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**Abstract**
This document contains a high level description of the target concept to support a uniform gate-to-gate ATM network for Europe which will meet the forecast growth in air transport demand into the early part of the 21st Century, meet the airspace users’ expectations for more flexible and cost-effective Air Traffic Management (ATM) services, while remaining sensitive to environmental issues.

**Keywords**
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EXECUTIVE SUMMARY
EXECUTIVE SUMMARY

Introduction

The Operational Concept Document (OCD) presents a high-level description of ATM operations in Europe for 2020 and is one of a sequence of related foundation documents. The first edition of the Operational Concept Document (Edition 1.1) was published in January 1999 setting a vision of ATM to 2015. This was followed by the development of an ATM Strategy for Europe for the Years 2000+. The Strategy defined the means of achieving the concept by setting out the processes and measures by which the forecast demand in Europe could be met through a stepped-in-time implementation programme up to the year 2020. This revised version of the OCD, therefore, extends its target vision time horizon to align with that of the Strategy and reflects the progress already achieved.

The need for new concepts for an ATM System for Europe is driven by: the requirement for the present ATM concepts and infrastructure to absorb the forecast growth in demand, to meet the users’ expectations in terms of improved flexibility, punctuality and reduced costs, and to fully exploit current and emerging technologies, while improving safety.

The concept describes the types and scope of ATM services needed to meet both the forecast increase in air transport movements, and the airspace users’ expectations for more flexible and cost-effective ATM services. The document sets out the main options that are available and highlights the differences between these options in terms of likely benefits and trade-offs. However, because of the uncertainties inherent in forecasting some longer-term events, not all of the issues surrounding the target concept are, or can be, fully explored or resolved at this stage.

The goal is to achieve the overall objective set out in the ATM Strategy for 2000+.

Target Concept Statement

A collaborative and co-ordinated layered planning framework for ATM operations in a gate-to-gate context based on the principles of Collaborative Decision Making and System Wide Information Management

The Need For Change

Despite substantial increases in ATM capacity in the last 15 years the Performance Review Commission (PRC) has shown that capacity is lagging behind traffic demand and that the installed capacity is not being fully exploited. Moreover, the present ATM organisation and infrastructure have inherent limitations. The underlying requirement for change is the need to handle forecast traffic increases of +90% by 2020 safely and cost-effectively while providing airspace users with the ability to operate on schedule and with greater flight efficiency. Technological changes alone will not resolve these capacity issues.

The available airspace has a complicated structure aligned along national boundaries and fragmented by special use and military requirements. The average flight time in Europe is just 75 minutes and the majority of flights occur entirely within the European region yet may cross through several different jurisdictions each applying different rules to similar airspace. National airspace organisations and management structures do not make the best use of the finite airspace resources available. For technical changes to be effective it is necessary to first rationalise national interests with actual traffic patterns and to harmonise the rules applied. At the same time the airspace requirements of military users must be considered.

The prevailing weather patterns in Europe often restrict available airport capacity, particularly in winter. Many airports within Europe are approaching design capacity, even in good weather. Without significant infrastructure improvements, delays caused by the restrictions imposed by the actual airport structure will increase. This variable is beyond the scope of the ATM network but new concepts must ensure that, on a daily or even hourly basis, the system utilises all available airport capacity at maximum efficiency regardless of weather. By improving the interface between ATM, Airport, and Aircraft Operators and reacting to changes in information received, the most efficient use of limited airside resources will be achieved.

The concept examines methods to improve the operational productivity and safety of the overall ATM network. These improvements cannot come at the expense of either ATC or cockpit workload which must be kept within acceptable

1 Mission, Objectives and Strategy Document (MOSD), Context and Scope Document (CSD), User Requirements Document (URD)
limits. The target concept for Europe for the year 2020 details the types and scope of ATM services that will be needed to meet both the forecast increase in air transport movements, and the airspace users’ expectations for more flexible and cost-effective ATM services.

**Trends And Options**

The document sets out the main options that are available and highlights the differences between these options in terms of likely benefits and trade-offs. There is a complex relationship between capacity and flight efficiency. Flexibility diminishes as the number of aircraft increases. The OCD envisions a system that combines total flexibility in areas of lighter traffic with a more structured routing system in busier areas. Some delays will still occur. It will not be cost effective to build an ATM network predicated on unusual peaks in demand or one that will eliminate all delays in all circumstances. Finding the best compromise is the goal of this effort.

To properly realise the goal outlined in ATM 2000+, this concept document must examine the changes anticipated in a number of areas, including some not normally associated with ATM. These areas include aircraft operations, airspace organisation and management, flow and capacity management (F&CM), sequence optimisation, separation assurance, airport operations, information management and services. Future planning in ATM must consider the changes planned within these areas to maintain relevancy and to maximise any benefits to ATC that may be obtained from these changes.

The inherent inability of the present ATM concepts and infrastructure to absorb the forecast growth in demand, to meet the users’ expectations in terms of improved flexibility, punctuality and reduced costs, or to fully exploit current and emerging technologies, drives the need for new concepts for the European region. In addition, there are other more general ATM trends that influence the concept to some extent. These involve:

- Greater emphasis on the definition of performance goals and measurements combined with stringent analysis of operating costs and potential investment returns;
- Common rules and procedures for the ground and air elements applied uniformly throughout Europe;
- Collaborative and integrated airspace planning and management for the whole European region that involves both military and civilian planners;
- The need to include environmental considerations in the decision making process with the goal of reducing the effect of operations on the surrounding region both on the ground (noise) and in the atmosphere (gaseous emissions);
- Common training objectives for both controllers and pilots, particularly for the application of new concepts and equipment;
- Pressure from major fleet operators to relate ATM charges to the actual level of service provided.

Technical trends influence operational concepts. There will be a continuing need for a ground based ATM element as at present. Changes in communication techniques (such as data link for non-time critical transmissions) and surveillance (satellite based networks providing high quality global coverage and data) will increase sector capacity and reduce controller workload. They will also produce an increase in safety by reducing the potential for misunderstanding when large quantities of data are transmitted.

**The Target Concept**

The target concept is predicated on collaborative and co-ordinated layered planning, proposing a strategically-derived ‘Operations Plan’ (OP), based on collaborative decision-making amongst the involved parties supported by a system-wide information management, with an evolving change to managing resources as well as the demand.

The target concept should be viewed as the goal towards which the future ATM System is aiming, and which involves evolutionary change to provide incremental benefits in line with the growth in demand. It should not be seen as an ultimate system. The concept will need to evolve to reflect changes in the air transport environment. In this context, it encompasses the principle of moving to the ‘ideal’, (‘The Vision’), while recognising the limitations of the ‘real’. Operational development will focus on the gate to gate strategy, defining a concept that will enable a seamless process from flight preparation through flight execution to an integrated charging for services rendered in a cost-effective manner.

Maintaining, and where possible improving, safety will remain a primary goal even as ATM provides the most efficient operational environment. Indeed, the two tasks complement each other. Safety nets such as ACAS and STCA, and later,
elements of Advanced- Surface Movement Guidance and Control System (A-SMGCS), will provide a final conflict alert but are just that: a final alerting tool. The requirement to respond to such an alert will still indicate some form of safety system failure and will not be a part of separation planning. Instead, the system will rely on layers of planning and flight monitoring. In order these are:

- Efficient airspace management and design;
- Effective flow and capacity management;
- Multi-sector planning;
- Sector control teams, and
- The pilot.

**Airspace management and planning** will become a more integrated and collaborative function, supporting all aspects of planning, design, maintenance, update, civil/military co-ordination, regulation and airspace legislation. The main objective will be to optimise the airspace structure in Europe, its management and development of procedures for the benefit of all users at both the strategic planning and tactical levels. To this end, all European airspace will be considered to be the concern of ATM and will be a useable resource.

Pan-European airspace will be treated as a continuum with airspace re-designed to provide the best service to the user instead of following traditional national boundaries. However, every State will continue to have complete and exclusive sovereignty over the airspace above its territory (Article 2 of the Chicago Convention) including the capacity of every State to exercise its prerogatives with regard to security and defence in its national airspace.

Disparate systems operated by the different service providers must be harmonised to enable the sharing of information relevant to all traffic operating within Europe while protecting the integrity of that required by defence. All in all, the re-organisation of airspace to accommodate the anticipated volumes of traffic, both military and civilian, in the most efficient manner will require considerable effort both politically and operationally.

Changes in airspace have already been introduced. The Flexible Use of Airspace Concept (FUA) with the military authorities releasing traditionally closed areas for use by civilian flights on a planned basis has simplified control in the areas where it has already been employed. This trend will continue and evolve into the Dynamic Management of Airspace which will permit suitably equipped aircraft to select the most advantageous routing to destination (free route) although traffic structuring will still be required around major traffic centres.

The concept incorporates a mix of fixed route structuring, free routings and autonomous aircraft operations to answer the needs of a diverse aviation community. Some of these navigational changes require considerable investment on the part of all users and may not be practical until a significant number of users have invested in the technology. The OCD outlines as well the risks associated with each proposed change. The greater the benefit to the user however, the greater the costs and risks associated with the change. On the other hand the future European ATM system must be capable of continuing to accommodate a broad mix of aircraft capability.

**Flow and Capacity Management’s** role will change from one of managing demand to the maintenance of capacity as co-operative interaction between the service providers and users reduces the requirements for the management of critical events and eliminates the occurrences of traffic spikes at the major traffic centres.

Air Traffic Flow and Capacity Management will enable flight punctuality and efficiency with the emphasis on managing the balance between traffic demand and capacity, maintaining an overall ATM perspective to maximising the use of available resources and co-ordinating adequate responses in order to increase the level of safety and to maximise the performance of the European ATM System.

Airports have traditionally been considered as a separate entity, the end point rather than an integral part of planning. Plans to maximise the traffic capability and then providing the traffic flow to meet but not exceed that capability of each airport are an integral part of the concept. The failure to do this has the potential to negate the benefits of capacity gains in the en route environment.

It is anticipated that the objectives of ATS will not change in general terms. On the other hand, the daily operation, corresponding procedures and particular roles will have to evolve, in order to be able to respond promptly to real-time scenario variations and to maintain high levels of performance and productivity without jeopardising air traffic safety.

The increasing tendency towards computer-based support tools will progressively change the nature of ATS job requirements. But before these changes can be accepted a high level of trust in the accuracy of these tools must be developed and the role of the controller must be re-defined to incorporate these tools in his/her modus operandi. Since

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3 (This is consistent with the European Air Traffic Flow Management Consultation Group (EAG) requirement and the ATFCM Strategy)
human performance is a crucial component of ATM, human involvement and commitment issues will be analysed and documented throughout the concept transition process. Procedures will be developed and taught to assist the controller in the event of system failures.

Regardless of the technological changes, the human element will remain paramount in the ATM system of 2020. ATM will evolve into a more collaborative system with responsibilities delegated as required to that individual most capable of providing the service required. The controller role will evolve to “management by planning and intervention by exception”, with the pilot sharing some of the tasks for separation.

The development of an integrated information system must occur in conjunction with the progression towards a European ATM system and is an essential component of the concept. This development is crucial to all aspects of the proposed 2020 system. It will provide accurate and current information on airspace and airport availability, user-preferred trajectories, traffic (both current and forecast) and, weather and navigation restrictions. It will be accessible to all users and it will be the primary source for Flow and Capacity Management decisions. Both strategic and tactical decision making regarding traffic flows will increasingly rely upon this information. As a result, decisions will be more timely and less drastic in their impact than is currently the case. In consequence, continuous management of the quality, its integrity and interoperability of the shared information in accordance with defined quality standards will be essential.

The ICAO flight plan is the current source of information for all phases of flight control. As a flight progresses this filed information, particularly in the areas of routing and altitude, becomes less accurate. For accurate traffic planning, additional data that is not currently included in the flight plan is required. Changes to the flight planning system are required to incorporate this additional information and to continuously update all information. The flight plan must also be made readily available to each ATC unit responsible along with all changes as they occur.

The availability and display of accurate weather information is an essential ingredient of a safe and efficient ATM system. Decisions regarding routings, airport capacity, wake vortex spacing requirements and the potential provision for traffic interruptions as a result of severe weather cannot be made without precise and reliable weather information. Better weather information and display systems will be a feature of the operations room in 2020.
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Part 2

SCOPE, NEED FOR CHANGE AND TRENDS
1 SCOPE & PURPOSE OF THE DOCUMENT

1.1 Scope

The first edition of the Operational Concept Document (OCD) (Edition 1.1) was published in January 1999 setting a vision of ATM to 2015. This was followed by the development of an ATM Strategy for the year 2000+, which defined the means of achieving the concept. It sets out the processes and measures by which the air traffic forecast demand in Europe could be met through a stepped in time implementation programme up to the year 2020. This revised version of the OCD, therefore, extends its target vision time horizon to align with that of the Strategy.

1.2 Purpose

Despite substantial increases in ATM capacity in the last 15 years the Performance Review Commission (PRC), has shown that capacity is lagging behind traffic demand and that the installed capacity is not being fully exploited. Moreover, the present ATM organisation and infrastructure have inherent limitations, sometimes exacerbated by a shortage of resources, particularly human where a lack of European harmonisation for the recruitment, training and management of staff can often have adverse effects on capacity. The aggregate effect is that the System will be unable to cope with the total forecast traffic increase, which is expected to result in a nearly doubling of aircraft movements by 2020 (+90%) when compared to those in 2000. In addition, progress made since 2000 in the implementation of a number of Operational Improvements listed in the Strategy, (e.g. ACAS, RVSM and ARN-V4), together with technical progress in various areas and the confirmation that Collaborative Decision Making (CDM) as a key theme for the further development of ATM, indicates the need to review and update both the OCD and the ATM 2000+ Strategy.

