concentrate on fostering and deepening the integration of human activity in ATM and extending its scope and content. Greater emphasis must be given to the development of human factors methods and human/technology integration, striving for an optimised synergy of human and technical aspects in Europe's future ATM network.

4. Performance Planning: From Strategy to Operations

4.1. Performance Planning

A shortcoming of the regional planning was the absence of clear links between performance and implementation actions. No European view existed of what the capacity of the overall network would be in a few years. Some information was available at the local level, but there was no consolidated European plan. The progress made since MATSE/6 now allows a structured and practical approach to be applied, and where all necessary data will progressively become available. This section describes this approach, which encompasses the measures proposed in the first strategy version, and the purpose of which is to facilitate timely and successful implementation of the changes needed.

4.1.1. Strategic Performance Framework

The ATM 2000+ Strategy is the vehicle for improving Air Traffic Management service provision in Europe and meeting the Airspace Users' needs' within the framework of a performance-driven and top-down planning process.

This implies a need to consider performance requirements stemming from the strategic principles and high-level objectives of the Strategy, and to reflect the recommendations of the SRC, PRC and Civil Military Interface Standing Committee (CMIC), and proposals for safety regulatory requirements approved by the EUROCONTROL Permanent Commission.

The other source of information available is the set of potential operational improvements for the ATM processes, as well as their enabling factors, since only a change in the way the ATM operations are conducted can deliver improved performance.

The goal is to build a Strategic Performance Framework (SPF) that provides the most suitable combinations of improvements, and which:

- Establishes a clear and justified link between stakeholder needs and proposed solutions;
- Accommodates the forecast demand and the performance requirements;
- Provides a high level plan for the delivery of operational improvements to meet the requirements;
- Allows priorities to be set for development and implementation actions.
- Provides a reference to guide the R&D and validation activities necessary to support the plan, and to derive the implementation actions and programmes to realise it;

This process is summarised in Figure 2 below and further explained in the rest of this chapter. Its application was used to generate the material presented in Chapters 4 and 8.

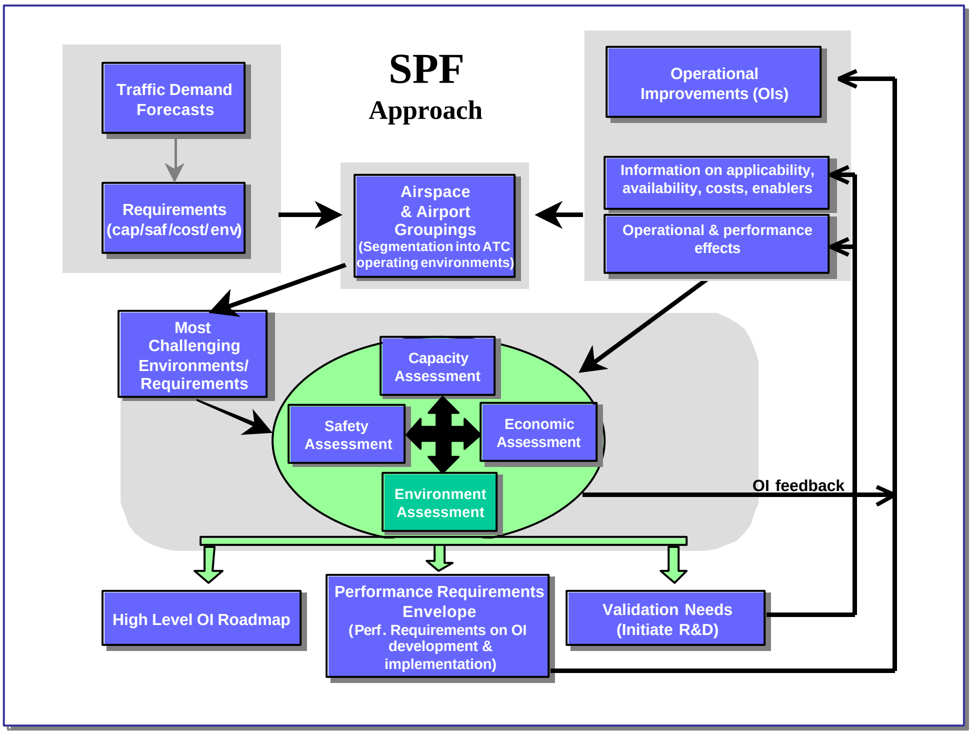


Figure 2: the SPF approach

4.1.2. Roadmap: connecting performance, operational improvements and enablers

For the Strategy to be effective, it is essential not only to establish the logical connection between the performance requirements and the operational improvements, but also with the enablers, whose timely implementation makes it possible to realise the operational improvements. The notion of a roadmap also incorporates the collection, analysis and maintenance of the descriptive elements of the operational improvements, the enablers and the various connections.

Each of the operational improvements proposed is tied to the forecast availability of the necessary enablers and preceding operational changes, and each provides the foundation for the next operational improvement. It has to be understood however that ATM involves a complex interaction between all of its component parts, and that changes in one area are linked to those in some or all of the other areas. Also, that some enablers support a number of operational improvements in a number of areas.

The roadmap constitutes the heart of Volume 2 of the Strategy. The main change steps are designed to keep pace with the traffic increase, while providing tangible and early benefits for the Airspace Users. They are grouped by topic along defined Directions for Change for the main functional elements of the ATM processes, which lead to the implementation of the European target operational concept.

Enablers are organised into four main categories:

- Procedural: cover the definition, validation, approval and publication of the new procedures involved by the operational improvement;
- System: include all the technical systems, and architectural and infrastructure features that need to be in place or improved to allow the operational improvement to be exploited;
- Human aspects: cover the human factor studies and required to design the operational improvement and enabling procedures and systems, as well as the training of ATM personnel, flight crews and other staff;
- Institutional: address the implementation of relevant regulations and other arrangements.

It must also be noted that the Strategy focuses on improving the ATM services and that reductions in cost could also come from aspects external to the Strategy, e.g. ATM provision or industry regulations and organisation, which might also influence the future direction of the ATM service strategy.

4.2. Implementation Planning

4.2.1. European and National Planning

The roadmap of operational improvements follows a path of change through time, and defines what changes are required where and at what stage to meet the strategic system performance requirements defined in the strategic performance framework. The more mature operational improvements also provide the basis for defining both the:

- European Convergence and Implementation Plan (ECIP), setting out commonly agreed medium-term performance targets and the convergence and implementation actions required by different stakeholders to achieve the targets by applying the operational improvements to the European ATM system, and
- European ATM Programme (EATMP), which comprises the portfolio of programmes undertaken in common at European level to develop and apply the operational improvements to the European ATM system.

The ECIP constitutes an ECAC-wide common Implementation Plan for Europe for improving ATM performance. It takes account of clearly defined and quantified ATM Performance Targets for the short and medium term.

The more developed Operational improvements generate ECIP Implementation Objectives aimed at meeting the targets and setting out the commonly agreed actions needed to effect those changes. Implementation objectives are broken down into Stakeholder Lines of Action describing the actions that need to be taken by each of the aviation stakeholders and by when.

The scope of implementation objectives varies from pan-European through multi-national to harmonisation to reflect that since the interactions between provider and user systems and procedures are broadly similar in sectors and centres with similar traffic, there is an opportunity for joint programmes and projects between Air Navigation Service providers and Airspace Users that will deliver overall efficiency gains

These ECIP Implementation Objectives and Stakeholder Lines of Action provide the building blocks for developing Local CIP Documents describing the plans and actions that will deliver performance improvements in each participating State. The Local CIPs Documents constitute the medium-term implementation plans for the ECAC States.

ECIP Implementation Objectives also allow the programmes to be included in the European Air Traffic Management Programme portfolio of the EUROCONTROL Agency to be identified. ECIP is supplemented by objectives approved by the PC but not handled under EATMP e.g. in relation to ESARRS.

4.2.1.1 Common European Medium-Term Implementation Plan and Programme

The ECIP is a rolling medium-term plan with a look-ahead period of 5 years and describes the agreed common implementation actions to be taken by the EUROCONTROL States, and other European States participating in the EATMP. It takes as its foundation the EUROCONTROL Revised Convention requirement to realise a uniform European gate-to-gate ATM system based on quantifiable and measurable performance targets.

4.2.1.2 Performance Targets and Profiles

The ECIP takes account of clearly defined and quantified ATM Performance Targets for the short and medium term. Strategic performance requirements are set by the EUROCONTROL Council on the recommendations of the SRC or PRC, or drawn from other relevant global or pan-European policies or strategies. Where possible, these strategic requirements are then transposed in short and medium-term performance profiles aimed at meeting the strategic targets, globally and for individual ATC units, and incorporated in to the ECIP. As a general rule, performance profiles are set for the next 5 years ahead, and are adjusted on a yearly basis to reflect past performance achievements. As time passes, the medium-term targets become short-term targets (for next Summer), and new medium-term targets are derived.

4.2.1.3 Performance improvements

ECIP implementation objectives describe the implementation actions needed from different stakeholders to apply the operational improvements to the European ATM network, and to satisfy the future system requirements and meet the short and medium-term performance targets and profiles. Once endorsed by the EUROCONTROL Council, the implementation objectives are included in the ECIP, and are used to identify the supporting programmes to be included in the EATMP. These are described, together with the supporting Services and management processes, in the EATMP Work Programme (EWP) overview document.

Some objectives may need to be supported by more than one programme because of their scope, while others may require only local implementation actions (e.g.: applying a safety policy). Additionally, each implementation objective is broken-down into a number of Stakeholder Lines of Action (SLoA) that set out what needs to be done by each of the involved stakeholder groups and by when to achieve the objective.

The scope of the implementation objectives varies from Pan-European (to be applied in all ECAC States), through multi-national (to be applied in some ECAC States), to harmonisation (to be applied at individual State or ATS Unit level) objectives to be applied by individual States where needed. This categorisation reflects the fact that interactions between service provider and user systems and procedures are broadly similar in comparable operating environments, and there is an opportunity to initiate joint programmes and projects to deliver performance gains in such circumstances. Equally, some operational improvements will not be needed in all operating environments, or may only provide cost-effective performance gains in specific operating circumstances.

The primary focus of the ECIP thus far has been on generating additional capacity to address the significant gap with the air traffic demand and reduce delay while maintaining or improving safety. The emphasis will now shift to provide a balanced set of objectives covering all of the key ATM performance areas

4.2.1.4 National Planning and Actions

The ECIP implementation objectives and SLoA are flowed down to, and provide the building blocks for, local CIP (LCIP) documents for each of the participating States. These describe the national plans and actions to achieve the national performance targets, and constitute the medium-term capacity and implementation plans for each ECAC State. As such, they reflect the intention of each of the national stakeholders involved to apply their best endeavours to complete the actions allocated to them in the plans. It is the implementation of the actions contained in the LCIPs at national level that produces the operational changes and provides the performance gains in the European ATM network.

An overview of the link between the ATM 2000+ Strategy, the Strategic Performance Framework, the ECIP, States LCIPs and the EATMP is shown below.

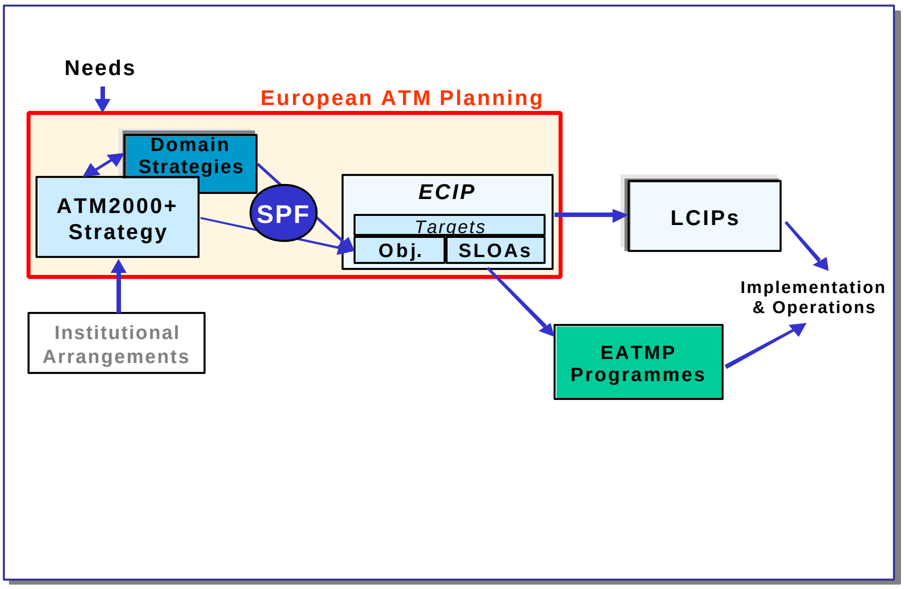


Figure 3: Link between planning documents

4.2.1.5 Monitoring and Reporting Progress

European performance planning is an iterative and top-down process, which uses information on past performance gains to update future performance targets and plans. The LCIP documents provide a comprehensive and independent view of the progress made in national plans and implementation actions, as well as how these contribute to multi-national and pan-European EATMP programmes, as well as meeting ESARRs. They also provide a means to monitor local actions and report on the progress being made. Details of what has been achieved in terms of progressing the implementation objectives, and in meeting national performance targets are compiled in an ECIP Status Report produced at the beginning of the year following.

The actual progress and performance improvements achieved are then reflected back into future plans as part of the iterative process.

4.2.2. Other Planning Criteria

4.2.2.1 Stepped Evolutionary Change

For reasons of safety and project cost and risk containment, the introduction of improvements has to be based on a process that follows a stepped path that starts from the existing system. This is both to allow the changes to be validated before their operational implementation, and to enable service providers and Airspace Users to amortise current ATM and avionics investment. The extent of the existing infrastructure to be retained, and the pressure placed upon it by the transition to new concepts, has to be addressed within the framework of optimising the overall costs and maximising benefits, including safety.

The changes introduced also have to fit within the parameters of the International Civil Aviation Organisation (ICAO) global and regional plans, and remain in step with the ICAO standardisation process, to ensure continued inter-operability with other areas of the world.

It must also be realised that an evolutionary path is fully compatible with the introduction of new concepts to replace existing practices.

4.2.2.2 Concerted, Synchronised Action, and Commitment Now

Concerted action is required if the capacity and efficiency of the ATM network is to be enhanced while improving safety standards. This is essential to avoid a return to the ATM delays experienced in the late 1980's. The long lead times involved in introducing new air and ground systems mean that all of those involved in aviation in Europe must commit themselves to a Strategy that includes a series of operational improvements together with a supporting management framework.

CNS/ATM projects have to be synchronised internally and with evolving operational needs. In principle, synchronisation is necessary for all phases of the project life cycle. The synchronisation of the deployment phases of projects is important to ensure that the investments made can result in operationally useable products that will provide benefits. This is particular important in terms of the dependencies that exist between airborne systems and ground systems.

The planning of projects' life cycles (from conceptual phase to and including maintenance phase) should take into account the:

- Required implementation times for airborne and ground systems;
- Required time for technology to mature and to be validated.
- Institutional framework and the political environment;

As far as possible, rule-making that influences avionics systems, flight procedures and ATC systems and procedures should be co-ordinated to ensure consistency of requirements and reduce the number of retrofit cycles. Similarly and for new operational improvements, the safety oversight/certification processes that lead to the approval of avionics systems, flight procedures, ATC operations should be co-ordinated to ensure convergence of judgements.

It has to be recognised, however, that it may not be possible to synchronise changes in the most ideal way because of the varying levels of investment which have been made at different times in the past by each State, and the constraints which affect the deployment of systems both on the ground and in aircraft. The Strategy nevertheless provides a means to minimise the impact of less than optimal deployment timings and maintain the uniformity of the European ATM network from the Airspace Users' perspective.

The timings used represent the point at which particular operational features will become available for use in all, or designated parts, of the European airspace by suitably capable aircraft following any validation and certification periods. The practical problems associated with transition will inevitably lead to different implementation dates for different European areas for some of the changes. It is also inevitable that the necessary changes to aircraft avionics will be spread over time, and that some suitably equipped aircraft may be capable of adopting changed procedures and gaining benefits prior to the predicted implementation date given. Since, in many instances, the full benefits of change cannot be realised until most aircraft are suitably equipped and capable of operating to new procedures, or the size of the airspace in which the procedures are applied is sufficiently extensive, one of the strategic actions will be to ensure that the equipment change and transition periods are as concentrated as is possible.

Mechanisms should be defined to provide incentives for Airspace Users to adapt aircraft capabilities to take a operational advantage of the operational improvements. While some improvements may indirectly bring benefits to all aircraft, and while operational improvements cannot be always translated into further segregation of traffic according to aircraft equipment or crew capability, there should be a fair recognition of the effort made by those that equipped to enable the benefit to materialise.

The use of blanket exemption policies should be avoided to maximise benefits expected from improvements in a given airspace, and be replaced, where possible, by appropriate forms of encouragement for military or air defence to equip when faced with constraints related to budget rather than physical aircraft design.

4.2.2.3 Segmentation

The Strategy addresses the needs of all Airspace Users and all phases of flight within the whole of ECAC. However, not all of these factors are uniform and variations exist in services, equipment and implementation needs. Priorities for change differ across ECAC because the impact of drivers and processes vary. For example, the urgent issues in and around busy airports differ greatly from the needs of low-density airspace.

It is therefore necessary to consider the types of segmentation that may be required when determining the potential applicability of the various change steps, and a structured segmentation model will be used for the detailed planning activities. This document considers only the higher-level segmentation dimensions, which would provide the framework for the model, along the following two lines in addition to the time dimension:

Geographical: Traffic complexity depends on a number of factors including both the density of the traffic and traffic patterns (e.g.: complexity ranges from high densities of climbing and descending aircraft in the vicinity of busy airports at low altitudes, to low densities of cruising aircraft at the higher altitudes). The segmentation used will address airports and airspace issues.

Stakeholder: The different types of Airspace Users have different and sometimes conflicting requirements in terms of services and flight profiles, as well as different capabilities in terms of crew or airborne equipment, and different economic baselines and drivers.

In this Strategy, a simple segmentation has been applied, which

- Distinguishes en-route airspace, terminal areas and airports as broad categories of environments to assess the performance gains of the operational improvements;
- Focus on the notion of most challenging area where the performance needs are the higher.

4.2.2.4 A strategy, not a frozen blue print

A number of the changes associated with the Directions for Change and Steps for Improving Performance described in chapters 6 and 7 of Volume 2 require validation and cost-benefit analysis to determine the extent of the benefits that can be realised, and where and how they can best be applied. Likewise, the capacity and safety gains that they will bring will depend on the actual performance of the enabling technologies needed to support them.

Validation and cost-benefit analysis will be achieved through focused Research and Development (R&D) and the establishment of business cases prior to the implementation of the changes. Volume 1 of the Strategy describes the management processes associated with those aims.

The changes described in Volume 2, particularly in the medium to longer time scales, should be seen as providing guidance as to the most likely path to realise the future uniform European ATM network, based on the best information currently available. They will need to be reviewed, and if necessary revised, as newer information becomes available over time. The Strategy management processes incorporate mechanisms for such review.

Nevertheless, once a decision to implement a certain change in a harmonised way has been made on the basis of the solid rationale resulting from the planning mechanisms described above, it will be key that the change is fully realised, timely and in the right way. Enforcement measures should be in place to ensure the success of the change, while taking into account the availability of the necessary financing resources through adequate mechanisms.

4.2.2.5 From ATM Concepts to Systems Architecture

To enable a systematic design of the overall operational architecture, it is essential to translate the concepts into more specific functional objectives. Progress towards these objectives will normally be in evolutionary stages, each with its own set of benefits and each enabled by some technical or procedural change.

Programmes will be established to embrace related projects such that overall planning is enhanced. Programmes may be local in nature (one Centre or State), extended to include multi-lateral arrangements between States, or embrace the whole ECAC region.

Thorough understanding of the way in which trade-offs between potential benefits apply in different locations is essential to the effective statement of each project or programme requirement. The stages in such programmes provide cumulative “stacks” of benefits towards the target concept objectives.

The combination of enablers comprises a part of the overall action plan but also helps to determine the system architecture. It is the dynamism of this link between evolving benefits and systems changes that provides life to system architecture developments.

4.2.2.6 Other organisational measures

The following measures to link performance and implementation, and included in the preceding issue of the Strategy have been at least partly implemented and need a continuing effort:

- Activities required to support the agreed performance targets to be maintained in a consolidated European implementation plan, where information sharing on the current and future needs and capabilities of all stakeholders is key to making right and timely implementation decisions, and to determine and run the most efficient actions in goal-oriented projects;
- Implementation management to be based on collective or central activities at the higher planning levels and through adapted working arrangements, followed by actions by the authority responsible for implementation and operations. This includes the practical application of objectives decided by the EUROCONTROL Council and General Assembly based on proposals by the PRC and SRC. The instruments for implementation planning and development are the ECIP, and the EATMP work programme for common activities;
- The EUROCONTROL Agency to act as the central planner and co-ordinator for the implementation of these activities, to produce an overall plan that considers the inter-relations between all activities, and directly manage a number of common development activities and common projects. ECIP Objectives to provide a framework for agreement to local (implementation) activities, at defined target dates, and achievement criteria consistent with overall plans;
- The SRC to act as a focal point for co-ordinating harmonised ATM safety regulatory views on the acceptability of proposed changes being co-ordinated by the Agency;
- Rationalisation of objectives, functional changes and evolution to be presented as a Systems Architecture. This will allow the timing, scope and scale of development programmes to be verified in respect of system objectives;
- Programmes to be clearly delineated so as to keep them focused;
- The early phases of a project life-cycle to establish clearly the case for change and outline acceptable timetables, including future decision points;
- Resources required for implementation, in particular those from States’ budgets, to be secured up-front. This includes budget, recruitment, training, and administrative support;
- Early pre-operational trials and pilot implementation exercises, including the most fundamental concept paradigm changes, to be carried out in a more systematic way, using opportunities across ECAC, thereby reducing the time from laboratory to real operations and, through emulation, accelerating the dissemination of advanced functions;
- Post-implementation evaluations to be performed, based on criteria developed by the PRC, and with the involvement of the SRC in its area of competence.

4.3. Performance assessment methodology and assumptions

The Strategic Performance Framework (SPF) applied to the Strategy has been established using the assumptions and method summarised below.

The **method** relies on high level system engineering considerations suitable to address issues at a strategic phase, and offers the possibility to refine the assessment as more precise data become available from more detailed safety cases, operational evaluations or economic studies. A substantial step forward has been made compared to the performance assessment presented in the previous edition, but the full application of the method and the quantitative results remains dependent on the quality of input data and in particular proper validation results. Consequently, the results for the longer-term will always carry a degree of uncertainty.

Some general assumptions were made:

- The baseline is the year 2000 for annual traffic statistics, and the LCIP documents of year 2001 are used as the baseline for plans concerning Stakeholders Capacity Plans.
- The list of candidate operational improvements is the result of those presented in the previous edition of the Strategy and the further thinking and elaboration performed by the EATMP Domains and presented in their strategies; they include state-of-the art concepts.
- A high-level enabler analysis was done to determine earliest possible availability dates. A collection and analysis of validation results enabled the answers to be found to a number of outstanding performance uncertainties.

It should be noted that implementation dates should be influenced by the needs for a better performance (be it safety only or other parameters as well). However, this does not exclude an earlier start of operations at a small scale, as this is generally essential to acquire the experience required to larger scale application. In addition, the application dates should not be confused with the dates at which research, development, validation, transition, etc. actions are necessary to prepare the implementation.

The **assessment** was made in 3 main **stages**:

- Stage 1: Develop a Capacity driven OI Roadmap
- Stage 2: Assess the Roadmap on Safety Impact against Safety Requirements
- Stage 3: Assess the Roadmap on Cost Impact against Economic Requirements

The stages do not imply prioritisation of performance areas, but are the consequence of the fact that safety improvements can only be considered on the basis of the system to be put in place to handle a certain volume of traffic. Iterations were used to adjust the roadmap where the safety requirements were unlikely to be achievable or the costs prohibitive.

Four general **time periods** are considered for the assessment, although specific dates are attached to individual operational improvements. The purpose was to both reduce the number of cases to consider, and to smooth the effect of different ideal dates for different MCEs, in particular with regard to the uncertainties inherent in the exercise. The periods also recognise that the short-term is practically defined, and that the longer term does not require the same degree of detail.

The **safety assessment** is based on results of safety cases where available, and for most of the operational improvements on expert judgement supported by the use of a safety model that distinguishes three main layers for safety action: the generation of critical events, resolution of critical events and incident recovery. The model allows for strategic discussion on how an operational improvement can affect safety and for the safety benefit to be quantified. It is also possible to perform a quantitative assessment.

The assessment should normally be done by comparing the states of the system, before and after any envisaged change, but for this first exercise only broader qualitative comparison was made.

A basic tenet has been to proceed by comparison from the current situation, using the assumptions that in the most challenging areas the current level of safety meets the requirements, and that in lower traffic density airspace safety requirements will be able to be met by a combination of the present settings and the additional gains brought by the application of current practices that have not yet been implemented and/or new operational improvements as appropriate.

Capacity was assessed for each period as follows :

- Determination of the Capacity Requirement per MCE;
- Identification and analysis of the baseline operational situation;
- Identification of the operational improvements applicable to the MCE and the period, and a conduct analysis of the enabler;
- Application of operational improvement required to meet the capacity requirement in addition to the baseline, followed by consideration of available evidence of potential benefits and the possible interactions between operational improvements.

For the last step a preference order is also applied which consists, where a choice is possible, in placing precedence on the operational improvements that are likely to prolong the deployment of existing practices and minimise the need for substantial investments (for example, apply current practice, optimise use of existing resources, airspace and runway, then invest in automation).

A capacity framework, indicating the elementary means through which capacity can be enhanced, was used to avoid double counting.

The **economic assessment** concentrated on the verification that the economic strategic objective of a non-increasing total ATM related unit cost was respected. Here also the knowledge of the cost is limited and it is necessary to combine known data and evaluations. Known costs from projects have been used directly, and served as a reference to assess others. The cost characteristics of operational improvements have been determined. When cost data were not readily available, a project with similar characteristics was identified and used as a reference for evaluating the magnitude of cost categories and their most probable values.

The cost breakdown considered the following categories: study, technical development (e.g. changes to avionics or ground systems), implementation and operating, regulation (e.g. certification). A total cost scale was established as a function of several factors: geographical scope, complexity of avionics or ground system changes, number of aircraft or ground facilities affected (ATC or CNS). Uncertainty was approached through estimating the lower bound (10% chance to be below), typical value (50% chance to be below or above) and higher bound cost (10% chance to be above). The cost scope included all ECAC-wide costs of ground and airborne equipment, system enablers, and training. This is not yet per stakeholder but will be done to cater for e.g. military costs and to include the effects of specific cost mitigation mechanisms.

The **traffic data** are based on CFMU data. Future traffic levels have been determined according to STATFOR 2001 (high growth scenario) using growth data for airport-pair traffic (annual traffic volumes), and deducing crossings of ACCs, TMAs and airports according to year 2000 traffic routing statistics. The annual demand was scaled down to typical busy-hour demand, which was necessary to compare with the hourly capacity, considered to be the most practical indicator to reflect the effect of capacity improvements. The typical busy-hour is defined as corresponding to a volume of traffic at or above that of 98% of the hours in the day.

5. Overall Road Map of Change Through Time

5.1.1. General

The main operational improvements resulting from the analysis performed are described in this chapter. These represent a complex multi-faceted and interrelated collection of information and are presented from different perspectives to satisfy the requirements of different categories of readers.

The diagram on the next page is a simplification of the overall picture. More detailed descriptions of the operational improvements are given in Appendix 1. The diagram allows readers to understand that there will be both:

- A series of continuous improvements along well established broad solutions, the exploitation of which will still bring significant benefits;
- The advent of new solutions, themselves being unique events or the origin of a new set of progressive steps.

However, even a simplified diagram demonstrates that the ATM issues and solutions involved are complex, and that there are no easy or simple paths to enhancing the network.

It must also be emphasised that although all operational improvements and enablers are described in a similar manner, they are not all known with the same certainty. The longer term aspects have not been the subject of the same amount of validation as the shorter term aspects. While the Strategy presents a comprehensive road map, and seeks for the consensus of the ATM Community to move consistently in the proposed direction, it does not request that a firm commitment be made for all proposed changes. The commitment will come element by element on the basis of proof; the Strategy will be updated as necessary to reflect additional knowledge, and the validation or invalidation of statements.