The operational concept for the European Area presents a high level description of how the ATM System should develop within the target time frame (The Vision). The ICAO Air Navigation Commission has established the Air Traffic Management Operational Concept Panel (ATMCP) to develop a comprehensive concept of an integrated and global ATM system. While there is much in common and considerable overlap on methodology between the EUROCONTROL OCD and the developing ICAO OCD they are not fully synchronised in time. Since any concept must be grounded in reality, the document will be subject to ongoing evaluation and validation.

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5 European Convergence Implementation Plan (ECIP)
Local Convergence Implementation Plan (LCIP)
1.3 This Document

The Operational Concept Document comprises two volumes of which Volume 1 is organised into 4 separate parts in order to accommodate different target audiences. Some of the parts can be issued separately (e.g. Executive Summary, Target Concept).

Volume 1, this document, defines the needs for change, discusses the trends and options with their choices and trade offs, and specifies an operational concept for a specified timeframe and is organised as follows:

- Part 1: Executive Summary;
- Part 2: Scope and Purpose of the document, including The Need for Change and Trends and Options;
- Part 3: The Vision;
- Part 4: Glossary.

Volume 2 contains a detailed description of how an operational concept is applied. It identifies the functions and processes, and their corresponding interactions and information flows, concerned actors, their roles and responsibilities. It is organised into 4 parts described as shown in Figure 1-2 below.

Figure 2 OCD Documents

2 THE NEED FOR CHANGE

2.1 Introduction

The efficiency of ATM can be improved to some degree by a better and more efficient use of the present resources. Existing and planned EUROCONTROL initiatives, like the Central Flow Management Unit (CFMU); Integrated Initial Flight Plan Processing System (IFPS); the Flexible Use of Airspace (FUA) concept\(^6\), Reduced Vertical Separation Minima (RVSM); 8.33 kHz programme; optimised route structures, and improved controller support tools have provided flexibility, capacity and safety gains.

However, the current ATM System and supporting processes are already fully committed in some European areas and cannot safely absorb higher traffic demand without restricting traffic levels during peak periods. These initiatives alone will not provide the extra capacity needed to meet the forecast demand for the next 20 years, particularly in the already congested airspace areas. In consequence, the capacity problems will continue to get worse as the traffic levels increase if no further improvements are made.

The need for new concepts for an ATM System for Europe is driven by: the requirement for the present ATM concepts and infrastructure to absorb the forecast growth in demand, to meet the users’ expectations in terms of improved flexibility, punctuality and reduced costs, or to fully exploit current and emerging technologies, while improving safety.

\(^6\) The FUA concept addresses dynamic airspace sharing and co-ordination procedures between civil and military authorities. Plans exist to extend the FUA principles to encompass all European airspace within agreed procedures.
The risk of loss of separation increases as traffic levels rise, and at a proportionally faster rate. Increases in traffic levels, therefore, have to be matched by increases in safety if unacceptable delays are to be avoided. This requires the use of new procedures and associated working practices, including training, supported by enhanced automated tools that many of the present legacy systems are unable to support.

It is possible to introduce more advanced technical systems without employing new concepts. However, technical systems alone cannot resolve capacity issues by themselves and have to be accompanied by operational changes before benefits can be realised. Also, they do not address the central problem facing ATM in Europe: that of maintaining or increasing target levels of safety whilst finding extra capacity. Additionally, a fragmented, technically driven approach would bring its own problems in terms of uniformity and the provision of seamless services.

One of the most significant constraints is the limitation imposed by the current airspace sector operations and their associated ATC workload. Traditionally, capacity increases have been achieved by dividing airspace into smaller and smaller sectors to off-set the workload that they bring. This method, however, follows a law of diminishing returns because of the additional co-ordination work it generates. There is also evidence that any future gains made this way would progressively reduce, and be insufficient to meet the forecast growth in demand.

One of the fundamental issues which the concept has to address is to find ways to improve safety levels and the operational productivity of the overall ATM System. It must generate additional capacity, while at the same time improving services and keeping ATC and cockpit workload within safe and acceptable limits.

### 2.2 Continuing Traffic Growth

The underlying requirement for change stems from the need to handle forecast increases in traffic safely and cost-effectively, while providing airspace users with the ability to operate on time and with greater flight efficiency with due regard to the environment. Recent events may have lead to a reduction, both in passengers and flights, but history has shown that such downturns are of a temporary nature.

Present traffic densities vary across the European airspace, with the main points of en-route congestion (bottlenecks) situated largely in the core area, particularly around the larger cities and industrialised areas. It is expected to see a continuing growth of traffic with the emphasis on peak hour, short-haul flights involving the hub airports and main city pairs links.

![Figure 2-1 Forecast Traffic Increase](image-url)
Future traffic growth within the European Area will occur in an airspace area which is unique in a number of ways:

- Parts of European airspace are amongst the busiest in the world and contain high concentrations of climbing and descending traffic;
- The majority of flights (88%) take place entirely within the European Area boundaries with 70% of traffic flying over 10% of the airspace;
- There is a high percentage of short-haul flights: 60% fly less than 400 NM (average flight distance is 472 NM);
- Because of these short-haul flights, 65% of flight time is below FL 300, thus making the provision of ATC more complex.

The airspace itself has a complex structure, aligned principally on national boundaries and with classes of airspace in which different states apply different rules. Added to this, the prevailing weather patterns in Europe often restrict available airport capacity, particularly in winter when low visibility conditions can frequently occur.

### 2.3 Safety and ATM Security

#### 2.3.1 Safety

Based on today’s agreed levels of safety, the forecast increase in traffic will lead to a proportionate increase in the number of ATM related incidents. This is unacceptable to both user and provider alike. The future ATM System will consider aviation Safety its highest priority and will have to address these issues through appropriate safety objectives with a monitoring performance process, supported by safety risk management practices which lead to establishment of common regulatory standards.

#### 2.3.2 ATM Security

The continuing threat to security through acts of terrorism involving aircraft, ATM infrastructure and people requires a proactive response from those involved in ATM. The future ATM System will be capable of meeting the response through a coordinated approach to the protection of airspace and territory.

### 2.4 ATM Stakeholders

In addition to providing additional capacity, the future ATM System will also have to meet the user community’s expectations for a more cost-efficient and flexible ATM System capable of responding dynamically to their operational and business needs. This will be supported by evolution to a holistic and collaborative decision-making environment.

#### 2.4.1 Airspace Users

In particular, the airspace users have emphasised that the future ATM System should:

- Accommodate a wide variety of aircraft capabilities and provide differing levels of service according to the users’ needs;
- Provide a gate-to-gate service in which the management of flights is based on accurate and dynamically updated planning, where tactical **ATC intervention will be by exception** throughout all phases of flight.
- Be predicated on a process in which greater flight efficiencies are achieved through user-preferred flexible and dynamic trajectories;
- Keep the airspace users as the final decision makers in the planning and execution of flights;
- Operate in a manner that is seamless and with systems that are interoperable;
- Ensure the co-existence of both General Air Traffic (GAT) and Operational Air Traffic (OAT) operations;
- Meet national security and defence requirements.

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7 A full list of user requirements is given in Volume II of the EATMS User Requirements Document.
8 With regard to military airspace users, the target operational concept must meet the objectives set out in the ATM 2000+ Strategy.
The airspace users do, nevertheless, recognise that there have to be some trade-offs to find an economically sensible balance between the need to increase capacity, to provide greater flight efficiency and, at the same time, to improve levels of safety.

### 2.4.2 Airlines

After safety, the ability to operate punctually and efficiently is the most significant concern to airlines. Within a gate-to-gate context a delay in one leg of a series of flights can have a knock-on effect for the remainder. However, it is recognised that different commercial operators (e.g. low cost vs. charter vs. cargo) have their particular priorities depending on their business objectives. They seek to satisfy their objectives optimising their operations by determining the optimum departure and arrival times for their aircraft and the routes and levels at which they wish them to fly.

### 2.4.3 Military

Military airspace requirements and operations stem from tasks set by governments for air, sea and ground forces. As well as the need for day-to-day training and evaluation of capability, this may necessitate the use of military power to protect sovereignty and security in Europe and also may necessitate military operations in support of international organisations (e.g. UN, NATO). In defined circumstances military activity would take precedence over civil aviation.

Military aviation operates a wide range of aircraft types with different performance characteristics and capabilities, including Unmanned Aerial Vehicles (UAV). These aircraft are required to operate in all airspace environments and often have special airspace requirements. Some military aircraft, such as transport aircraft can, in general, comply with civil airspace equipage requirements while others lack the physical space for the appropriate equipment. On the other hand, some military aircraft may offer equivalent performance with different equipage. The ATM System will take these requirements and limitations into consideration.

### 2.4.4 General Aviation (GA)

General Aviation, will continue to be a significant user of ATM Services. The objectives of Business (Corporate and fractional ownership) aviation are, in general, similar to those of commercial airlines. They also need to be able to react at short notice to the demands of customers whilst, at the same time, meeting commercial objectives.

Aerial Work aviation has a multiplicity of objectives depending on its role and often needs to reserve airspace for particular type of operations (e.g. aerial survey work). In addition, there are considerable numbers of powered and non-powered sport and recreational aircraft operating principally under Visual Flight Rules that have a legitimate right of access to European airspace, but who may not be able to fully comply with equipage requirements.

### 2.4.5 Unmanned Aerial Vehicles

The introduction of civil applications in the use of Unmanned Aerial Vehicles (UAV) will place new and unique demands on airspace requirements. In the near term their application could be mission specific (e.g. fisheries protection). However, in the long term the commercial benefits introduced by Unmanned Aerial Vehicles could see their application extended into more conventional roles such as the carriage of freight. The integration of such flights into a future ATM System will require considerable Research and Development studies.

### 2.4.6 ATM Service Providers

The ATM System is based on the provision of services in which all resources are considered to be part of the ATM System. By far the largest stakeholders in this regard are Air Navigation Service Providers (ANSP), including the Military, that provide service to airspace users and airports. In addition, services are provided by:

#### 2.4.6.1 Meteorological Services

High quality meteorological information for the calculation of flight trajectories, both at pre-flight and during flight (i.e. forecasts and nowcasts), is a pre-requisite for flight safety and an efficient future ATM System;

#### 2.4.6.2 Aeronautical Information Management (AIM)

The capability of Aeronautical Information Services (AIS) to collect and disseminate, in real time, systems information regarding the dynamic and static structure of the ATM System will be considerably enhanced by the use of Information
The future ATM System will continue to accommodate a broad mix of aircraft capabilities but, at the same time, ensuring that more capable aircraft can take advantage of a performance driven system.

2.4.7 Airports

ATM concepts, processes and procedures must ensure that the available and potential airport air-side capacity at any particular point in time is used to optimum effect.

Many of the major European airports already suffer from air traffic congestion and are potential sources of flight delay. The provision of additional runways and airports, together with improvements in passenger handling and the terminal and access facilities that are needed to meet the increase in air travel demand, are part of national, institutional and political decision-making processes. Also, the increasing use of regional airports, must be recognised. Airports, therefore, must be considered as part of the overall ATM System within a gate-to-gate context.

By 2020, several European airports in the high density traffic areas are expected to be routinely operating at their maximum capacity levels for prolonged periods of the day. Some major airports are presently developing airport management systems which will connect the support systems already available to different stakeholders in order to optimise the overall throughput of the airport. These airport management systems will have to become an integral part of the future ATM System interacting with Air Traffic Flow and Capacity Management, and en route ATS as well as airline flight operations management systems.

An objective of the target concept, therefore, is to help further enhance airport capacity by ensuring that the ATM System optimises the use of the available air-side airport infrastructure (i.e. stands, aprons, taxiways and runways), particularly in low visibility conditions. Another objective will be to optimise runway throughput in adjusting spacing by taking into account the real wake vortex signature enabled by adequate supporting tools and appropriate procedures. Parallel landsid infrastructure changes also need to be considered in order to realise the full benefit of improvements made to airside operations.

2.5 Gate-to-Gate and Integrated Planning

At present, there is little integration or collaboration between the ATM System, the aircraft operators and the airspace users’ planning processes. The overall objective of the gate-to-gate strategy for the future concept is to develop an integrated concept that will provide a smooth and seamless process from flight preparation through flight execution to charging for the services provided. The sharing of information between the parties is fundamental to its success. This information must be made consistent, accurate, up-to-date and available from an open system accessible to all interested parties.

The intention is to improve the interface between ATM, the airports and aircraft operators to ensure the most efficient use of all local airport resources and airspace. Nevertheless, it has to be recognised that the gate-to-gate strategy may not be fully implemented during the early time-frame, and the benefits, which it offers, will arise incrementally over time.

2.6 Environmental Considerations

Equally, as well as meeting the requirements of the airspace users, the future ATM System has a responsibility to support the safeguarding of the environment. Environmental measures that protect against emission and noise pollution will be an important factor. The most effective contribution that the concept can make in helping to reduce the environmental effects of aircraft operations, particularly at and around airports, is, inter alia, to reduce delay and congestion through use of appropriate procedures. However, as in other concept areas, a balance has to be found between the safety and efficiency of ATM operations and their environmental effects.

- **Aircraft emissions** - Studies show that carbon monoxide and hydrocarbon emissions are highest when aircraft are operating at low power settings (descent idle, taxiing, queuing). In addition, under high temperature and pressure conditions nitrogen oxides and carbon dioxide are emitted.

- **Aircraft noise** - The use of automated support tools and advanced navigation aids will help to optimise approach and departure patterns around airports. Without any infringement on safety, support tools will assist in providing a balance between:
  - noise abatement requirements;
• the reduction of aircraft emissions;
• the increase of airport efficiency;
• the optimisation of controller workload
• capacity enhancement.

2.7 Capacity and Flight Efficiency

In simple terms, the overall capacity of the current ATM System is determined by four inter-related factors, all of which have to be in balance if delays are to be avoided:

- Airspace - the volume of traffic flows that the airspace can accommodate;
- ATM System - the number of aircraft which the ground ATM System is capable of handling safely;
- ATS - the level of productivity that each ATC unit is able to achieve safely;
- Airports - the numbers of movements that can be safely handled during the period of operation.

The physical capacity of the airspace is a function of how much airspace is available, the amount and capabilities of the traffic that wishes to use it, and the rules and separation minima applied.

At present ATM capacity is mainly constrained by airspace, airports, and ATM System performance.

The present division and use of airspace does not make the most efficient use of airspace resources, both en-route and at and around airports, at a European level and more dynamic management and use of airspace needs to be achieved.

In terms of airport capacity, the relevant issue is for the future ATM System to exploit the available airport air-side facilities to the full and to make optimum use of the airspace around airports; and in particular, to improve and maintain the traffic throughput in all weather conditions.

A system capable of supporting unrestricted demand, total flexibility and consistent punctuality would involve substantial and prohibitive costs, and is probably not possible because of the limitations imposed by the airspace and runway infrastructure available. Likewise, it would not be cost-effective to build an ATM System predicated on unusual or infrequent peaks in demand, and the future ATM System will not be able to eliminate all delays in all circumstances. Also, the costs of providing marginal capacity increases in saturated traffic areas need to be examined carefully in relation to the level of benefits which could be gained. These issues form part of the trade-offs which need to made to find the best solution for particular airspace areas and the majority of airspace users.

2.8 The Key Drivers for Change

The key drivers for change that the concept has to help address are:

- To simultaneously improve safety levels while providing additional capacity to meet the increased demand while reducing direct and indirect costs.

These key drivers are the prime considerations specially because of the:

- Current constraints on capacity in the high traffic-density areas in European airspace and airports;
- Increasing severity of these constraints (without the introduction of new concepts);
- Ripple effects that this will have on the whole European air transport system;
- Additional pressures of airline de-regulation and greater competition (e.g. low-cost airlines).

They are, however, not the only issues that have to be taken into account in the development of the future ATM System. Capacity increases will also need to be in place in order to meet actual traffic demand, and the future ATM System has to find a balance between the long time periods associated with change, and the unnecessary costs associated with providing too much excess capacity too soon.
3 TRENDS AND OPTIONS

3.1 Trends

3.1.1 Operational Trends

The operational implications of the endorsed European policies and strategies, coupled to the areas where there are clear possibilities for progress, feed a number of inevitable trends or directions for change. These include:

- Better adherence to existing separation minima and the introduction of reduced separation minima where needed;
- More dynamic and flexible use of airspace;
- Optimisation of route structures;
- The increasing use of free routes and user-preferred trajectories;
- More sophisticated Air Traffic Flow and Capacity Management with a growing emphasis on capacity rather than demand management;
- More integrated planning between ATM, aircraft operators and airports especially with regard to the strategic deconfliction of traffic flows;
- Improved cockpit awareness of the surrounding traffic situation;
- Greater use of automated support tools to reduce ATC and cockpit workload;
- Tactical ATC intervention by exception rather than rule.

3.1.2 Technical Trends

A number of advances in the technical domains are already mature and will enable beneficial changes in ATM operations. Whilst the OCD describes an operational concept, it is worth noting technical trends in particular because of the interaction between available technical performance, its deployment conditions, and the exact operational procedures that it can support. Many of the issues about options for change discussed later in this chapter are related to these areas.

There will be a continuing need for a ground-based ATM element and a Communications, Navigation and Surveillance (CNS) infrastructure for the foreseeable future. In addition to the provision of separation, there is a need to provide information for and about flights for reasons such as national security. Additionally, States have a legal responsibility to provide a certain number of ATM services, including assistance to aircraft in emergency or suffering equipment failure. There is a requirement therefore, for certain CNS and ATM infrastructures regardless of the type of operational concept adopted.

The identification of operational requirements and benefits needs to precede decisions on technical developments. Nevertheless, concept development cannot take place in a vacuum, and the operational concept has to be underpinned by a feasible and achievable technological framework. In view of the time needed to develop technical systems, it is reasonable to assume that the future ATM System infrastructure out to 2015/2020 will be founded on existing technology or known future developments and trends. The future trends include:

**Communications** - the use of datalink communications for the exchange of non time-critical messages and clearances between air-ground, air-air, and ground-ground elements, and the use of the Aeronautical Telecommunications Network (ATN) as the primary communications network;

**Navigation** - the continuing development and use of global satellite systems for navigation services;

**Surveillance** - integrated surveillance systems to provide high quality global surveillance coverage and data for all phases of flight which will provide identical and continuous information to all users;

**Data Processing** - new open connective networks and powerful database servers offer the possibilities for a European-wide integrated flight data and information sharing between all major stakeholder systems, to replace current fragmented databases and

The trends are inevitable in the sense that the driving forces for change are clear and there are no obvious reasons to resist them. They are generally associated with areas where progress has been, or is being, made and which still offer the potential for further development.
systems thus facilitating better automated support, improved planning processes, improved use of capacity and greater safety;

**Air/Ground Systems** - more sophisticated Flight Management System capable of optimum (4-D) trajectory planning and following, advanced automated Human Machine Interface (HMI), and the development of synergised systems (voice recognition, artificial intelligence, etc.) to reduce controller and cockpit workload whilst at the same time improving target levels of safety;

**Technical support to Collaborative Decision Making process** - the technical process of the sharing of information from a common database used in Collaborative Decision Making has to identify the integrity, availability, accessibility and security of the information.

**Controller Support Tools** - the greater use of computer support tools to facilitate operations will lead to the reallocation of tasks and responsibilities. Their introduction will permit the earlier detection of potential conflicts and traffic congestion, thus contributing to increased safety and performance. But reliance on support tools creates a special set of difficulties that must be taken into account. Certain controller skills are de-graded with the introduction of each tool. Procedures that provide the ability to manually assume responsibility for the automated task must be developed and the training to employ them safely must be provided to all ATM personnel prior to the operational deployment of the tools.

The various trends set out identifiable directions of change. However, there are still many options for the future ATM System where there are choices and trade-offs to be made, where there are still uncertainties as to the feasibility of the potential change, or of the benefits that could be gained. These are discussed around their main themes below.

### 3.1.3 Related ATM Trends

There are also other more general ATM related trends which will influence the concept to some extent. The more significant of these involve:

- An ATM System based on the provision of services with a greater emphasis on the definition of performance goals and measurements combined with stringent analysis of operating costs and potential investment returns;
- Common rules and procedures for the ground and air elements applied uniformly across Europe, and for common training objectives for controllers and pilots, particularly for new concepts and equipment;
- Growing pressure from the aircraft operators for ATM charges to be related to the levels of service actually provided;
- The Single Sky initiative of the European Commission and the idea of Functional Blocks of Airspace which may well introduce a new element of competition between ATM service providers as well as the need for closer partnership and cooperation;
- A move to a collaborative and integrated European airspace planning and management, involving both civil and military authorities and activities, to ensure that airspace resources are utilised and managed efficiently

### 3.1.4 ATM Components

ATM components can best be described as those invariant processes\(^\text{10}\) (or tasks) which necessarily have to occur for the ATM system to be able to function. They encompass such core ATM tasks as the management of airspace resources, the planning and management of flows of aircraft and of individual flights, the separation of aircraft from hazards, etc. In simple terms, invariant processes provide a means to describe the basic building blocks, or “what”, of ATM, independent of the conceptually driven “who”, “how” and “where”.

This perspective of what ATM consists of has the advantage of breaking the concept down into understandable segments which are entirely independent of any pre-determined concept themes or organisations. By not being concerned with where things are done, who performs them, or how they are carried out, this approach helps to identify the main lines of action along which change has to be effected. However, the keystones are the roles and responsibilities, and ATM organisations employed in relation to decision making within each component or set of components.

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\(^{10}\) As explained in the EUROCONTROL Concept Task Force Document Paper 12 dated 12.07.96
Figure 3-1 above shows the ATM Components without describing their interactions. These are described in detail in the OCD Volume 2 (ConOps). Each of these concept components fulfils one or more specific ATM purposes, and are described below:

### 3.1.4.1 Airspace Organisation and Management

The Organisation & Management of Airspace concerns the strategies, rules and procedures, by which the airspace will be structured to accommodate the different types of air activity, volume of traffic, and differing levels of service and rules of conduct. It also concerns all forms of airspace structuring in which Structured Routes systems are only established in areas where the demand for dynamic flight trajectories cannot be accommodated. Airspace Management is the process by which airspace options are selected and applied to best meet the needs of the ATM community. Airspace Management will be flexible and dynamic and applied on the principle that all airspace is a continuum useable resource of ATM concern.

The introduction of the Flexible Use of Airspace (FUA) concept is the first stage in a move to the optimisation and more flexible use of the European airspace resources. Planned extensions to the concept to include full European civil and military airspace co-ordination will pave the way to greater flexibility. The main issues to be resolved are how far the Flexible Use of Airspace concept should be extended in some airspace areas like the lower airspace, how far it is feasible to make the airspace management process more dynamic and collaborative, and how to accommodate the different needs of all of the various airspace users.

The trend towards more flexible use of airspace retains the notion of airspace regimes and categories to segregate different types of airspace users. Options range from the use of airspace boundaries to keep different users apart, to the treatment of the European airspace as a continuum where separation is provided on a flight by flight basis. The advantage of the latter would be freedom of access to all airspace for all users. The disadvantages are that all users would require either a designated equipment fit and certified performance, or that the ATM System and procedures would have to be sufficiently extensive to cater for a highly non-uniform aircraft population.
There are also options involving:

- How far airspace flexibility 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 flexible control sector boundaries could be used in conjunction with flexible airspace boundaries, and if it is possible to align boundaries with particular traffic flows or peaks in demand);

- The retention of fixed sectors but, using automated support tools to reduce workload, and, therefore, increase capacity;

- The introduction of dynamically-sized sectors, dependent on particular traffic flows and density;

- The replacement of sectorisation with control on a flight-by-flight basis or larger sectors using data-link facilities enabling:
  
  - the optimisation of traffic structuring in those areas where some route structures will still be needed to meet capacity targets;
  - the adoption of free-routes and user-preferred trajectories, enabling flights to operate outside a pre-defined route structure.

Various measures are already in hand to optimise the existing fixed route structures in Europe and to make greater use of RNAV capabilities. This feeds two options:

**Traffic Structuring** - Structuring traffic, by arranging traffic flows and patterns using pre-defined routes, exists today as a means of enhancing airspace capacity and improving punctuality. While it is possible to improve airspace capacity by better airspace management and enhanced or reduced separation, the busiest traffic areas will still operate close to
airspace capacity limits at times of peak demand. There will be a continuing need to manage traffic and employ routes and routings in the busiest traffic areas to enhance capacity by designing out conflicts and thereby reducing ATC workload.

**Free-Routes and User-Preferred Trajectories** - The trend to the employment of free-routes and user-preferred trajectories is led by the introduction of RNAV capabilities and a desire to move away from the restrictions on flexibility and flight efficiency imposed on airspace users by route networks. Free-routes and user preferred trajectories will enhance flight efficiency and will be an alternative to structuring traffic. In the provision of separation the options are to:

- Provide separation assurance for flights by the ground organisation, while enabling the airspace users to choose their own trajectories (free-routing). Such operations can already be supported to some extent by existing infrastructure and avionics;

- Delegate the responsibility for separation assurance to the flights themselves, giving users the freedom to choose their own trajectories (autonomous operations).

**Concept Mix** - Given that both concept options will be used in the European airspace, there will be a balance to be achieved between:

- How much traffic structuring will be needed as a means of providing extra capacity in the busiest traffic areas and in reducing ATC workload;

- What mixture of pre-defined routes and free routings will offer the most benefits, and in what airspace and at what times.

### 3.1.4.2 Air Traffic Flow and Capacity Management

Air Traffic Flow and Capacity Management concerns ensuring the most efficient balance between capacity and demand. It covers actions at the strategic level (many months ahead) when services are being planned, at pre-tactical looking for optimisation of available resources and at the tactical level in readiness for and on the day of operation. It acts on flow rates and traffic densities, including airport capacity, to allow airspace users to determine their method of operating while mitigating conflicting needs for airspace and airport capacity. Aircraft Operators will be able to decide which of their flights are expedited and which are delayed. The principle driver for the process will be collaborative decision-making possible only through an effective System-Wide Information Management. Air Traffic Flow and Capacity Management will be a key element of the future ATM System as traffic levels rise, the number of airports operating close to their capacity increases, and the “firebreaks” in demand are squeezed out.

Flow management was introduced into the present ATM concepts as a protective measure using regulatory mechanisms to manage traffic. There will always need to be some means of comparing demand and capacity and managing any imbalance between the two, particularly with respect to airport capacity limits and changing meteorological conditions. There is however, a trend towards a more sophisticated, adaptive and dynamic process which can operate to finer capacity and time limits, with a progressive emphasis on the efficient and collaborative management of resources and capacities at airports and en-route so as to meet demand.

The options for Flow and Capacity Management are strongly influenced by option choices made in other ATM areas. The **principal option** is for it to become a part of an integrated, layered planning process, supporting flights operating on predictive trajectories or in structured traffic flows, where the balance between capacity and demand is refined over time in co-operation with users and other service providers. The degree of integration to be applied between the various planning layers, between Air Traffic Flow and Capacity Management, en-route ATM, and the airport slot allocation process, as well as the time horizons which should be used will depend largely on the choices that are made in other concept areas. At present, the balance between airport demand and available capacity is addressed in the airport scheduling process, and airspace capacity is related to demand through flow management. There is a range of options as to how integrated and comprehensive the process for reconciling demand and capacity at the strategic planning stage could be.
3.1.4.3 Air Traffic Control

The main issues related to Air Traffic Control are:

- **Traffic Synchronisation** that concerns the management of the flow of traffic through merging (Sequencing, which includes smoothing and metering) and crossing points such as traffic around major airports or airways crossings, and;

- **Separation Assurance** which is fundamental and relates to the application of separation between aircraft.