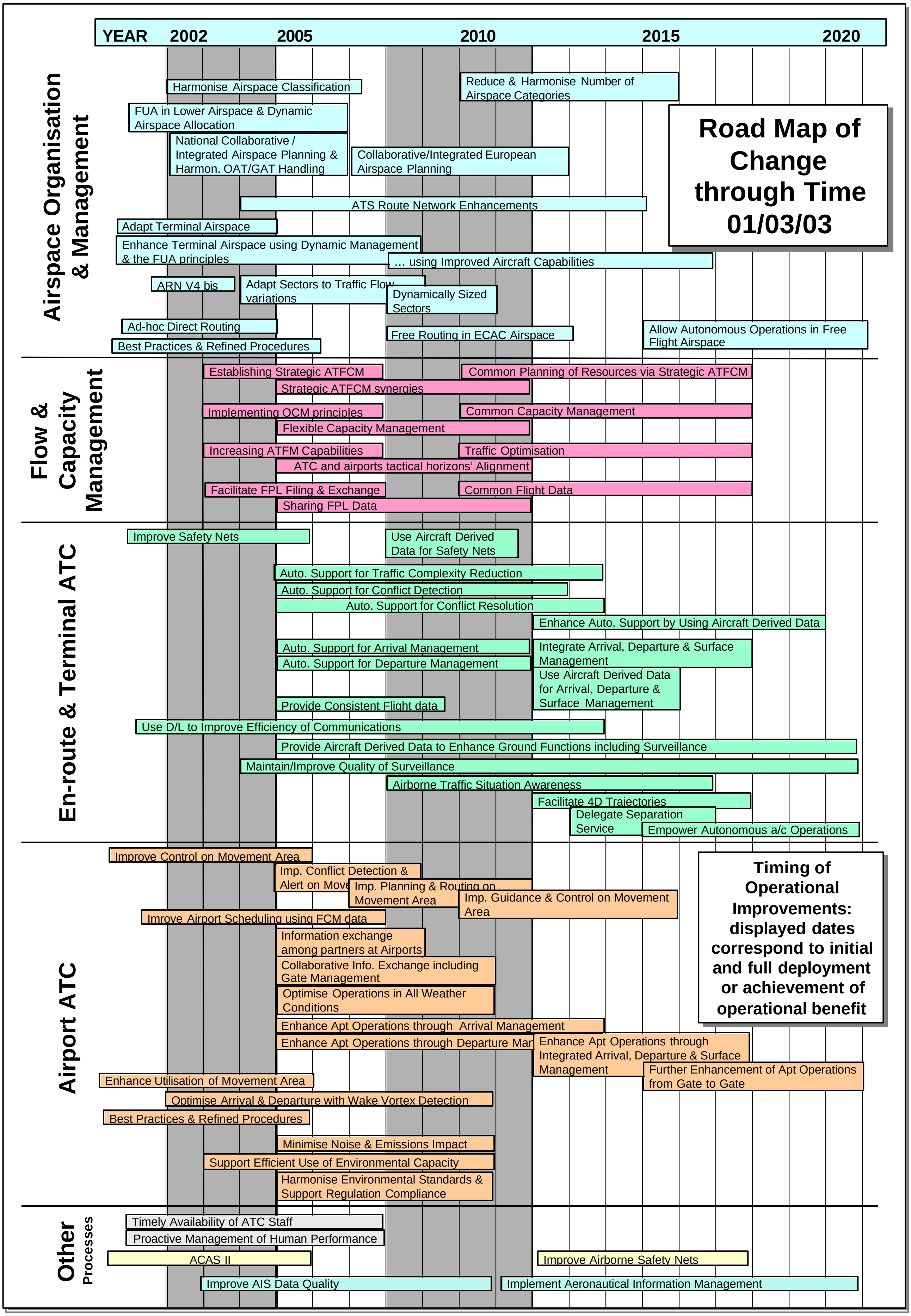
This chapter focuses on the overall road map. After this chapter, the reader can read either

- Chapter 6 organised along the ATM processes and the directions for change related to elementary aspects of these processes, thus providing a more in-depth understanding of the operational meaning; or
- Chapter 7 organised as a series of time steps, with the main developments during every step.
- In addition, Appendix 2 expands the conceptual changes addressed in Chapter 5 of Volume 1.

5.1.2. Implementation of Operational Improvements

The first dates in the diagram indicate the "Date of First Expected Benefit" with the end date being that when full benefit throughout Europe will be realised.

There is currently no requirement for stakeholders to implement any or all of the operational improvements. It is expected that stakeholders, in particular ANSPs, will assess, from the 4 perspectives of safety, capacity, cost and environment, which operational improvement, or combination of operational improvements, will bring most benefit in there area of responsibility and therefore should be implemented. Naturally, it is anticipated that this will not be done in isolation but in consultation with other ANSPs to realise the benefits of implementation over as wide an area as possible.


YEAR 2002 2005 2010 2015 2020
Road Map of Change through Time 01/03/03
Airspace Organisation & Management
Harmonise Airspace Classification
Reduce & Harmonise Number of Airspace Categories
FUA in Lower Airspace & Dynamic Airspace Allocation
National Collaborative / Integrated Airspace Planning & Harmon. OAT/GAT Handling
Collaborative/Integrated European Airspace Planning
ATS Route Network Enhancements
Adapt Terminal Airspace
Enhance Terminal Airspace using Dynamic Management & the FUA principles
... using Improved Aircraft Capabilities
ARN V4 bis
Adapt Sectors to Traffic Flow variations
Dynamically Sized Sectors
Ad-hoc Direct Routing
Free Routing in ECAC Airspace
Allow Autonomous Operations in Free Flight Airspace
Best Practices & Refined Procedures
Flow & Capacity Management
Establishing Strategic ATFCM
Common Planning of Resources via Strategic ATFCM
Strategic ATFCM synergies
Implementing OCM principles
Common Capacity Management
Flexible Capacity Management
Increasing ATFM Capabilities
Traffic Optimisation
ATC and airports tactical horizons' Alignment
Facilitate FPL Filing & Exchange
Common Flight Data
Sharing FPL Data
En-route & Terminal ATC
Improve Safety Nets
Use Aircraft Derived Data for Safety Nets
Auto. Support for Traffic Complexity Reduction
Auto. Support for Conflict Detection
Auto. Support for Conflict Resolution
Enhance Auto. Support by Using Aircraft Derived Data
Auto. Support for Arrival Management
Integrate Arrival, Departure & Surface Management
Auto. Support for Departure Management
Use Aircraft Derived Data for Arrival, Departure & Surface Management
Provide Consistent Flight data
Use D/L to Improve Efficiency of Communications
Provide Aircraft Derived Data to Enhance Ground Functions including Surveillance
Maintain/Improve Quality of Surveillance
Airborne Traffic Situation Awareness
Facilitate 4D Trajectories
Delegate Separation Service
Empower Autonomous a/c Operations
Airport ATC
Improve Control on Movement Area
Imp. Conflict Detection & Alert on Move
Imp. Planning & Routing on Movement Area
Imp. Guidance & Control on Movement Area
Timing of Operational Improvements: displayed dates correspond to initial and full deployment or achievement of operational benefit
Imrove Airport Scheduling using FCM data
Information exchange among partners at Airports
Collaborative Info. Exchange including Gate Management
Optimise Operations in All Weather Conditions
Enhance Apt Operations through Arrival Management
Enhance Apt Operations through Departure Man
Enhance Apt Operations through Integrated Arrival, Departure & Surface Management
Further Enhancement of Apt Operations from Gate to Gate
Enhance Utilisation of Movement Area
Optimise Arrival & Departure with Wake Vortex Detection
Best Practices & Refined Procedures
Minimise Noise & Emissions Impact
Support Efficient Use of Environmental Capacity
Harmonise Environmental Standards & Support Regulation Compliance
Other Processes
Timely Availability of ATC Staff
Proactive Management of Human Performance
ACAS II
Improve Airborne Safety Nets
Improve AIS Data Quality
Implement Aeronautical Information Management

5.1.3. Prioritisation of the change steps

In building the roadmap, priority criteria have been defined for the order in which solutions to enhance performance should be developed, with due consideration of the lead times that are necessary to deploy an operational improvement or its enablers. In general terms, the main criteria are the contribution to enhanced performance and the earliest date of availability. However, for operational improvements in an early stage of development no firm quantitative performance assessment can used, and a qualitative judgement has been made on the order in which to apply the improvements. This judgement is based on a consideration of relative costs, and effectiveness of implementation.

This has led to the following logical order that reconciles both the need for immediate gains through robust and safe solutions, and the timely exploitation of new concepts:

- Make better use of the existing:
    - Best practice at small scale: Performance enhancements need to take place at all ATM domains/fronts (airspace, airports, ATC, ATFM) simultaneously. In all of these there is a significant performance potential in the systematic and general application of best current practices. This requires visible and focused activities, not the creation of European programmes, but these activities can benefit from pro-active involvement of the Agency;
    - Use of the network: ATFM improvements must be focused on a higher predictability and better planning of the total system and consequently better protection of sectors against overload situations. This must be accompanied by proper capacity management.
- Ensure achievement of ongoing agreed operational improvements for which implementation objectives and supporting programmes have been activated;
- Improve use of resources:
    - Airspace and Route optimisation towards the One Sky concept need to take place in parallel with the above, with continued and expedited investments. Objectives are a flexible, dynamic airspace, with optimised routes where necessary and free routings where possible;
    - Airport ATC OIs should be given priority, focusing at increasing Manoeuvring Area Utilisation and safety, and improving the predictability of the planning at airports.
- Reduce unit workload by provision of decision support to controllers, both for en-route and aerodrome ATC; in particular to reduce time spent in routine communications, facilitate the identification and handling of potential conflicts and provide automation support to traffic sequencing.
- Prepare the future steps: traditional mean should accommodate demand until around 2007 in the high-density areas. To be deployable and operational soon after 2007, the development of ATC tools that increase productivity need to be expedited.

The priority of safety specific operational improvements s (e.g. safety nets) is determined by the safety needs and are not questioned in terms of priority versus other operational improvements. Furthermore, all operational improvements have to be developed in such a way that individual change steps enhance current safety levels, either as pure safety enhancers, or as creating the conditions for the related expected capacity increase to materialise. Therefore, safety is an integral part of an operational improvements development.

Besides the implementation actions, a priority remains to validate the target operational concept that determines the overall direction of the change, to ensure that all intermediate steps lead consistently and expeditiously to the long term goal.

5.1.4. Prioritisation of the implementation programmes to realise the roadmap

The priority for development and implementation programmes is the logical consequence of the performance-oriented roadmap. The programmes must show a strategic fit in terms of:

- Contribution to the realisation of an operational improvement;
- On time delivery of its products;
- Delivery of the expected performance;
- Identification and consideration of all relevant enablers;

- Appropriate validation in support of the above areas;
- Stakeholder acceptance.

Programmes aimed at operational improvements should in particular be complete in terms of:

- Lifecycle: coverage of all required project lifecycles up to deployment preparation and co-ordination; clear check points and deliverables;
- Validation: timely and correct coverage of all validation requirements/phases;
- Enabler: clear specification of enabler requirements, and co-ordination with relevant enabler programmes if separate;
- Horizontal needs and requirements: human factors, information management, avionics and procedures

The enablers are essential to an operational improvement (without the enabler the operational improvements can not be realised), or enhance it (with the enabler the performance of the OI will improve, or the enabler is needed in subsequent phases of the operational improvement enhancement). A high priority is given to an enabler if it is an essential enabler and the priority of the supported operational improvements is high and/or the enabler results in a reliable infrastructure cost saving.

Separate programmes can be created to deliver enablers, provided that their deliverables result in *validated* higher cost/effective solutions, and/or are required by operational improvement programmes. They should also be complete in terms of lifecycle, validation, horizontal needs and requirements.

5.1.5. Main short-term pan-European implementation actions

To facilitate decision making and offer a simplified picture, the proposed changes can be grouped according to the main performance improvement they deliver. They lead to recognise a set of consistent packages for validation and include all the necessary ingredients for airspace users and ground service providers.

Benefit Focus	**Action**
Safety	ACAS phase 2 Measures from the high level safety initiative ESARRs (EUROCONTROL Safety Regulatory Requirements)
Network Capacity	Development of an optimal, dynamic European airspace structure and management, including regional initiatives Development of a dynamic and pro-active flow and capacity management. Steps to maximise ATM network utilisation CDM for ATFM Extension of the use of 8.33kHZ VHF channel spacing Human resources management
Sector productivity	Deployment of advanced surveillance techniques Operational use of air-ground data communication
Airport Throughput	Improved procedures CDM at airports
Infrastructure Efficiency	Interoperability criteria and information management mechanisms, if possible at global scale, to allow system architecture convergence and seamless interfaces Further use of satellite navigation Establishment of a common recognised repository of traffic, safety and delay data European AIS data base (EAD)

In addition, generalisation of best practices and systemisation will generate continuing improvements in safety, security, capacity and environment.

Implementation of change is not limited to Europe-wide programmes. States and or service providers also take many initiatives, individually or within multi-national projects, most of them using commonly defined requirements/specifications. National projects address identified performance shortfalls at local scale.

In a similar manner, the road map can be represented in a simplified manner as follows:

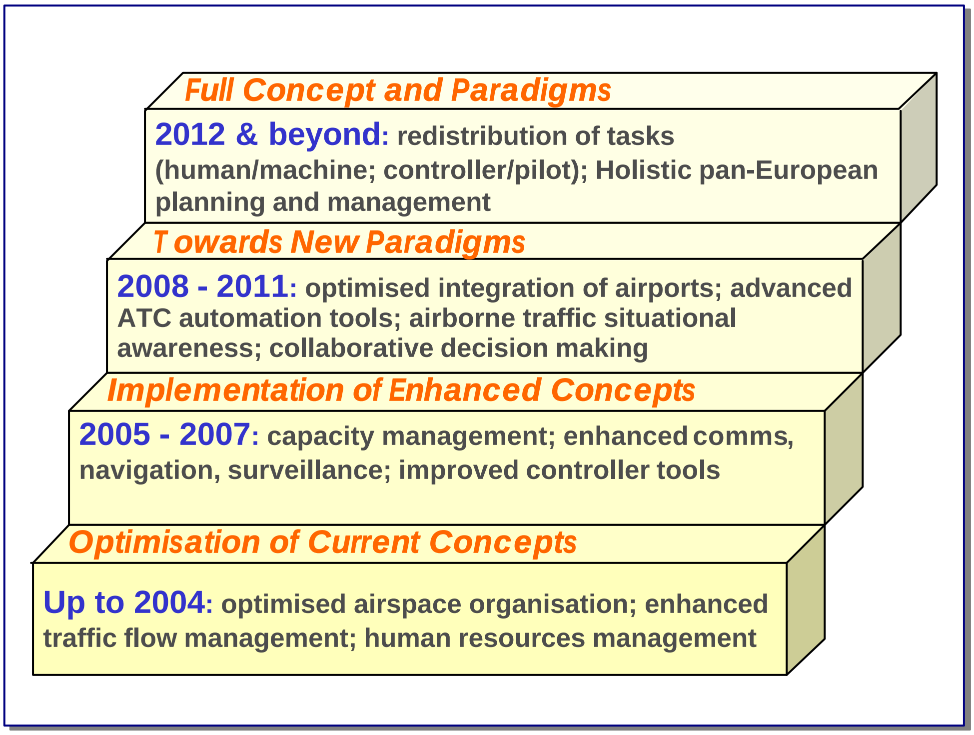


Figure 4: Simplified road map

6. The Directions for Change

6.1. General

ATM comprises functional processes that act in parallel or in sequence through the various phases of flight, including planning. Performance and quality of service are the result of a complex interaction of these processes.

For the purpose of this Strategy, the following main processes can be considered to encompass the majority of the operational improvements:

- Airspace organisation and management;
- Flow and capacity management;
- En-route and terminal ATC;
- Airport ATC.

These four main processes are supplemented by a number of operational improvements that pertain to the management of information (including aeronautical information and meteorological information) and the management of human resources and safety management. In turn, the enabling technical infrastructure will evolve in parallel to satisfy the operational needs.

This chapter describes the directions for change under each of the above processes and functions, which are necessary to achieve the target operational concept described in the OCD. They broadly correspond to the EATMP Domains and are the subject of specific activities, including the elaboration, by the experts concerned, of domain strategies that assemble the individual domain vision and expertise. This Strategy document translates those findings into an overall and consistent framework.

Each direction for change comprises a number of operational improvements, which represent the next stage of decomposition. The operational improvements associated with each of the processes are listed below under each process. A detailed description of each the operational improvements may be found in Appendix1.

6.2. Use of Best Current Practice

A number of procedures, functionalities and practices are recognised as providing operational benefits, but are not yet applied widely. Examples are re-sectorisation, which can be fine-tuned within an ACC as traffic patterns modify year on year, or particular procedures adapted to recurring local situations or problems and allow them to be addressed in a more systematic and efficient manner. This may also be used to de-complexify traffic situations.

A strategic aim is for all involved in aviation to compare their procedures with the best current practices, and to modify them to reflect those best practices wherever possible. This will contribute to a more uniform ATM service, as well as bringing local service improvements.

The general and systematic dissemination and harmonised use of best current practice is a source of significant and cost-effective benefits in the short to medium-term. When coupled with the development and application of consistent performance indicators and transparent results, they should help and encourage the identification of solutions for the current shortcomings.

Both the Airspace Organisation and Management and Airport Domains have operational improvements encompassing the "Implementation of Best Practices and Refined Procedures". Both should be implemented during Step1.

6.3. Airspace Organisation and Management

The principles underlying the Flexible Use of Airspace concept together with advances in avionics and altimetry, the further development of area navigation techniques, and satellite-based navigation systems capable of providing more accurate and timely position information, will provide the cornerstones for progressive improvements in the way that airspace is managed and used.

Together with modelling and simulations of optimum airspace structures, this will lead progressively towards a uniform airspace organisation and a single pan-European continuum of airspace. This organisation is based on the principle of contiguous volumes of airspace that are designed on operational performance criteria not constrained by national boundaries, thus providing maximum freedom for all Airspace Users consistent with the required level of safety and capacity required while making due allowance for the security and defence needs of the member States. There should be involvement of the military in all aspects of airspace design as early as possible.

The directions for change listed below will also underpin parallel improvements in procedures for flight planning and information on flight and airspace status.

(**Note:** The figures in brackets following the operational improvements in this section refer to the listing of the operational improvements in the Transition Plan for the Implementation of the EUROCONTROL Airspace Strategy (TPIAS) for the ECAC States)

6.3.1. Simplification of Airspace Organisation

The main objective will be to optimise the organisation of the entire European airspace to permit the maximum freedom of movement for all Airspace Users. Simplification will harmonise the use of ICAO ATS airspace classification in the European airspace and ultimately reduce the categories of airspace to only two types. This will improve safety by the introduction of less complex airspace configurations, and provide the basis for the adoption of common and unambiguous rules and procedures for both IFR and VFR operations. The objective will be achieved by stepped implementation throughout the life cycle of the Strategy.

Operational improvements	
Harmonise ICAO Airspace Classification in ECAC Airspace (1A+2A)	Step1
Reduce and Harmonise The Number of Airspace Categories in ECAC Airspace (3A+4A+5A)	Step3

6.3.2. Airspace Management and Civil/Military Co-ordination

The implementation of the full application of the Flexible Use of Airspace concept in all States that are no longer constrained by national boundaries will lead to collaborative/ integrated civil-military airspace planning and management processes for European airspace. The changes will incorporate the dynamic allocation of airspace and enable a harmonised system for the handling of General/Operational Air Traffic. This objectives will be achieved in the medium to longer-term.

Operational improvements	
Enhance Real-time Civil/Military Co-ordination (1B)	Step1
Extend FUA to Lower Airspace and Introduce Dynamic Airspace Allocation (3B+4B1)	Step1
National Collaborative/Integrated Airspace Planning and Harmonisation of OAT/GAT Handling(2B&4B2)	Step1
Collaborative/Integrated European Airspace Planning (5B+6B)	Step2

6.3.3. Utilisation of User-Preferred Trajectories

Advances in aircraft navigational capabilities complemented by advanced ATC support tools will facilitate the phased implementation of free route airspace concept in ECAC airspace and thus enable Airspace Users to freely plan and fly their preferred trajectories. The extent of use of free route airspace concept will depend on a variety of factors such as traffic complexities, the need to strategically de-conflict traffic flows, and the resulting performance gains. It is recognised that structures will still be needed to create additional capacity in some parts of the airspace or at certain times, and free route airspace will be used where possible outside those areas and times. A possible related ultimate evolution in this direction for change, and in relation to aircraft separation could be the delegation of separation assurance tasks to the flight deck in designated portions of the airspace. This would be achieved after a period of initial application of separation assurance criteria as specified in ATC clearance, such as station keeping.

Operational improvements	
Ad-hoc Direct Routing (1C)	Step1
Free Routing in ECAC Airspace (2C+3C+4C)	Step3
Allow Autonomous Operations in Free Flight Airspace (5C+6C)	Step4

6.3.4. Route Network Optimisation

The implementation of RVSM has enabled the initial optimisation of the ATS route network. The overall objective of improving the present fixed route network to reflect the improved airspace flexibility offered by the FUA concept and the early use of RNAV techniques will be progressively realised. As a consequence, route structures, where they are still required, will be designed, to avoid concentrations of aircraft over congested points. Overall, more direct and fuel-efficient routes will be available, together with by-pass routes to avoid busy traffic areas.

Operational improvements	
Enhancement of ATS Route Network (2D+3D+4D)	Step1

6.3.5. Terminal Airspace Optimisation

The present and on-going re-design and optimisation of the arrival and departure routes (STARs and SIDs) used to structure traffic flows around the busier airports will help to enhance Terminal Airspace capacity and may increase the throughput at some airports. Implementation of the objective will be realised through improving aircraft performance capabilities leading to, in the long term, the ultimate goal of 4D RNAV capabilities in Terminal Airspace.

Operational improvements	
Adapt Terminal Airspace Organisation (1E)	Step1
Enhance Terminal Airspace using Dynamic Management and the FUA principles (2E+3E)	Step1
Enhance Terminal Airspace Organisation Using Improved Aircraft Capabilities (4E+5E)	Step3

6.3.6. ATC Sector Design Optimisation

Where traffic densities permit, there will be an evolutionary change from fixed airspace divisions to flexible airspace allocation. The objective is to increase capacity by moving to an entirely flexible airspace structure, whereby airspace sector boundaries are adjusted to particular traffic flows and peaks in demand in real-time, and are not constrained by National boundaries. In the short term the initial application of RVSM will increase sector capacity, progressively leading to dynamically sized sectors in the medium-term.

Operational improvements	
Adaptation of Sectors to Variations in Traffic Flows (2F +3F)	Step1
ARN V4 (BIS) (1F) Step1	
Dynamically Sized Sectors (4F)	Step3

6.3.7. ATM procedures

As a consequence of the effects that evolving concepts and new technologies may have on current safety arrangements for air traffic operations, and in support of the Gate-to-Gate concept, there is an ongoing requirement to develop and validate new and/or revised ATS procedures which enhance safety whilst leading to improved operational efficiency.

ATM procedures development and validation is the process used to ensure the safety and efficiency of air traffic operations within the airspace where such procedures are applied. This process results in new ATS procedures, which are normally consistent with any relevant ICAO Standards and Recommended Practices. The ongoing development and validation of new and/or revised ATM Procedures is vital for the identification and management of intrinsic risks associated with any operational changes that may be contemplated in order to take advantage of improved technology and airborne navigational capabilities.

In an ever-changing ATM environment, the ongoing development and validation of new procedures contributes to ensuring that safety objectives can be achieved and that the safety of air traffic operations is not adversely affected. Increases in air traffic, and/or changes to traffic patterns and traffic handling, in particular when combining and mixing the use of various capacity-enhancing concepts, may have an impact on current safety arrangements. Ongoing assessment of the requirement for new ATS procedures, and competent evaluation of the effects that any new ATS procedures would have on existing procedures are pre-requisite to effective risk response.

6.4. Flow and Capacity Management

The strategic intent of Air Traffic Flow and Capacity Management (ATFCM) is to both protect the ATM network from overload, and achieve a closer alignment between Airline Operators' requirements, Airports, ATFCM and Air Traffic Control. The application of this strategy will be about balancing capacity and demand, from strategic planning to tactical execution of flights, taking into account airport and airspace limitations, unexpected events, or abnormal traffic peaks. ATFCM will be the primary means of ensuring flight punctuality and efficiency, whilst managing the available capacity as best as possible. Changes will centre on moving from a flow management system currently based mainly on regulating mechanisms to the essential function of collaborative management of capacity and demand, although it is recognised that this will still entail flow regulation under certain conditions.

The developments will build on the successful implementation of the CFMU, and further enhance its functions and services to maximise the performance of the European ATFM network. Objectives will include maximising the performance of ATFCM, developing the tactical element of ATFM to maximise the pro-active use of the available capacity, achieving coherence between ATFCM measures and airport runway slots for co-ordinated airports, extending freedom of choice for Airspace Users, developing the strategic and pre-tactical capacity management phases, and developing more effective measures for dealing with unusual situations.

This will be realised through the progressive development of existing tools and procedures whilst improving the flow of collaborative information through improvements in data networks and the introduction of air-ground data links.

The target of ATFCM will be to organise the capacity provision and the traffic demand throughout ECAC and bordering airspace in order to optimise the traffic. The different ATFCM phases are designed according to their contribution to this general target. They require improvements at the CFMU and in particular to ATFM, but also compliance of the rules by all to ensure that all parties get the best out of the ATM network. Awareness of the importance of proper functioning of ATFCM should be facilitated by training and informing all operational personnel.

6.4.1. Strategic Flow and Capacity Planning

Strategic Flow and Capacity Planning is aimed at analysing the evolution of the forecast demand and the identification of potential problems and in evaluating possible solutions. Developments in information technology, in data sharing and CDM will permit greater access to information, and in combination with improved capabilities of ground organisations, enable the production of Seasonal Forecasts for all stakeholders.

The objective will be realised through a series of iterative processes starting with the provision of more detailed information of the service providers' plans and capabilities to users. Subsequent steps will see the development of tools, including simulation facilities, with which to better assess collaboratively agreed actions between major Airspace Users and service providers. Ultimately, these processes will be further refined, in the long term, to extend interactive communications and CDM capabilities to all stakeholders.

Operational improvements	
Establishing Strategic ATFCM	Step1
Develop synergies with Resource Managers for strategic ATFCM	Step2
Common Planning of Resources via Strategic ATFCM	Step3

6.4.2. Optimised Capacity Management

The objective of Optimised Capacity Management is to refine the details of the original forecast over time and to prepare and promulgate an optimised and detailed operational plan (ATFCM daily plan - ADP) (e.g. airspace configuration(s), forecast flight operations and types). This activity covers the Pre-tactical, but also part of the tactical period. Validated ADPs will be used by ATFCM to refine the estimated future traffic demand and the expected capacity of the overall ATM system and to apply demand/capacity balance mechanisms, either to adjust the capacity to the demand or, where this cannot be achieved, to minimise the adverse effect of capacity limitations on demand.

ATFCM will progressively change from the reactive management of demand to the proactive management of capacity and empower stakeholders to align their own plans against the ADP. This will be achieved, in the longer term, through collaborative analysis and decision making to enable stakeholders to identify problem areas and to negotiate and agree potential solutions with ATFCM.

Operational improvements	
Implementing OCM Principles	Step1
Flexible Capacity Management	Step2
Common Capacity Management	Step3

6.4.3. Tactical Flow and Capacity Management

Tactical Flow and Capacity Management aims to maintain the plan (ADP) consistent with the real time picture, safely and efficiently, to react to any non forecasted event and to make information on the capacity and traffic situation available to all partners, enabling them to take the best benefit of any opportunity. Tactical Flow and Capacity Management will act in a supervisory role, and make full use of all available information facilities (e.g. Prediction tools, Traffic Load Monitoring, etc.) to monitor and anticipate adjustments to the forecast in terms of the most efficient configuration of resources. If delays are unavoidable, an equitable re-partition will be negotiated with the airspace users affected.. As the time-horizon of interaction of ATCFM with air traffic in the Tactical Phase approaches real-time, a closer and more interactive interface with ATC will be required.

The progressively shorter time-horizons for sector workload protection and flow management activities by ATFCM will begin to overlap with the time-horizons of the ATC activities. There will be a need for a bridge between the two functions that will enable, with the introduction of automated support tools for workload optimisation and conflict prediction, the harmonisation and rationalisation between ATFCM and ATC, of their tasks, roles and responsibilities.

Operational improvements	
Increasing ATFM Capabilities	Step1
Alignment with ATC and airports tactical horizons	Step2
Traffic Optimisation	Step3

6.4.4. Flight Planning

The objectives of Flight Planning are to facilitate flight planning and achieve universal access to common flight data including the profile of the flight. It concerns interaction and CDM between Airspace Users and ATFCM on an individual flight plan. The provision of accurate flight forecast data and of ATM constraints that may apply during the flight will, using automated flight plan filing tools, enable ATFCM to assist the airspace user to optimise the flight. When any event is seen to require modification to the ADP, the effects of this change will be investigated collaboratively, and solutions agreed. The aims are to ensure the consistency of the information used by different stakeholders and to provide the flexibility to be able to resolve identified problems efficiently and equitably.

In the short-to-medium term, this will be achieved through the introduction by ATFCM of more responsiveness and information including user access to the flight profiles in the ADP. Ultimately, there will be a common pool for the exchange and dissemination of up-to-date data between Airspace Users and ATS providers.

Operational improvements	
Facilitating FPL Filing and Exchange	Step1
Sharing FPL Data	Step2
Common Flight Data	Step3

6.5. En-Route and Terminal Air Traffic Control

The objective of ATC is to ensure a safe, orderly and expeditious flow of traffic. Although the controller's job is much more complex and covers a number of other related tasks, this is mainly achieved through monitoring, conflict detection and resolution, and the sequencing and metering of traffic. It is the workload associated with these tasks, and with communicating instructions to pilots by RT, that is the major constraint on further airspace capacity growth.

Future operational improvements will involve the use of enhanced computer processing powers, and more sophisticated computer assistance tools and human-machine interfaces, to provide automated assistance for some routine ATC tasks, and to improve shorter-term planning. Radiotelephony (RT) will be augmented by air-ground data communications, initially as a means of transferring non-critical messages (in terms of both time and safety), but this could eventually be extended to include some critical messages in certain circumstances. The net effect will be to reduce ATC workload per flight and thereby increase the potential capacity of the ATM network.

The development and implementation of the assistance identified in the following sections will be progressive and will need to remain in line with the operational needs and the ability of the controllers and pilots to fit them safely and usefully within their cognitive control processes at anytime; therefore it will be a central consideration throughout the transition.

In addition, there is a need for safety nets involving tools that monitor the traffic situation and trigger alarms when predictions of the evolving traffic situation indicate that safe separation minima or safety parameters are likely to be infringed. Ground based safety nets will not be coupled to airborne safety devices, such as ACAS, to maintain independence between the ground and airborne segments of the safety assurance system.

6.5.1. Separation Assurance Safety Nets

Controllers continuously monitor traffic to identify potentially dangerous situations. Automated ground based safety nets add to this human safety monitoring function by providing warnings on a systematic basis where the system determines that there is a risk of separation infringements. Collision avoidance safety nets such as ACAS are not considered as being part of the normal ATC process since they do not deal with preservation of separation minima but with prevention of collisions and they are discussed in section 6.9 below.

Separation assurance safety nets should be more widely implemented to provide warnings on potential hazardous situations between aircraft and:

- other aircraft, through the short term conflict alert tool (STCA)
- special airspace, through the airspace proximity warning tool (APW)
- terrain, through the minimum safe altitude warning tool (MSAW)
- other aircraft and vehicles on airport manoeuvring area (runway incursion alert tool)

The effectiveness and reliability of ground based safety nets can be improved by using aircraft derived data. Additional and more accurate data will improve the calculation of potential separation infringements and contribute to a reduction in false alarm rates and to the optimisation of alerting parameters.

Operational Improvements	
Improve Ground Based Safety Nets in ATC Units	Step1
Use Aircraft Derived Data for Ground Based Safety Nets	Step2

6.5.2. ATC Decision Support

ATM capacity is heavily dependent on the tactical control of aircraft movements at ATC sector level and, therefore, often related to the capacity limit of the tactical controller, rather than the potential quantity of aircraft separated by the prescribed minimum standard. While automated flight data processing, fixed procedures and automation of communication have facilitated the task of the planning controller, the burden of the air traffic control task rests mainly with the tactical controllers.

There should ultimately be a re-distribution of the tasks between the tactical and planning controllers. The provision of decision support tools to aid the planning controller to resolve conflicts before they present themselves to the tactical controller and to assist in last minute co-ordination will contribute to reducing the workload of the tactical controller so that traffic overloads are mitigated and safety risks are minimised.

ATC decision support will be improved by the provision of automated support to conflict detection, conflict resolution, and traffic complexity reduction.

Currently, there is a gap between the management of traffic flows at European level and the control of flights in individual sectors. Additional support tools will be developed for decreasing controller workload by further smoothing flows of traffic and de-conflicting flights in a multi-sector/multi-unit environment. In particular these tools will assist controllers in alleviating Traffic complexity, density, or flow problems.

The tools will be further enhanced by using aircraft derived data: as a first step using interoperability between AOC and ATM systems to enhance the accuracy of ATC trajectory prediction; then by direct transfer of discrete parameters from aircraft to ground systems; and finally, when ATM systems will receive aircraft generated trajectory data from current aircraft position to destination. The comparison between the flight plans used in airborne FMS and ground ATM systems is expected to greatly enhance safety and efficiency.

Operational Improvements	
Provide Automated Support for Traffic Complexity Reduction	Step2
Provide Automated Support for Conflict Detection	Step2
Provide Automated Support for Conflict Resolution	Step2
Enhance ATC Decision Support by Using Aircraft Derived Data	Step2

6.5.3. Arrival, Departure and Surface Movement Management

The main function of arrival and departure management is to maximise utilisation of the airport and minimise airborne congestion and delay. Whilst en-route limitations are mainly governed by the separation with other aircraft and available airspace capacity, arriving and departing traffic have the additional constraint of the runway and airport surface capacity which is dependent on many factors and also need an efficient surface movement management to make best utilisation of the available surface capacity. These functions will need enhanced procedures and controller training, and will be supported by automated assistance tools .

Efficient surface movement, departure and arrival management requires to be considered in a gate-to-gate context where each flight is regarded as a continuum from pushback to engine shutdown.

Improved arrival management will aim at smoothing unavoidable arrival delays over larger portions of airspace along the route of the aircraft. Since many airports use runways for both arriving and departing flights, Arrival and Departure Management (AMAN and DMAN) ultimately need to be considered as a combined entity, itself closely linked to surface movement.

In the passive mode, AMAN will provide time advisories to controllers for metering of aircraft through constraint points. In active mode, AMAN will provide controllers with tactical control order advisories (speed and/or heading) through the constraint points allowing better utilisation of airspace and reducing controllers' workload.

Automated support to departure management aims at optimising the sequence of departures for one or more runways and providing advisories to controllers, exploiting runway capacity, CFMU-slot-compliance and airline and airport preferences, as well as constraints such as the departure rates into specific directions or minutes-in-trail or miles-in-trail minima for specific SIDs.

The development of management tools has been undertaken in an incremental way to master complexity. Several operational improvement steps are therefore proposed for an incremental implementation of the three components, which address the individual tools (automated support for arrival management, departure management and surface movement management), then their integration and ultimately the use of aircraft derived data for arrival, departure and surface movement management to improve their effectiveness. Collaborative decision making principles will be applied to these tools.

Operational Improvements	
Provide Automated Support for Arrival Management	Step2
Provide Automated Support for Departure Management	Step2
Provide Automated Support for Integrated Arrival, Departure and Surface Movement Management	Step4
Use Aircraft Derived Data for Arrival, Departure and Surface Management	Step4

6.5.4. Interoperability, Communications and Surveillance Efficiency

Communications between the tactical controller and pilots are a major contributing factor to ATC sector overload problems. Air/ ground and air/ air data communications open a new operational perspective with reduced workload, and thus increased productivity (reduction of voice communications workload and automation of some of aircrew and controller routine tasks); increased flexibility (provision of a new communications medium); ?improved situational awareness; considerable increase in availability and sharing of information for all parties involved in ATM.

The current generation of Flight Data Processing Systems calculates future flight paths on the basis of known flight plan data, generic aircraft performance data, known ATS environment constraints and surveillance data provided by terrestrial sensors. In future systems, airborne data will be transmitted from the aircraft to the ground. Automated Downlinking of Airborne Parameters (DAP) will provide airborne data e.g. speed, heading, vertical rate and intent data to ATC ground systems.

Currently ATC Units are interconnected through on line data interchange (OLDI). In view of consistency with future enhancements, in particular the use of aircraft derived data, it will be necessary to introduce new forms of interoperability and wider availability of data. All users of flight data, will need a source of up-to-date, consistent, complete flight information for all planned and active flights that cross Europe. This will facilitate efficient information exchange between ground systems and aircraft Flight Management Systems (FMS) and provide a common view on the ATS environment to ground and airborne systems, including trajectory information and the operation of ATC tools and planning of flights without consideration of the boundaries of areas of responsibilities.

In the future environment, alternative solutions will be required for exchanging the clearances and instructions. Transferring routine air/ground communications from voice to data channels is a key goal for future ATC. Data exchange will supplement and not replace voice communication.

Using enhanced surveillance and communication techniques, it will be possible to improve the surveillance function by systematically receiving airborne data, in particular aircraft intent data to improve the trajectory prediction of ground systems and conformance monitoring.

Saturation of Secondary Surveillance Radar (SSR) interrogations has become a major problem in ATC. Deficiencies include garbling due to overlapping replies from two or more transponders, over-interrogation, reflections and shortage of Mode 3/A codes. The mandatory carriage of ACAS creating additional interrogations and the ICAO global requirement for all aeroplanes to carry and operate a pressure altitude reporting transponder exacerbate the growing problem of radio frequency congestion in airspace subject to high traffic density. To ensure that an acceptable level in the probability of detection is maintained, SSR Mode S alleviates shortage of SSR code and enables radar interrogators to address individual aircraft selectively. In this basic form, it has been termed Mode S Elementary Surveillance.

Operational Improvements	
Provide Consistent Flight Data	Step2
Use Data Link to Improve Efficiency of Communications	Step2

Automatic Provision of Airborne Data to Enhance Ground Systems Functions Including Surveillance	Step3
Maintain and Improve the Quality of Surveillance	Step1

6.5.5. Co-operative ATS

The introduction of air-ground and air-air data link, improvements to communications and greater automation will facilitate the sharing of data between air and ground systems in real time. This, in turn, will pave the way for co-operative ATS (COOPATS) that will:

- Provide for full information sharing between the air and ground;
- Optimise the provision of flight data to the ATM ground system and other authorised users (such as meteorology);
- Evolve towards an ATM environment where air-ground communication becomes an automated and secondary task;
- Support autonomous flight operations in designated airspace.

Situational awareness is a key factor in aviation safety. At present complete situational awareness is almost exclusively related to ground ATM functions, and based on available surveillance and flight data from aircraft that are being controlled. Pilots have a limited degree of situational awareness. Additionally, the ground ATM system is unable to benefit from information held in aircraft FMS about the flight and its future intentions, or the flight crew to benefit from information held on the ground about the present ATM situation or likely constraints.

Air traffic situational awareness is the flight crew's knowledge of the aircraft's state and the external operational environment relevant to the flight. As well as information on the terrain, aircraft position and weather, knowledge of the surrounding traffic situation in the air and on the ground (Air Traffic Situational Awareness) and of current ATM planning and constraints (Air Traffic Management Awareness) will become a central component for the safe management of the flight. Air Traffic Situational Awareness is a cornerstone of Co-operative ATS and will be one of the essential enablers for the delegation of separation assurance tasks to the flight deck in well defined and highly regulated circumstances.

Delegated services will enable the ground ATM to benefit from the capability of the flight deck – as a result of improved airborne situational awareness – to accept the delegation of some separation tasks. Delegation may apply in cases such as: station-keeping by aircraft; in trail climbs and descents; and parallel approaches. The extent of the delegation can vary from maintaining a certain spacing in particular conditions (eg: in-trail) up to separation from all other traffic. These levels of delegation can only come incrementally in the light of extensive experience in more elementary forms, and are subject to the establishment of suitable procedures and the demonstration that safety, human factors, cost-effectiveness and other conditions are met. The full delegation of separation can ultimately lead to autonomous aircraft operations in designated airspace where aircraft separate themselves from other aircraft. The safety, procedures, human factors, capacity aspects, costs and other requirements of autonomous aircraft operations will be determined and condition its applicability. However, it is recognised that such operations would likely start in airspace with low-density traffic.

The Common Trajectory Co-ordination (COTRAC) service supports optimal use of user-preferred trajectories. The purpose of which is to establish and agree 4D trajectory *contracts* between aircrew and controllers in real time using graphical interfaces, air and ground data communications and automation systems (in particular the FMS), by means of a structured negotiation method in order to significantly enhance ATM capacity and flexibility. The co-ordination of trajectories will be performed more effectively by involving Airline Operations Centres (AOCs) in the loop. COTRAC will enable trajectory based ATM.

Operational Improvements	
Provide Airborne Traffic Situational Awareness	Step3
Delegate Separation Service	Step4
Facilitate User-preferred 4D-Trajectory	Step4
Empower Autonomous Aircraft Operations	Step4

6.6. Airport ATC

Within the gate-to-gate concept of the Strategy, airport ATM operations focus on maximising airside capacity commensurate with the existing infrastructure. This will be achieved by the application of new concepts and procedures supported by improved technical systems, which will also help to maintaining or improve safety and reduce the impact of airport operations on the environment. To facilitate this aim, a series of measures will be implemented, including the consistent use of best practice; new surface management concepts and procedures, including advanced landing systems; integrated capacity management processes based on CDM and system-wide information sharing; and improved weather forecasting, including wake vortex detection. Airport operations are crucial in gate-to gate as they interface with most ATM actors and those of landside and they have to manage these interfaces. In addition, airports directly integrate with other modes of transport and feed air transport with passengers and goods, as well as stimulating competition when alternative transport modes are available. .

The cumulative effect of these improvements, together with related changes in other core ATM processes, will provide the basis for the enhancement of traffic throughput in low visibility conditions, so that declared airport capacity can be consistently applied in all weather conditions. However, full realisation of full airside capacity gains is also dependent on complementary landside improvements.

6.6.1. Traffic Management on the Movement Area

Improvements in managing arrival and departure traffic and runway operations, ensuring optimisation of the airport surface traffic flows, and the minimisation of ground and airborne delay are the primary aims. Delivery of the improvements will be contingent on the integration of the aerodrome control service with airport operations, aircraft operations and en-route ATM in a gate-to-gate system. Safety will be enhanced through the implementation of improved tools and procedures for conflict detection and alert, as well as improved ground guidance systems that increase situational awareness both in the cockpit and on the ground. Cost efficiencies realised by reduced taxiing times will also produce environmental benefits..

Operational Improvements	
Improvement of Aerodrome Control Service on the Movement Area	Step1
Improvement of Conflict Detection and Alert for the Movement Area	Step2
Improvement of Planning and Routing on the Movement Area	Step2
Improvement of Guidance and Control on the Manoeuvring Area	Step3

6.6.2. Airport Capacity Management

The aim is to develop management information techniques using CDM and Systems Wide Information Management (SWIM) processes that will generate efficient flows of aircraft from/to the runway system in order to optimise arrival and departure streams. As experience is gained, these management techniques will be refined further with the aid of new technology, reducing or potentially eliminating altogether the amount of time aircraft have to hold in the air or on the ground. The process will start with the strategic planning phase beginning with the improvement of airport scheduling using flow and capacity management data, and then further develop in the medium term to involve all concerned airport stakeholders.

Operational Improvements	
Improvement of Airport Scheduling using Flow and Capacity Management data	Step1
Enhancement of Airport Operations through Information Exchange between ATC, ATFM, Airport Operators and Aircraft Operators	Step2
Airport Collaborative Information Exchange Including Gate Management	Step2
Optimisation of Airport Operations in All Weather Conditions	Step2

6.6.3. Airport Throughput

A series of improvements will be introduced which, initially, will address arriving traffic and departing traffic and, subsequently, their integration with ground movement traffic. The aim is to optimise the airport manoeuvring area traffic flows and the minimisation of ground and airborne delays. Implementation will be technologically orientated, supported by new cockpit and ground procedures, and will be realised through enhanced arrival and departure management tools which sequence and meter traffic to maximise runway utilisation. Further developments in the long-term will address not only the integration of aircraft surface movement, but also ground vehicles on the movement area. The ultimate aim, beyond 2015, will be an enhancement of the system which extends the planning horizon by including both departure and arrival airports within the gate-to-gate context.

Operational Improvements	
Enhancement of Airport Operations through Arrival Management	Step2
Enhancement of Airport Operations through Departure Management	Step2
Enhancement of Airport Operations through Fully Integrated Arrival, Departure and Surface Traffic Management	Step3
Further Enhancement of Aerodrome Operations from Gate to Gate	Step3

6.6.4. Airport Airside Capacity

Further medium-term improvements to airport capacity which are complementary to other planned initiatives will address reduced separation and reduced runway occupancy times. New procedures will be developed, supported by improved surveillance systems, which will enable airports to reduce aircraft separation both in single and parallel runway configurations. At the same time, developments in wake vortex detection will enable separation standards for both arrivals and departures to be minimised but consistent with safety.

Operational Improvements	
Enhancement of Movement Area Utilisation	Step1
Optimisation of Arrivals and Departures Based on Wake Vortex Detection	Step2

6.6.5. Airport Horizontal Initiatives

The introduction of short-response improvements in airport operations performance will be achieved through the selective introduction of "best in class" procedures and techniques on an European basis. The implementation of best practice will address the application of best practice arising from benchmark studies and deriving and applying capacity models to more accurately determine airport capacity. Additionally, it will address a reduction in the environmental impact of air transport. However, the successful implementation of best practice, whether at individual airport level, or on a harmonised basis, will require a pro-active stance by airports, and co-ordination and co-operation with other stakeholder groups.

Operational Improvement	
Implementation of Best Practices and Refined Procedures	Step1

6.6.6. Environmental Protection at Airports

Airport operational environmental protection will address the minimisation of the impact of aircraft noise and of gaseous emissions, harmonised environmental standards on an European basis and demonstrated compliance with regulations and noise capacity management. Application of aircraft noise and emission regulations and standards at airports will be achieved through improved cockpit and ground procedures. The monitoring of aircraft noise at airports will not be an ATM function. Nevertheless, there will be correlation between the two to ensure compliance with procedures.

Operational Improvements	
Minimisation of Noise and Gaseous Emissions	Step2
Support for Efficient Management of use of Available Environmental Noise Capacity	Step1
Harmonisation of Environmental Standards and Support For Compliance with Environmental Regulations	Step2

6.7. System-Wide Information Management

6.7.1. Information Sharing

Today's information barriers arise because most ATM legacy systems have been developed and built independently and bottom-up, thereby preventing the easy exchange of information even though it may be readily available in isolated systems. In some instances, the same information is created several times in several places by different systems. In addition, some actors are extremely reluctant to share information, which they consider to be "commercially sensitive".

Information sharing and CDM have been identified as fundamental enablers for the success of a fully co-ordinated, harmonised, evolutionary and flexible planning and control process. Lack of integration, interoperability and information availability in the air and on the ground has been cited as a hindrance to more efficient planning and operational decision-making. ATM information management will need to evolve in order to remain compatible with the changing information management concepts of the interacting stakeholders (airspace users, airports, military systems, MET service providers etc.). Whilst the principles of CDM and gate-to-gate exist today, they are not standardised and little benefit can be derived. There is an urgent need for work to be done on defining interfaces.

Information Management (IM) provides a framework aimed at supporting the cross-domain harmonisation and integration of those concepts, standards, procedures, systems and architectures which are directly related to improving the logistics of information sharing between all ATM stakeholders.

One of the key enablers for CDM is an environment in which the best possible picture of the current and likely future traffic situation is assembled, and the various actors are provided with comprehensive, accurate and timely information for their decision making. This is referred to as System-Wide Information Management (SWIM). An open systems environment and better information management will allow information sharing on a much wider basis than hitherto, and support a permanent dialogue throughout all phases of flight.

By introducing common information management concepts for all ATM information, SWIM will ensure that the information needs of stakeholders within and outside the ATM system can be satisfied in a much more cost-effective, flexible and efficient way than today. This should also allow working in a closed loop that includes the AOC and flight deck.

CDM requires a new approach to sharing information, but its initial application does not require major investment in information networks. It can be implemented first by interfacing existing systems to provide better quality of data based on common information elements and interactions. This interfacing can start on an ad-hoc basis initially, but will require the progressive development and introduction of commonly agreed standards and procedures. This should be accompanied by industrial system components for advanced applications.

6.7.2. Aeronautical Information Services

The current role of Aeronautical Information Services (AIS) is to deliver information in conformance with the Integrated Aeronautical Information Package, as defined in ICAO Annex 15. AIS ensure the flow of information needed for the safety, regularity and efficiency of international civil aviation. Each Contracting State is required to provide an aeronautical information service and to publish aeronautical charts. States are responsible for the information provided. The information must be timely, provided in a suitable form and of high quality. Today the provision of information is largely a semi-automated process which requires significant manual intervention and one which remains wedded to the principle of a master, paper reference document, the Aeronautical Information Publication (AIP), changes to which are promulgated by printed Amendments and Supplements or electronic NOTAM.

6.7.2.1 AIS in CNS/ATM

The role and importance of aeronautical information/data has changed significantly with the implementation of area navigation, required navigation performance (RNP) and airborne computer-based navigation systems that are data-dependent. Aeronautical data have, therefore, become crucial and critical to the network.

AIS and mapping (MAP) services are essential components of ATM. Quality aeronautical information is required for the precise navigation necessary for guidance for gate-to-gate operations. These include the ability of aircraft to navigate on the ground and en-route using on-board navigation systems that can calculate the precise position and the optimum tracks and trajectories based on the latest information.

To support and facilitate the transition to the new global CNS/ATM system, aeronautical information and charting systems, will be further developed and oriented more towards global requirements as well as regional and national needs. A comprehensive reference database of quality assured aeronautical information for the ECAC area will be developed. These developments will contribute to improved safety, increased efficiency and will provide more cost-effective services to users. New specifications for electronic aeronautical data including terrain and vertical obstruction information will be developed.

Specifications for AIS and MAP digital information will need to be developed to take advantage of emerging communication facilities such as data link.

6.7.2.2 AIS in Collaborative Decision-Making and System-Wide Information Management

The development of CDM tools necessary to support the future global ATM network will require access to global aeronautical information of the required quality. The aim, within the framework of system wide information management, will be to move to a system that provides on-line quality aeronautical information to users in real-time. To achieve this, aeronautical information must be provided in electronic form based on a commonly agreed and standardised data model. Strict quality principles will be put in place to ensure that aeronautical data is available, verified and validated.

6.7.3. The AIM Strategy

AIS must make the transition from supply of predetermined products to the management of aeronautical information to serve future ATM needs. The service shall meet this challenge by enabling all the various elements of data to be made directly and quickly accessible by use of new techniques and technology. New specifications for origination, upkeep and exchange of electronic aeronautical information are required, catering for existing categories of information and for additional ones, including terrain, vertical obstruction and airport data or information (such as taxiway data for advance surface guidance and control system (A-SMGCS) and for in-flight transmission via data link. To achieve this an Aeronautical Information Management (AIM) system must be introduced to handle the logistics of information sharing in the future information-rich networked ATM environment. The objective of the AIM Strategy is to achieve a uniform and efficient aeronautical information management structure, within the framework of system-wide management of information, to support all phases of flight.

The objectives of the AIM Strategy are to:

- Develop AIS into AIM as a core process of ATM;
- Ensure the provision of aeronautical information of agreed quality & timeliness for all phases of flight;
- Ensure the accessibility of aeronautical information during all phases of flight;
- Migrate from the publication of aeronautical information products to the provision of each individual data element of aeronautical information in electronic format to support the ATM environment and CDM;
- Adopt harmonised data content, structures and procedures on a global basis to enable a fully digital aeronautical information environment;
- Support the management of human resource activities associated with the transition towards the future aeronautical information environment;
- Resolve institutional, organisational, legal, financial and intellectual property issues associated with the evolution of system-wide management of aeronautical information;
- Support the continued harmonisation and integration, as appropriate, of military and civil aeronautical information.

The objectives listed above have given rise to a number of main lines of action, which cover not only technical and procedural issues but also identify ancillary legal, financial and organisational aspects that will need to be addressed.

Operational Improvements	
Improve AIS data quality	Step1
Implementation of Aeronautical Information Management	Step2

6.7.4. Meteorological Services

All phases of flight can be significantly affected by meteorological conditions. Safety, regularity and efficiency of air traffic will increasingly depend upon the timely, accurate, complete and up-to-date availability of Meteorology (MET) information to pilots, controllers, and planners.

Through co-operative links between ATS and MET service providers, ECAC needs will be integrated to provide the information that is necessary and sufficient for aviation purposes:

- Wind information for flight planning;
- Severe weather (thunderstorms, icing, turbulence);
- Volcanic ash;
- Low visibility and low cloud;
- Wind shear, turbulence and wake vortex;
- Airport conditions, snow, ice, etc.;
- Distribution, integration and display of information.

Improved accuracy and timeliness will facilitate flight trajectory prediction resulting in greater precision in ATM networks and collaborative decision-making. This will improve efficiency of ATM and aircraft operations. Adverse weather conditions can be identified and managed more efficiently, thereby improving safety and flexibility, for example by routing aircraft around bad weather and providing more timely information on the need for diversion.

The management of aeronautical MET within ECAC will be progressively improved by co-ordination, under the EUROCONTROL Organisation, of activities such as:

- Assessment of current capabilities, developments and best practice;
- Assessment of emerging capabilities and the changes necessary and sufficient to meet future operational needs;
- On-board aircraft meteorological data gathering for real-time MET data;

- Provision of appropriate MET facilities at airports including data processing and communications;
- Minimisation of environmental impact of aircraft;
- En-route capacity optimisation during adverse weather;
- Assessment of costs, network-wide benefits and cost-recovery;
- Co-operative formulation of global standards with ICAO and World MET Organisation;
- Implementation of performance management and feedback to Meteorological Offices.

These activities will lead to programmes of work associated with ATM including, inter alia, the extent to which MET improvements act as an enabler to:

- Time-based separation on final approach;
- Greater ATFM accuracy;
- Trajectory prediction and conflict resolution;
- Airport air-side capacity optimisation during adverse weather;
- Use of RNAV in TMAs;
- Reductions in weather-induced accidents.

In due course, the Strategy will address the benefits of:

- Air-to-ground observations to improve overall forecast performance;
- Ground-to-air forecast updates (nowcasting);
- Air-to-air significant weather reports.

6.8. Human Resources Management and Human Factors

Most of the envisaged technological and operational changes and improvements have human and social implications and a considerable impact on the working practices, workload and performance of ATM staff.

It is stressed, in particular, that the quality and timeliness of adequate training are keys to successful transition to working with new procedures or operating environments.

This means that all staff requirements both in numbers and performance should be addressed and future roles and responsibilities of ATM staff are proactively defined and implemented to ensure safe and efficient ATM operation at all times. This should include specific actions to address related issues, in particular roles and responsibilities of staff, staff training, adaptation and buy-in to change, staff ageing or the long term future of jobs.

The vision is that human issues are naturally considered and managed as key enablers for all improvements in European ATM and that harmonised and integrated human performance is achieved, now and in the future. Within this framework the human aspects of developments in the areas of safety and within the overall ATM context institutional and legal issues should be considered.

This implies:

- Building ATM tasks and tools on people’s strengths and compensating for human limitations;
- Placing methods, tools and procedures to ensure that the right people are in the right place at the right time;
- Involving staff at early stages to build confidence and to sustain commitment for transition and change;
- Offering careers in ATM which are sufficiently rewarding to attract and retain high quality staff;
- Working in partnership with EATMP Stakeholders to foster the evolution of ATM that meets the increasing demand for safe and efficient air travel.

In regard to human issues in ATM the following specific **trends** have been identified:

- **Changing attitudes towards human issues:** increased awareness of the importance of considering human aspects in ATM. Specific human factor issues such as human error, stress and teamwork are established components of day-to-day operations. Once properly addressed they will have a significant impact on the safety and efficiency of ATM. Efficient use of new tools and procedures largely depends on well-designed task sharing and human-machine interfaces.

- **Shortage of ATC staff in the ECAC area:** The shortage of ATC staff will, in some areas, remain a constraint for the next five to seven years despite efforts made, and solving this issue must be given a high priority. Long-term staff planning tools will enable improved management of staff planning processes.
- **Changing attitudes towards work, employment and mobility:** In some parts of Europe, young people have a more open and flexible approach to employment and desire to work in different environments for shorter periods of time rather than remaining in the same environment for life. To attract them to jobs in ATM is increasingly difficult. Increasing efforts to market and communicate the challenges and career opportunities in ATM are required to attract and retain candidates with high potential.
- **Impact of electronic media on learning and information processing**
- **Increase of automation and automated tools in ATM:** This issue needs to be addressed and managed as early as possible in the life cycle of new ATM system developments.
- **Changing roles and responsibilities of ATM staff:** The sharing of roles and responsibilities amongst ATM staff, between controllers and pilots and between humans and machines, is likely to change. A different set of skills, knowledge and core competencies is required of ATM staff to work in a safe and efficient manner.
- **Organisational changes in ATM:** To ensure a high safety level in ATM, staff needs to be sufficiently prepared and protected to cope with the evolving business culture.

The major **challenges** related to human issues and associated actions are:

- **The right investments in human issues:** To increase awareness that proactive management of human issues is a key enabler in any ATM organisation, and that the human-related issues are key success factors for current and future ATM. To encourage close co-operation, resources sharing, and exchange lessons learnt.
- **The right people at the right time:** To improve ATM staff planning and deployment throughout the ECAC area, the marketing of ATM jobs and emphasise the career opportunities available in order to increase the number of new recruits. To use advanced, effective and efficient methods and processes for selection and recruitment of ATM staff. To develop and implement new ATM training methods and tools (e.g. E-learning) and thus make training more efficient. To develop regulations for safety critical tasks in ATM and license staff if appropriate. Also to develop and implement personal and career development options with the aim of motivating and retaining ATM staff.
- **The right job, the right workplace and the right tools:** To support the creation of ATM tasks and tools which have to be built on people's strengths and weaknesses and compensate for human limitations. To identify the right level of knowledge and skills, and provide training and development opportunities for changing roles and responsibilities. To quickly identify and balance the impact of automation on human performance through the measurement of mental workload, situational awareness, error management, trust, teamwork, etc. To identify and manage cultural and organisational factors that foster involvement and commitment for transition and change.

Two major operational improvements have been retained for the medium-term:

- **Timely availability of ATC staff:** Availability of suitable numbers of ATC staff with the right skills, knowledge attitude and motivation to assure and deliver expected ATM performance and sufficient ATC staff to operate Air Traffic Services. This will be achieved through continuous improvements of the manpower planning, job marketing, recruitment, selection, training, licensing and career development processes;
- **Proactive management of human performance:** Full integration of human factors into the life cycle of ATM systems to ensure the best balance between human and machine capabilities, and achieve a state-of-the-art and sustainable situation in this area. This will be achieved in a number of cases by adjustments to the future roles, skills, tools and methods of all actors in the ATM system.

Strategic Direction

Many operational improvements have human aspects as important enablers that will need appropriate handling in the lifetime of the Strategy. A clear need is to link and apply the HUM products and expertise to the development of the various operational improvements, ensuring early implementation of human issues into the developments of new systems and procedures.