**Traffic Synchronisation** - is the tactical establishment and maintenance of a safe, orderly and efficient flow of air traffic. Traffic synchronisation is inter-related with Separation Assurance, and can be associated to Air Traffic Flow and Capacity Management, in the perspective of contributing to a continuous and organised flow of traffic. It also include the provision and handling of queues, both in the air and on the ground if necessary. It operates on individual flights and is closely related to, and sometimes indistinguishable from, the Separation Assurance process described below.

A number of processes govern the expeditious flow of traffic for busy en route areas, Terminal Control Areas (TMAs) and airports, such as: flow slots, traffic sequencing. There are many ways in which the granularity to which these processes operate could be refined, both in time and position, and in the degrees of integration that could be achieved. There are also choices in who organises the traffic flows, the time horizons adopted for applying this process, and the levels of integration to be used.

En route ATM is required to deliver traffic for the airports in a particular sequence at specific times. This will influence aircraft operating levels and, in consequence, flight efficiency. The sequencing of traffic for airports raises questions as to the optimum level of integration which is feasible and the most beneficial (e.g. single airport, groups of airports, or across all of the European airspace - and the impact that this would have on the capacity and efficiency of the whole European network.

One of the most significant questions concerning the busiest airports therefore, is the management of aircraft on and close to airports at the busiest traffic times. This can be achieved through airport management systems or by employing arrival/departure management systems or traffic holds or queues, as a means of providing a consistent flow of aircraft, thus optimising airport capacity and providing maximum throughput.
The emphasis in the options for Traffic Synchronisation will vary between the busiest airports and others:

**Busiest Airports** - Because demand is expected to exceed the available capacity at many of the larger airports there are issues concerning how the processes that govern the expedition of traffic longitudinally (in time) might work. Questions to be answered include: what time parameters, who will apply them, and the need for, and extent of, holding either in the air or on the ground.

**Other airports** - Demand at these airports, although increased, will not exceed capacity and the key issue for them will be the optimisation of flight movements.

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**Separation Assurance** - concerns the means by which individual flights remain separated from others, in accordance with separation standards, and from other hazards (e.g. terrain, obstacles, vehicles etc.). In many ways it is the foundation stone of the ATM operation. Separation Assurance, together with ground and air-based safety nets, are the last layer of the ATM Safety Layer process described later in this document.

A fundamental principle of ATM is to apply separation between aircraft being provided with the appropriate air traffic services. The main safety layer remains that of preserving separation distances between aircraft, rather than by using collision avoidance systems simply to miss other traffic, the safety net. The way in which Separation Assurance is applied, and the allocation of responsibilities to the humans involved, has a direct impact on workload, and is the central factor in shaping a concept and determining what it can deliver in terms of capacity and flight efficiency. Decisions made about Separation Assurance also directly affect the choices that can be made in other concept component areas, particularly those concerned with airspace organisation and management, F&CM and synchronisation.

There is a broad set of options on how separation can be applied, who should be responsible, over what time horizons, and how much automated support can or should be used. The primary options fall between retaining the current tactical controlling methods, but arranging it in orderly and predictable flows to retain the human cognitive process or designing structures where human intervention becomes an exception.

The main options are centred around a mix of:

**Enhanced Tactical Operations** - these are predicated on retaining the present ground-based tactical functions with shorter planning horizons. They incorporate an advanced tactical mode of operations based on traditional airspace sectors, but with extensive automated assistance to reduce ATC workload. This implies an extensive ground ATM element, but less predictability in terms of punctuality, and the need to find a balance between flight efficiency gains and potential delays.

**Enhanced Planning Operations** - these will also retain an extensive ground ATM infrastructure. They will use extended tactical planning horizons (in the region of 20 minutes) based around multi-sector planning operations that will extend flight clearances and cross-border operations, synchronise traffic flows and reduce the levels of tactical intervention needed. How far ahead it is feasible and beneficial to plan has still to be determined. Enhanced planning is dependent on the...
timely availability of high-quality predictive information, conflict free planning techniques, the introduction of multi-sector planning and operations to support the longer time horizons used, and significant changes to the present ground roles and responsibilities.

The use of multi-sector planning raises two main issues: should it primarily be allied to longer deconfliction horizons to reduce the incidence of tactical intervention needed, or should it be considered as a means to generally synchronise flows of traffic and workload over time to prevent the over-loading of control sectors, or should a Multi-Sector Planner perform both tasks? In either case, what should be the rules to define the responsibilities as to whom has the authority to devise and implement decisions concerning flights across a number of control sectors?

![Figure 3-5 Separation Assurances](image)

**Distributed Air and Ground Responsibilities** - Airborne Collision Avoidance System has already brought a new degree of situational awareness to the cockpit. This trend is likely to continue with the introduction of Airborne Separation Assistance Systems (ASAS), incorporating surveillance functions, longer look-ahead capabilities and improved cockpit Human Machine Interface (HMI), so that flight-deck crews will become more aware of the surrounding airborne traffic situation. This has led to the concept of autonomous aircraft operations, where flight-deck awareness can be put to active and practical use.

Distributed air and ground responsibilities involves ground ATC sharing the responsibility for Separation Assurance with aircraft suitably equipped to ensure their own separation from other aircraft, thereby reducing ground ATC workload and enhancing flight efficiency. The concept of autonomous operations is still in its early stages and although initial research shows some promising results, there are a number of important issues that need to be resolved, for example:

- Feasibility and potential benefits of autonomous operations in busy traffic areas which are already well served by CNS/ATM infrastructures;
- Levels of functionality required in various traffic densities and the levels of benefits that could be obtained in relation to the costs involved;
- Ability of autonomous aircraft to negotiate safe trajectories in multi-conflict situations;
- Separation minima to be adopted which, due to the certification issues involved, may be in excess of, or less than, that which could be achieved using ground based systems;

11 For example, the FREER-1 study (Free Route Experimental Encounter Resolution (Autonomous airborne mode))
balance of how many aircraft would have to be suitably equipped before worthwhile benefits in terms of flight efficiency and costs in the European airspace could be realised;

degree of delegation of responsibility for Separation Assurance in Managed Airspace (MAS).

**Autonomous aircraft operations** will need changes to aircraft avionics, to ground CNS and ATM infrastructures and to controller/flight-crew roles and responsibilities. There are distinct benefits for the users in areas where there is little or no ground CNS/ATM infrastructure and some users believe that it has benefits in other areas. As the future ATM System must fit within the global ICAO CNS/ATM structure, the pressure to cater for autonomous aircraft operations within European airspace will grow as its use spreads in other areas. The choice therefore, is not whether these operations should form part of the concept, but how the future ATM System can follow a migration path to encompass them.

**Automated Support** - The use of automated support is a key factor in off-setting the potential increases in workload that will be caused by the increased levels and complexity of air traffic in the future. It will lead to changes in the roles and responsibilities of the ground control teams and between the ground and the air.

A central requirement is to have the “human in the loop”, but the information that will be available in the future will be far more extensive, comprehensive and complex than now. Greater reliance will have to be placed in automated support tools to process the information and to provide potential resolutions to problems. The main options therefore, relate to the creation and validation of the best balance between:

- Automating ATM functions whilst enabling the human to retain a mental image of the air picture;
- Supporting the capacity increases required;
- Delegating decision-making capability to the support tools in some circumstances, whilst retaining overall human control.

3.1.4.4 Airport Operations

**Airport Operations** - concern the traffic management and safety processes on or in the vicinity of airports. They include the interaction with stand allocation and other airport management functions. As an integral part of ATM, Airport Operations ensure the efficient use of capacity of the airside infrastructure. This will be achieved by maximising operations in all weather conditions through the application of surface movement, guidance and control systems while increasing safety by providing interactive information on the accurate position and intent of all vehicles and aircraft on the manoeuvring area. Within the gate-to-gate concept integrated automated arrival and departure management tools, will contribute, through sequence optimisation and management, to the most effective and safe use of airport capacity.

The main goal for the ATM process, therefore, is to maximise capacity in all weather conditions, subject to the existing physical limitations of the airports’ infrastructure, regulatory and environmental constraints. The trends are towards:

![Airport Operations Diagram](image)

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12 See also section 4.5.1 ‘Air Traffic Control Service’ with regard to possible changes in the extent of the mental ‘air picture’ and situational awareness that will need to be retained in the future.
Automated assistance to support arrival and departure sequence optimisation;

Integrated planning across the whole airport;

Reducing the “capacity gap” between airport throughput in normal and in low visibility conditions.

Issues are to determine how to balance the optimal sequence desired by the airport against those desired by Flow Management and by the users.

3.1.4.5 Airspace Users Operations

Airspace Users Operations - concerns the operations of the customers of ATM and is the central focus of the activities of all the other processes. As such, it is essential that the trends and potential future changes in aircraft operations are examined so as to assess the impact that they might have on the future ATM System. Initially, the interaction of Aircraft Operations with the ATM System may be somewhat limited but as time progresses and System-Wide Information Management becomes an integral part of the Collaborative Decision Making process, full integration of Aircraft Operations in the ATM System is foreseen. The aspects related to this component are developed further in Volume 2 of the OCD (Concept of Operations [ConOps]).

3.1.4.6 Information Management and Services

Information Management and Services - is a guiding principle in which the management of an information-rich environment will be key to the ATM concept. It is a support process, essential to all ATM concept components, which provides the foundation for subsequent decision making processes. It deals with the logistics of Information Management, information sharing in a distributed environment of information suppliers and consumers that will allow the ATM community to conduct its business in a safe and efficient manner. Conceptually, it covers a broad spectrum of issues, including:

- Continuously tracking the actors’ information needs and their willingness and ability to share information;
- Continuous management of the quality and interoperability qualities of the shared information in accordance with defined quality standards;
- Continuous management of an adequate supply of updates to the shared information;
- Management of the dissemination process customised to each information consumer’s needs;
- Management of information security; ensuring optimum usage of storage and communication resources;
- Management of information ownership, cost, pricing and liability.

It also concerns the provision or receipt of services to, or from, external agencies that interface, but are not, or are only indirectly involved, with the actual provision of Air Traffic Services (ATS). These are included in order to be able to examine potential future changes to those interfaces and to assess the impact that might have on the future ATM System. In general terms these external interfaces can be divided into the following organisations or agencies: adjacent ATC areas, Air Defence (AD), Meteorological, Search and Rescue (SAR), Emergency, Accident/Incident Investigation, Regulatory, Cartographic and Law. Interaction with any of these external agencies can influence, for example Air Traffic Flow and Capacity Management and/or Airspace Organisation and Management in aspects such as weather systems or military exercises.

Information Management enables two of the key elements of ATM in the future - Information Sharing and Collaborative Decision Making.
System-Wide Information Management

In step with advances made in the Information Technology industry, there are distinct trends in the way airspace users, airports and ATM service providers conduct their business and manage operations, namely:

- using increasing amounts of (digitised) information faster and in more automated and integrated/networked ways, in order to achieve the mission and to optimise the use of scarce resources (e.g. aircraft, crew, fuel, airspace, runways, ATM capacity, environmental constraints etc.) to the maximum extent possible;
- where possible, decisions will be taken collaboratively rather than in isolation;
- information will become a commodity, and it will need to be shared on a system-wide basis.

The trend towards an information-rich collaborative decision-making environment will change the focus from the individual problems of interface standardisation and information exchange to the need for overall co-ordination and management of the logistics of information sharing in a distributed environment. The integrity and security of data will be paramount. ATM is coming under pressure to adopt system-wide concepts and practices aimed at the removal of today’s technical, organisational and institutional barriers that prevent easy and timely use of relevant information.

System-Wide Information Management results in the timely availability of validated, current and relevant information to the appropriate destinations of all of the actors who have the authority to access it. This can range from information needed in the strategic planning phases, through that needed by controllers on the day of operation in real-time, to the final archiving of data so that it can, in turn, be used for future strategic planning.

3.2 Option Choices

The options described set out the possible ways to the future ATM System. Each option has different capabilities and characteristics in terms of the benefits it may offer and the cost and risk that it might incur. The options all interact with each other to a greater or lesser degree, but in some cases, they may be mutually exclusive (for example: an area which will rely solely on Free-Routing and Autonomous Aircraft Operations may have no need for the ground based infrastructure needed to support Structured Route airspace operations).

The choices as to what options are finally selected will depend on the issues in the following areas:

- Institutional;
- National;
- Economical;
- Financial;
- Technological.

At this stage the precise balance of benefit, cost and risk, and the relative merits of one option against another are unknown, although there are many opinions, based either on initial research or intuition. As a general rule, it is seen that the greater the benefits to user freedom provided by the more advanced technical solutions, the greater are the cost and risk, initially, to the users and service providers. However, benefits could increase in time as equipment costs are amortised and risks reduced until a plateau is reached. The results of research over the coming years however, can be expected to clarify and quantify the benefits and the costs and risks involved so that informed decisions on what options to choose can be made.
3.3 Trade-Offs

Each of the main concept options will have an impact on the trade-off between potential capacity gains, on flight efficiency and on the complexity of the user and service provider systems needed to support them. However, no one concept option can provide a total answer and there is no “one size fits all” perfect Pan European solution.

Different areas of European airspace will have different priorities, dependent on the characteristics of their traffic demand and the capabilities of their system(s). Any future system can be expected to require most, if not all, of the options outlined previously, but with emphasis on particular aspects in order to resolve an area’s specific problems. A major concern for a significant proportion of the airspace will be to find the extra capacity needed to meet the future demand in the busiest areas. In other areas the emphasis will be on providing flight efficiency and flexibility, and both will need to satisfy increasing safety level requirements.