In addition, in the EC's proposal for a *Single European Sky,* human aspects are one of the main lines of action with some identified major areas to be dealt with in close co-ordination with the EUROCONTROL Agency in the short-medium term. These include the increased mobility of ATM staff and the establishment of an appropriate social dialogue.

The HUM products developed so far have now to be customised and implemented by the Air Navigation Service Providers (ANSPs).

Up to now work has focussed on the development of a recommended strategic framework (e.g. concepts, methods and tools) for the management of human issues in ATM. In the coming years the strategic direction for future HUM activities will be in the validation, refinement and full exploitation by responsible authorities of the strategic framework for the management of human issues in ATM, with:

- **Investment in long-term innovative research**;
- **ECAC customisation and implementation support:** to provide support in order to apply the framework for the management of human issues in ATM;
- **Human factors integration support to EATMP:** to apply HUM expertise, methods, tools and products to concept formulation, design, implementation and operation of projects. To provide a regulatory framework for human factors integration through the application of human factors cases similar to a Safety Case for Safety Management.
- **Expansion and maintenance of HUM products:** in accordance with stakeholder needs and evolving strategic priorities, to complement and adapt existing products to guarantee their validity of use, including the integration of ATM-related environmental issues.
- **Marketing and communication:** To build and maintain relationships between all practitioners through regular information exchange and meetings. To encourage and support the establishment of national and local expertise and processes in order to improve the management of human issues in ATM.
- **Acceptance of Change:** The number of changes foreseen in the time span of the Strategy is closely related to proper information and consultation. This should be applied through the principle of "labour buy in', in advance of the management acceptance, to secure successful transition.

  In discussing future roles and the assistance that automation can provide, aspects such as the balance between creative/routine monitoring tasks with the human in the loop, or vigilance and job satisfaction, etc, will need to be addressed and assessed

Operational Improvements	
Timely Availability of ATC Staff	Step1
Proactive Management of Human Performance	Step1

6.9. Collision avoidance Safety Nets

Collision avoidance safety nets, either for prevention of collisions between aircraft (ACAS) or with the ground (GPWS and its evolutions) are not considered as part of the ATM process, and will be kept distinct from the normal separation process and the ATM safety assessment. Nevertheless, they may affect ATM and imply dedicated procedures to prevent undesired effects of their interactions with ATC.

The mandatory carriage of Airborne Collision Avoidance System (ACAS) II started in 2000 and ACAS will be fully deployed in 2005. Beyond this implementation, it is foreseen that a second generation of airborne collision avoidance systems would benefit from the advances in data communications and the availability of aircraft intent information to improve threat detection and alert using situational awareness, in particular broadcast traffic information (TIS-B) around airports, to prevent runway incursion and to prevent penetration of airspace used for special activity. This includes Enhanced Ground Proximity Warning Systems (E-GPWS) to reduce CFIT. In addition to airborne meteorological radar, devices to detect atmospheric hazards will be considered, e.g. for wind shear or turbulence and possibly be the subject of supplementary operational improvements at a later stage.

Operational Improvements	
Implementation of ACAS II [TCAS II, Version 7] in ECAC Airspace	Step1
Improved Airborne Safety Nets	Step4

6.10. Technical Integration

Enablers can be defined as elements being necessary to achieve required operational improvements of ATM systems. They can be split up into two categories, technical and other enablers, the latter encompassing agreements on adaptations of working arrangements between ATC Units or the training of operational/technical Staff for new ATC procedures and the introduction of new technologies.

Technical enablers constitute a large category but there are a few universal rules applicable to all of them. In particular, their definition and implementation should make use of common standards defined by industry on the basis of set safety and operational requirements, and where necessary to achieve interoperability requirements, enforced by regulatory measures. Following this principle should result in:

- Better products that are more robust with reduced costs;
- Assured industrial support;
- Facilitated integration of new or enhanced system elements.

Generally, it is vital that the technical infrastructure on the ground is compatible with modern aircraft and equipment, to prevent that airborne investments are wasted because they are not used for the purpose for which they have been built.

6.10.1. Overall Architecture and Data Processing systems

Both the air and the ground share the need for their systems to process flight data described by reference to a common aeronautical environment. The aircraft trajectory is predicted at various stages, from the early strategic and broad flight plan to the accurate description of the a flight segment between two way-points and the behaviour of the aircraft in the next few ten seconds. The trajectory is the object with which both ATM and the aircraft operators work. In the future concept, it is the central object for the all processes and for the exchange of information and CDM applications. The systems that support the computation of flight trajectory data will therefore have a vital importance in the future.

This calls for the urgent need to define and standardise a common data dictionary to describe the various types of information handled for ATM purposes and carried by CNS systems, and to prepare a common architecture to enable the interoperable functioning of the ATM systems. It must be an overall ATM/CNS architecture encompassing the airborne and ground components, as well as the interfaces to the ATM stakeholders. It should be open to allow for evolution, adaptability and scalability to cater for subsequent changes and developments, and be based on robust industrial solutions. Owing to the long lead times in defining and deploying new architectures in real-time safety critical systems like ATM systems, care should be paid to influence the design of supporting technologies while reducing to the strict minimum the recourse to ATM-specific solutions.

The advantage of a properly expressed information architecture including the interoperability aspects is that it allows the definition of a component-based logical architecture, which is the approach followed in the Overall ATM/CNS Architecture Project. The logical architecture describes the location and grouping of services and functions, and thus where interfaces have to be provided. The concept of component-based architecture is designed for distributed environments where information and actions are shared between partners. Basically, a component is a self-contained building block, providing/using services, and exercising a responsibility in the system. It communicates with the others via plug-and-play such as middleware and other open communication means. The resulting architecture de-couples technology from applications, simplifies development and incremental evolution. It is founded on operational scenarios that are developed from the operational concept to ensure that the architecture meets operational needs, and is reliant on middleware to meet interoperability needs and to distribute information and functions.

The basic logic is that services drive information requirements, and in turn the architecture and the enabling infrastructure. It therefore ensures that system design and transition steps are driven by the needs instantiated by a clear vision of the long term harmonised aim. The complexity of adding to existing infrastructure or developing new links should not be a barrier to implementing new information distribution methods.

6.10.1.1 Flight data processing systems

FDPS are the heart of the ground ATM systems. Even though the CFMU/IFPS have unique functions, they also handle trajectory data. FDPS need to be adapted to the way routes are designed and traffic handled by control units. Legacy systems are still in a number of cases based on IT design concepts inspired from the time where memory was a rare resource and computing power very limited, and hence their internal representation of trajectory and other operational data is reduced to the extreme and twisted by proprietary tricks that offer limited possibility of dialog between systems and do not allow to develop modern automated assistance tools.

A particular effort is necessary to make FDPS open and interoperable, as a set of components in the future architecture, in particular by ensuring that data objects are suitable to the future concepts.

6.10.1.2 Flight management systems

FMS will benefit from accurate navigation sensors. In the period covered by the Strategy, it is foreseen that 4D functionalities will be developed to allow accurate 4D rendezvous at specified way-points, and a capability to support the pilot in maintaining a time or distance based spacing from a preceding aircraft. The FMS will need to be open and communicate with other systems via data link.

6.10.2. CNS STRATEGIES

The role of the CNS infrastructures is to support and enable the practical operation of ATM. ATM improvements can often only be realised when supported by improvements to one or more of the CNS components.

CNS developments are not only driven by ATM needs, but also by the general evolution of technology. This enables the implementation of more cost-efficient infrastructures, and may also provide opportunities for ATM evolution.

Interaction between ATM and CNS strategy developments and plans is needed to ensure that CNS support required by ATM is available, and that ATM is able to benefit from increased CNS functionality and performance enablers through technical evolution.

CNS infrastructures need to be compliant with operational and general requirements. Operational requirements are directly derived from the supported ATM function and include safety requirements. These requirements have an impact on the design and development of the CNS components and their test methods. General requirements apply to the entire infrastructure and are related to economical principles and the environment in which the CNS components are used. Important requirements include:

- The applied technology for CNS needs to be mature;
- Whenever technically and economically feasible, new technology and CNS components should built on or integrate with existing CNS infrastructure;
- Upgraded or new CNS infrastructures need to be scaleable in terms of performance and geographical coverage;
- CNS infrastructures involving airborne components need to be globally inter-operable.

Development and implementation strategies have been defined for the CNS domains in which system and service enhancements are laid down as a function of time. The strategies develop from a number of specific requirements, such as operational need, technical practicability, dependencies on other domains, etc. They provide the direction for the development and deployment of the necessary enablers.

The link between enablers and improvements for aircraft and airport operators and ANSPs has been defined.

6.10.2.1 Communications Strategy

The primary objective of the communications (COM) strategy will be to provide the framework for the development of a safe, secure, efficient and cost-effective set of communications solutions. The events of 11 September 2001 have emphasised the need for enhanced communications that must be able to withstand attack. Hence the strategy will evolve to meet the new challenges. The need for global solutions coupled with backward compatibility is well understood. It is also essential to consider developments in the light of the economic states of the aviation industry and to recognise the impediments to implementation that an economic downturn can impose.

Communications may be subdivided into three main elements, namely:

- Ground/ground;
- Air/ground;

- Air/air.

The challenge for ground/ground communications is to provide a cost-effective infrastructure that can interconnect existing national infrastructures, including connections to airlines, airports and external organisations. The need to interface with legacy systems is an essential part. Both voice traffic and large volumes of data must be catered for. Security, network addressing, and network resilience are key factors. Of particular importance will be protection against cybercrime.

Future operational requirements dictate the need for enhanced air/ground communications. For example, ATM based on flight intent will necessitate a substantial increase in data exchange between aircraft and air traffic control centres. Voice communications for urgent and non-routine requirements will need to be maintained. The strategy foresees the implementation of VDL Mode 2 and also considers systems such as VDL Mode 4 & 3. In the longer-term, spread spectrum systems could play an important role and validation work has already begun.

Air/air communications would be implemented for operational applications such as Automatic Dependent Surveillance. In addition, given the independence from ground based systems, air/air communications will become important for operations over the ocean or remote areas.

Satellite technology is advancing rapidly and the related costs are reducing. It is therefore appropriate to validate satellite technology to provide cost-effective coverage and to relieve spectrum congestion. For example, the possibility of using satellite based services to compliment VHF services will be studied.

Evolution of the communications strategy will be undertaken in close consultation with stakeholders.

6.10.2.2 Navigation Strategy

The main objective of the Navigation Strategy is to identify a cost-effective, customer oriented, evolutionary transition of the European Air Navigation Systems towards a uniform European ATM network, and to provide a harmonised and collaborative ECAC framework to achieve this transition. The strategy describes available and potential air navigation applications and means of supporting these applications, in terms of required performance, functionality, and enabling infrastructure. It recognises the users' requirements as the main driver in its development, against a background of the ICAO Global Air Navigation Plan for CNS/ATM systems.

The main strategic streams are aimed at:

- Achievement of a total RNAV environment with defined RNP values in designated airspace for all operations ECAC-wide;
- Facilitating the implementation of the 'free routes' concept;
- Supporting the continued operation of General Air Traffic of non-compliant State aircraft;
- The implementation of 4D RNAV operations, to support the transition to a full gate-to-gate management of flight by 2015;
- Judicious deployment and use of supporting ground- and space-based infrastructure for all phases of flight, ensuring the transition to Global Navigation Satellite Systems (GNSS), including SBAS and GBAS, in the long-term, in line with ICAO recommendations;
- Supporting the continued operations of aircraft with lower capabilities as long as operationally feasible and in full awareness of the impact of changes on this population.

Advances in navigation functionality will be implemented to enable improvements in airspace design (structure, sectorisation, associated route network, applicable route spacing, separation minima and responsibilities, etc.), and allow for a high degree of flexibility for aircraft operations and for the navigational equipment used. Ultimately, all these elements, together with appropriate ATM tools, will enable operators to conduct their flights in accordance with their preferred trajectories, dynamically adjusted, in an optimum and cost-efficient manner.

The 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 for all phases of flight. Therefore, the total number of ground navigation aids is expected to be reduced to that necessary to provide that back up. Of particular relevance to ECAC in this respect is the EC decision to proceed with

EGNOS/GALILEO. In addition, provision of MMR will allow a smooth transition to satellite technology as well as availing of MLS at those airports where it is installed and ILS Cat III is no longer supported.

6.10.2.3 Surveillance Strategy

The Surveillance Strategy describes the evolution of the surveillance infrastructure through the exploitation of the benefits of new technologies, as they become available. The strategy is based on the use of various technological surveillance solutions allied to the anticipated context and performance requirements for particular geographical areas. It addresses the full scope of the gate-to-gate concept, and takes into consideration low cost solutions for general aviation and aerial work.

In response to the request for a clear explanation of how Primary Radar, SSR, SSR Mode S, Automatic Dependent Surveillance (Broadcast and Contract) and general-purpose data links will operate together within the framework of the Strategy up to the year 2015 a Surveillance roadmap has been developed to expose the various issues that interrelate and to draw conclusions regarding the potential future carriage of airborne surveillance systems.

Operational requirements emanating from the Strategy depend on the density of traffic to be monitored, and can be grouped into three generic categories, termed Development Phases, namely; Enhanced Surveillance, Intent Based ATM and Co-operative Separation Assurance. Various techniques are available to introduce the development Phases. These techniques can themselves be implemented by different candidate technologies.

All of the above factors need to be considered when examining the type of surveillance services that need to be provided over the life of the Strategy. Hence the road map foresees that each area of airspace needs to determine its own surveillance requirements depending on the specific issues to be addressed.

It is recognised that in high density areas, early introduction of SSR Mode S is seen as essential to overcome the limitations of the current SSR systems and allow capacity to increase whilst maintaining current target levels of safety. Enhanced Surveillance, that is the extraction of air derived data, is essential to improve safety nets and increase capacity through the implementation of Controller support tools. Intent Based ATM developments could be further implemented using adequate techniques that will eventually be required to allow air to air surveillance data exchange and the introduction of Co-operative ATS applications.

In low-density areas benefits from increased surveillance coverage will be realised by early deployment of ADS techniques in oceanic areas, as well as additional conventional radar sensors. Enhanced Surveillance is not foreseen per se, however safety benefits could lead to a wider implementation than currently envisaged. Enhanced Surveillance in these regions and use of intent to facilitate Co-operative ATS applications could be implemented using ADS techniques.

Thus a picture is emerging of a mixed surveillance infrastructure, comprising ground based surveillance techniques overlaid and inter-operating with ADS techniques, each performing specific tasks selected from the Development Phases.

6.10.3. Frequency Spectrum Management and Protection

6.10.3.1 Spectrum Management

One of the most important conditions for an improvement of ATM capacity, safety, and security is the availability and efficient use of the appropriate radio frequency spectrum enabling the maintenance of existing systems and development new of CNS systems of the ATM (i.e. data and voice communication, radio determination and radio navigation services). However, increasing competition for the use of frequencies, mainly from non-aviation interests, is jeopardising this availability. A political initiative was taken by MATSE/6 to ensure that sufficient frequency spectrum is allocated for aviation needs. It will require continuous attention and support to provide aviation with the required spectrum in the future.

6.10.3.2 Frequency Management

Considering the current saturation of the spectrum used by the aviation (especially in the VHF Communication band (AM(R)S) an improvement of the frequency management and assignment methods, including a review of the current assignments, a refinement of the allocation rules, as well as availability of central allocation system is required.

6.11.Quality Management and Continuous Improvement

The development and implementation of a comprehensive EUROCONTROL Excellence Policy and Strategy is to be undertaken by the EUROCONTROL Quality Forum (EQF).

This approach to Continuous Improvement and Excellence should:

- Provide a common framework for implementation of the EUROCONTROL Excellence Policy and Strategy,
- Provide a common understanding of Excellence to enable faster learning and transfer of Best Practice,
- Provide a way of measuring progress in the implementation of the Quality Management System and Continuous Improvement processes,
- Take into account the investments already made by ANSPs to fulfil the requirements of ICAO Annex 15 to have AIS ISO 9001 certified,
- Promote the use of systematic Continuous Improvement methodologies in accordance with guidelines such as the EFQM Excellence Model or ISO 9004:2000,
- Support the overall approach to Safety, Capacity, Cost, Environment and Security.

7. The Steps for Improving Performance

7.1. Main Change Periods and Steps

This section introduces the main change steps and associated periods to achieve the operational improvements described in chapter 6, fulfilling the requirements in chapter 3, and applying the approach of chapter 4 it expands the overall road map described in chapter 5.

For illustrative purposes, the ATM operational enhancements in the Strategy are grouped into four separate steps: leading to the target operational concept. The duration of the periods reflect the nature of the changes and vary because the foreseen activities and developments for the shorter-term are more mature and can be planned more accurately than those for the medium and long-term. The later step will be further refined when a more realistic planning of achievements can be given for medium and long-term improvements.

The steps can also be broadly characterised by the nature of work and decision they currently require:

Step 1: Already planned, being deployed; not much possibility of change;

Step 2: Subject of programmes, generally well advanced, but some discussion remains regarding possible implementation conditions;

Step 3: In development, requires substantial amount of validation, close to programme decision;

Step 4: Mainly at R&D stage, but some strategic orientation may need to be decided.

Statements in the next sub-sections concerning the anticipated performance improvement for each step are preliminary estimates, based on expert judgement, and are being reviewed on the basis of more analytical work. The next iteration of the work will benefit from both refinements of the performance assessment approach and better information and data on the individual changes. In addition, it should be noted that, for example, individual capacity gains provided by the different improvements cannot simply be added, since they might not provide gains in all parts of the airspace or in all traffic situations. They should also not preclude other gains being sought from the application of 'best practices'. It must be borne in mind that in all of the proposed improvements safety is never degraded. Indeed, most, if not all, of the operational improvements have an integral safety component.

7.2. Step 1 (up to 2004)

MAIN STRATEGIC ACTIONS	This step includes the full deployment of the harmonisation and integration measures which have already been developed and, for most of them, planned and which are visible in the stakeholder capacity plans and the ECIP/LCIP documents. It also relies on classical control-sector organisations. The main lines of action are to: • Reinforce the safety of the ATM network through deployment of safety management processes, ground safety nets and ACAS, as well as measures to enhance the quality of AIS; • Improve capacity as a priority and enhance efficiency wherever possible, by concentrating on airspace (organisation, routes and sectors), current procedures and human resources management (staff numbers and performance); • Enhance the performance and responsiveness of tactical ATFM (improve utilisation of available capacity); • Improved airport operations through efficient use of airport infrastructure; • Extend the use of best current practice.
CONCEPT CHANGE (re. App.2)	The main focus will be on extending the use of best practice and setting the foundations for the future strategic management and harmonisation of airspace. Initial applications for CDM will be introduced, mainly in ATFM. Airspace sector optimisation and additional flight levels in the upper airspace will remain the prime means of generating additional capacity.
SAFETY GAINS	Safety levels will benefit from the streamlining of procedures, the increased availability and improved training of the ATC staff, and the extended use of safety nets and further deployment of ACAS II.
OTHER PERFORMANCE GAINS	The combination of the changes is expected to be able to meet the capacity targets set by the EUROCONTROL Provisional Council, and some reduction in fuel burn per flight, which will benefit both flight efficiency and environmental objectives. It should help to at least stabilise total costs.
HUMAN RESOURCES	Associated changes to the management of human resources will comprise: • Development and introduction of methods and tools to analyse current and future tasks and the roles and responsibilities of operational staff; • Provision of strategic and tactical manpower planning data and tools to provide and maintain a sufficient number of qualified personnel; • Introduction of co-ordinated recruitment, selection, training and licensing procedures to provide a high ability profile of operational and technical staff; • Provision of resources and upgraded training for new human-machine interfaces and controller work positions; • Further deployment of individual and team resource management practices; • Development and introduction of awareness and training programmes for transitions and changes in tasks, roles and responsibilities of operational staff.
QUALITY MANAGEMENT, EXCELLENCE AND	• Develop a EUROCONTROL Excellence Policy and Strategy defining a common approach for Quality Management, Excellence and Continuous Improvement, and obtain approval by end of 2003,

CONTINUOUS IMPROVEMENT	• Implement a Quality Management System with a Continuous Improvement process as a minimum first step for core services and processes, e.g. implementation of a system to ISO 9001:2000, • Develop a common approach and methodology to define, measure and assess agreed targets and performance results, • Commence initial assessment against a common and agreed measure of Excellence

OPERATIONAL IMPROVEMENTS APPLICABLE IN: STEP 1 - UP TO 2004	**SEGMENTS WHERE CAPACITY WILL BE DELIVERED**
AIRSPACE ORGANISATION AND MANAGEMENT	
Harmonise ICAO Airspace Classification in ECAC Airspace (1A+2A)	
Extend FUA to Lower Airspace and Introduce Dynamic Airspace Allocation (3B+4B1)	ACC
Enhancement of ATS Route Network (2D+3D+4D)	ACC
Adapt Terminal Airspace Organisation (1E)	TMA
Adaptation of Sectors to variations in Traffic Flows (2F +3F)	ACC
ARN V4 (BIS) (1F)	ACC
Ad-hoc Direct Routing (1C)	
Implementation of Best Practices and Refined Procedures	ACC, TMA
FLOW AND CAPACITY MANAGEMENT	
Establishing Strategic ATFCM	ACC
Implementing OCM Principles	ACC
Facilitating FPL Filing & Exchange	ACC
Increasing ATFM Capabilities	ACC
EN-ROUTE ATC	
Improve Ground Based Safety Nets in ATC Units	
Maintain and Improve the Quality of Surveillance	
AIRPORT ATC	
Improvement of Aerodrome Control Service on the Movement Area	APT
Improvement of Airport Scheduling using Flow and Capacity Management data	APT, TMA, ACC
Enhancement of Movement Area Utilisation	APT
Implementation of Best Practices and Refined Procedures	APT
Support For Management of The Available Environmental Noise Capacity	
HUMAN RESOURCES MANAGEMENT	
Timely Availability of ATC Staff	ACC, TMA, APT
Proactive Management of Human Performance	ACC, TMA, APT
OTHER IMPROVEMENTS	
Implementation of ACAS II (TCAS II, Version 7) in ECAC Airspace	
Improve AIS data quality	

Note: Grey shadow indicate: *Pre-requisite for increased capacity* *OI not-capacity driven*

ACC (Area Control Centre);TMA (Terminal Control Area); APT (Airport)

TECHNICAL ENABLERS **Step 1 - up to 2004**	
GROUND INFRASTRUCTURE	**AVIONICS**
DATA PROCESSING SYSTEMS / TOOLS	
• Implementation of the Enhanced Tactical Flow Management System (ETFMS); • Upgraded human-machine interfaces and controller work positions; • Improved surface management systems and procedures at major airports; • Initial introduction of CDM applications; • European AIS data base. • Upgrade of STCA, MSAW, APW and runway incursion tool in order to allow the processing of data derived directly from the aircraft • Trajectory Prediction	• Most of avionics requirements already installed, not necessarily for all users and all airspace; • V-MASPs above FL280 mandated and implemented in 2002.
COMMUNICATIONS	
• Expansion of 8.33 kHz spacing to create more RT channels; • Introduction of ATN data communications infrastructure; • Introduction of mobile data communications at major airports to support departure clearances and ATIS;	• 8.33 KHz above FL245 mandated for implementation in 2002; • VDL Mode2 nominated as an optional replacement for ACARS.
NAVIGATION	
• Full exploitation of RVSM; • Increasing exploitation of satellite navigation; **PRECISION RNAV: BEING IMPLEMENTED IN SOME STATES.**	• Basic RNAV mandated since1998; • Precision RNAV: no ECAC wide mandate but capability can be exploited in some States.
SURVEILLANCE	
• Introduction of Mode S Elementary surveillance in the Core Area.	• ACAS II version 7.0 mandated since 2000; • Mode S Elementary mandated from 2003.

R&D / VALIDATION NEEDS

This period does not require research, but development activities. The main validation are related to the validation of performance gains and the support to operational acceptance and transition.

7.3. Step 2 (2005 to 2007)

MAIN STRATEGIC ACTIONS

- Continuous action on safety with the final deployment of ACAS, improvements of the quality of surveillance through the introduction of Mode S (Elementary) and further actions on AIS quality;
- Continue to improve capacity as a priority and enhance efficiency wherever possible, by changes to airspace organisation, ATFM and human resources management, and by providing increasing support, mainly to the executive controller, in particular for Arrival and Departure Management and for more consistent flight data;
- Optimisation of the use of airspace including extension of FUA to lower Airspace and the introduction of Dynamic Airspace Allocation through adaptation of sectors to variations in traffic flows. These will apply in both the En-route and TMA environments;
- Improvements in flow and capacity planning will more closely match capacity with demand;
- Improved airport operations through CDM, SMGCS, Arrival and Departure Managers and optimisation of operations in all weather conditions;
- Meeting the continuing need for staff and for management of human performance;
- As a pre-requisite for later increased capacity, the automation of Conflict Detection and Resolution will be implemented during this period;
- Prepare existing systems for further integration to meet the traffic increases, and introduce new basic features into flight data processing systems.

CONCEPT CHANGE

(re. App.2)

Airspace and ATS routes will continue to be optimised and extended levels of automation will start to be introduced in both the en-route and airport environments. Airspace planning will be fully integrated at national level. Collaborative decision making applications and integrated approach and departure sequencing will be available at major airports, and there will be further improvements to ATFM capacity management allowing the introduction of ad-hoc direct routing and the start of limited transfer of responsibilities in some airspace. Limited application of ATM information exchange between the ground and air using data communications will be introduced, and there will be increasing use of automated controller support tools.

SAFETY GAINS

Safety levels will continue to benefit from the streamlining of procedures, the increasing availability and improved training of the ATC staff, the extended use of safety nets and the further deployment of ACAS II. In addition, the other operational improvements will be implemented in such a way that adequate safety conditions are created that facilitate the delivery of the additional capacity needed.

OTHER PERFORMANCE GAINS

The combination of the changes is expected to be able to meet the capacity targets, and some reduction in fuel burn per flight, which will benefit both flight efficiency and environmental objectives. Also, there should be a significant reduction in ground movement emissions.

HUMAN RESOURCES

Associated changes to the management of human resources will expand the work done in the first period to achieve the human resources operational improvements proposed, thus creating by 2007 a sound nominal environment, where state-of-the-art methods and practices are in place and where the ATC controller shortage issue is solved.

QUALITY MANAGEMENT, EXCELLENCE AND CONTINUOUS IMPROVEMENT	• Establish effective networks for the identification and transfer of Best Practices, • Establish the methods for the transfer and sharing of Best Practices and commence benchmarking, • Conduct assessment against a common and agreed measure of Excellence including external validation, • Evolve the overall approach to Quality Management, Excellence and Continuous Improvement in line with emerging standards and Best Practices.

OPERATIONAL IMPROVEMENTS APPLICABLE IN **STEP 2 – 2005 TO 2007**	SEGMENTS WHERE CAPACITY WILL BE DELIVERED
AIRSPACE ORGANISATION AND MANAGEMENT	
Extend FUA to Lower Airspace and Introduce Dynamic Airspace Allocation (3B+4B1	ACC, TMA
National Collaborative/Integrated Airspace Planning and Harmonisation of OAT/GAT Handling (2B+4B2)	ACC
Collaborative/Integrated European Airspace Planning (5B+6B)	ACC
Enhancement of ATS Route Network (2D+3D+4D)	ACC
Enhance Terminal Airspace using Dynamic Management and the FUA principles (2E+3E)	TMA
Enhance Terminal Airspace Organisation Using Improved Aircraft Capabilities (4E+5E)	TMA
Adaptation of Sectors to variations in Traffic Flows (2F +3F)	ACC
Ad-hoc Direct Routing (1C)	
Implementation of Best Practices and Refined Procedures	ACC, TMA
FLOW AND CAPACITY MANAGEMENT	
Develop synergies with Resources managers for strategic ATFCM	ACC
Common Planning of Resources via Strategic ATFCM	ACC
Flexible Capacity Management	ACC
Common Capacity Management	ACC
Sharing FPL Data	ACC
Common Flight Data	ACC, APT
Alignment with ATC and airports tactical horizons	ACC
Traffic Optimisation	ACC
EN-ROUTE ATC	
Provide Automated Support for Conflict Detection	
Provide Automated Support for Conflict Resolution	
Provide Automated Support for Traffic Complexity Reduction	
Provide Automated Support for Arrival Management	APT
Provide Automated Support for Departure Management	APT
Provide Consistent Flight Data	ACC, TMA, APT
Use Data Link to Improve Efficiency of Communications	ACC, APT
Maintain and Improve the Quality of Surveillance	ACC, TMA, APT
AIRPORT ATC	
Improvement of Aerodrome Control Service on the Movement Area	APT
Improvement of Conflict Detection and Alert for the Movement Area	APT
Improvement of Planning and Routing	APT
Improvement of Airport Scheduling using Flow and Capacity Management data	ACC, TMA,APT
Enhancement of Airport Operations through Information Exchange between ATC, ATFM, Airport Operators and Aircraft	APT
Airport Collaborative Information Exchange Including Gate Management	APT
Optimisation of Airport Operations in All Weather Conditions	APT

Enhancement of Aerodrome Operations Through Arrival Management	APT
Enhancement of Aerodrome Operations Through Departure Management	APT
Enhancement of Movement Area Utilisation	APT
Optimisation of Arrivals and Departures Based on Wake Vortex Detection	APT
Implementation of Best Practices and Refined Procedures	APT
Minimisation of Noise and Gaseous Emissions Impact	
Harmonisation of Environmental Standards and Support For Compliance with Environmental Regulations	
Support For Management of The Available Environmental Noise Capacity	
HUMAN RESOURCES MANAGEMENT	
Timely Availability of ATC Staff	ACC, TMA, APT
Proactive Management of Human Performance	ACC, TMA, APT
OTHER IMPROVEMENTS	
Improve AIS data quality	
Implementation of Aeronautical Information Management	

TECHNICAL ENABLERS **Step 2 – 2005 to 2007**	
GROUND INFRASTRUCTURE	**AVIONICS**
DATA PROCESSING SYSTEMS / TOOLS	
• FDPS upgrades to support advanced data processing and flexible route operations; • Initial deployment of automated conflict detection/resolution tools; • Progressive deployment of arrival, departure and surface management tools; • Provision of real-time data to facilitate civil/military collaborative use of airspace; • Ground-ground communications in support of proactive capacity management; • Common high quality ATM environment data.	• The avionics requirements will be similar to that of the first step, with a further deployment of data communication capabilities. The period will also see the initial introduction, on a voluntary basis, of ADS-B, SBAS/GBAS and wake vortex detection, to facilitate the acquisition of operational experience in selected sectors/airports and anticipate their wider use in the subsequent periods • Airborne display to facilitate Situation Awareness.
COMMUNICATIONS	
• Data link (improve communication efficiency) but with a capacity contribution dependent on the number of equipped a/c.	• Progressive expansion of the proportion of fleet with data link capability.
NAVIGATION	
• Enhanced guidance system for improvement of conflict detection and alert on the movement area.	
SURVEILLANCE	
• Full deployment of Mode S elementary Surveillance in core area and enhanced Mode S in some States; • First implementation of ADS-B; • Basic surveillance data acquisition of surface traffic	• Mode S transponder for enhanced surveillance; • Initial implementation of CDTI on a voluntary basis; • Initial transfer of intent data.