Capacity-driven options for the busiest areas of European airspace and the busiest airports, based on the ground management of Separation Assurance, show emphasis in the need for:

- Structured Routes;
- focusing on metering and sequence optimisation;
- the provision of ‘reservoirs’ of aircraft to ‘feed’ the ATM System and operate airports at maximum efficiency;
- enhanced tactical planning so as to improve en-route and airport operations.

The trade-offs will be between the provision of flight schedule predictability and punctuality against reductions in flight efficiency and flexibility.

Free-routing options, still based on the ground management of Separation Assurance, show emphasis in the need for enhanced planning tools and enhanced tactical tools. The trade-offs will be between the provision of flight efficiency and flexibility against, some possible reduction in capacity.

Outside of the European core area, autonomous aircraft operations options, based on airborne Separation Assistance, show emphasis in the need for enhanced planning tools for the ground, on data communications and on Airborne Separation Assistance Systems. The trade-offs will be between the provision of the highest levels of flight efficiency and flexibility against increased cost of aircraft equipage and in the revision of roles and responsibilities and the balance of shared responsibility between the human and the automated tools.

3.4 A Mixture of Concept Options

In practice, some aspects of all of the main concept options described in the previous chapters will have to be incorporated in the target concept to cater for the differing traffic scenarios likely to be encountered in European airspace. The real choices are more about the circumstances in how and when the options can best be exploited, rather than whether or not to introduce them. Changes will also be influenced by the degree of additional capacity that the various options will deliver. In some instances, this may only become clear when they have been fully investigated through R&D and validation activities.

Concept Focus

The primary need is for the concept to identify means by which the additional capacity may be generated to meet the forecast traffic growth in the busy traffic areas while improving safety levels. This will condition the flexibility and flight efficiency that can be offered during peak traffic periods. In future, the airspace will be regarded as a common resource for ATM purposes in which the air traffic will evolve, within a continuum of airspace. There will be a continuing need to manage traffic and employ traffic structuring in the congested traffic areas of the European to provide the extra levels of capacity needed during periods of high demand. This structuring will involve a mixture of free routes, where the traffic conditions and workload permit, and fixed routes to manage the sequencing of traffic in congested areas, around airports and cater for less capable aircraft. The introduction of Free Route operations will enable airspace users to better achieve their strategic goals. The availability of more accurate flight data will enhance the traffic predictability and significantly increase the capacity management instruments.
These changes will be accompanied by the exploitation, in specific airspace, of Airborne Separation Assistance Systems (ASAS) to delegate Separation Assurance tasks from the ground to the air. Enhanced automated support and the associated HMI will be key factors in containing the workload of the human within acceptable bounds.

Airspace volumes will continue to be used to segregate different types of airspace use, although these volumes will be managed more dynamically as the Flexible Use of Airspace (FUA) is extended to include all air transport operations throughout Europe. Classification of airspace will continue to be based on ICAO classifications, although these may need to alter over time to reflect changes in airspace use and aircraft capabilities.

ATM, airspace users operations and airport planning functions will become more integrated, and more comprehensive, facilitating an evolutionary transition from demand to capacity balancing as information on flights becomes more accurate and timely, and the inter-operability of systems improves. Strategic planning will provide a better match between demand and available capacity. This, in turn, will provide the foundation of a baseline Operations Plan (OP) that will be dynamically refined as more details become available through information management, such as the dynamic availability of Temporarily Segregated Area (TSA). A role of ATC will be to participate in the implementation of the Operations Plan as necessary to reflect the real time situation. More advanced Flight Data Processing System (FDPS) will support better predictive tools and longer tactical horizons leading to the introduction of enhanced planning, (e.g. traffic organisation and distribution including multi-sector planning). The rate at which concept changes occur will depend on a number of factors but will be driven largely by the benefits it can generate.

The evolution in the stages of increased flexibility will depend mainly on the timings of the advances of the necessary supporting systems, the interoperability of legacy systems, the rate of upgrade of aircraft fleets, and the perceived costs and benefits.

This progression, while probably generating some benefits along the way, will eventually transform the ATM scene into one where the best possible use is made of capabilities available in both the air and ground elements. However, it will be essential to identify the balance between the benefits of the investments made in the ground systems versus the investments required in the aircraft. Additionally, the limits of the cost/density threshold that will permit the operation of aircraft capable of autonomous operation have still to be considered.

3.5 Performance

No matter which option or group of options is chosen, the changes themselves cannot be expected to deliver maximum benefits unless they are linked to performance. Benefits accrued to both provider and user could be negated if agreed service delivery targets are not first established and then adhered to.

How the targets are defined and delivered should be agreed at a European institutional level. This will achieve consistency in application ensuring equity and transparency to all actors. On the other hand, it should not preclude the negotiation of local agreements where circumstances dictate, but with transparency remaining a key driver.
Part 3

THE VISION
4 THE TARGET CONCEPT

The target concept should be viewed as the goal towards which the future ATM System is aiming, and which involves evolutionary change to provide incremental benefits in line with the growth in demand. It should not be seen as an ultimate system. The concept will need to evolve to reflect changes in the air transport environment. In this context, it encompasses the principle of moving to the “ideal”, (“The Vision”), while recognising the limitations of the “real”.

4.1 The Target Concept Statement

The major actors in the future European ATM System will evolve and take on different roles to those performed today as they become more integrated. Their new roles and responsibilities are outlined later in this chapter and are described in detail, in Volume 2 (Concept of Operations).

Target Concept Statement

A collaborative and co-ordinated layered planning framework for ATM operations in a gate-to-gate context based on the principles of Collaborative Decision Making and System Wide information Management

Operating Gate-To-Gate

Starting at the moment in a flight where the user first interacts with ATM and ending with the switch-off of the engines. It also includes the process of charging users for ATM services.

Collaborative and Co-ordinated Layered Planning System

The real-time sharing of planned and, current data between ATM, airports, Airline Operations, including Military Operations, and aircraft which enables the different system layers (i.e. strategic, pre-tactical and tactical planning) to support flexible and co-ordinated decisions. The shared availability of a common information pool, enhanced equipment, automated tools and operating procedures designed to increase flexibility, capacity, efficiency and safety.

Reaching the Target

The target will be reached through flexible and dynamic airspace and airport operations management, incorporating demand/capacity management based on two airspace types in which there are clearly stated responsibilities for separation assurance. It will involve changes to roles and responsibilities under-pinned by enhanced automated support.
Flexible and Dynamic Airspace Management

Achieving the fully flexible use of airspace evolving to more dynamic airspace management in both “Time and Space”.

Airport Operations Management

- the efficient use of capacity of the airside infrastructure by maximising operations in all weather conditions;
- contribute, through sequence optimisation and management, to the most effective use of airport capacity.

Capacity Management

Managing capacity rather than demand based on:

- service quality agreements;
- layered sets of planning functions;
- proactive and collaborative working process involving all concerned partners;
- considering the network effect from a central perspective (think global, act local).

Two Airspace Regimes

Unmanaged Airspace (UMAS)

- all traffic not known environment;
- rules of the air.

Managed Airspace (MAS)

- known intent traffic environment with:
  - structured routes/free route airspace;
  - explicit responsibility for separation with the ground and/or with the air;
  - autonomous operations.

Roles and Responsibilities

Human ultimately responsible for real-time decision making

- revised individual and team roles (ground and air);
- enhanced planning (e.g. traffic organisation and distribution);
- extensive automated support and tools.

Separation Assurance

Allied to the airspace regime and vested in the air or on the ground - but explicit.

Decision Making and Information Management

Information sharing, including air-ground sharing of information, is seen as fundamental for the success of a fully co-ordinated, harmonised evolutionary and flexible planning system. This concept will be underpinned by Collaborative Decision Making supported by System Wide Information Management.

4.2 Main Objectives and Focus

The OCD sets out the practical operational target for realising the principles and objectives contained in the ATM Strategy for 2000+.

Safety, ATM Security, Economics, Capacity, Environment, National Security and Defence requirements, Uniformity, Quality, Human involvement and commitment.
The Strategy objectives, together with equity of treatment and flexibility of operations, encapsulate the various users' requirements for the future ATM system.

At a more specific level, the safety objective conforms to the European Safety Policy, and can be broadly characterised as “improving safety levels\(^{13}\) in the face of increasing traffic demand”.

The capacity objective broadly encapsulates the ability to modulate capacity to accommodate variations in demand, and to deploy additional capacity at short notice to handle special demand. It assumes that it is the responsibility of ATM to provide the necessary en-route and terminal airspace capacity, and to exploit scarce airport air-side resources to the full.

The target operational concept embodies a new approach to the way that ATM services are provided in order to obtain system-wide benefits. The principal concept characteristics and their main advantages are:

**Flight Management from Gate-to-Gate** - flights will be managed continuously within the ATM system throughout all phases of flight. 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 reflect the best balance that can be achieved by providing the best service possible to the aircraft whilst at the same time recognising the prevailing ATM circumstances. This will enhance the efficiency of both individual flights and total fleet utilisation, while improving the management of traffic;

**Collaborative Decision-Making** - decisions will be made by those best positioned to make them, including the military, based on the sharing of validated real-time information. This will provide the means for greater efficiencies on a system-wide and individual flight basis. Improved and transparent information management will provide a foundation for a dialogue between the various parties in real-time during all phases of flight;

**Responsive Capacity Management to Meet Demand** - a combination of flexible ATC sectors and capacity management will be applied to ensure that demand can be handled safely and efficiently with minimum delay. This will provide operational and cost efficiencies by allocating resources to satisfy variations in traffic;

**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 continuum in a flexible and dynamic way throughout Europe;

**Extended Levels of Automation and Communication Support** - future operational improvements will require the support of more sophisticated automated assistance tools and human-machine interfaces able to exploit air/ground data communication, higher quality trajectory prediction data, and the exchange of data between ground units through a System Wide Information Management (SWIM). This will increase ATC productivity and enhance safety nets.

In practical terms, the concept focuses on providing ATM capacity above the present capabilities in the busier traffic areas, while improving safety levels, through a variety of measures including traffic structuring, and providing the users with the opportunity for greater flight freedom of movement in the other areas.

Freedom of movement encapsulates the ability to operate aircraft as economically as possible in accordance with the user’s business needs. However, there will have to be trade-offs between capacity and flight efficiency to meet the forecast demand in some areas. The principles are that these trade-offs should be explicit, and that the future ATM System must have the in-built flexibility to optimise freedom of movement according to the prevailing circumstances and traffic demand.

The target concept was developed essentially taking into consideration the future impact on the ATM using as a model the breakdown of the ATM components mentioned in the previous chapter. However, there are essential related issues that can’t be disregarded from the ATM context or framework such as Safety, Gate-to-Gate principle, Human Aspects, Environment and Military aspects. These specific subjects will be object of conceptual reference in the following paragraphs before focusing on the details of the ATM component operational concept.

\(^{13}\) Accidents, incidents and risks associated with ATM operations, as distinct from airworthiness, etc. Exactly how this should be translated into practical objectives and actions will be the subject of subsequent work. The baseline will be a uniform system of accident/incident reporting over the European area.
4.2.1 Safety

Safety is the highest priority in aviation. The main purpose of ATM services is to ensure the separation of aircraft both in the air and on the ground, while maintaining the most efficient operational and economic conditions. Safety Assurance will be applied through a multi-layer planning and execution process consisting of the following sequential phases:

- **airspace management** - the effective organisation and management of the airspace will enhance the ability of the ATM service provider and users to implement the first layer of safety assurance;

- **flow and capacity management** - the conflicting needs of airspace users identified in the scheduling and flight planning processes will be mitigated throughout the following phases of Air Traffic Flow and Capacity Management:
  - flow and capacity planning;
  - optimised capacity management
  - tactical flow and capacity management;

- **multi-sector planning** - potential conflicts within a medium-term time horizon between traffic streams and/or individual aircraft across sector boundaries will be identified and resolved;

- **sector team** - de-conflicting traffic transiting the sector will be achieved by the planning controller in a short-to-medium term timeframe. The tactical controller will provide the active ground monitoring of aircraft separation, and intervention where necessary;

- **pilot** - the active air monitoring and conduction of the flight, and intervention where necessary, by the pilot provides for the ultimate layer of safety assurance;

- **safety net** - safety-layered planning will be underpinned by air- and ground-borne tools (e.g. ACAS and STCA) which will be independently applied and be independent of the human cognisance and planning process.

In an ATM system degraded mode, as reliance on computer based planning tools increases, a commensurate decrease in controller skills will occur. Yet the controller must be prepared to perform the tasks performed by the tools should they fail. Consequently, the development of compensating procedures and the training to employ them will parallel the implementation of technological improvements.

The whole safety layer process will be underpinned by regulation which will include such issues as certification, system redundancy, procedures and training.

Figure 4-2 ATM Safety Layers
4.2.1.1 Safety nets

The use of air and ground-based safety net tools is considered as being an added value part of the safety layer execution process only. **Safety nets should be independent of any planning** process as well as the human cognisance process and should act as a stimulation and a warning. They should trigger co-ordinated actions when safety is in danger of being compromised and requires immediate human intervention, either in the air or on the ground, to resolve the situation.

4.2.2 Gate-to-Gate

Gate-to-gate is a concept that involves considering and managing a flight as a continuous event, from planning, through execution, to the post-flight activities. Its scope extends from the first interaction of the flight with ATM (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.

The overall objective of Gate-to-Gate operations is to define, develop and implement an integrated ATM Concept that will enable a smooth and seamless process from flight preparation through flight execution to an integrated charging for services rendered in a cost-effective manner.

The concept requires the sharing of information, together with the use of advanced communications methods to distribute more real-time data. It naturally exploits the concept of Collaborative Decision-Making.

Gate to gate is about the seamlessness of operations related to aviation. In this context it is acknowledged and it must be clear that the views of partners, other than ATM, are considered as well.

The concept has links to the land-side aspects of the airport and in an inter-modal perspective for the end user (passenger or cargo). Although it may be useful to have a view of the concepts involved for this, it is not in the mandate of this OCD to extent its considerations so widely. The land-side aspects themselves should be seen as external to this OCD, but, at the same time, are strongly interconnected as they may constrain or facilitate air operations, and as information has to be exchanged between the air- and land-sides.

![Gate to Gate Phases of Flight](image)

**Figure 4-3 Gate-to-Gate Phases of Flight**

**Note:** The description of the Phases of Flight can be found at Part IV – Descriptions/Explanations

4.2.3 Role of the Human in the Future ATM system

The implementation of the increasing number of automated tools and technologies in Communications, Navigation and Surveillance (CNS) together with the enhancement of harmonised and integrated civil/military co-ordination and airspace management plans and procedures will have a considerable impact on the working practices of civil and military ATM staff.

Human Factors research in ATM suggests that there are seven main interacting factors that need to be addressed to ensure partnership between automated support and the ATM Staff and in particular Air Traffic Controllers. These are:
- Trust - The ultimate use of automated tools will depend on the humans trust in its reliability. Neither mistrust nor complacency are desirable;

- Situational awareness - Tools for conflict detection and conflict resolution are likely to impact on the knowledge and prediction of future events. The higher the level of automation is, the more difficult is maintaining the situational awareness. Therefore human machine interfaces will have a deep impact on controllers possibilities to handle unusual situations and it is crucial to keep the interface appropriate and intuitive;

- Team performance - Automation will affect the interactions and communication patterns of controllers and interactions with supervisors and with pilots. The added value of good team resource management to the safe performance and execution of expeditious air traffic management is high;

- Skill changes - When certain aspects of a task are automated, the human operator will no longer experience the daily on-the-line handling of the tasks. This may consequently result in a reduced performance of the skill involved. New technology will, on the other hand, require new skills to be trained and new knowledge to be acquired;

- Workload - Much of the automation being developed is intended to reduce controller workload, or to smooth the current workload levels. Caution needs to be applied as experience from other industries suggests generally that whilst there are reductions, they rarely meet the intended levels;

- Recovery from system failure - Automation needs to be implemented in ways that allow the human to build on his ability to ensure safe recovery of real time events, should system failure occur. Operational concepts, procedures and the design of automated systems have to include such properties if a safe operation should be assured;

- Error analysis - The introduction of automatic system promises to reduce or remove some forms of human errors presently seen. Changing the characteristics of the system will however alter the human-machine interaction and will therefore introduce other types of human error and may decrease system error detectability and recoverability.

Human-Human and Human-Machine task sharing will be employed both on the ground (in the control team), and between the air and the ground (between the flight-crew and control team). Only the evaluation of realistic task sharing within new environments can determine the impact on the current human role, and what measures will be needed to allow the human to retain the ultimate responsibility for real-time aircraft separation.

Consequently, the trend will be towards the evolution of a new working environment in which task sharing aims are focused on enhancing the differing strengths of human and machine and minimising their limitations, rather than using machines to replicate the human’s current tasks.

The increasing of automation support will progressively change the nature of ATM job requirements. Both Pilots’ and Air Traffic Controllers jobs’, will evolve and additional or new methods for recruiting, selecting and training, will be needed.

Transition and Change Management - In the face of a changing world adequate the management of transitions and changes at organisational level as well as working level has become of great importance. Proper management of all resources and the relationship within the ATM system between people, their environment and equipment in regard to responsibility for aircraft separation, will be main subjects for strategic management actions.

Since human performance is a crucial component of ATM, human involvement and commitment issues will be analysed and documented throughout the concept transition process. This is necessary to ensure commitment and ownership by all actors, for the significant changes that will occur.

4.2.4 Military Aspects

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. Military requirements and operations stem from tasks set by governments for air, sea and ground forces.

The Operational Concept for the future ATM System incorporates the high level operational requirements of National Security and Defence. These include the recognition that the military users of European airspace carry out operations that do not comply with ICAO but are conducted under national aviation rules and procedures. Drivers for change in the ATM
System must include the need to ensure security for the operation of air transport and to counter the threat from terrorism, as well as the need for national defence and security in general. Consequently, there will continue to be a need for the enhancement of civil-military co-operation in all aspects of ATM and the need to initiate actions to ensure the accommodation of all airspace users requirements, both civil and military. Such actions should lead to the optimal use of airspace, in a collaborative way, ensuring safety and better use of synergies, including technology convergence/interoperability to the extent possible.

Each European State must be able to train and operate its military air, sea and ground forces to enable them to discharge their responsibilities for security and defence. In order to carry out its operational tasks, military aviation should be able to have:

- Freedom to operate in all weather conditions in all areas of European airspace;
- Special handling in particular for priority flights and for time-critical missions (e.g. real-time air defence missions);
- Exemptions for military aircraft not fully equipped or not offering equivalent performance to the civil standards;
- Temporary airspace reservations in a flexible and dynamic way, to contain activities which are incompatible with normal application of the Rules of the Air;
- Airspace restrictions for non-flight-related activities (e.g. as protection of areas of national interest, gunnery, missile firing, etc.).

4.2.4.1 Sovereignty

Every State will continue to have complete and exclusive sovereignty over the airspace above its territory (Article 2 of the Chicago Convention) including the capacity of every State to exercise its prerogatives with regard to security and defence in its national airspace. However, the responsibility for the provision of ATM from one State to another one (or international organisation) can be delegated. The main reasons for the delegation of ATM are based on operational requirements of safety and efficiency as well as technically adjustment straightening of Area of Responsibility boundaries.

In times of crisis and war it may be necessary for the Military to assume responsibility for ATM and/or to prohibit the civil use of specified areas of airspace and to ensure that military operations have priority over all other airspace users.

The provision of ATS over the high seas is undertaken by States, which have accepted this responsibility via a regional air navigation agreement. These agreements are part of ICAO Air Navigation Plans. Over the high seas, the rules in force shall be those established under the Chicago Convention (Article 12 of the Chicago Convention).

4.2.4.2 Air Defence

The military have responsibility for the securing and policing of a State’s airspace, and military aircraft need to react at short notice to perceived or possible threats. Operational Air Defence flights will continue to have priority access to all airspace. There may be a similar requirement when training for active Air Defence missions.

4.2.4.3 Search and Rescue

The Military provides Search and Rescue (SAR) services for military purposes and also may contribute to the Search and Rescue service provision of the States. The priorities of these missions are such that they take precedence over General Air Traffic operations.

4.2.4.4 Training and Exercises

Military and State aircraft will need to be able to reserve airspace for training or exercise activities. The active support of ATM providers will be essential to the efficiency of such operations.

4.2.4.5 State Aircraft14 Flying as Operational Air Traffic

Operational Air Traffic operations are the main element of military aviation activity and they should be able to be conducted in any of the proposed airspace types. These operations need to be supported by efficient and effective civil/military co-ordination both at a procedural and system level. The rules applicable to these operations will be promulgated nationally and States will endeavour co-ordination of those procedures within Europe and between the civil and military

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14 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 (Provisional Council session 11 on 12/07/01).
authorities in the frame of the application of the Flexible Use of Airspace. However, a principal objective of the concept is to treat the airspace as a single continuum and consequently, the conduct of Operational Air Traffic should also be as “seamless” as General Air Traffic operations (State aircraft may not enter into other States airspace without Diplomatic Clearance or special permission).

4.2.4.6 State Aircraft Flying as General Air Traffic

Not all State aircraft will be able to comply with civil General Air Traffic operations procedures and there will be a need for agreed operational or technical waivers, and, in exceptional cases, special priorities may be requested (e.g. a degree of confidentiality for some flights).

4.2.4.7 Other Military Airspace Users

There will be continuing requirements for airspace reservations generated by military non-flying activities that will require other aircraft to remain clear of those portions of airspace (e.g. ground-to-air and ground-to-ground firing, high-intensity emissions etc.).

4.2.4.8 Systems Interoperability

The national, NATO and other Air Defence Command and Control Systems’ requirements to build a Recognised Air Picture (RAP), where applicable, will become more critically dependent on access to high integrity real-time flight data. In addition, the implementation of civil/military initiatives such as Flexible Use of Airspace will also require the capability for data exchange. Furthermore, new ATM concepts will require greater inter-operability between civil and military systems both on the ground and in the air. These systems will evolve at different rates and be replaced or upgraded at different times.

One of the key points 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 therefore cater for the transition periods.

4.2.4.9 Security of Military Data

The interoperability of military and civil systems, and the use of shared information, raises institutional and systems architecture issues in the need to ensure protection of classified/sensitive military data within the future ATM System.

4.2.5 Environmental Issues

The role played by air transport in socio-economics is recognised world-wide as fundamental to the progress of modern society. However, environmental concerns about gaseous emissions and noise together with safety issues are having an increasingly important political, economic and social impact on aviation. Indeed, aircraft noise is expected to remain the major cause for community opposition to airport construction and capacity expansion. Consequently, local communities around airports are becoming of increasing influence on the expansion of airport operations.

Current solutions on noise and emissions are often of opposite effect to each other as, in reducing noise, there is currently increase in flight distance. Additionally, these solutions bear an impact on ATM safety, capacity and performance that have to be addressed.

Gate-to-gate, as foreseen within the target concept, is associated with developments on airspace organisation and structure, either en-route or on the approach/departure paths at airports. The ATM System within Europe should contribute to the protection of the environment by considering noise, gaseous emissions, and other environmental issues in the implementation and operation of the global ATM System.

Improvements brought about by efficient management of the air traffic evolving at the airports’ surface, complemented by Collaborative Decision Making measures and supported by corresponding institutional issues and technological resources, will be a major step in reducing fuel inefficient routings, airborne/ground holdings, non-optimal flight profiles and noisy approach/landing and take-off/departure procedures.
4.3 Airspace Organisation and Management

Airspace management and planning will become a more integrated and collaborative function, supporting all aspects of planning, design, maintenance, update, civil/military co-ordination, regulation and airspace legislation. The main objectives will be to optimise the airspace structure in Europe, its management, and the development of procedures for the benefit of all users at both the strategic planning and tactical levels. To this end, all European airspace will be considered to be the concern of ATM and will be a useable resource.

The organisation, the flexible allocation and the use of airspace will be based on the principles of access and equity, while recognising the specific needs of the Military. On this basis, any restriction on the use of any particular volume of airspace will be considered transitory. The airspace will be organised and managed in a manner that will accommodate all current and potential new uses of airspace.

European airspace will be considered as a continuum for ATM purposes, organised in accordance with the need for the provision of ATM services, not constrained by National boundaries and based on the principles of contiguous volumes of airspace, under the responsibility of units providing ATM services, in particular ATC services. This does not imply changes to sovereignty, or preclude the application of special conditions to ensure the national security and defence requirements of individual States.

The coordinated planning between adjacent areas will be conducted with the objective of achieving a single airspace continuum. The airspace within that continuum will be free of operational discontinuities and inconsistencies. Airspace will be organised to accommodate the needs of the different types of users on a timely basis. Transition between areas will be transparent to the users at all times.

Airspace organisation and management will provide the first layer of safety. Effective airspace organisation and management will enhance the ability of the ATM service provider and airspace users to accomplish separation assurance and also increase ATM System safety, capacity and efficiency.

4.3.1 Airspace Organisation

The airspace organisation function will provide the principles, rules and procedures, by which the airspace will be structured to accommodate the different types of air activity (including military operations), volume of traffic, and differing levels of service and rules of conduct. The principles underlying the Airspace Organisation rules and procedures include the following:

- airspace will be organised to facilitate the seamless handling of flights and the ability for flights to be conducted along optimum flight trajectories within gate-to-gate without undue restriction or delay;
- airspace organisational boundaries, divisions and categories will be adapted to traffic patterns and changing situations, and will support the efficient operation of the other ATM services. Flexibility within airspace organisation will include regular strategic planning processes and will allow actual operations to dictate a more optimum configuration, while at the same time accommodating security and defence requirements;
- airspace planning will be predicated on dynamic flight trajectories whenever practicable. Structured route systems will be established when the demand for dynamic flight trajectories cannot be accommodated; and
- although there will generally be no permanent/fixed airspace, certain airspace will be subjected to service limitations including access over an extended period, motivated by national interests or safety issues and appropriately considered in coordination with the ATM community.

There will always be airspace that is primarily used or organised for a specific purpose (e.g. trajectory-oriented airspace, high density airspace, special use airspace). However, aircraft not operating in that particular mode nor equipped accordingly for such airspace will be accommodated by the system where deemed safe and appropriate. Accommodation will be made without constraining the primary use of that airspace.

European airspace will ultimately consist of 2 different types of airspace - Managed Airspace (MAS) and Unmanaged Airspace (UMAS). The definition of these types of airspace encompasses all the current ICAO airspace classification, legislation and applicable rules (including Visual Flight Rules (VFR) and Instrument Flight Rules (IFR)). However, aircraft not operating in that particular mode nor equipped accordingly for such airspace will be accommodated by the system where deemed safe and appropriate. Accommodation will be made without constraining the primary use of that airspace.

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Managed means that a strategic or tactical decision as to the service to be provided will have been taken by the appropriate authority.
The vertical, lateral and time boundaries of the airspace regimes organisation will be determined during the airspace planning phases taking into consideration the forecast air traffic flows and the corresponding aircraft capabilities. It will be possible to dynamically readjust the boundaries between Managed Airspace and Unmanaged Airspace in accordance with the needs of En-route and Terminal operations. ATM will have the responsibility to make the information on the extent of Managed Airspace available to all potential airspace users during the planning phases and on the day of operation. Particular attention will be paid to safety-related information. FL Z will be defined as the common division level, applicable throughout European airspace, between the Managed Airspace (MAS) and the Unmanaged Airspace (UMAS).