R&D / VALIDATION

For this period, research has been largely performed. Attention will now need to concentrate on the still pending development issues. This concerns in particular the dynamic management of airspace, the introduction of the automated tools in the work of the controller, the interactions between partners for CDM, and the wake vortex detection. Any necessary R&D must be given the necessary priority to ensure timely development and implementation, as the 2005-2007 period is close.

7.4. Step 3 (2008 to 2011)

MAIN STRATEGIC ACTIONS

Further introduction of new concepts:

- Acceleration of the integration of ATM and other related information systems (AOC's, Airports, etc.) and processes, supported by increasing use of data communications; this will facilitate collaborative decision-making;
- More flexible and dynamic Airspace management and organisation:
  - Continuous need for Airspace/Route/ATFM improvements using improved aircraft capabilities to organise traffic where necessary;
  - Introduction of Free Route airspace in ECAC where possible;
  - A Collaborative/Integrated European Airspace Planning function.
- Better trajectory prediction and conflict avoidance planning through the availability of more accurate trajectory and surveillance airborne information, and the introduction of advanced computer support tools.
- Capacity through increased automated system support e.g. for conflict detection and resolution and traffic complexity reduction; further improvement of the surveillance function; these will be enhanced through airborne data availability;
- Airport Utilisation Improvements in all weather conditions towards optimum use of resources
- Further enhancement of provision of AIS (AIM)

CONCEPT CHANGE

(re. App.2)

The period will see *Co-operative ATS* making steps beyond the air-ground data exchanges with progress on all concept characteristics. Extended use of data communications and enhanced information techniques will increase the use of CDM applications, and more acurate trajectory and surveilance information will lead to better conflict avoidance planning. Airspace categorisation will be simplified and uniformity strengthened. Free routing will be introduced in the upper airspace. The baisis of ATFM will shift from mainly traffic to capacity management and become more dynamic and tactical. Automatic support for controllers will be further enhanced.

SAFETY GAINS

- Further increases in safety levels, with the provision of airborne situation awareness; continuation of systematic, pro-active review and remedial of safety issues.
- Like during the second step, appropriate safety conditions will allow to generate the extra capacity;

OTHER PERFORMANCE GAINS

The combination of the changes is expected to be able to meet the capacity requirements, and further reduction in fuel burn per flight, which will benefit both flight efficiency and environmental objectives. This period will be marked by significant investments to exploit advanced avionics capabilities and prepare the basis for the following period. This will have an impact on the cost side, but should be compensated by operational advantages.
Some of the capacity benefits relate to implementation actions started in the previous period. Similarly, this period will serve as a foundation for the initial introduction of new concepts to be fully exploited later.

HUMAN RESOURCES

The management of human resources will benefit from the achievement of the preceding periods in terms of staff numbers and quality, and proactive management of human performance. Regarding Human resources issues, the vigilant awareness of the ATM professionals and the daily use of methods and tools in place will facilitate the timely and adequate resolution of issues, and will simply need to be maintained at the state-of-the-art.

QUALITY MANAGEMENT, EXCELLENCE AND CONTINUOUS IMPROVEMENT	Further develop and evolve the overall approach to Quality Management, Excellence and Continuous Improvement in line with emerging standards and Best Practices.

OPERATIONAL IMPROVEMENTS APPLICABLE IN **STEP 3 – 2008 TO 2011**	SEGMENTS WHERE CAPACITY WILL BE DELIVERED
AIRSPACE ORGANISATION AND MANAGEMENT	
Reduce and Harmonise The Number of Airspace Categories in ECAC Airspace (3A+4A+5A)	
Collaborative/Integrated European Airspace Planning (5B+6B)	ACC
Enhancement of ATS Route Network (2D+3D+4D)	ACC
Enhance Terminal Airspace using Dynamic Management and the FUA principles (2E+3E)	TMA
Enhance Terminal Airspace Organisation Using Improved A/C Capabilities (4E+5E)	TMA
Adaptation of Sectors to variations in Traffic Flows (2F +3F)	ACC
Dynamically Sized Sectors (4F)	ACC
Free Routing in ECAC Airspace (2C+3C+4C)	ACC
FLOW AND CAPACITY MANAGEMENT	
Establishing Strategic ATFCM	ACC
Develop synergies with Resources managers for strategic ATFCM	ACC
Implementing OCM Principles	ACC
Flexible Capacity Management	ACC
Facilitating FPL Filing & Exchange	ACC
Sharing FPL Data;	ACC, APT
Increasing ATFM Capabilities	ACC
Alignment with ATC and airports tactical horizons	ACC, APT
EN-ROUTE ATC	
Use Aircraft Derived Data for Ground Based Safety Nets	
Provide Automated Support for Conflict Detection	ACC, TMA
Provide Automated Support for Conflict Resolution	ACC, TMA
Provide Automated Support for Traffic Complexity Reduction	ACC, TMA
Provide Automated Support for Arrival Management	TMA, APT
Provide Automated Support for Departure Management	TMA, APT
Use Data Link to Improve Efficiency of Communications	ACC, APT
Automatic Provision of Airborne Data to Enhance Ground Systems Functions including Surveillance	ACC
Maintain and Improve the Quality of Surveillance	ACC
Provide Airborne Traffic Situational Awareness	
AIRPORT ATC	
Improvement of Conflict Detection and Alert for the Movement Area	APT
Improvement of Planning and Routing	APT
Improvement of Guidance and Control	APT
Enhancement of Airport Operations through Information Exchange between ATC, ATFM, Airport Operators and Aircraft	APT
Airport Collaborative Information Exchange Including Gate Management	APT
Enhancement of Aerodrome Operations Through Arrival Management	APT
Enhancement of Aerodrome Operations Through Departure Management	APT
Optimisation of Arrivals and Departures Based on Wake Vortex Detection	APT
HUMAN RESOURCES MANAGEMENT	
Proactive Management of Human Performance	ACC, TMA, APT
OTHER IMPROVEMENTS	
Improve AIS data quality	
Implementation of Aeronautical Information Management	

TECHNICAL ENABLERS **Step 3 – 2008 to 2011**	
GROUND INFRASTRUCTURE	**AVIONICS**
DATA PROCESSING SYSTEMS / TOOLS	
• Implementation of a common, open architecture; • Modular FDPS able to accommodate the assistance tools and the exchanges of data, compliant to interoperability requirements; • Assistance tools for controller, including medium-term conflict resolution; • Integrated European tools for airspace management;	The accompanying avionics requirements will support the required evolution of the ATM functions, but represent the beginning of a significant generation change in a number of areas. This third step will exploit the new required avionics and provide advantages to those equipped, but the full return will come in the following 4th period.
COMMUNICATIONS	
• Infrastructure to support data communications and enhanced surveillance.	• 8.33 KHz below FL245 - date for possible extension to below FL245 has yet to be determined but it is likely to be during this period; • VDL mode2; • Other communications modes and broad-band data link according to decisions made during 1st step.
NAVIGATION	
• Optimisation of the ground navaids to take account of the existence of GNSS as prime means of navigation.	• GNSS: from 2008 for GNSS is expected to be usable as prime means of navigation (but not sole means); • RNP RNAV: possible mandate to be issued in 2003 to allow implementation in 2010; • Both ILS and MLS will continue to be available for precision approaches with MLS replacing those Cat III ILS than can no longer be supported.
SURVEILLANCE	
• Wider implementation of Enhanced surveillance, using ADS-B.	• ADS-B - optional according to operational requirements to be met; • ASAS Package 1.

R&D / VALIDATION

Not all operational improvements and their enablers will have been proven by this stage. Some fundamental issues still exist that will require R&D. There should nevertheless be no delay in launching the necessary actions. It may seem that this 3rd step islong-term, but from an airborne equipment definition and mandating point of view, it is quite close and important decisions will have to be made in the very near future.. This also applies to the overall architecture of the ATM system and the most advanced airspace organisation/ATFM concepts.

7.5. Step 4 (2012 to 2020)

MAIN STRATEGIC ACTIONS	Realisation of the target operational concept: Flights will be managed gate-to-gate and airspace will be regarded as a continuum for planning and management purposes. A majority of flights will be able to fly fuel-efficient routes, but overall, this is the ATM network and the totality of traffic that will managed to create an optimised traffic situation. • Optimisation of the use of airspace and airport resources, as well as of procedures, and processes; • Achievement of a system wide management of information for all kinds or aeronautical data and trajectory information, enabling a real gate-to-gate management of flights; • Interactive Flow and Capacity Management supported by the above; • Implementation of co-operative ATM through integrated mobile data communications and surveillance, including airborne situational awareness, in a number of ACCs, major airports and TMAs, supported by a significant number of suitably equipped aircraft, for which User preferred 4-D Trajectory will be negotiated with the ground; • Enhancement of the assistance tools based on the availability of more accurate data and other technical improvements; • Integration of Arrival/Departure and Surface Management; • Re-distribution of tasks within a sector team and between the human and the machine to take advantage of information available and refined control processes fully exploiting the cognitive strengths. This will improve levels of safety and productivity; • Suitably capable aircraft, under prescribed circumstances or in certain airspace areas, are able to accept delegation of separation tasks, and ultimately exercise autonomous separation.
CONCEPT CHANGE (re. App.2)	Achievement of all the conceptual change characteristics and the full realisation of the Co-operative ATS.
SAFETY GAINS	The full implementation of the Safety Management System and the experience accumulated in preceding periods will create the conditions for safe transition to new concepts. Additional safety improvements, in particular a new generation of safety nets will supplement the safety effects of the main operational changes.
OTHER PERFORMANCE GAINS	The combination of the changes is expected to be able to meet the capacity targets, and further reduction in fuel burn per flight, which will benefit both flight efficiency and environmental objectives. This period will be marked by the progressive and finally full exploitation of the investments in advanced avionics capabilities and ground systems, and will deliver significant economic benefits.
HUMAN RESOURCES	The management of human resources will benefit from the application of the principles and methods in place since the preceding periods and updated as necessary.

OPERATIONAL IMPROVEMENTS APPLICABLE IN STEP 4 – 2012 TO 2020	SEGMENTS WHERE CAPACITY WILL BE DELIVERED
AIRSPACE ORGANISATION AND MANAGEMENT	
Enhancement of ATS Route Network (2D+3D+4D)	ACC
Dynamically Sized Sectors (4F)	ACC, TMA
Free Routing in ECAC Airspace (2C+3C+4C)	ACC
Allow Autonomous Operations in Free Flight Airspace (5C+6C)	ACC
FLOW AND CAPACITY MANAGEMENT	
Common Planning of Resources via Strategic ATFCM	ACC
Common Capacity Management	ACC
Common Flight Data	ACC
Traffic Optimisation	ACC
EN-ROUTE ATC	
Provide Automated Support for Conflict Detection	ACC, TMA
Provide Automated Support for Conflict Resolution	ACC, TMA
Provide Automated Support for Traffic Complexity Reduction	ACC, TMA
Enhance ATC Decision Support by Using Aircraft Derived Data	ACC, TMA
Provide Automated Support for Arrival Management	TMA, APT
Provide Automated Support for Departure Management	TMA, APT
Provide Automated Support for Integrated Arrival, Departure and Surface Management	TMA, APT
Use Aircraft Derived Data for Arrival, Departure and Surface management	TMA, APT
Use Data Link to Improve Efficiency of Communications	ACC, TMA, APT
Automatic Provision of Airborne Data to Enhance Ground Systems Functions including Surveillance	ACC, TMA
Provide Airborne Traffic Situational Awareness	ACC, TMA
Delegate Separation Service	ACC
Facilitate User-preferred 4-D Trajectory	ACC, TMA
Empower Autonomous Aircraft Operations	ACC
AIRPORT ATC	
Improvement of Guidance and Control	APT
Enhancement of Aerodrome Operations Through Arrival Management	APT
Enhancement of Aerodrome Operations Through Departure Management	APT
Enhancement of Aerodrome Operations Through Fully Integrated Arrival, Departure and Surface Traffic Management	APT
Further Enhancement of Aerodrome Operations from Gate to Gate	APT
OTHER IMPROVEMENTS	
Improved airborne safety nets	
Implementation of Aeronautical Information Management	

TECHNICAL ENABLERS **Step 4 – 2012 to 2020**	
GROUND INFRASTRUCTURE	**AVIONICS**
DATA PROCESSING SYSTEMS / TOOLS	
• Information structures compliant to the SWIM philosophy and interoperability requirements; • Open, modular and interoperable FDPS; • Advanced support tools and full A-SMGCS;	
COMMUNICATIONS	
• High speed fixed and mobile links supporting the implementation of SWIM and providing the quality of service required for the most sophisticated applications.	• Broad-band - possible mandate.
NAVIGATION	
• Optimised ground infrastructure.	• 4D FMS - optional and a possible mandate to be evaluated;
SURVEILLANCE	
• Intent based surveillance becomes essential.	• ADS-B possible mandate; • ASAS Package 2 and 3.

R&D / VALIDATION

While, in general, measures have to be taken to secure appropriate support from R&D with priority given to areas that support quick solutions, the basic R&D needed to prepare for the longer-term evolutionary steps should not be neglected, bearing in mind that R&D may have to be undertaken in due time if implementation is to be realised in the planned time scale. The R&D needs for this period address in particular the changes that will be required in the technological area. However, there should also be a significant set of studies and experiments to explore and validate the most advanced concepts that imply different distributions of tasks, or that would modify them, in particular with respect to the non-nominal modes and the extreme working conditions.

8. Validation and Development Considerations

8.1. General

This chapter complements Chapter 7 in Volume 1, and provides additional guidance material concerning validation, development and operational issues. It must therefore be read in conjunction with the Volume 1 material to obtain a comprehensive view.

8.2. Involvement of Industry

To help ensure more realistic and cost-efficient specifications, Industry should be involved as early as possible in the life cycle of a project.

The EUROCONTROL Organisation will manage the processes that involve the definition and validation of new ATM solutions, and make the maximum use of Industry's capabilities, ensuring the early involvement on that part of Industry that is potentially in a position to deliver the commercial product.

The EUROCONTROL Organisation's role will be to guide the market by defining agreed high level requirements/specifications, addressing all aspects required for interoperability and delivery of performance, and helping to initiate and/or ensure the availability of validated products.

In relation to Industry involvement in R&D activities, increased emphasis will be placed on disseminating relevant information on R&D projects and results. The EUROCONTROL Organisation must organise regular meetings with suppliers.

Bearing in mind the importance of reinforcing the links between Industry and research establishments to reduce the gap between research and industrial development and ensure validation of the concepts and developments, the Agency, in conjunction with Industry and service supplier organisations, will aim to create a functional platform (an Industry Based Prototype) where systems from several suppliers, covering ground and air segments, could be interconnected to represent a complete operational environment, and ease functional validation. Expected benefits include increased standardisation and inter-operability, as well as reduction of development and implementation risks.

In addition to the normal standardisation process, emphasis should be placed on de facto or voluntary standardisation processes, capitalising on existing industry organisations. To achieve this, the EUROCONTROL Organisation must give high priority to the validation of new functions and products, and disseminate the appropriate results widely. It should also develop processes for promulgating the compliance of products and systems with a particular standard.

8.3. Research and Development

ATM R&D has a significant role in making improvements possible, validated, actual and timely. Its effectiveness lies on five main related processes, each requiring close co-ordination of activities and adequate financing, and requiring high cohesion together. They are:

- Better identify R&D and needs for validation and requirements out of the roadmap;
- Collect, analyse and fully exploit all available knowledge on relevant subjects;
- Plan work to deliver timely the additional validation information required;
- Execute effectively projects, avoiding unnecessary duplication and making best use of available resources and competence;
- Pay sufficient attention and devote sufficient resources to innovative ideas for new solutions.

The required actions related to R&D also build on the relevant section of the ECAC Institutional Strategy and comprise:

- Implementing more effective ATM R&D co-ordination mechanisms across various European and National Organisations to support ATM developments;
- Collecting data on projects to determine the most efficient use of resources;

- Maintaining R&D expertise in a distributed European framework;
- Concentrating R&D resources on the development and validation needs of the uniform European ATM network;
- Ensuring that R&D reflects the latest scientific knowledge and technology developments regarding aviation and the environment.

The validation of future procedures and technologies against quantified system performance objectives (safety and operational, technical and economic criteria) must be completed in due time using R&D. The Strategy relies strongly on the progressive implementation of innovations rather than the continuation of traditional solutions. Measures have to be taken to secure appropriate support from R&D. The challenge is to both complete the full validation of quick solutions, and prepare for the future evolutionary steps with the basic R&D needed.

Growing pressure for cost-effectiveness will be applied to all aspects of expenditure including R&D. However, simply reducing R&D costs might result in losing potential high value creativity. A better co-ordination of efforts to achieve greater efficiency on a European scale should therefore be achieved.

ATM R&D must meet the essential needs of the Strategy, ensuring that successful R&D products move quickly into development and implementation by reducing the time necessary to implement results and start receiving the expected benefits. To this end, pre-operational field trials should be encouraged at local, national and international level in a co-ordinated way. These should take account of the European-wide visibility of the tested component rather than focus on its restricted local application. R&D must estimate benefits by identifying the benefit mechanisms, and validate and quantify the effects of the tested improvement during pre-operational field trials.

In recent years, performance of expensive avionics equipment has outstripped that of ground ATM systems, and priority will be given to improving ATM performance without imposing additional mandatory carriage requirements which do not provide clear benefits for the users.

The planning and execution of ATM R&D must be co-ordinated in order to maximise the value of its output. Collaborative programmes which lead to more efficient use of resources and a more effective exchange of ideas must be fostered to cover the need for improved exchange of research information. Synergy between all ATM R&D actors including Industry and users will be developed. Involvement of users in the R&D planning process is essential.

The regular review of ATM R&D will be maintained and strengthened. An overall European ATM R&D Strategy addressing R&D priorities, which translates the R&D needs associated with the ATM components into specific strategic actions, should be maintained.

The EUROCONTROL Agency may use the leverage effect of its R&D budget to support projects compliant with the Strategy. In this way, it can play a major role in ensuring that R&D is delivering the right products to the ATM programmes at the right time. The Agency's efforts must be co-ordinated with the European Commission's programmes, taking into consideration the accession of the European Community to EUROCONTROL, to maximise effectiveness and ensure that these efforts take account of the interaction of ATM with other activities and more general policy issues.

The aim will be that the ATM R&D needs of common interest be described and prioritised collectively, and then addressed through a collection of several programmes financed by the EUROCONTROL Agency's, National and other budgets, and complemented by local actions for national issues. A more concentrated sponsorship will deliver cost reduction through economies of scale. The proportion of ATM R&D activities carried out or funded by a single stakeholder is expected to decrease as European integration progresses and the use of common solutions increases. Enhanced co-operation, funding rules and competition mechanisms must be implemented as appropriate both during tendering and execution phases.

The co-ordination mechanisms have recently been fostered with the following two initiatives:

- Co-operative ATM Research in EUROCONTROL (CARE), to promote the benefits of co-operation, and incite to define projects in that way;
- Advisory Council for Aeronautics Research in Europe (ACARE), established to define a Strategic Research Agenda (SRA). Based on the needs to be covered, it will be a vehicle to guide the definition of the EC's next framework programmes on research and technological development. The ATM part of the SRA should be consistent with the roadmap and include innovative research as well.

8.4. Economics

8.4.1. Cost-Benefit Analysis in General

The infrastructure changes needed to support new concepts and procedures require investment from both the Airspace Users and ANSPs. It is essential that the level of benefit received by the organisations making the investment is commensurate with the investment required. Since all aviation parties will experience the costs and benefits of the Strategy, cost-benefit studies will have to evaluate the effects of the changes on the whole of the air transport network.

One potential difficulty for this approach is that the organisation making the investment may not benefit directly from the ensuing improvements. The Strategy aims at making sure that, where possible, each organisation receives a fair return on the investment required to fund the changes via operational benefits.

Cost-benefit assessments will need to consider the effects of the proposed changes at an overall level, and for the typical main groups of interests, to ensure that the changes proposed are both viable and affordable. However, it is inevitable that in some instances the changes will involve more drawbacks than advantages for some minority groups.

Even though safety is not to be the subject of trade-offs, it would not be realistic to consider it can be improved at any cost. Safety gains can be seen as enabling (being a pre-requisite to) the above performance gains and they can be valued in this context where other valuations of safety would not be found appropriate.

8.4.2. Demonstrating the Economic Case

It is essential that the economic case for activities needed to realise the Strategy be demonstrated. The following two elements are the basis of the case and key to achieving this:

- An estimate of the value of the extra performance that the change is expected to deliver;
- The total costs of delivering the change.

A comprehensive set of cost estimates has to be established. The planning and high level costing of programmes within strategies must be the responsibility of the authorities responsible with the help of cost-benefit analysis experts.

Much of the information needed may be derived within the EUROCONTROL Organisation, but the States must provide some information.

As part of the management of the Strategy, the economic case should be monitored constantly to assure all stakeholders that value is delivered.

8.4.3. Economic Approaches

Volume 1, section 6.4 recognises the possible co-existence of a performance-driven approach and a business-driven approach if so decided by individual States.

The PRC primarily, as well as other EUROCONTROL bodies, work on this subject and are addressing issues that require further study.

The requisite studies, when considered in the context of the PRC work, will result in proposals to be put to the EUROCONTROL Council. They do not imply any automatic commitment to apply the results of this definition or development work.

The considerations presented in the January 2000 version of the Strategy under the economics title have now been superseded by the ongoing PRC work and are therefore not repeated here,

8.4.4. Economic Studies

The Economic Objective is set out in Chapter 3 and the descriptions above propose some possible solutions. However, the shortage of knowledge of the economic impact of the changes in ATM makes the identification of agreed lines of action on Economics difficult at this time. Political issues will have to be addressed before some of the options can be considered.

A proposal for possible studies is set out in Appendix 3, which will in itself generate further questions and proposals to look at other options. The responsibility for much of this will fall on the EUROCONTROL Organisation. It is important that the Organisation ensures that the required resources are made available for this work in the early days of the Strategy to underpin its implementation. A number of studies may also be addressed in the European Commission as far as economic regulation and impact of institutional changes are concerned.

8.4.5. Trade-Offs on Objectives

The simultaneous satisfaction of all user requirements and fulfilment of all the strategic objectives is unrealistic. Conflicts of interest are inevitable, typically for access to the same airspace or runway at the same time, or for the service levels required. The approach proposed in the Strategy is to make sure that the different trade-offs supported by the various classes of users are explicit, and that wherever possible the optimum solutions are selected for all affected Airspace Users. The exception is safety, which cannot be traded.

The identification and use of trade-offs are based on subtle balances between all of the relevant factors, as illustrated in the following areas described below.

8.4.5.1 Capacity Vs Costs

Providing capacity at acceptable safety levels is an important objective. The key capacity issues to be resolved are access to airspace and airports (the ability to realise flights), and the ability of some Airspace Users to respect a schedule (predictability and delay), together with the ability of other users and airports to operate with a degree of flexibility within a schedule framework.

A capacity margin has to be developed to permit flexibility and cope with unexpected events. Providing excess capacity within reasonable limits is less costly than allowing a capacity shortfall generating large delays. This means that there has to be a trade-off between costs and capacity that ensures that any excess capacity generated remains within reasonable limits, and that its costs do not outstrip the benefits that can be realised.

8.4.5.2 Individual Vs Collective Benefit

Airspace Users and ATS providers have different viewpoints concerning the optimisation of individual flights as opposed to optimising the network for the benefit of all flights. However, both regard the overall network performance as the main driver.

Airspace Users are strongly opposed to regional synchronised gate-to-gate scheduling as a means of network optimisation, and regard it as a restriction on their entrepreneurial freedom. They advocate that airport scheduling should stay local if possible, rather than becoming a centralised system which imposes restrictions, and that ATM should use collaborative decision-making mechanisms to advise them of the potential consequences of changes to local plans, and the impact that this may have on the network or local capacity available.

8.4.5.3 Mandating Vs Incentive

Equipment mandating must be used when there is a strong safety case to do so. In this and all other instances, business cases, and early involvement of users, must be used to drive a consensus-building process and deliver early and incentive-led benefits.

It is not possible in all cases to prevent proposed improvements from resulting in an unfavourable cost/benefit ratio for some users. This is particularly true in instances where the mixed mode operations resulting from the partial implementation of a measure would negate the anticipated benefit. System designers should work to limit such occurrences to the minimum. In no case should the safety benefit be negative to any class of user. A particular attention will be paid in this respect to military users, and might need the introduction of specific mitigating measures and incentives, such as refunding.

This applies also particularly to mandating measures affecting airports, which, although part of the ATM network, are still independent business units and have their own financial objectives and targets to meet.

Mechanisms and criteria that include the appropriate incentives must be found to handle those situations that necessarily involve mandating to ensure that timely progress can be made.

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10. Acronyms and Abbreviations

4D	Four Dimensional
ACC	Area Control Centre
ACARS	Aircraft Communications Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ADS	Automatic Dependent Surveillance - Broadcast
ADS-B	Automatic Dependent Surveillance - Broadcast - Broadcast
ADS-C	Automatic Dependent Surveillance - Contract
AEA	Association of European Airlines
AIS	Aeronautical Information Services
AO	Arrivals Operations
AOC	Airline Operations Centre
AMAN	Arrival Manager
ANS	Air Navigation Services
APATSI	Airport/Air Traffic System Interface
APO	Airport Operator
ARDEP	Analysis of Research and Development in Europe
A-SMGCS	Advanced Surface Movement Guidance and Control System
ASAS	Airborne Separation Assurance System
ASM	Airspace Management
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATIS	Air Traffic Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
B-RNAV	Basic - Area Navigation
CADS	Computer Aided Departure System
CDM	Collaborative Decision-Making
CDTI	Cockpit Display of Traffic Information
CEAC	Committee for European Airspace Co-ordination
CFIT	Controlled Flight into Terrain
CFMU	Central Flow Management Unit
CMIC	Civil-Military Interface Standing Committee
CNS	Communications, Navigation and Surveillance
COTS	Commercial Off the Shelf (system)
CODA	Central Office of Delay Analysis
CRCO	Central Routes Charges Office
CWS	Collision Warning System
DMAN	Departure Manager
EA	Europe Airsports
EAD	European AIS Database
EATCHIP	European Air Traffic Control Harmonisation and Integration Programme
EC	European Commission
ECAC	European Civil Aviation Conference
ECARDA	European Coherent Approach of Research and Development in Air Traffic Management
ECIP	European Convergence and Implementation Plan
ENPRM	European Notice of Proposed Rule-Making
ERA	European Regions Airline Association
ESA	European Space Agency
ETFMS	Enhanced Tactical Flow Management System
EUROCAE	European Organisation for Civil Aviation Electronics
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FEATS	Future European Air Traffic System
FUA	Flexible Use of Airspace (Concept)
FDP	Flight Data Processing (system)
FIR	Flight Information Region
FMP	Flow Management Position
FMS	Flight Management System

FOC	Full Operational Capability
GDP	Gross Domestic Product
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HDD	Head Down Display
HIPS	Highly Interactive Problem Solver
HMI	Human Machine Interface
HIRO	High Intensity Runway Operations
HUD	Head Up Display
IACA	International Air Carrier Association
IAOPA	International Council of Aircraft Owner and Pilot Associations
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IOC	Initial Operational Capability
IFATCA	International Federation of Air Traffic Controllers Associations
IFPS	Initial Integrated Flight Plan Processing System
IPR	Intellectual Property Rights
ISO	International Organisation for Standardisation
ITT	Invitation to Tender
JAA	Joint Aviation Authorities
MATSE	Transport Ministers' meeting on the Air Traffic System in Europe
MAP	Mapping
MASP	Minimum Aviation Specification Performance
MET	Meteorology
MMR	Multi-Mode Receiver
MNS	Mobile Network Services
MSAW	Minimum Safe Altitude Warning
MSSR	Monopulse Secondary Surveillance Radar
MTCD	Medium Term Conflict Detection
NAV	Navigation
NAT	North Atlantic
NATO	North Atlantic Treaty Organisation
OAT	Operational Air Traffic
OCD	Operation Concept Document
PENS	Pan-European Fixed Network Services
PRC	Performance Review Commission
PRU	Performance Review Unit
R&D	Research and Development
RDPS	Radar Data Processing System
RNAV	Area Navigation
RNP	Required Navigational Performance
RT	Radiotelephony
RVSM	Reduced Vertical Separation Minimum
SARPs	Standards and Recommended Practices
SMAN	Surface Management System
SMGCS	Surface Movement Guidance and Control System
SRC	Safety Regulation Commission
SRU	Safety Regulation Unit
SSR	Secondary Surveillance Radar
STCA	Short-Term Conflict Alert
TACT	CFMU Tactical Computer System
TMA	Terminal Control Area
UAC	Upper Area Control Centre
URD	User Requirements Document
VDL	VHF Datalink
VHF	Very High Frequency
WMO	World Meteorological Organisation

Appendix 1: Operational Improvements, Enablers and Benefits

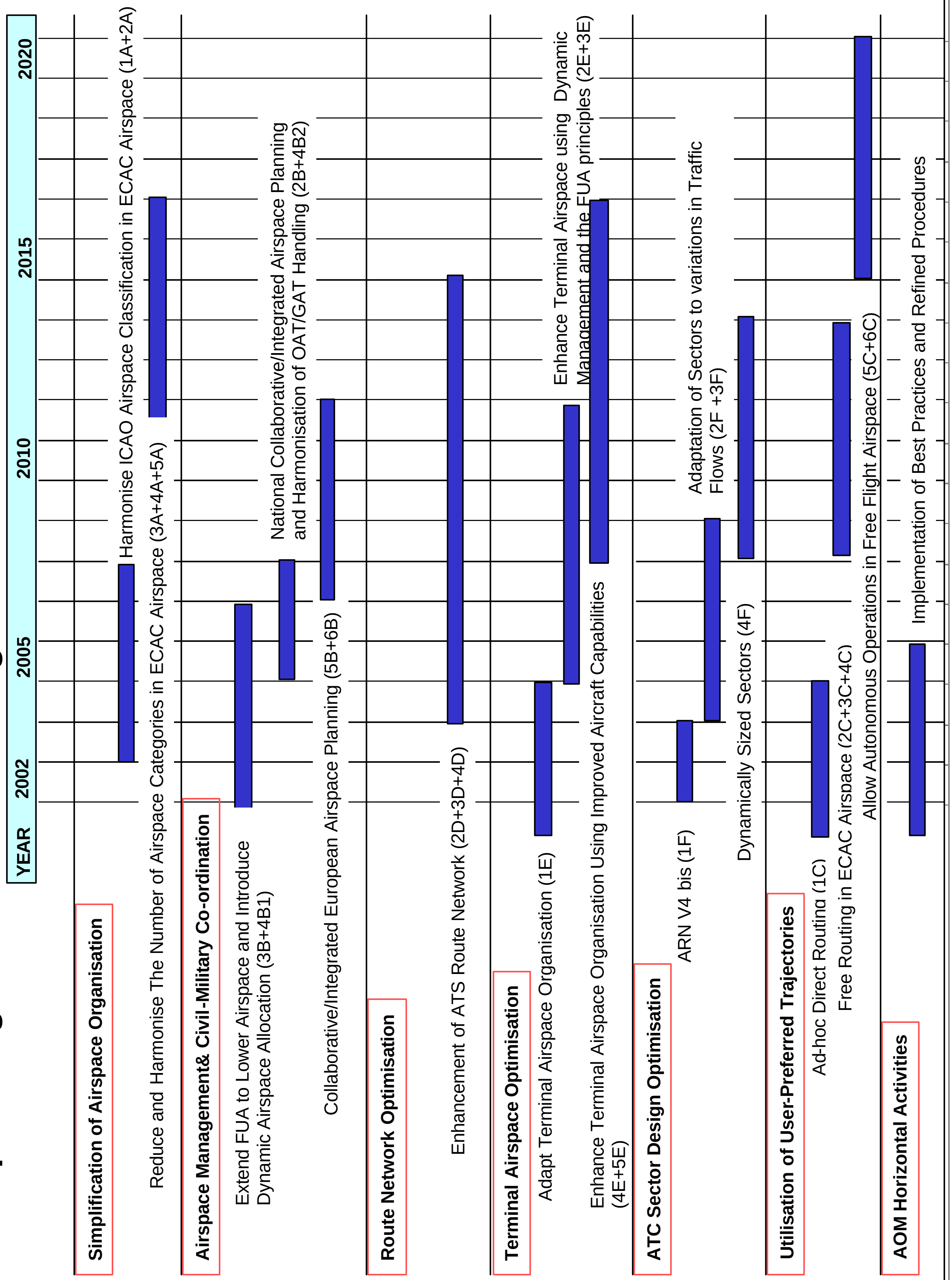
The tables in this Appendix show the operational improvements for each of the main processes and Directions for Change given in Chapter 6, as well as the operational improvement related to AIM, Human resources and Airborne safety nets:

- Airspace Organisation and Management;
- Flow and Capacity Management;
- En-Route and Terminal Air traffic Control;
- Airport ATC;

Each table is accompanied by summary descriptions of the effect of the operational improvements included in the table, to aid understanding of the change to be applied.

The start dates shown in the tables for each of the improvements are related to the approximate date when the first implementation of the improvement is likely to be realised. This date may precede the date at which benefits will be realised in the most challenging environments.

Airspace Organisation and Management



Airspace Organisation and Management

Simplification of Airspace Organisation

Harmonise ICAO Airspace Classification in ECAC Airspace (1A+2A)

After State: Re-organisation of Upper Airspace and associated traffic handling in each ECAC State to ensure application of a common ICAO ATS Airspace Class above a common agreed division level, followed by application of harmonised and simplified way the ICAO Airspace Classes below such common level in all ECAC Region.

Harmonise ICAO Airspace Classification of all Upper ECAC Airspace above a common agreed division level (1A)

After State: Reorganisation of Upper Airspace and associated traffic handling in each ECAC State to ensure application of a common ICAO ATS Class above a common agreed division level and later on through Action 2A to apply in a more harmonised and simplified way the ICAO ATS Airspace Classification below such common level in all the ECAC Region.

Harmonise and Simplify Application of ICAO Classification of all ECAC Airspace (2A)

After State: Reorganisation of airspace below the common agreed division level (Action 1A) and associated traffic handling in each State to ensure common adoption and uniform application of ICAO ATS Classification in the ECAC Region.

Reduce and Harmonise The Number of Airspace Categories in ECAC Airspace (3A+4A+5A)

After State: Rationalisation of the existing airspace structure (ICAO Class A-G) by the initial introduction of 3 airspace categories (N, K and U), in accordance with the Traffic Environment Model, and gradually reducing to 2 airspace categories (N and U).

Reduce Number of Airspace Categories to only Three Types (3A)

After State: Rationalisation of the existing airspace structure (ICAO Class A-G) by the introduction of only 3 airspace categories (N, K and U), in accordance with the following Traffic Environment Model:

- N iNtended Traffic Environment within which all traffic is known to ATS, both with position and with flight intentions
- K Known Traffic Environment within which all traffic is known to ATS either with position only or with flight intentions as well.
- U Unknown Traffic Environment within which not all traffic is known to ATS.

Harmonise and Reduce Vertical Airspace Division to a Commonly Agreed Base Level (4A)

After State: Bring to a common level the division between Category N/K and Category U airspace throughout the ECAC region.

Reduce Number of Airspace Categories to only Two Types (5A)

After State: Gradual removal of Category K airspace to be changed into:

- Category N, when ATS systems are capable of providing real-time data on the position and intentions of all aircraft within the applicable airspace;
- Category U, in other cases.

Airspace Management & Civil/Military Co-ordination

Extend FUA to Lower Airspace and Introduce Dynamic Airspace Allocation (3B+4B1)

After State: As with the Upper Airspace, the application of FUA in the Lower Airspace will be centred upon airspace being made available according to users needs with airspace classification not imposing unnecessary restrictions.

Flexible Terminal Airspace as well as change in airspace classification and, whenever possible, joint use of airspace will be considered to respond to variations in users' needs. Improvement of the current FUA Levels 2 & 3 process with more dynamic airspace management in which joint civil and military airspace managers will have to respond to and accommodate changes in traffic types and flows by both GAT and OAT. The extent of 'Dynamic Airspace Allocation' (DAA) application will depend on how far flexibility of airspace structures can be exploited while still remaining manageable, how dynamic and adaptive airspace changes could be, and on what parameters they should be based, for instance, how far ATC sector boundaries could be adapted on a tactical basis to respond to airspace changes and to cope with particular traffic flows and/or specific military operational requirements.

Extend FUA to Lower Airspace (3B)

After State: As with the Upper Airspace, the application of FUA in the Lower Airspace will be centred upon airspace being made available according to users needs with airspace classification not imposing unnecessary restrictions.

Flexible Terminal Airspace as well as change in airspace classification and, whenever possible, joint use of airspace will be considered to respond to variations in users' needs.

Extend FUA with Dynamic Airspace Allocation (4B1)

After State: Improvement of the current FUA Levels 2 & 3 process with more dynamic airspace management in which joint civil and military airspace managers will have to respond to and accommodate changes in traffic types and flows by both GAT and OAT.

The extent of 'Dynamic Airspace Allocation' (DAA) application will depend on how far flexibility of airspace structures can be exploited while still remaining manageable, how dynamic and adaptive airspace changes could be, and on what parameters they should be based, for instance, how far ATC sector boundaries could be adapted on a tactical basis to respond to airspace changes and to cope with particular traffic flows and/or specific military operational requirements.

National Collaborative/Integrated Airspace Planning and Harmonisation of OAT/GAT Handling (2B+4B2)

After State: Improvement of national airspace policy and planning to better accommodate shared use of airspace between all users groups and harmonisation of ASM rules with neighbouring States. In addition, to ensure that the principles, rules and procedures for OAT/GAT handling can be commonly applied to the maximum possible extent within ECAC airspace.

National Collaborative/Integrated Airspace Planning (2B)

After State: Improvement of national airspace policy and planning to better accommodate shared use of airspace between all users groups and harmonisation of ASM rules with neighbouring States.

Harmonise OAT/GAT Handling (4B2)

After State; Harmonisation of OAT/GAT handling covers three main actions:

- identify the various types of military operations which can be accommodated in applying the same, or nearly the same, rules and procedures as civil aviation and those which cannot, and therefore require separate rules and procedures; current OAT and GAT definitions will be revised accordingly;
- define common rules and procedures for handling military operations within ECAC airspace;
- develop common principles, rules and procedures for the safe handling of civil and military traffic in a mixed environment within ECAC airspace (e.g. use of common separation criteria, co-location or integration of civil/military air traffic services).

Collaborative/Integrated European Airspace Planning (5B+6B)

After State: the national high level airspace policy bodies will enhance their co-operation on a sub-regional basis with the intention of establishing a pan-European policy body responsible for all ECAC airspace above a common agreed level and leading eventually to an integrated European airspace planning process. With the increasing establishment of cross-border structures, there will also be the need to evolve from the "Lead" Airspace Management Cell (AMC) concept to a "Sub-Regional" AMC concept for ensuring the harmonised management and allocation of airspace and route structures (CDRs, TSAs and CBAs) on a sub-regional rather than national basis.

Collaborative European Airspace Planning (5B)

After State: Following on from action 2B, the national high level airspace policy bodies will enhance their co-operation on a sub-regional basis with the intention of establishing a pan-European policy body responsible for all ECAC airspace above a common agreed level and leading eventually to an integrated European airspace planning process.

With the increasing establishment of cross-border structures, there will also be the need to evolve from the "Lead" Airspace Management Cell (AMC) concept to a "Sub-Regional" AMC concept for ensuring the harmonised management and allocation of airspace and route structures (CDRs, TSAs and CBAs) on a sub-regional rather than national basis.

Integrated European Airspace Planning (6B)

After State: In the context of the Airspace Strategy, airspace design, in terms of use of preferred trajectories, development of the ATS route network, optimised airspace structures and elements of sectorisation [see Lines of Action - C, D, E, F] will evolve from national responsibilities with co-ordination at European level into a more integrated function with an ECAC-wide perspective.

Airspace management will also be exercised as much as possible at a pan-European level, subject to appropriate safeguards to protect national security and defence needs.

In order to facilitate achievement of this integrated planning, an appropriate legislation and decision-making process will need to be put in place as soon as possible.

Route Network Optimisation

Enhancement of ATS Route Network (2D+3D+4D)

After State: Traffic demand in the ECAC area is increasing at annual rates in excess of 5%. From year to year there is a change in the distributions of traffic as new holiday destinations become popular. In addition there is a new trend towards the utilisation of satellite airfields. All of these changes in demand require constant upgrading of the airspace infrastructure in a medium time scale (2 or 4 years period), which is dictated by the need for simulations, validations, controller training requirements and system modifications.

Because of this lengthy time frame, the medium-term optimisation project is carried out in an overlaying development cycle in which the elements in the development period are implemented in successive phases. It is expected that this process will continue until alternative airspace structure initiatives, such as FRAP, reduces the requirement to continue the process. Each development cycle uses available aircraft capabilities such as 4D RNAV, RVSM, RNP1 etc., as they come on stream and as they demonstrate their effectiveness as capacity enhancing enablers. It is possible that the degree of accuracy achieved with the set of navigation capabilities and in particular 4D RNAV will lead to the need to reduce the complexity of the route network.

ARN-V5 (Pre-tactical Rerouting Operations and Possible Use of RNP 1 Capabilities) (2D)

After State: Traffic demand in the ECAC area is increasing at annual rates in excess of 5%. From year to year there is a change in the distributions of traffic as new holiday destinations become popular. In addition there is a new trend towards the utilisation of satellite airfields. All of these changes in demand require constant upgrading of the airspace infrastructure in a medium time scale (2 or 4 years period), which is dictated by the need for simulations, validations, controller training requirements and system modifications.

Because of this lengthy time frame, the medium-term optimisation project is carried out in an overlaying development cycle in which the elements in the development period are implemented in successive phases. It is expected that this process will continue until alternative airspace structure initiatives, such as FRAP, render the process obsolete. Each development cycle uses available aircraft capabilities such as RNAV, RVSM, RNP1 etc., as they come on stream and as they demonstrate their effectiveness as capacity enhancing enablers.

ARN-Vx (RNP 1) (3D)

After State: Traffic demand in the ECAC area is increasing at annual rates in excess of 5%. From year to year there is a change in the distributions of traffic as new holiday destinations become popular. In addition there is a new trend towards the utilisation of satellite airfields. All of these changes in demand require constant upgrading of the airspace infrastructure in a medium time scale (2 or 4 years period), which is dictated by the need for simulations, validations, controller training requirements and system modifications.

Because of this lengthy time frame, the medium-term optimisation project is carried out in an overlaying development cycle in which the elements in the development period are implemented in successive phases. It is expected that this process will continue until alternative airspace structure initiatives, such as FRAP, render the process obsolete. Each development cycle uses available aircraft capabilities such as RNAV, RVSM, RNP1 etc., as they come on stream and as they demonstrate their effectiveness as capacity enhancing enablers.

ARN-Vz (4D RNAV) (4D)

After State: Traffic demand in the ECAC area is increasing at annual rates in excess of 5%. From year to year there is a change in the distributions of traffic as new holiday destinations become popular. In addition there is a new trend towards the utilisation of satellite airfields. All of these changes in demand require constant upgrading of the airspace infrastructure in a medium time scale (2 or 4 years period), which is dictated by the need for simulations, validations, controller training requirements and system modifications.

Because of this lengthy time frame, the medium-term optimisation project is carried out in an overlaying development cycle in which the elements in the development period are implemented in successive phases. It is expected that this process will continue until alternative airspace structure initiatives, such as FRAP, reduces the requirement to continue the process. Each development cycle uses available aircraft capabilities such as 4D RNAV, RVSM, RNP1 etc., as they come on stream and as they demonstrate their effectiveness as capacity enhancing enablers. It is possible that the degree of accuracy achieved with the set of navigation capabilities and in particular 4D RNAV will lead to the need to reduce the complexity of the route network.

Terminal Airspace Optimisation

Adapt Terminal Airspace Organisation (1E)

After State: Revised terminal airspace structures, including ATS airspace classification, will be introduced, where required, to take advantage of ACFT capabilities.

Enhance Terminal Airspace using Dynamic Management and the FUA principles (2E+3E)

After State: Airspace organisation will be enhanced in some Terminal Airspace with the use of FUA, evolving to the dynamic adjustment of Terminal airspace boundaries and/or permitting the modification of the airspace classes and/or categories in order to respond in real-time to changing situations in traffic patterns and/or runway(s) in use.

Enhance Airspace Organisation (e.g. use FUA and RNAV where suitable) (2E)

After State: Terminal Airspace will be adapted in line with the availability of airspace and the capability of aircraft.

Airspace organisation will be enhanced in some Terminal Airspace with the use of FUA and/or RNAV, where suitable, based on common agreed design criteria for SIDs/STARs and possibly instrument approach procedures.

Dynamic Management of Terminal Airspace (3E)

After State: Terminal Airspace will be configured in real time to meet requirements in line with traffic demand.

Dynamic management of Terminal Airspace will mainly be based on experience of likely traffic volumes and profiles.

Enhance Terminal Airspace Organisation Using Improved Aircraft Capabilities (4E+5E)

After State: Enhanced RNAV may facilitate improvements in the efficiency and capacity of Terminal Airspace through the provision of increased flexibility and reduced route separation.

Airspace organisation will be improved in some Terminal Airspace with the use of enhanced RNAV, where suitable, based on common agreed design criteria for SIDs/STARs and possibly instrument approach procedures.

The introduction of 4D RNAV will permit consistent spacing and ensure efficient timing and accurate approach sequencing.

Improve Terminal Airspace Organisation with Application of Enhanced RNAV (4E)

After State: Enhanced RNAV may facilitate improvements in the efficiency and capacity of Terminal Airspace through the provision of increased flexibility and reduced route separation.

Airspace organisation will be improved in some Terminal Airspace with the use of enhanced RNAV, where suitable, based on common agreed design criteria for SIDs/STARs and possibly instrument approach procedures.

Application of 4D RNAV in Terminal Airspace (5E)

After State: TBD

ATC Sector Design Optimisation

Adaptation of Sectors to Variations in Traffic Flows (2F +3F)

After State: When the limits of sector capacity are reached, they can be further increased through a reduction in sector complexity by alignment with flows or specialisation of functions. Furthermore, sectorisation will be tailored to meet capacity demands, to accommodate traffic flow variations, to take advantage of released airspace and to satisfy operational needs.

Sectors Adapted to Particular Traffic Flows and/or Specialised Functions (2F)

After State: When the limits of sector capacity are reached, they can be further increased through a reduction in sector complexity by alignment with flows or specialisation of functions.

Sectors Adapted to Variations in Traffic Flows and/or Airspace Availability (3F)

After State: Sectorisation will be tailored to meet capacity demands, to accommodate traffic flow variations, to take advantage of released airspace and to satisfy operational needs.

ARN V4 (BIS) (1F)

After State: The six extra available flight levels will result in a change in the traffic balance for sectors. In order to ensure an efficiently balanced sectorisation, sectors may need to be changed where such a division exists between FL290 and FL 410.

Dynamically Sized Sectors (4F)

After State: Respond in real-time to changing situations in traffic patterns and/or to short-term changes of users' intentions by the dynamical adjustment of airspace boundaries of ATC sectors, in order to provide the best balance between their size and controller workload.

Utilisation of User-Preferred Trajectories

Ad-hoc Direct Routing (1C)

After State: The joint use of airspace, by direct agreement between civil and military ATS units involved, reduces the GAT controller's workload by suppressing the need for the individual co-ordination of any off-route GAT, allows more ad-hoc direct routings and permit radar vectoring.

Free Routing in ECAC Airspace (2C+3C+4C)

After State: The initial development of the Free Route Airspace Concept in 8 ECAC States (B, NL, L, D, DK, N, S, SF) Upper Airspace in which all users shall freely plan and fly their preferred route between an entry point and an exit point without reference to the pre-defined ATS route network, will possibly evolve to be expanded to all ECAC States and to the Lower Airspace above a commonly agreed base level.

Free Routing in 8 States (2C)

After State: Apply the Free Route Airspace Concept in 8 ECAC States (B, NL, L, D, DK, N, S, SF) in order to give freedom for operators to plan and fly user-preferred routing above a commonly agreed base level with flights remaining subject to ATC

Expanded Free Routing Application (3C)

After State: Application of the Free Route Airspace Concept on a wider basis than the initial implementation by the 8

States.

Initial expansion of its implementation both to lower flight levels and to other groups of ECAC States (e.g. CEATS).

Free Routing in all ECAC States (4C)

After State: Apply the Free Route Airspace Concept in all ECAC States in order to give freedom for operators to plan and fly user-preferred routing above a commonly agreed base level with flights remaining subject to ATC.

Allow Autonomous Operations in Free Flight Airspace (5C+6C)

After State: Controllers will be able, under defined conditions, to delegate the responsibility for specific SA tasks to the flight-crew of suitably-equipped aircraft (e.g. climb in trail, aircraft ahead, station-keeping, climb/descend when clear,...). Such delegations will be part of the clearances, as today in VMC, resulting from mutual agreement between controllers and pilots. Then progressively to allow, within specified airspace volumes in N environment, a move from the current regime of ensuring separation through ATS systems based on ATC clearances, to one of resolving possible conflict by transfer of the separation responsibility to the air crew, based on detailed airborne knowledge of pertinent aircraft trajectories (e.g. actual position, speed, projected flight paths,...).

Transfer of SA Responsibility in Specific Cases (5C)

After State: Controllers will be able, under defined conditions, to delegate the responsibility for specific SA tasks to the flight-crew of suitably-equipped aircraft (e.g. climb in trail, aircraft ahead, station-keeping, climb/descend when clear,...). Such delegations will be part of the clearances, as today in VMC, resulting from mutual agreement between controllers and pilots.

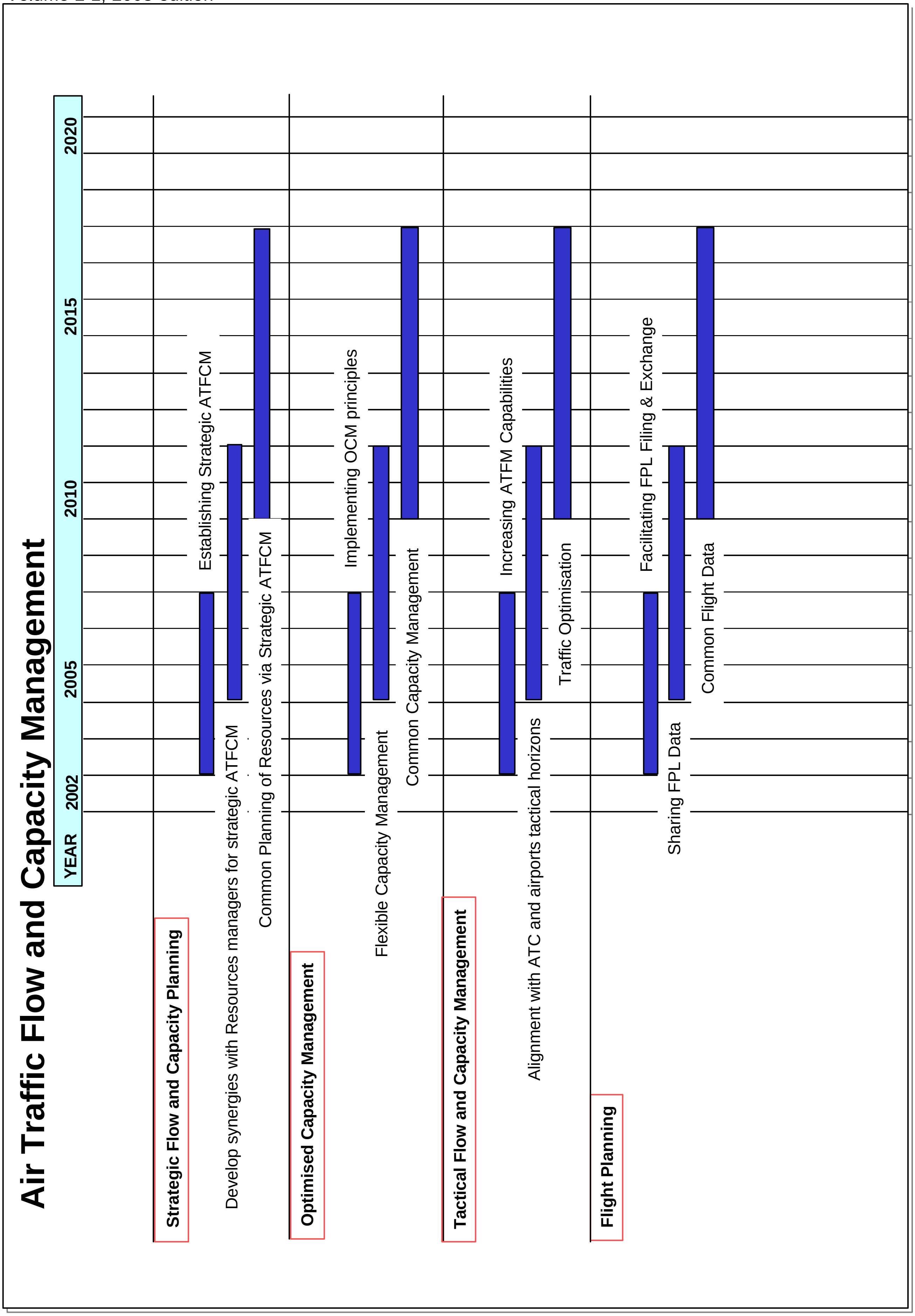
Full Transfer of SA Responsibility (6C)

After State: Allow, within specified airspace volumes in N environment, a move from the current regime of ensuring separation through ATS systems based on ATC clearances, to one of resolving possible conflict by transfer of the separation responsibility to the air crew, based on detailed airborne knowledge of pertinent aircraft trajectories (e.g. actual position, speed, projected flight paths).

Airspace Organisation & Management Horizontal Activities

Implementation of Best Practices and Refined Procedures

After State: Include applying best practices from bench marking studies.


Air Traffic Flow and Capacity Management
YEAR
2002
2005
2010
2015
2020
Strategic Flow and Capacity Planning
Establishing Strategic ATFCM
Develop synergies with Resources managers for strategic ATFCM
Common Planning of Resources via Strategic ATFCM
Optimised Capacity Management
Implementing OCM principles
Flexible Capacity Management
Common Capacity Management
Tactical Flow and Capacity Management
Increasing ATFM Capabilities
Alignment with ATC and airports tactical horizons
Traffic Optimisation
Flight Planning
Facilitating FPL Filing & Exchange
Sharing FPL Data
Common Flight Data

Air Traffic Flow and Capacity Management

Strategic Flow and Capacity Planning

Establishing Strategic ATFCM

After State: Strategic ATFCM will characterised by improvements in the assessment of the balance between traffic demand and airspace capacity. Earlier information of problems in critical areas will allow better co-ordination to manage the provision of En-route capacity and use of the airspace with strategic routing schemes. Planning will be progressively improved from a reactive process into a proactive process

Develop synergies with Resources managers for strategic ATFCM

After State: Involvement of more and new types of actors (e.g. airport and airspace managers) in order to reach ECAC-wide coverage will see the further steps in the development of a strategic/proactive system by the evaluation of plans of major airspace users and service providers so as to determine demand requirements and capacity availability. This phase will see the development of tools so as to better assess the demand, the initiation of collaboratively agreed actions to reduce demand in critical areas and the development of closer information-sharing and co-ordination with airport scheduling committees.

ATFCM will receive User and Service Provider data for collation and input into the Data Repository. These will be used to create the Seasonal Forecasts and to provide relevant data. ATFCM will analyse the data, via data evaluation and display tools, to identify potential problems of over-demand/under-capacity and of over-capacity and will use automated tools and "what-if" prediction simulation facilities to identify solution options to any problems. ATFCM, in collaboration with Users and Service Providers, will negotiate and agree remedial actions. Once these have been agreed ATFCM will update the Seasonal Forecasts and make them available to involved stakeholders. Simulation facilities will enable users and service providers to perform common analysis activities, enhancing the decision-making process.

Common Planning of Resources via Strategic ATFCM

After State: Common Planning will see the completion of steps for a strategic/proactive system which will enable the full development of collaboratively refined Seasonal Forecasts. This iterative process will eventually develop into a fully interactive planning and decision making process that will provide the optimum balance between users' needs and service providers' capabilities. There will be an extension of inter-communications and CDM capabilities of all Users and Service Providers, in which the use of the simulation facilities introduced in the previous phase will be extended:

1. The facilities provided by ATFCM to the scheduling committees will be extended to other stakeholders (principally ATS planners);

2. Simulation facilities will be extended to enable Users and Service Providers to perform their own individual simulation and analysis activities on a scheduled, batch-run basis;

3. The introduction of more extensive and capable communications and simulation facilities will enable Users and Service Providers to perform real-time, group-interactive simulation and analysis activities.