Adoption of such an airspace organisation is based on the knowledge of flight position, flight intention and separation responsibilities. The role of ATM service provision will be in accordance with the traffic evolution without the need for differentiation airspace categories.

### 4.3.2 Airspace Management

Airspace management is the process by which the airspace will be organised to best meet the needs of the airspace users. Competing interests for the use of airspace make management a highly complex exercise, necessitating a process that equitably balances those interests. The management of airspace will adopt the following guiding principles:

- Airspace will be dynamic and flexible;
- All airspace will be based on user demand. Sector boundaries will be adjusted to prevailing traffic flows;
- Airspace use will be coordinated and monitored in order to accommodate the conflicting legitimate requirements of all users and to minimise any constraints on operations;
- The airspace management processes will accommodate dynamic flight trajectories and provide optimum system solutions;
- When conditions require that different types of traffic be segregated by airspace organisation, the size, shape and time regulation of that airspace will be set to minimise the impact on operations;
Airspace reservations will be planned in advance with changes made dynamically whenever possible;

Structured traffic flows will be applied only where required to enhance capacity or to avoid areas where access has been limited or where hazardous conditions exist;

Uniform airspace organisation and management principles will be applicable to all region. European wide principles will be applicable at all levels of density and will affect total traffic volume. Complex operations may limit the degree of flexibility;

Free selection of flight trajectories by airspace users will be progressively encouraged and enabled through implementation of adequate supporting tools and procedures.

4.3.2.1 Unmanaged Airspace (UMAS)

Unmanaged Airspace will be a traffic environment in which not all traffic is known to ATM. Continuous two way communications and transponder may be required in certain circumstances. There will be no interaction with ATM for aircraft operating in Unmanaged Airspace, except for those flights that wish to notify their presence either by filing a flight plan (in the air or on the ground) or by broadcasting their position (and perhaps intentions) by electronic means (e.g. ADS-B). ATS, in particular Flight Information Services, may be provided to aircraft in Unmanaged Airspace on request.

Unmanaged Airspace will be subject to similar rules as those applied now (Rules of the Air), but there will be harmonisation of airspace categories and uniformity of rules throughout Europe. Easier access to more accurate information will be provided and equipped aircraft will have the ability to negotiate and agree to separation action between each other.

4.3.2.2 Managed Airspace (MAS)

Managed Airspace will be an environment in which all traffic and its intent is known to ATM. It will consist of airspace (defined by vertical, lateral and time boundaries) required to support en-route and terminal operations within which the separation assurance of aircraft is normally the responsibility of the ground ATM organisation (see Autonomous Operations below). Traffic structuring, in the form of 3-D route networks (Structured Routes), will be used in the busiest areas at peak times to enhance capacity, to organise traffic flows and to reduce the incidence of conflicts for En-route and Terminal operations. MAS will support the operation of aircraft utilising user-preferred trajectories outside the structured routes (the Free-Route Airspace concept). A particular challenge will be to ensure that the interfaces between the respective airspace organisations are both transparent and seamless.

Note: The concentration of air traffic around airports will continue to mandate the need for specifically organised airspace volumes dedicated to terminal area operations.

In Managed Airspace, excepting within airspace dynamically specifically designated to accommodate Autonomous Operations, the responsibility for Separation Assurance will rest with the ground ATS. However, in some specific traffic situations the responsibility for separation may be explicitly delegated to suitably equipped aircraft under specific instructions of application issued by ground ATS.

The overall boundaries and route structures in Managed Airspace will be defined by collaborative and integrated airspace planning and management service. The service will have the responsibility for optimising airspace use throughout Europe via long, medium and short-term planning layers and utilising the benefits of Collaborative Decision Making and System-Wide Information Management. The structure will be flexible enough to accommodate demand in terms of both traffic density and the spread of aircraft capabilities.

In order to provide the capacity needed during the peak demand periods, the degree of airspace structuring applied will be predicated on the forecast and actual demand and will vary over time. Likewise, in periods of low demand, greater flexibility will be possible in the less congested airspace of some European regions. Instrument Departure and Standard Arrival Routes will continue to be needed in the vicinity of airports.
Managed Airspace will be organised in the following way:

4.3.2.2.1 Structured Routes

Operations within structured routes, where applied, will be optimised by using the benefits of CNS availability:

- Route structures will be tailored to meet capacity demands, to accommodate traffic flow variations, to take advantage of the release of Special Use Airspace (SUA) and to satisfy safety and operational needs;
- Route structures will be dynamically sized, providing IFR flights with more operational flexibility and, at times, freeing up airspace for VFR flights;
- Route structures will be better optimised to increase flight efficiency;
- The capability of flights for more accurate navigation and the improved predictive ability of airborne and ground-based systems will enable the current horizontal separation standards to be reduced, resulting in increases in capacity.

Notes:

1. The service provided by the future ATM System will encompass aircraft with differing navigation capabilities. It is anticipated that the pressures to increase flight efficiency and capacity will have encouraged all aircraft to be equipped with 4-D navigation capabilities.

2. To airspace users, the detail of most of these improvements will be transparent, what they will notice is the reduced workload in communicating with the ground, increased flight economy and increased freedom of movement.

4.3.2.2.2 Free-Route Airspace

Operations in Free Route Airspace can be seen as a development of the current practice of direct routing clearances issued by ATC. In this airspace aircraft will be able to flight plan their own user-preferred trajectories (subject to any overriding airspace restrictions) within a known environment (their identity, position and intentions are known) and with links to the structured routes at both ends. ATM intervention will be more frequent at pre-tactical level than currently and will utilise the principles of Collaborative Decision Making to determine and agree the best course of action for flights.

The preferred trajectory may change from day-to-day because of changing airspace restrictions, the differing strategic options of the flight operator and by the vagaries of the weather and other traffic. The development of automated support systems in the air and on the ground, coupled to new procedures and working arrangements in ATM, will permit the use of Free-Route operations in Managed Airspace and so provide significant benefits in flight economy and flexibility for users.

4.3.2.2.3 Autonomous Operations (AutOps)

The volumes of airspace that will be allocated to Autonomous Operations will be promulgated by the ATM Operations Plan (OP) to accommodate the demand patterns expected across the European airspace. This will take into account the forecast traffic flow densities, the capabilities of flights and the balance of benefit to the users’ quest for flexibility and economy. The aim will be to adjust the volumes of airspace allocated to Autonomous Operations to maximise the benefits for capable aircraft, while providing an incentive for aircraft operators with less capable aircraft to upgrade their avionics.

Responsibility for Separation Assurance from other aircraft operating in the same airspace will rest with the aircraft participating, although some Separation Assurance responsibility can be undertaken by ground-based ATM (emergencies) or delegated to other organisations (e.g. the military). User trajectories will be self-determined but known to the ground ATM organisation (Collaborative Decision Making).

Aircraft conducting Autonomous Operations will be supported by a ground ATM organisation that will provide the following services:

☐ Flight Information Service:
  - on request;
  - providing precautionary anticipated information when specific local areas are predicted to be too congested for safe airborne Separation Assistance.
4.3.2.2.4 Terminal Airspace

Operations within Terminal Airspace will vary according to the complexity of the airspace, the amount of traffic to be accommodated and the number and complexity of airports within their areas. In principle, the emphasis will remain on the establishment of RNAV and FMS routes but, with the addition of tactical flexibility to accommodate other routings, dependent on the level of traffic density. As a baseline, the Terminal Airspace of the future will be characterised by:

- More accurate navigation and monitoring capabilities allowing:
  - reduced separation minima;
  - reduced spacing between routes.
- Flexible routes with dynamic route restructuring and Terminal Airspace re-sizing in response to traffic flow so as to use only the airspace necessary to satisfy operations;
- More accurate weather data from forecasts, now-casts from flights, and from weather detection radar, that can be analysed via improved meteorological services to assess the cost-benefit of different flight routings;
- Aircraft with 3-D and 4-D navigation capability with RNAV and ASAS, some with the ability to accept responsibility for self-Separation Assurance;
- The introduction of aircraft continuous descent and climb profiles, where achievable, to increase efficiency and reduce environmental impact
- The ability to collect accurate data on aircraft position and intention (via dynamic flight plans and from the aircraft’s FMS);
- Improvements to airspace planning in which conflicts have been designed out, including the problems caused by the mix of traffic with different capabilities (in equipment or performance capability);
- The assistance of integrated Departure/Arrival Management Systems (DMAN/AMAN) of other airports and with its own airport will permit when appropriate:
  - accurate monitoring of flights and their conformance to their planned trajectories;
  - improved prediction of 3-D trajectory information, based on more accurate data from ground-based surveillance systems and from flights;
  - integration with other Departure/Arrival Management Systems in the same Terminal Airspace, or to provide a departure service to multiple airports co-located in a single Terminal Airspace;
  - integration with En-route ATM Systems.

Note: In complex Terminal Airspace with very high traffic levels, because of the overriding need to ensure adequate throughput and safety, a number of constraints will probably still affect aircraft operations by limiting the flexibility of dynamic route or routing change ability and constraining an aircraft’s desired trajectory. Principal amongst these constraints will be environmental issues regarding noise and gaseous emissions pollution.

4.3.2.2.5 Sectorisation

Sectorisation will be based on traffic flow demands, traffic flow complexity and workload factor considerations, without being restricted by facility boundaries. Sectors will be optimised and be dynamically adjustable to provide the best balance between size and controller workload.
4.4 **Air Traffic Flow and Capacity Management (ATFCM)**

**Air Traffic Flow and Capacity Management within Europe**

Air Traffic Flow and Capacity Management will enable flight punctuality and efficiency with the emphasis on managing the balance between traffic demand and capacity, maintaining an overall ATM perspective to maximising the use of available resources and co-ordinating adequate responses in order to maximise the performance of the European ATM System.

4.4.1 **Context**

Air Traffic Flow Management is the current ICAO terminology for Air Traffic Flow and Capacity Management. It reflects the principle that ATFM currently contributes to a safe, orderly and expeditious flow of air traffic by ensuring that available ATC capacity is utilised to the maximum extent possible, and that the traffic volume is compatible with capacities declared by the appropriate ATS provider.

A major objective of the Operational Concept is to maximise the overall ATM System capacity to such an extent that acting on the demand will only be required in exceptional circumstances. An optimised traffic flow and capacity management function will anticipate the need for ATM System capacity and will act to minimise the effects of ATM System constraints. In this context, the emphasis of Air Traffic Flow and Capacity Management will move from constraining demand to optimising the capacity of the System to meet the predicted demand.

Air Traffic Flow and Capacity Management will allow airspace users to optimise their participation in the ATM System while mitigating conflicting needs for airspace and airport capacity. Use of collaborative decision making support tools will enable the most efficient use of airspace resources; provide the greatest possible access to airspace resources; provide equitable access for all airspace users; accommodate user preferences; and, ensure that demand on an airspace resource will not exceed its capacity.

An enhanced management of Demand & Capacity Balancing will be the next natural step in the evolution of ATFCM taking into consideration the perspective of the orientation of European aviation towards a more dynamic and open market orientated philosophy.

4.4.2 **ATM System Capacity Management**

The capacity of an ATM System depends on many factors, such as airspace and route network structure and complexity, the navigation accuracy of the aircraft as well as other aircraft capabilities, weather related factors, ground system capabilities/status (including systems backup availability) and controller workload. Every effort should be made to provide sufficient capacity to cater for both normal and peak traffic levels; however, in implementing any measures to increase capacity, the responsible authorities shall ensure the corresponding enhancement of safety levels.

An important consideration is the limitation imposed by airport capacity. While every effort will be made to optimise available airport capacity, the continuous growth in demand will continue to exert pressure on major airports.

The declared capacity for portions of airspace and airports shall be the responsibility of the corresponding service providers or entity owners. In any case, the declared capacity should not exceed the optimal number of flights being provided with an ATM service that the system can safely accommodated in the prevailing circumstances.

The current “capacity enhancement function” is in place to co-ordinate achievement of capacity targets by the EUROPEAN states. This function will evolve into the definition of European Capacity Objectives as part of an European Capacity Plan (ECAP) and a contributor to the Operations Plan (OP). It will focus on those several measurable ATM targets capable of improving the ATM system performance (e.g. including airspace and airport capacity, safety levels, deviations to user requests, CNS etc) and enhancing stakeholder satisfaction. The European Capacity Plan will be periodically reviewed in order that capacity demand balancing is managed in a dynamic way.

Air Traffic Flow and Capacity Management will develop the range of actions, measures and procedures in co-ordination with all the actors involved to deliver the appropriate capacity to satisfy the traffic demand by:

- Identifying and using the appropriate available capacity;
- Maximising the ATM System capacity in line with the demand profile.
Within this context, actions of one actor can affect other ones. It will be essential to create the means to identify interactions between actors as well as accessing corresponding impacts and preparing adequate responsive actions. Therefore, it will be crucial to consider the need of a Collaborative Decision Making process among the actors as a cornerstone to the efficient capacity management of the air traffic flow through the use of appropriate rules and tools associated with a system-wide information on constraints and resources availability.

4.4.3 Collaborative Planning and Execution Process

The ATFCM process will consist of ensuring Flow and Capacity Management operations from Planning, through the consideration of initial planned resources (Airspace structure, ATC capabilities, Airport capabilities), to usage on a seamless and continuous basis. The main differences between the ATFCM phases will therefore be the number and role of partners involved in the Collaborative Decision Making process in each of the respective phases, the time given to do it and the need for advance notice of the decision taken.

During the full process, ATFCM will make use of the known planned resources to evaluate the impact on the demand and anticipate the appropriate actions in collaboration with the participating actors.

The ATFCM process will be constituted by phases which will be continuously iterative, collaborative and interactive, in which the output of one phase will aim at preparing the next. It will be conducted both at the local level (e.g. Flow Management Positions, Airspace Management Cells, Airport Coordinators, Airline Operations Centres) and at the global European level for overall consistency.