Optimised Capacity Management (OCM)

Implementing OCM Principles

After State: Collaborative Pre-Tactical Capacity Management will see the initial steps in the progressive shift from the reactive management of demand to proactive management of capacity, together with improved historical data and the use of simulation tools to provide better picture of short-term events. Flow and capacity management will be applied primarily to the:

- Optimisation of the airspace and airport capacity usage;
- Network management to balance demand versus capacity in the overall area
- Pre-tactical management to refine and disseminate the ATFM daily plan.
- Post day of operation analysis

Flexible Capacity Management

After State: Flexible Capacity Management will see the intermediate steps in the progressive shift to proactive management of capacity, together with more complete historical data and simulation tools capability. Emphasis will be put on improved collaboration with military and airports to optimise activities of all concerned This will provide a progressively better picture of short-term events than in the previous phase, so as to be able to begin the matching of capacity to demand and the provide the initial stage in an advisory service to stakeholders to optimise flow planning. The ADPs will be produced from the Seasonal Plans and held in the AODb. The ADPs will then be progressively and iteratively developed and refined, under the management of ATFCM, as the day of operation approaches. The ADPs will require externally-derived data provided by most Users and Service Providers at this stage (e.g. AMC, ACCs, Airspace Users, airspace organisation plans etc.), and internally-derived data from the Data Repository (historical data when appropriate, anticipated flight plans and estimations of spare capacity requirements). All eligible stakeholders will have access to the DOP data in the AODb, subject to restrictions on material of national or commercial sensitivity.

Simulation facilities will be used to identify, collaboratively, solutions and scenarios to meet demand and to prepare for crisis and special situations. If the demand still exceeds the capacity, then ATFCM will seek to minimise restrictions imposed on airspace users. In addition, when identified, ATFCM will be able to offer Users options to optimise their operations. Airspace users will have access to: pre-IFPS Flight Plan programs to refine and correct their Flight Plans before their submission to IFPS.

Common Capacity Management

After State: Common Capacity Management will see the final steps in evolution towards the collaborative and proactive management of en-route and airport capacities, including all service providers and users with the means and procedures to make the most efficient use of the available airspace and services. The iterative development and refinement of the ADPs, as performed by ATFCM in the previous phase, will be extended to all eligible stakeholders (principally Users and ACCs), enabling them to check their plans against the DOP and to run their own, or group investigations (under the principles of collaborative decision-making). Simulation facilities will be used to provide a "picture" of the day of operations that will identify problem areas.

Flight Planning

Facilitating FPL Filing & Exchange

After State: Facilitating FPL Filing & Exchange will see improvements in the information exchange with, and the assistance to, airspace users in support of flight plan filing and dissemination of more up-to-date information on airport and airspace constraints. Airspace users will be able to make more informed decisions when compromises are needed between delay, re-routing, trajectory limitations or costs. ATFCM will introduce more responsive and informative error reporting programs to ease the process of correction by the users.

Users will also have access to the flight profiles held in the DOP so as to be able to confirm or revise their plans. That the same, accurate flight plan data is available to ATS, the User and ATFMC.

Sharing FPL Data

After State: Sharing of FPL Data will deliver/implement universal access to accurate and consistent flight plan information, including the profile of the flight and the progress of it. (e.g. through information exchange with flight plan service providers and with airports). FPL changes will be dynamically cross-checked against up-to-date information on airports, airspace and ATFM constraints. Furthermore, FPL will be re-assessed against changes in airports, airspace and ATFM situation.

Common Flight Data

After State: Common Flight Data will include full flight data information sharing between all actors. This data will describe the latest confirmed intentions of each flight, with the level of accuracy and detail (e.g. trajectory, equipment, performance, weight, status, slot, etc…) to meet requirements of the actors concerned.

Tactical Flow and Capacity Management

Increasing ATFM Capabilities

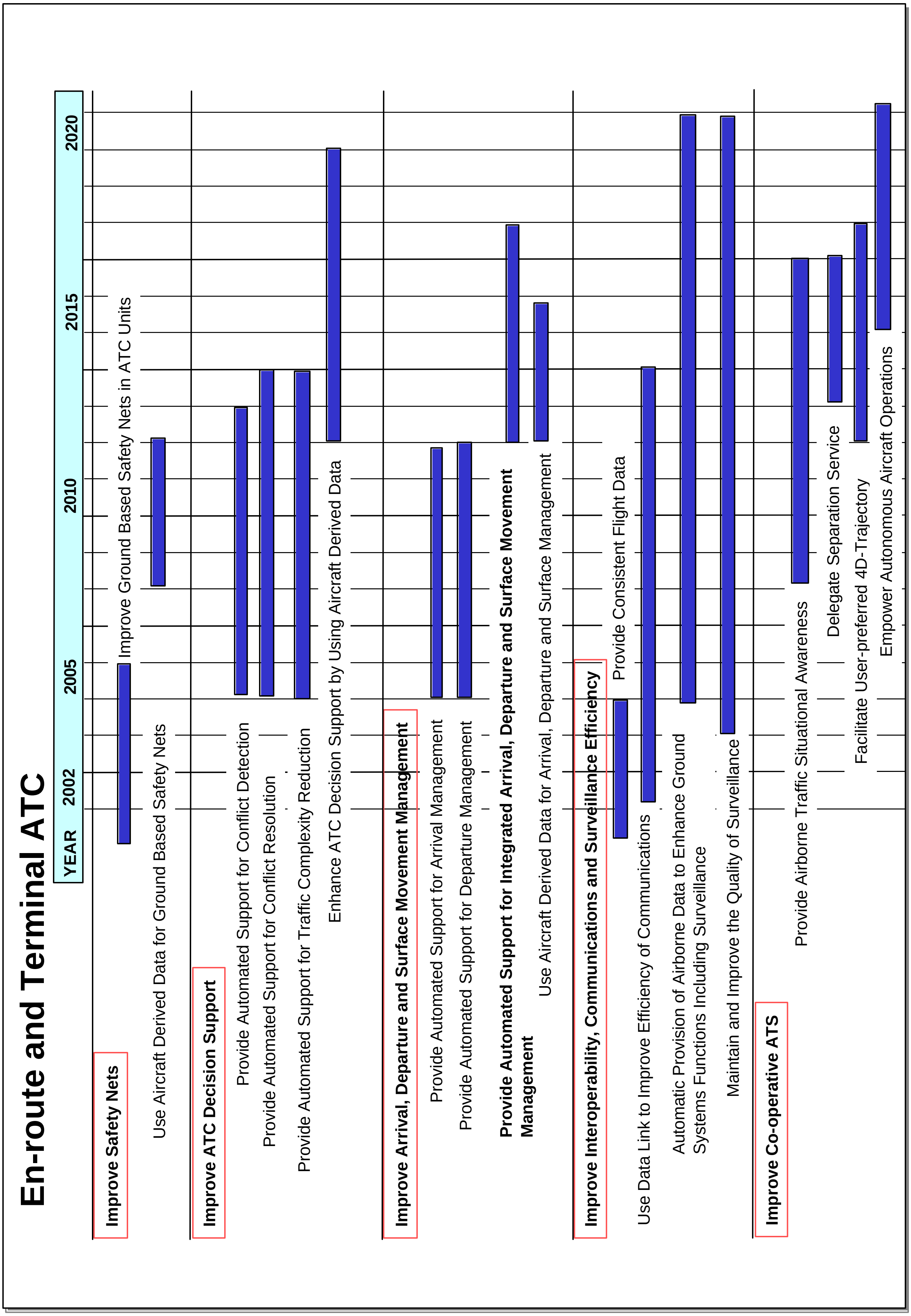
After State: Enhancements will be made to the quality of tactical flow management through improved traffic monitoring capabilities via the availability of surveillance-derived traffic information and meteo information. This will enable more accurate prediction of traffic and ATC workload, which in turn will allow actors to benefit from last minute opportunities. It provides the first elements to close the gap between ATC and ATFM. These activities take place on the day of operation.

Alignment with ATC and airports tactical horizons

After State: ATC, Airport Operations and ATFM will align their short-term planning horizons thanks to enhancements in data consistency and accuracy. As all actors have access to the same data, the planning horizons will meet. This will result in fine-grained layered planning combining the global or wide-area view with local execution and follow-up. The gap between ATC, ATFM and airport operations will be reduced

Traffic Optimisation

After State: A common, complete, accurate and up-to-date picture of the current traffic situation will be available to all actors with the required level of detail and access. This "flow picture" will be available to Users and Service Providers. Analysis tools will be used toidentify the extent of discrepancies or disturbances to the ADP and, when identified, simulation tools will be used to explore alternatives and offer remedial options. Any involved Stakeholder will be able to initiate negotiation for agreement on remedial action (e.g. re-routing, sector or airspace reorganisation) with the appropriate bodies (ACCs, AMC, and Airspace Organisation). In addition, the input of Met forecast data will enable Stakeholders to predict conditions that may cause a significant variation in the Plan and to initiate remedial action before the event.


En-route and Terminal ATC
YEAR
2002
2005
2010
2015
2020
Improve Safety Nets
Improve Ground Based Safety Nets in ATC Units
Use Aircraft Derived Data for Ground Based Safety Nets
Improve ATC Decision Support
Provide Automated Support for Conflict Detection
Provide Automated Support for Conflict Resolution
Provide Automated Support for Traffic Complexity Reduction
Enhance ATC Decision Support by Using Aircraft Derived Data
Improve Arrival, Departure and Surface Movement Management
Provide Automated Support for Arrival Management
Provide Automated Support for Departure Management
Provide Automated Support for Integrated Arrival, Departure and Surface Movement Management
Use Aircraft Derived Data for Arrival, Departure and Surface Management
Improve Interoperability, Communications and Surveillance Efficiency
Provide Consistent Flight Data
Use Data Link to Improve Efficiency of Communications
Automatic Provision of Airborne Data to Enhance Ground Systems Functions Including Surveillance
Maintain and Improve the Quality of Surveillance
Improve Co-operative ATS
Provide Airborne Traffic Situational Awareness
Delegate Separation Service
Facilitate User-preferred 4D-Trajectory
Empower Autonomous Aircraft Operations

En-route and Terminal Air Traffic Control

Improve Safety Nets

Improve Ground Based Safety Nets in ATC Units

Before Systems without an automated safety net fully rely on the performance of the controller to detect separation infringements, also under circumstances of high workload.

After State: Ground based Safety Nets provide an alert to air traffic controllers that separation minima may be infringed by the aircraft, or that a potentially threatening situation to the safe conduct of the flight is developing. Ground based Safety Nets are as independent as possible from Flight Data Processing Systems. They are not a planning tool in Air Traffic Control and do not relieve the controller from problem identification and monitoring functions. They are designed to provide a warning with sufficient time for action to be taken to resolve the situation on the basis of Radar Data Processing data extrapolations.

Safety nets have been implemented in several ATC Units.

Safety nets provide warnings indicating potential hazardous situations between aircraft and:

- other aircraft, through the short term conflict alert tool (STCA);
- special airspace, through the airspace proximity warning tool (APW);
- terrain, through the minimum safe altitude warning tool (MSAW);
- other aircraft and vehicles on airport manoeuvring area (runway incursion alert tool).

The functioning of Safety Nets has a high dependency on the quality of data, in particular surveillance data.

The ground based automated safety nets add an additional layer of safety assurance to the provision of separation by the air traffic controllers. They enable the controllers to take corrective action required following oversights or otherwise, before the TCAS/GPW alarm in the aircraft is triggered.

Use Aircraft Derived Data for Ground Based Safety Nets

Before Ground based ATC safety nets function independently from data provided by the aircraft. Principally, safety nets are based on extrapolations from surveillance information.

After State: The effectiveness and reliability of ground safety nets can be improved by adding aircraft derived data to the ground based safety nets. An example of this is the reception and processing of 25 feet vertical increments. Aircraft derived data will improve the accuracy in the calculation of potential separation infringements, which form the basis for warnings to the controller and will provide improved position accuracy. These factors will contribute to a reduction in calculated false alarm rates.

Improve ATC Decision Support

Provide Automated Support for Conflict Detection

Before Conflict detection in current systems is basically a manual task, performed on the basis of paper or electronic flight strips. Planning controllers prepare separation at hand-over sector boundary points, while tactical controllers are responsible for maintaining the separation along the entire flight path within the sector. The heavy workload of tactical controllers is one of the reasons for performance shortfall resulting in capacity problems.

After State: Automated Support for Conflict Detection introduces a systematic detection of potential conflicts between pairs of aircraft and critical airspace boundaries in a timeframe of approximately 20 minutes before the occurrence.

The planning controller will be enabled to anticipate and take action to resolve detected separation shortfalls well before the calculated point of conflict. The calculation is based on trajectory prediction as a set of points between the current position and a 4-D position further downstream along the aircraft's route. Automated conflict detection will assist controllers after initial departure phase and before final arrival phase.

Capacity will be gained by improved task sharing between the planning and tactical controllers. Automatic flight progress and conformance monitoring and medium term conflict detection are important means to achieve this goal. In particular, conflict detection is an enabler for a different use of airspace with new procedures for the application of free routes. Within a free route environment conflict detection would become very cumbersome without high-performance conflict detection tools.

Conflict detection is normally based on the flight trajectory within the centres area of interest, which is displayed to appropriate controllers through their HMI. Results of the conflict detection process are applicable at sector or multi-sector levels depending on the extent of the area of interest associated with the controller.

Provide Automated Support for Conflict

Before Conflict detection as explained in the OI "Provide Automated Support for Conflict Detection" only provides indications of possible conflicts. It is the responsibility of the controller team to consider and decide upon the action to resolve the conflicts.

After State: The logical next operational improvement in the field of ATC Data Processing after the automation of conflict detection will be automated provision of conflict resolution advice.

Automated conflict resolution will be applied in the high complexity airspace of the ECAC area for all types of traffic in departure, en-route and arrival phases in all types of airspace.

It is expected that automated conflict detection and resolution will assist controllers after initial departure phase and before final arrival phase.

The resolution should as much as possible take into account the air traffic situation beyond the immediate AoR of the control team.

Provide Automated Support for Traffic Complexity Reduction

Before Traffic Flow Management implements solutions to known capacity problems relating to weather or ATC service provider limitations. Traffic Flow Management is performed through interaction and collaborative decision making between local ATC Service Providers and the CFMU, who acts for the entire European Region, in particular for non-airborne flights.

After State: Additional support tools will be developed for decreasing controller workload by further smoothing flows of traffic and de-conflicting flights in a multi-sector/multi-unit environment. In particular these tools will assist controllers in alleviating:

- Traffic complexity
- Traffic density
- Traffic flow problems

Enhance ATC Decision Support by Using Aircraft Derived Data

Before Trajectories predicted by ATC ground systems have limitations as to their accuracy. Without positive information from on-board avionics the predictions are based on information from the ICAO flight plan, supplemented by current position data and qualified extrapolation. Aircraft derived data will improve the accuracy of ground based trajectory calculations and reduce the amount of associated uncertainty. Reliable trajectories will, in turn, greatly enhance the usefulness of ATC decision support.

After State: Interoperability between AOC and ATM systems will enable the acquisition of aircraft derived data from the AOC as a first step to enhance the accuracy of ATC trajectory prediction. Further operational improvements will be brought by direct transfer of discrete parameters from aircraft to ground systems.

Finally, ATM systems will receive aircraft generated trajectory data from current position of the aircraft to destination. This will enable the comparison between the flight plans used in airborne FMS and ground ATM systems , which is expected to greatly enhance safety and efficiency. Traffic flow problems brought by direct transfer of data from aircraft to ground systems. ATM systems will need to process relevant aircraft parameters including aircraft generated trajectory data.

Improve Arrival, Departure and Surface Movement Management

Provide Automated Support for Arrival Management

Before Arrival management has the major function to match the constraints and limitations imposed by the landing runway(s) with the stream of quasi randomly arriving aircraft. Arrival management 'rate based' support tools with varying degrees of sophistication have been implemented already at a number of European airports: Amsterdam (proprietary arrival management system), Frankfurt (Compass), Paris (Maestro), Copenhagen (Maestro +).

After State: Development of advanced and associated validation of Arrival Management is continuing and support to Arrival Management operational implementations and trials is given. Passive / Active AMAN: in the passive mode, AMAN will provide time advisories to controllers for metering of aircraft through constraint points. In active mode, AMAN will provide controllers with tactical control order advisories (speed and/or heading) through the constraint points allowing better utilisation of airspace and reducing controllers' workload.

Current 'rate based' systems do not require controllers to exactly follow up the planning of the AMAN tools. This limits the optimisation process and the ensuing benefits. A high adherence to the automatic planning enables the controllers to maintain optimal capacity and efficiency.

Provide Automated Support for Departure Management

Before Runway capacity is considered as a principal constraint in to-day's air traffic control system. Several problems exist with regard to optimising departure sequences. Uncertainties of pushback, start-up and taxi times limit the capability of aerodrome control to achieve their preferred sequence. Several actors can influence the sequence of the departures, with each actor seeking to apply local and individual optimisation resulting in a potential for under utilisation of the runway.

After State: Automated support to departure management aims at eliminating the individualised planning and optimisation functions carried out by the individual actors. Automated support to air traffic controllers at European airports will be provided by optimising the sequence of departures for one or more runways and providing advisories to controllers.

The DMAN calculated departure schedule will exploit runway capacity, be CFMU-slot-compliant and take into account airline and airport preferences. It will also comply with constraints such as the departure rates into specific directions or minutes-in-trail or miles-in-trail minima for specific SIDs.

Collaborative decision making principles will be applied to departure management automation.

Controllers will have to respect the sequencing advisories provided by the automated system. However interactivity between controllers and DMAN will be required.

Provide Automated Support for Integrated Arrival, Departure and Surface Movement Management

Before The development of arrival, departure and surface movement management is embedded in separate projects. Belgocontrol has undertaken a prototyping activity to combine basic arrival and departure functions in a single HMI (Traffic MANager TMAN).

After State: The enhancement of aerodrome operations through fully integrated arrival, departure and surface traffic management improves the aerodrome throughput through the sequencing and metering provided by integrated arrival, departure and surface management functions. The full integration of Arrival, Departure and Surface Management will result in a continuous, expeditious and orderly flow of arriving and departing aircraft. The surface management will also address the movement of ground vehicles on the manoeuvring area and the delivery of Start-Up, Push-Back and Taxi clearances via data link. OI includes application of 'station keeping within the TMA.

Use Aircraft Derived Data for Arrival, Departure and Surface Management

Before Arrival, departure and surface movement management support tools function independently from data provided by the aircraft other than for surveillance.

After State: The effectiveness of the data processing tools will be improved by adding aircraft derived data to the ground based functions, as demonstrated in particular by the PHARE trials.

Improve Interoperability, Communications and Surveillance Efficiency

Provide Consistent Flight Data

Before The workload at ATSUs has been reduced by the increasing introduction of data exchange which has removed the need for ground / ground voice co-ordination and increased the proportion of flight plans that are entered without the need for manual intervention.

The operational use of data exchange between Flight Data Processing Systems for co-ordination purposes is commonly referred to as “On- Line Data Interchange “ (OLDI), for which a EUROCONTROL Standard has been approved. OLDI has been implemented in the core area of Europe as the first level of interoperability. SYSCO is an expansion of OLDI.

The principles of civil/military co-ordination were developed under the Flexible Use of Airspace concept and the data exchange to facilitate it is documented in a EUROCONTROL specification.

The implementation of IFPS has resulted in the dissemination of flight plans which are syntactically and semantically correct allowing automated input. The notification of updated flight data by flight data processing systems at ATSUs allows the CFMU to keep its database in line with the current situation

After State: Current flight data processing systems already have a high degree of interoperability. Routine exchange of flight data between ATC centres for co-ordination and transfer purposes and data exchange with military and CFMU systems is already specified at a European level and widely implemented.

Further integration of ATSUs will generate requirements for the wider availability of data including trajectory information and the operation of ATC tools and planning of flights without consideration of the boundaries of AoRs. Requirements for additional interoperability arise from EATCHIP operational requirements and from concepts and requirement documents being produced under EATMP Interoperability is required between flight data processing systems of civil ATC services and between such systems and those of other actors which comprise the following: IFPS, ATFM, Military ATC services, Aircraft Operators, Airport Operators, Aircraft, Air defence agencies, Airspace Management Cell.

Use Data Link to Improve Efficiency of Communications

Before Accurate and timely exchange of messages is essential for air traffic control. One of the constraining factors in ATC is the amount of messages that need be exchanged between controller and pilots. In busy traffic circumstances, saturation of voice channel in use by an air traffic control sector may put limitations on the capacity.

Initial services based on ACARS have been introduced in the last decade: Departure Clearance (DCL), Oceanic clearance (OCM), Automatic Terminal Information Service (ATIS).

After State: In the future environment, alternative solutions will be required for exchanging the clearances and instructions. Transferring routine air/ground communications from voice to data channels is a key goal for future ATC. Data exchange will not replace but supplement voice communication.

ATC/DP will continue to develop the operational services listed in this section using air/ground data communications. These services represent enabling applications.

1. A subset of Controller Pilot Data Link Communications (CPDLC) based on ATN: Clearance and Information communications Service (ACL), ATC Communications Management Service (ACM), Departure Clearance Service (DCL), Downstream Clearances Service (DSC).

2. A subset of Down-linked Airborne Parameters (DAP): Controller Access Parameters (CAP) (also used for controller situational awareness), Pilot Preferences down link (PPD)

3. Data Link Flight Information Services (D-FIS) in: Data Link Operational Terminal Information Services (D-OTIS), Data Link Instantaneous Runway Visual Range Delivery (D-RVR), Data Link SIGMET Service, Full scale FIS and meteorological air/ground data interchange

The use of data link equipment should not increase significantly the amount of head-down time and key-stroking, in particular within the cockpit. Any possible increase in head-down time in the cockpit or at the sector suite shall not provoke any disruption, breakdown in operating procedures or incompatibility with working methods essential to other functions and duties of controllers and aircrew.

Automatic Provision of Airborne Data to Enhance Ground Systems Functions Including Surveillance

Before The current surveillance system consists of primary and secondary radar for the detection of aircraft and the determination of their position and identity.

After State: Using enhanced surveillance and communication techniques, it will be possible to improve the surveillance function by systematically receiving airborne data (System Access Parameters - SAP), in particular aircraft intent data to improve the trajectory prediction of ground systems, including ATFM and ATC. These services represent enabling applications. Note that Controller Access Parameters and Pilot Preferences Down-link have been listed under the previous operational improvement as well.

1. Available services description: Controller Access Parameters (CAP), Flight Plan Consistency 2D and 3D (FLIPCY), Pilot Preferences Down-link (PPD).

2. Service description under development: Flight Path Intent (FLIPINT), System Access Parameters (SAP).

Maintain and Improve the Quality of Surveillance

Before Saturation of SSR mode 3/A/C interrogations has become a major problem in ATC. Deficiencies include garbling due to overlapping replies from two or more transponders, over-interrogation, reflections and shortage of Mode 3/A codes.

The mandatory carriage of ACAS creating additional interrogations and the ICAO global requirement for all aeroplanes to carry and operate a pressure altitude reporting transponder exacerbate the growing problem of RF congestion in airspace subject to high traffic density

After State: To overcome these difficulties and ensure that an acceptable level in the probability of detection is maintained, SSR Mode S (select) has been developed that alleviates shortage of SSR code and enables radar interrogators to address individual aircraft selectively. In this basic form, it has been termed Mode S Elementary Surveillance. However, Mode S also permits additional data to be exchanged between aircraft and ground interrogators. This has been termed Enhanced Mode S Surveillance and consists of the downlinking of (pre-determined) aircraft parameters (DAPs), both for access by controllers and/or surveillance data processing systems

Improve Co-operative ATS

Provide Airborne Traffic Situational Awareness

Before For airborne traffic situational awareness, pilots depend on overhearing voice communications. This enables a very limited and unreliable picture of the air situation. The TCAS display is not designed for situational awareness

After State: Air traffic situational awareness is the flight crew's knowledge of the aircraft's state and the external operational environment relevant to the flight. As well as information on the terrain, aircraft position and weather, a central component of the flight crew's decision process for the management of the flight includes their knowledge of the surrounding traffic situation in the air and on the ground (Air Traffic Situational Awareness) and of current ATM planning and constraints (Air Traffic Management Awareness).

Air Traffic Situational Awareness does not constitute separation assurance in itself. Nevertheless, taking advantage of the expected sharing of information between the ground and the air, increased air traffic situational awareness will be one of the essential enablers for the delegation of separation assurance tasks to the flight crew.

Air Traffic Situational Awareness is a cornerstone of Co-operative ATS, improving the following operational services: Provision of accurate information concerning other traffic, Enhanced visual acquisition, Party line compensation, Improved anticipation of ACAS events, Enhanced Traffic Information Broadcast for Aircraft (TIBA) not in radar areas, Improved taxi and runway occupancy, Enhanced "see and avoid", in particular under emergency conditions, Optimised spacing when executing visual approach/land after procedures, Optimised spacing on final approach.

Delegate Separation Service

Before

After State:

Facilitate User-preferred 4D-Trajectory

Before ATM and avionics have taken quite different development paths. Both systems use the flight plan as originated by the Aircraft Operator as the basis, but process the flight plan independently in their respective systems, the FMC and the FDP.

Classical Surveillance and pilot-controller message exchange are in current systems the only means to align the processing of the flight plan with a view to minimising emerging differences

After State: The OI is covered by the application under development, the Common Trajectory Co-ordination (COTRAC) service, which is an operating concept in itself supporting optimal use of user-preferred trajectories. The COTRAC service, combined with delegated separation services has the potential to significantly progress toward the new form of ATM, the Co-operative ATS.

The purpose of COTRAC is to establish and agree 4D trajectory contracts between Aircrew and Controllers in real time using graphical interfaces, air and ground data communications and automation systems, in particular the FMS, by means of a structured negotiation method in order to significantly enhance ATM capacity and flexibility.

The co-ordination of trajectories can be performed more effectively by involving Airline Operations (AOC) in the loop, either directly through air/ ground data communications or optimised ground/ground data communications, enabling Collaborative Decision Making (CDM).

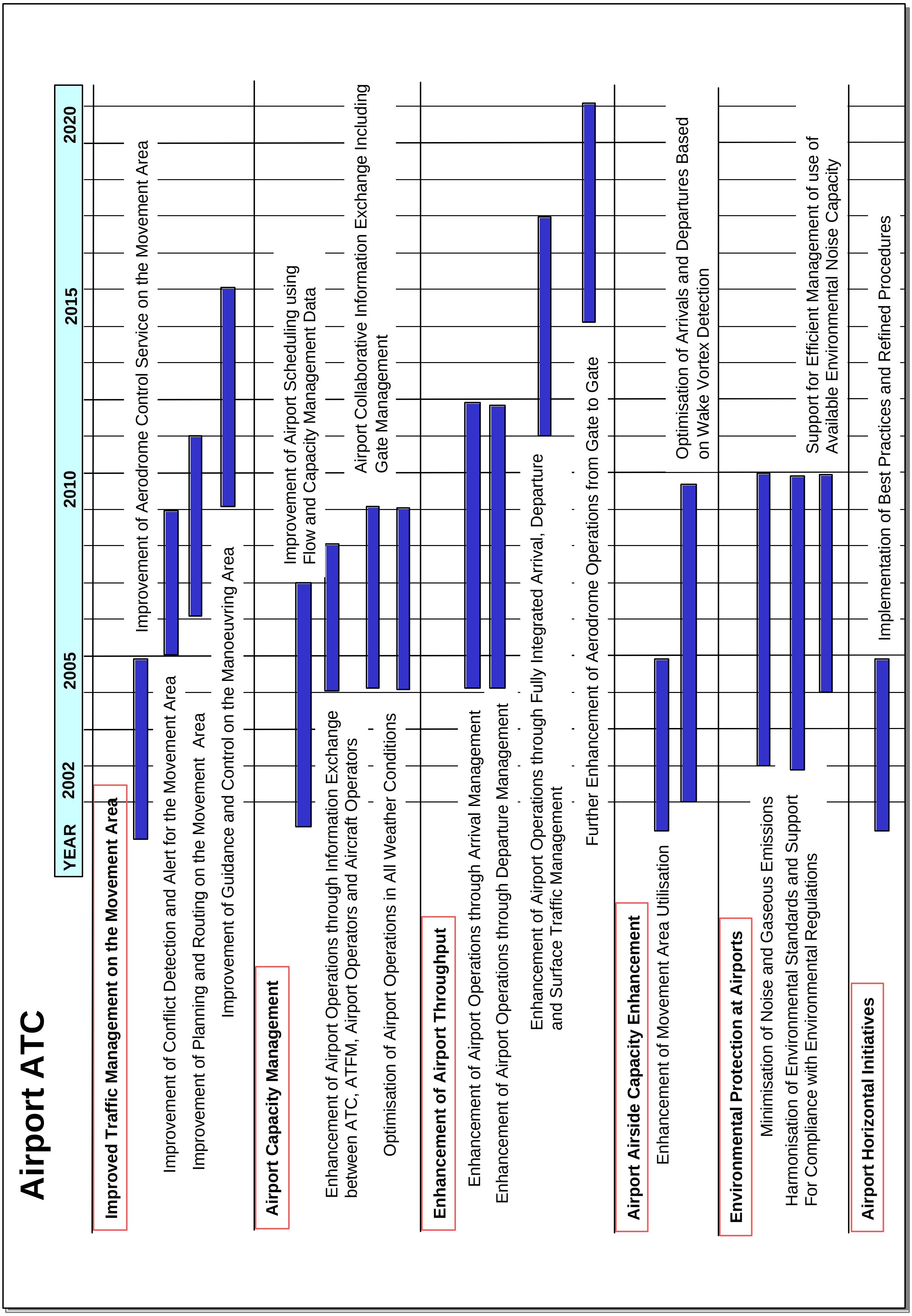
COTRAC will enable trajectory based ATM as described in the EATMS Operation Concept. COTRAC will be optimised through ground automated tools.

Empower Autonomous Aircraft Operations

Before The principle of Autonomous Flight operations is to enable ground ATM to benefit from the capability of the flight crew, as a follow-on to the increased airborne situational awareness and airborne separation assurance capabilities, to accept the full transfer of responsibility for separation assurance in FFAS.

After State: The flight crew will be solely responsible for Separation Assurance, except in exceptional circumstances, e.g. when a flight suffers a loss of capability due to system, human or environmental factors, or has a specific exemption that necessitates control from the ground (e.g. military, special flights).

The responsibilities of the controller will be to survey the predicted air situation beyond the flight crew's situational awareness range and to provide "safety advisories".


Airport ATC
YEAR
2002
2005
2010
2015
2020
Improved Traffic Management on the Movement Area
Improvement of Aerodrome Control Service on the Movement Area
Improvement of Conflict Detection and Alert for the Movement Area
Improvement of Planning and Routing on the Movement Area
Improvement of Guidance and Control on the Manoeuvring Area
Airport Capacity Management
Improvement of Airport Scheduling using Flow and Capacity Management Data
Enhancement of Airport Operations through Information Exchange between ATC, ATFM, Airport Operators and Aircraft Operators
Airport Collaborative Information Exchange Including Gate Management
Optimisation of Airport Operations in All Weather Conditions
Enhancement of Airport Throughput
Enhancement of Airport Operations through Arrival Management
Enhancement of Airport Operations through Departure Management
Enhancement of Airport Operations through Fully Integrated Arrival, Departure and Surface Traffic Management
Further Enhancement of Aerodrome Operations from Gate to Gate
Airport Airside Capacity Enhancement
Enhancement of Movement Area Utilisation
Optimisation of Arrivals and Departures Based on Wake Vortex Detection
Environmental Protection at Airports
Minimisation of Noise and Gaseous Emissions
Harmonisation of Environmental Standards and Support For Compliance with Environmental Regulations
Support for Efficient Management of use of Available Environmental Noise Capacity
Airport Horizontal Initiatives
Implementation of Best Practices and Refined Procedures

Airport ATC

Improved Traffic Management on the Movement Area

Improvement of Aerodrome Control Service on the Movement Area

After State: The improvement of this service lies in expediting the arrival and departure flows on the runway system and the movement of taxiing aircraft and other vehicles on the manoeuvring area, while reducing the potential for loss of separation. I.e. ground traffic throughput improvements (all vehicles with two-way communication means, e.g. aircraft, including towed a/c, and service vehicles).

Improvement of Conflict Detection and Alert for the Movement Area

After State: The further improvement of aerodrome control service for traffic on the manoeuvring area will consist of enhanced conflict detection & alert means and of procedures to improve the aerodrome ground movement throughput whilst maintaining or improving safety. Runway incursion monitoring and alert are specifically covered by this improvement.

Improvement of Planning and Routing on the Movement Area

After State: The improvement of planning and routing is to enhance the aerodrome control service to inbound and outbound traffic flows. This will be achieved through de-confliction and support of the management of ground traffic (it addresses the pre-tactical and tactical aspects of the aerodrome services).

Improvement of Guidance and Control on the Manoeuvring Area

After State: The improvement of guidance and control of taxiing aircraft and vehicles as well as impending conflict alert will be fully automated.

Airport Capacity Management

Improvement of Airport Scheduling using Flow and Capacity Management data

After State: The improvement of airport scheduling using flow and capacity management data addresses better co-ordination of ATFM en-route slots with airport slots facilitated by collaborative decision making and information management of real-time data at the major co-ordinated airports. This will provide optimised arrival and departure management, collaborative stand and gate management, slot shifting and slot swapping.

Enhancement of Airport Operations through Information Exchange between ATC, ATFM, Airport Operators and Aircraft Operators

After State: This OI addresses the improved exchange of information between ATC, ATFM, Aircraft Operators and Airport Operations. This will enable all involved agencies and personnel to remain fully aware of continually changing situations, thereby providing the capability for fully co-ordinated traffic movements even during times of disruption.

Airport Collaborative Information Exchange Including Gate Management

After State: The airport collaborative information exchange including gate management addresses the implementation of gate management, following the CDM approach, at airports. The initial focus will be on ensuring that the management and allocation of stands, gates and other airport facilities is optimised. This may be extended to encompass real-time facility management to ensure optimum use.

Optimisation of Airport Operations in All Weather Conditions

After State: The optimisation of airport operations in all weather conditions such that capacity is as close as possible to that in good conditions with the same safety levels.

Enhancement of Airport Throughput

Enhancement of Airport Operations through Arrival Management

After State: This improvement affects runway utilisation through ‘sequencing and metering’ provided by an automated arrival management function. Improved arrival management in combination with optimised runway utilisation procedures and infrastructure will assure the capability to build a safe, continuous, expeditious and optimised flow of arriving aircraft towards, on and vacating the airport runway(s).

Enhancement of Airport Operations through Departure Management

After State: The enhancement of aerodrome operations through departure management improves the runway utilisation by sequencing and metering provided by an automated departure management function. Improved departure management will result in a continuous, expeditious and optimised flow of departing aircraft through the runway(s) until established en-route.

Enhancement of Airport Operations through Fully Integrated Arrival, Departure and Surface Traffic Management

After State: The enhancement of aerodrome operations through fully integrated arrival, departure and surface traffic management will improve aerodrome throughput through the sequencing and metering provided by integrated arrival, departure and surface management functions. The full integration of Arrival, Departure and Surface Management will result in a safe, expeditious and orderly flow of arriving and departing aircraft. The surface traffic management function will also address the movement of ground vehicles on the manoeuvring area.

Further Enhancement of Aerodrome Operations from Gate to Gate

After State: The further enhancement of aerodrome operations from gate to gate addresses the use of automated support for integrated arrival, departure and surface traffic management, extending the planning horizon by including the departure and arrival aerodromes. The airport design will take into account that the landing aids stay as a minimum at Cat III capability in conformance with the ATM/CNS Strategy.

Airport Airside Capacity Enhancement

Enhancement of Movement Area Utilisation

After State: Enhancement of runway utilisation addresses operational benefits expected to be gained from reduced Runway Occupancy Times (ROT) procedures, and throughput improvement of the runway system and optimisation of runway utilisation by implementation of current "new procedures".

Optimisation of Arrivals and Departures Based on Wake Vortex Detection

After State: The optimisation of arrivals and departures based on wake vortex detection addresses the optimisation of runway arrival and departure rates by the accurate knowledge of separation minima requirements caused by wake vortex conditions.

Airport Horizontal Initiatives

Implementation of Best Practices and Refined Procedures

After State: The implementation of best practices and refined procedures addresses the application of best practice(s) arising from benchmarking studies and deriving and applying capacity models to more accurately determine airport capacity. E.g. increased runway utilisation by allowing reduced separations in appropriate circumstances, such as visual arrival/departure procedures.

Environmental Protection at Airports

Minimisation of Noise and Gaseous Emissions

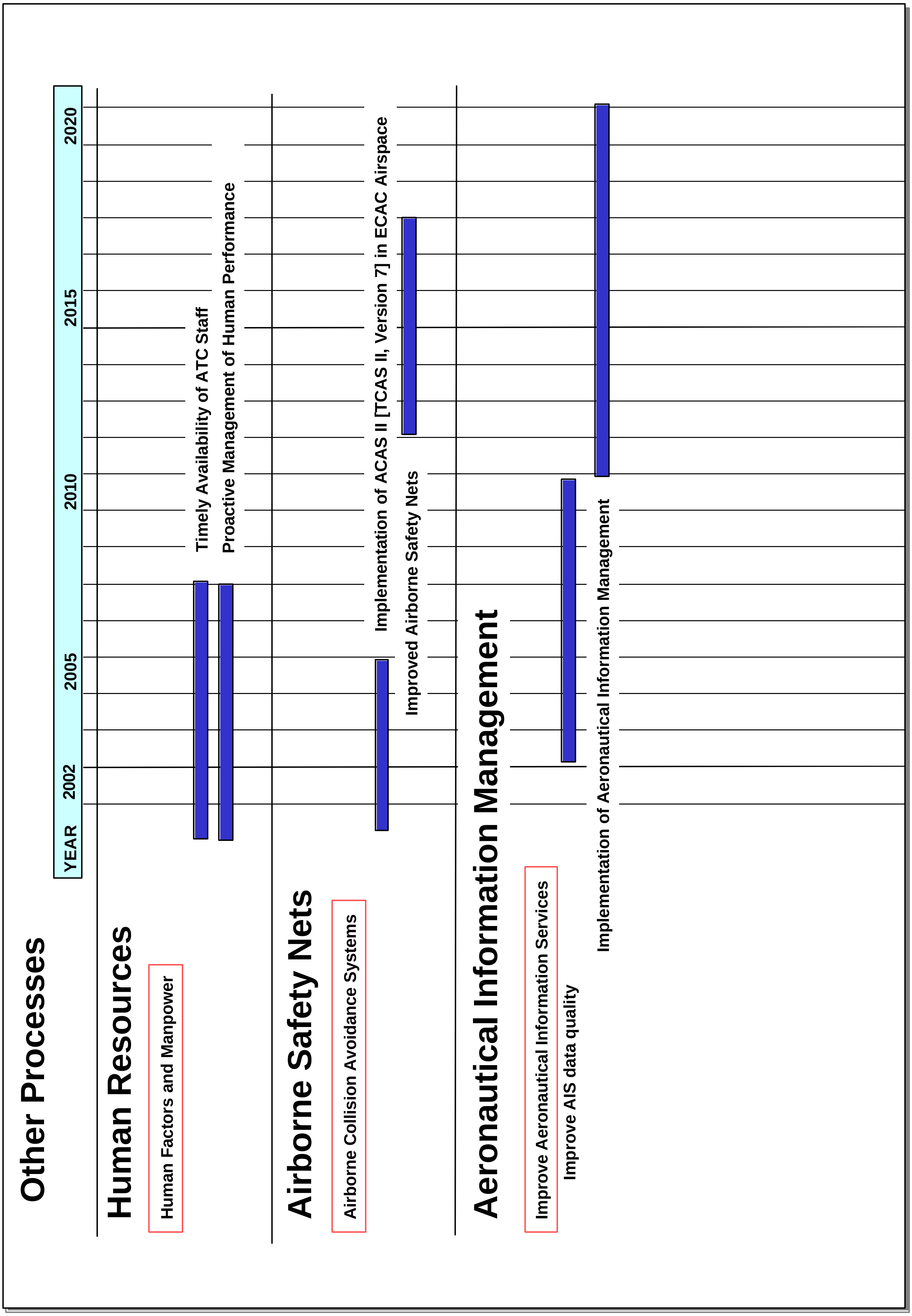
After State: The minimisation of noise and gaseous emission impact addresses the minimisation of the ATM related noise and emission impact resulting from aircraft operations at and around airports.

Harmonisation of Environmental Standards and Support For Compliance with Environmental Regulations

After State: The harmonisation of environmental standards & support for compliance with environmental regulation ensures that environmental noise and emission standards are harmonised on an ECAC wide basis, and that Airport ATM system and procedures are compliant with international and local environmental regulations and standards.

Support for Efficient Management of use of Available Environmental Noise Capacity

After State: The support for management of the available environmental noise capacity ensures that the Airport ATM system makes the best use of capacity, while taking the relevant environmental restrictions and constraints into account, allowing the sustainability of operations and growth.


Other Processes
YEAR
2002
2005
2010
2015
2020
Human Resources
Human Factors and Manpower
Timely Availability of ATC Staff
Proactive Management of Human Performance
Airborne Safety Nets
Airborne Collision Avoidance Systems
Implementation of ACAS II [TCAS II, Version 7] in ECAC Airspace
Improved Airborne Safety Nets
Aeronautical Information Management
Improve Aeronautical Information Services
Improve AIS data quality
Implementation of Aeronautical Information Management

Other Processes

Human Resources

Human Factors and Manpower

Timely Availability of ATC Staff

Before Chronic shortage of ATC staff within the ECAC area (10-12%) observed currently and in the past.

After State: Availability of suitable numbers of ATCO's with the right skills, knowledge attitude and motivation to assure and deliver expected ATM performance and services. The OI raises the staff situation and management to sustainable "State-of-the-Art": sufficient ATCOs to operate ATS services.

Proactive Management of Human Performance

Before Inconsistent and fragmented consideration of human factors in the development of ATM systems is observed today and is a barrier to both the beneficial exploitation of current procedures and tools, and successful and timely implementation of change.

After State: Full integration of human factors into the life-cycle of ATM systems to ensure the best balance between human and machine capabilities, and achieve a state-of-the-art and sustainable situation in this area. This will be achieved in a number of cases by adjustments to the future roles, skills, tools and methods of all actors in the ATM system, generated by new technology, concepts and operational

Airborne Safety Nets

Airborne Collision Avoidance Systems

Implementation of ACAS II [TCAS II, Version 7] in ECAC Airspace

After State: Improve flight safety in the whole airspace by the implementation of Airborne Collision Avoidance Systems (ACAS II [TCAS II, Version 7]) which complies with ICAO ACAS II SARPS.

Improved Airborne Safety Nets

After State: Improvement of airborne safety nets through the implementation of a second generation of airborne collision avoidance system making use of aircraft derived data.

Aeronautical Information Management

Improve Aeronautical Information Services

Improve AIS data quality

After State: AIS quality can be improved by the implementation of a Quality Management System targeted by end of 2003 and comprising several measures: Performance Improvement (Data Integrity, Adherence to the AIRAC system, Data Content and accuracy); Techniques and delivery (Paperless AIS, Integrated Briefing); Management (ISO 9000 Quality Management Systems, Standardised levels of service for AIS, Common AIS Staff Profile)

Implementation of Aeronautical Information Management

After State: A uniform and efficient aeronautical information management structure is implemented, supporting all phases of flight, and in the framework of system-wide management of information.

Appendix 2: Main Conceptual Changes

This Appendix describes the main thrust of the future operational concept, not the concept itself. Nevertheless, it must be realised that, even though transition will follow an evolutionary path, the macroscopic effect will be that of a radical transformation between the situation prevailing in the early 1990's and that foreseen at the time horizon of the Strategy. As a result, the traditional Air Traffic Control (ATC) concept is replaced, in a controlled way, by a new ATM concept implying a structural revision of the ATM processes.

Concept Changes

To overcome the shortfalls of the present network and provide an effective platform for meeting the objectives means having to challenge current practices with new ideas about how ATM should function in the future. The target operational concept has to find fresh means to satisfy safety requirements, and at the same time reduce ATC workload and enhance capacity, make better and more flexible use of the scarce resources available, and improve the quality, availability and currency of flight information to support more effective methods of collaborative decision-making. This requires both the improved planning of flights on a gate-to-gate basis, and better shorter-term planning and tactical responses using shared real-time information. The operational concept is in line with the ongoing development within the ICAO ATM Operational concept panel whose work will deliver a global ATM concept for use as a framework for global and regional planning.

The future user needs and prevailing aviation and ATM-related trends have led to the definition of an operational concept that focuses on creating a safe environment, providing extra capacity and improving ATM services. This will be achieved through the combined effects of the six main characteristics listed below, which will work to transform the ATM processes into **co-operative services to air traffic, managing the flight trajectory**:

- Strategic organisation of traffic flows and extended levels of automation
- Flight management from gate-to-gate;
- Enhanced flexibility and efficiency;
- Collaborative decision-making;
- Responsive capacity management to meet demand;
- Collaborative airspace management;

These will also contribute to enhanced safety, extend the principles of uniformity and seamless services, and help reduce aviation-related environmental pollution as well as the users' operating costs.

More specifically, Co-operative Air Traffic Services (COOPATS) refer to the improvements related to the introduction of significant enhancements in air/ground and air/air data communications and the associated enhanced automation. They will enable optimisation of the current procedures related to the provision of Air Traffic Services as well as the introduction of new procedures. From the operational perspective, they can be grouped as follows:

- Reduced controller and pilot workload, and thus increased productivity (**Capacity + Safety**), achieved by the introduction of automated support, by the reduction of voice communications workload and by the automation of some of aircrew and controller routine tasks;

- Increased flexibility (Efficiency + Safety), achieved by the provision of a new communications medium that aircrew and controllers can use in combination with existing voice communications;

- Improved pilot and controller situational awareness and monitoring (Capacity, Efficiency and Safety), achieved by an increase of the availability, quality and accuracy of the information and by the timely availability of information previously unavailable on routine basis (e.g. from aircraft systems);

- More balanced distribution of workload among pilots and controllers (**Capacity, Efficiency and Safety**), achieved by enabling an improved task distribution in ATC sectors and the delegation of part, or the totality, of the controller workload to the pilot (the extent of the delegation of tasks to the pilot still needs to be validated).

Strategic Organisation and Better Predictability

The achievement of capacity and safety gains will primarily come from a revision of the current ATM processes, by introducing organisational means such as strategic traffic deconfliction, traffic flow smoothing and distribution, and using consistent flight trajectory data for the different ATM actors. This would allow the complexity of the congested traffic situations and of the procedures to be reduced, thereby lowering the requirements for sophisticated automated assistance.

In order to obtain the full benefits, a number of future operational improvements will be dependent on the support of more sophisticated computer assistance tools and human-machine interfaces (HMI) that can exploit higher quality trajectory prediction, data communications and other technical developments.

However, in the tactical phase in particular, where safety requirements are critical, it would be illusory to believe that the solution is to simply add sophisticated tools to highly complex procedures and operating environments. Such tools would imply huge technical development and certification/qualification conditions that could inhibit their acceptance or efficiency.

The strategic approach adopted will mitigate the risks attached to the development and implementation of automation support tools.

Flight Management from Gate-to-Gate

Gate-to-gate is a concept that involves considering and managing a flight as a single continuous event. It means that the air traffic related operations of the main ATM partners, Air Navigation Service providers, Airspace Users and airport operators are such that the successive planning and operational phases of their processes are managed and can be achieved in a seamless and coherent way.

For ATM, or from a flight planning point of view, the scope of gate-to-gate extends from the first interaction of the flight with ATC (which for commercial flights may be up to 6 months ahead of the date of the flight), through the execution of the flight on its appointed day, to performance registration and the calculation of charges for the services received after it has taken place. From an airport or aircraft operations manager perspective, it encompasses the management of turn-around between flights with focus on the exploitation of airport resources (gate centred) ,and the continuity of use of an aircraft from a flight segment to the next. From a network viewpoint, it relates to the efficient and seamless handling of the interdependencies between the operations of the different partners involved.

This scope goes beyond the traditional perception of ATM, and coincides to a large degree to the scope of the airport and aircraft operators' processes, with a common goal of providing a seamless and coherent handling of flights. It requires the clear definition of agreed boundaries of responsibilities between the various actors in terms of how and when they interact with a flight in the planning and operational stages. While each particular phase of flight will be processed within a more specific time frame, the trajectory of the flight (and possibly several flights linked together) will always be considered as a whole.

ATM initiatives and programmes aimed at providing an consistent and seamless approach to the management of flights have been overseen, in the past, by different bodies. Different active strategies and related programmes led to a fragmented approach, resulting in incompatibilities and inconsistencies throughout the ATM system in the way that flights are managed.

Constraints imposed by traditional concepts means that there is only a limited exchange of information between the various actors involved in making decisions about a flight. In consequence, each flight is considered and managed as a series of separate, disconnected phases rather than as a single continuous event.

Decisions made in one phase currently do not take account of the impact that they will have on the next, because the necessary information that would help to optimise the flight across all of the remaining phases is not available to the right people in the right form at the right time. For example, a flight may be told to slow down to resolve a potential conflict while flying en-route, to speed up by the approach controller to make a particular runway slot time, and then to wait for an arrival gate by the airport controller because all gates are occupied. Each of the individual actions is unrelated to each other because the actors involved are not aware of the downstream requirements or constraints.

The overall aim of gate-to-gate is to define, develop and implement an consistent approach to flights based on uniform principles that provides for their smooth and seamless management throughout all phases of flight in support of their requirement for fair competition.

An essential factor in realising this objective is the timely open access to and availability of consistent, validated and up-to-date information about airspace availability conditions (ATM environment), flights intentions (demand) and their operating conditions shared by all of those involved in their planning and execution (aircraft operators, en-route ATC, ATFM, airport ATC, and airport operators and other interested authorities).

The “gate-to-gate” concept will be translated into concrete actions to ensure that decisions taken by any ATM actor is made in full knowledge of impact on the others with particular focus at:

- Strategic level to match the capacity of the network to the users’ schedules and 4D demand (en-route and airports) at the early planning stages;
- Pre-tactical level to update the intended flight parameters (route, profile, etc) over time to reflect changes in operators requirements, ATM measures, airspace and route availability, and any airport factors, prior to the flight;
- Tactical level to co-ordinate flow and capacity management measures and deployed en-route and airport capacities just prior to the flight to reflect actual and forecast events;
- Real time to amend the flight profile and timings dynamically during the flight to reflect actual conditions and events;
- Archive phase to provide details of the actual events after the flight to meet performance measuring and charging requirements.

These form part of the stepped operational improvements described in the Strategy.

The individual improvement measures are inter-related and are spread across all of the core ATM processes. Their benefits will be realised incrementally over time as enhanced airspace management concepts, systems and procedures are introduced, and the interfaces and information becomes available and openly accessible to the main actors.

Enhanced Flexibility and Efficiency

The basic objective will be that flights operate as intended. The trajectory of the flight will be continually optimised to reflect the best balance that can be achieved at any point in time between the user’s needs, the prevailing flight circumstances, and the requirement to ensure both the safety and overall efficiency of the ATM network. This process encompasses external phenomena like weather, airspace availability and capacity/load relationships in the airspace or at airports. The uncertainty on predicted aircraft positions will diminish as the accuracy of the information concerning the flight and the environment in which it takes place is refined over time and exchanged in real-time between the air and ground. This will directly help the controller’s conflict diagnosis and reduce the number of tactical interventions necessary. This approach to traffic handling will enhance individual flight efficiency while improving the management of traffic.

Collaborative Decision-Making (CDM)

Collaborative Decision-Making (CDM) refers to a set of applications that:

- Take into account the internal priorities of the Airspace Users or the Airport, before and during the flight,
- Make full use of data available through Information Management systems and procedures, about actual events, incorporating preferences and constraints;
- Are aimed at improving flight procedures, airport operations, flight operations and flow and capacity management through the increased involvement of Airspace Users and Airport Operations in the process of ATM.

The basic tenet of CDM is that all relevant and required information should be shared in real-time amongst all of the actors (civil and military) who have an interest in the progression of a flight, using modern communications methods. This information will enable the various organisations to continuously update each other on relevant events in real-time and will be used in improved decisions-making procedures. The only condition should be that the confidentially and security of the information is respected by all concerned.

CDM has applications in all phases of flight (in a gate-to-gate sense), and can, to a certain extent, be a synonym for a new customer-oriented approach on information management. The use of CDM in a very decentralised and distributed system like the aviation system is an advantage for individual actors. CDM acts in two ways:

- Service providers making decisions are better informed of actual user preferences and can better satisfy them,
- Users are better informed of provider capabilities and system constraints and can choose the best alternatives for their operations.

There will be occasions when communication and negotiation between the parties involved will be required to resolve a problem or meet a request for change (e.g. by aircraft operators for the sequencing of their aircraft for operational reasons), but in many instances a decision will also be able to be made by just one of the partners based on information supplied by the others (e.g. to fly a particular route to avoid forecast congestion points).

Two main levels of CDM have been identified:

- First level: Distribution of information that already exists somewhere in the system to additional actors, and co-operation to improve the planning estimates that are available to all. Where a number of actors each hold part of the picture, they can obtain a better prediction of what the overall outcome will be by pooling their information. This exchange of information facilitates the modification of planning processes and the day-to-day procedures so that the current actors can take into account the priorities of other actors communicated to them. In some cases, this is to enable the use of information that already exists in the system. In other cases, new information exchanges will be needed to support the process. Existing procedures will be improved or new procedures developed.

- Second level: Delegation of decision making to other actors, so that each decision is taken by the actor best placed to make that decision. This second level is only applicable when a decision can be separated from the overall “traffic picture”; where this occurs it reduces the amount of information that has to be sent to the “central” planner.

Responses will be more flexible, facilitating better management of the available resources. For instance, ATFM measures, and airspace and route availability can be co-ordinated with slot times just prior to a flight to help prevent unnecessary delays on the ground and in the air. Airspace Users will be able to apply factors that are not known to ATM, such as fleet management priorities, fuel consumption figures and other aircraft operating parameters, when determining solutions. This in turn enables decisions about a particular flight to be made by those best placed to do so based on the latest information available at the time, thereby enabling the flight to be dynamically optimised. For example, an aircraft operator advised that an airspace restriction will be removed earlier than previously anticipated can negotiate a shorter, more direct route with the CFMU, a later take-off time with airport/en-route ATC, and a later off-gate time with airport operations.

Collaboration between different stakeholders in the ATM system has to a certain extent always existed. However, it has until now been mostly an ad-hoc and manual process. In today’s ATM system, Collaborative Decision Making based on information sharing is primarily identifiable as a local process where good communications are feasible — for example at individual airports where close links between the ATS provider, the Airport Authority and/or the home-base Aircraft Operator are available.

An application can be considered as being CDM-oriented if it implies a decision, results in improved operations, involves at least two actors, is supported by an agreed rule or procedure, and is based on shared information of same level of quality.

The potential applications of CDM are very wide and varied in nature. However, even at the most basic level of purely improving the distribution of existing information amongst users, there are significant benefits, often at relatively low cost. Thus, "quick wins" should be realised, paving the way for long term implementations.

Responsive Capacity Management to Meet Demand

Capacity will be increased by a variety of inter-related measures founded on improved procedures, supported by new technology. This will include better and more flexible use of airspace, new or revised procedures between the air and ground, and between humans and machines, governing the current roles and allocation of responsibilities for separation assurance and traffic sequencing, as well as improved planning based on more accurate and timely flight information, the automation of certain ATM processes, and the extensive use of enhanced computer tools. At the same time, flexible mechanisms for capacity management including the dynamic adjustment of routings through under-used capacity areas, sector configuration management, and the dynamic allocation of human resources, will enable capacities to be adjusted to variations in demand. ATM managers will be accountable for capacity provision (within the limits of foreseeable events).

Collaborative Airspace Management

Open access to airspace availability conditions will encourage more accuracy in flight planning and flight predictability. As a consequence changes in ATM roles will increase the emphasis of work of the planning activities; airspace sectors will collaborate and be supported by a multi-sector planning function, to resolve potential problems at a larger scale, and to manage flights as continuums. Sector responsibilities for flights will extend over greater airspace areas that stretch across existing boundaries. The flexible and responsive management of capacity also calls for more adaptive sectors. Flight predictability will make it possible to tailor the usage of airspace to the actual needs of the different users by a better information on their needs

This, inter-alia, will lead to collaborative airspace planning and management mechanisms, involving both civil and military authorities for the whole ECAC airspace. The objectives are to provide a continuum and transparency of airspace structures at boundaries while satisfying national security and defence needs. The process will ensure that airspace resources are utilised to best effect across the whole region, so as to be more responsive to all Airspace Users' needs. Airspace will be planned and managed as a common continuous resource, based on user requirements.

The process will include more dynamic capacity management in which airspace managers, as part of a joint civil and military effort, will share information both strategic, pre-tactical and real-time and be able to respond to the changing traffic patterns.

Appendix 3: List of Possible Economic Studies

List of possible Economic Studies

The measures set out in the ATM Strategy for 2000+ should be supported by a new approach to the economic and financial framework for ATM. This will require investigation, studies and economic modelling to ascertain the effects of various economic measures, and to determine which provide the most effective and practical path to realising the economic objectives to reduce the ATM-related costs, while maintaining conditions for fair competition (a level playing-field) between the ATC providers.

A list of proposed topics for studies within the economic frameworks set out in Section 4.3 is given below. The list is not exhaustive, and indicates potential areas of study that might prove useful. Also, other complementary topics may be identified as further information becomes available. Additionally, the results of such studies would need to be considered further, and inclusion of the list does not imply that States or other stakeholders would, or should, adopt or apply the results obtained from such studies.

All studies should identify the impact on different stakeholders, including military aviation.

Performance Measurement

- Performance measurement (already initiated by the PRC).

Economic Regulation

- Possible economic regulation models, to provide clear principles for service providers;
- The economic advantages and implications of the separation of regulatory function from the service provision function.

Service Levels Policy

- The possibility of, and conditions for, certifying providers to offer services;
- A proposed model for cross-border agreement for facility sharing;
- Conditions for successful common management of facilities.

Business Risk and Reward

- Cost-recovery and pricing instruments to provide incentives for ANS providers.

Pricing Policy

- Using pricing as a tool to help solve capacity problems and manage congestion;.
- Common accounting codes to identify present & future costs of airport and airspace services.

Co-ordination of Use of Resources

- High-level overview of costs and benefits of the programmes and projects resulting from the application of the Strategy;
- Suitability of regional systems to assist in the rationalisation of ground based infrastructure.

Facilitating Financing of Investments

- Investment funds available;
- Means to apply synergy to common investment policies;
- A manual of good practice on financing for ATM facilities and services.