The Strategic and Pre-Tactical Planning phases will aim at establishing an “Operations Plan” as optimised and stable as possible, enabling all partners concerned to fine-tune the planning of their resources according to the latest known information. However, as real-time events will generate instability, the Execution (Tactical) phase will therefore look ahead from the real-time events in order to assess their impact on the overall situation and to react in an appropriate manner with adequately coordinated solutions that will lead to stability and maintenance of overall capacity optimisation. The ATFCM phases will be supported at each stage by post-analyses to ensure that the rationale for the following phase remains valid in the light of the operational experience. The ATFCM process is driven towards achieving excellence in the quality of service and an optimised performance of the ATM System.

The output of the ATFCM Phases process will be a set of Operations Plans (OP)\textsuperscript{16} that will balance the expected demand and forecast available capacity. This stage will begin as soon as practicable (12 months) through Collaborative Decision Making based on information sharing and optimising resources to maximise throughput, thereby providing a basis for predictable demand, in which collaboratively agreed solutions will seek to balance demand and capacity requirements.

\textsuperscript{16} The OP will contain data such as: Consistent Flight Plan data, Airspace allocation including capacity threshold values, Route configuration/routing schemes, change in airspace types/services provided, Free Route Airspace, airspace where Autonomous Operations will be carried out, etc.

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**Figure 4-8 ATFCM Phases**

Dynamic Operations Plan

<table>
<thead>
<tr>
<th>Time</th>
<th>Strategic/Pre-Tactical Planning</th>
<th>Tactical Re-Planning/Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year &gt;</td>
<td>Up to 1 week</td>
<td>1 day or less</td>
</tr>
</tbody>
</table>

The Key issue:
- Safety
- Punctuality
- Efficiency
- Information Sharing
- Collaborative Planning
- Collaborative Execution

<table>
<thead>
<tr>
<th>Time</th>
<th>Strategic Flow &amp; Capacity Planning</th>
<th>Air Traffic Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year &gt;</td>
<td>Harmonised Planning:</td>
<td>Real Time</td>
</tr>
<tr>
<td>- Users Demand</td>
<td>Dynamic Optimised &amp; Detailed OPS Plan</td>
<td>Minimise Disruptions impact, Take Benefit of Opportunities</td>
</tr>
<tr>
<td>- Airports Capacity</td>
<td></td>
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<tr>
<td>- Airspace Context</td>
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<tr>
<td>- ATS Capacity</td>
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</tr>
<tr>
<td>Strategic Flow &amp; Capacity Planning</td>
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The OP will contain data such as: Consistent Flight Plan data, Airspace allocation including capacity threshold values, Route configuration/routing schemes, change in airspace types/services provided, Free Route Airspace, airspace where Autonomous Operations will be carried out, etc.
4.4.4 ATFCM Phases

4.4.4.1 Strategic Flow & Capacity Planning

The need for a Strategic Flow and Capacity Planning Phase emanates from the need to understand the general context in which the ATM operations will take place. It will aim to make a long term (18 to 12 months before the day of operations) forecast of the demand and the availability of ATM and Airport resources. This phase can start as early as possible.

During this phase individual airlines will publish their Summer and Winter timetables well before the beginning of each season to position themselves in the travel business market. They will adjust their destinations, corresponding routes and flight schedules to the demands of the travel industry (one of the drivers for the publication of the timetables is the need of the travel industry to define their holiday packages, buy capacity on flights to selected destinations, either on charter or on scheduled flights, and to start taking early bookings).

The following Strategic events also take place during this Phase:

- Airports (based on data concerning of previous declared airport capacities, weather conditions, traffic flows and other relevant airport business plans and information) will identify their availability of landside and airside resources that will permit them to publish the Airport declared capacities and prepare the corresponding agreement of service quality plans with the users;
- The optimal airspace configuration will be defined from the consolidated picture of the forecast European traffic flows, thus enabling the preparation of strategic measures to create the corresponding Airspace capacity;
- ATS will identify their resources availability (human, systems, configurations, business plans and information) that will permit them to publish the ATS units’ declared capacities and prepare the corresponding agreement of service quality plans with the users;
- All the actors, in a collaborative and transparent manner, will make available their demand intentions and expected availability of resources in order to identify as soon as possible the context constraints and try to anticipate together, adequate and corrective strategic capacity measures.

These objectives will be achieved through a chain of collaborative actions that has to be conducted at both National and International Level. This will require a detailed analysis of the expected traffic levels and available capacity which will consider the available network resources, to determine the airspace and corresponding ATM System configurations to be used.

The traffic forecast will be compared with the planned ATM environment and, through iterative processes, users and service providers will be able to examine and refine their plans in order to optimise the users schedules and service provider’s plans. This iterative process will be conducted initially in a semi-automated environment, but will be progressively enhanced by the use of simulation tools and the growing benefits of Information Management, to accurately model the airspace and the demands placed on it.

This will lead to the collaborative elaboration of pre-defined scenarios and associated Modus Operandi related to the use of airspace (e.g. Conditional Routes, Temporary Segregated Airspace), sector management (e.g. ATC staff resources) and airport planning (e.g. schedule). These scenarios will aim to be as close as possible to reality in order to provide participating actors with a number of options and the necessary flexibility to respond to increased traffic demand.

The collective outputs from the Strategic phase will provide a harmonised planning platform for the next phase of the process.

4.4.4.2 Optimised Capacity Management

The role of Optimised Capacity Management will be, as better demand information and user capability data become available, to refine the details over time in terms of the following objectives:

- Resource allocations;
- Projected trajectories;
- Airspace organisation;
- Allocation of entry/exit times for airports and airspace volumes to mitigate any imbalance.
This Phase will consist of optimising the available capacity by successive refinements of tuneable factors (airspace organisations, resources arrangements, etc), and anticipating adjustments on the demand in some particular areas or time periods, if necessary, when there are strong imbalances.

The output of this Phase will be an optimised and detailed Operations Plan one day in advance of the implementation date (e.g. airspace configuration(s), forecast flight operations types) which will be made available to all actors.

On the day of operations, the pre-tactical activities will continue as more accurate information will become available, and will induce the amendment of the initial Operations Plan and dissemination of updates. The purpose of these pre-tactical activities will be to preserve the stability of the Operations Plan and its associated updates through the anticipation of any possible events. This will enable each of the partners of the network to be aware of the situation, thereby reducing the need to react in real time.

4.4.4.3 Tactical Flow and Capacity Management

The Tactical Flow and Capacity Management Phase will consist of considering real-time events and applying any refinements needed to the Plan in order to restore ATFCM stability. The need to adapt the original Plan could result from either or a combination of:

- Significant weather phenomena;
- Critical events;
- Unexpected ground or space infrastructure opportunities/limitations;
- More accurate Flight Management Data;
- Revised sectors capacity values, etc.

The main purpose will be to minimise the impact of any disruptions and to take benefit of any opportunity. This will rely on the provision of the traffic and capacity situation as accurate and as timely as possible to all partners. This phase will enable the partners concerned to conduct efficient real-time operations while taking benefit of their feedback.

4.5 Air Traffic Services

The role of Air Traffic Services will change in the future, in that the current “management by intervention” will evolve to “management by planning and intervention by exception”, however, tactical separation will remain an important element of the ATM system to deal with random and non-nominal situations. This evolution will contribute to improving the system flexibility on accommodating demand while meeting increasing target safety levels. Air Traffic Services will continue to be the most important element of ATM due to the safety implications of the services provided. However, it is recognised that the other ATM components will gain in importance. Airspace Management and Air Traffic Flow Management roles will be to anticipate, identify, organise and prepare the implementation of strategic planning in order to provide a high quality of service to the airspace users and to minimise the tactical implementation risks related to unplanned real-time operation.

It is anticipated that the objectives of Air Traffic Services will not change in general terms. On the other hand, the daily operation, corresponding procedures and particular roles will have to evolve, in order to be able to respond promptly to real-time scenario variations and to maintain high levels of performance, productivity and quality of service, without jeopardising air traffic safety.

Where applicable, the following Air Traffic Services will form the primary elements of the ATM service provided in the European region:

- Flight Information Service;
- Alerting Service;
- Air Traffic Control Service (ATC).

Air Traffic Services will benefit from advanced and integrated data information exchange and computer support. The main aim of the Air Traffic Services will remain principally in line with today’s services, but with emphasis on Air Traffic Control.
4.5.1 Air Traffic Control Service

The objective of Air Traffic Control Service is to maintain a safe, expeditious and orderly flow of air traffic. Specifically, its purpose is to:

- prevent collisions between aircraft and between aircraft and obstacles on the manoeuvring area. This function will evolve to ground-based safety assurance management, including safety monitoring and Separation Assurance, within the parameters of gate-to-gate operations and covering the rules governing the operation of the airspace regimes;
- maintain an orderly and expeditious flow of traffic. This function will be satisfied through the provision of traffic synchronisation and sequencing.

As mentioned already before in this document the main ATM components concerning Air Traffic Control Services are

4.5.1.1 Separation Assurance

Separation assurance concerns the prevention of collision between aircraft and between aircraft and obstacles on the manoeuvring area. Nowadays this is a function exclusively performed by the Air Traffic Control Services with some exceptions, in which it is performed by Pilots under specific conditions. Air Traffic Control Services use the current techniques to apply separation assurance which are based upon international agreed minima standards.

Automation support on the ground can contribute to shift the emphasis of the traditional Air Traffic Control Services methods of application of separation assurance in such a way that it can be more planning oriented, optimising aircraft trajectories and reducing tactical intervention. Additionally the introduction of automation support on the air providing aircrews with improved situational awareness and airborne separation assistance capabilities will be a major step on the possibility to eventual delegate in specific conditions the separation assurance function from the ground to the cockpit.

4.5.1.2 Synchronisation

Synchronisation normally relates to every Air Traffic situation that requires the maintenance of orderly and expeditious flow of traffic. This is currently managed and achieved by Air Traffic Control Services through the use of procedural and radar control techniques during the several phases of the flight and in particular during the approach and arrival in order to optimise the progress of flows of traffic and the runways capacity at the airports. In some airports the radar techniques are complemented by a first generation of support tools, the arrival managers, which aim at facilitating the task of Air Traffic Controllers. Automated support systems regarding synchronisation (e.g. departure managers, arrival managers, surface managers or en-route evaluation of flows) are under evolution and can be seen as of major importance to support and contribute to the improvement of Air Traffic Control Services performance within the time frame of this concept document.

4.5.1.3 Air Traffic Control Services Provision

The concept incorporates an evolving change to the current ATM environment in respect of roles and responsibilities, both on the ground, and between the air and the ground ATM elements. The greater use of computer support tools, and associated communications systems, to facilitate autonomous operations, and a move to more dynamic airspace structures will lead to the re-allocation of tasks and responsibilities.

As a consequence, the operational task of controllers will shift from perception and response oriented involvement towards increase in management and planning tasks with intervention by exception. This shift also implicates new personnel within the ATM environment such as system engineers. Organisational issues related to system monitoring and maintenance will become a safety issue.

The capacity of the controller to have the possibility to make more strategic plans will play a more predominant role. The ability to make the right decision in stressful situations will have to be retained. The frequency of such events should however be substantially reduced owing to improved advance traffic planning and the multi-layer planning process, as well as aids for recognising and resolving potential conflicts, and an improved knowledge of pilot flight plans.

Changes to the present roles and conduct of operations are expected for the Airport Tower controllers, where present visual procedures will be gradually replaced by the use of specific tools and sensors which will imply need for completely new procedures and principles for Tower operations.
The types of ATC organisations best suited to the future ATM system, including flexible and dynamic multi-sectors and planning, will be selected to best suit the traffic patterns and the provision of safe services, while matching the human factor requirements. Several options are possible. These are not necessarily mutually exclusive and are the subject of ongoing investigation.

4.5.2 Flight Information Service

The objective of the Flight Information Service is and will be to provide advice and information for the safe and efficient conduct of flights. This service will be complemented by a trajectory monitoring service to maintain situational awareness in the event that an aircraft should require assistance from the ground during autonomous operations. Flight Information Service will be provided within Managed Airspace, and available within Unmanaged Airspace upon request.

4.5.3 Alerting Service

The current purpose of the Alerting Service - to notify appropriate organisations regarding aircraft in need of search and rescue support and assistance - will remain largely as it is today, but will benefit from the availability of more timely and integrated information and its improved means, of delivery.

4.5.4 Evolution of Roles and Responsibilities

4.5.4.1 The Role of the Pilot

Although not an integral part of Air Traffic Control Services, the role of the pilot is intrinsically linked to that of the ground controller and is therefore included in this section.

There is a general requirement for flight crews to be more aware of the surrounding traffic situation and environment. Air-ground integration also calls for the evolution of both the air and ground ATC elements and flight operations to be developed in harmony and collaboration. In particular, the HMI will need to provide compatible air and ground representations of trajectories and the data determining the traffic situation. Consequently the role of the pilot will evolve as a consequence of the:

- increasing role of the AOC in real-time fleet management and flight programme handling; in particular for hub operations and the determination of user-preferred trajectories;

- the potential for the delegation of responsibility for separation and trajectory management to the flight-crew in autonomous operations and other specified circumstances (e.g. station keeping) will introduce new factors in aircrew-to-aircrew relationships. This will need careful consideration to determine the conditions under which this responsibility could be exercised (pilot workload).

4.5.4.2 The Role of the Controller

The roles and responsibilities of Controllers have evolved from knowing the last reported position of the aircraft (Procedural) to knowing, with the advent of radar, its current position (Radar Control). This evolution generated new responsibilities for controllers related to directing air traffic and, in some specific cases, moved the responsibility for navigating the aircraft and maintaining separation from the pilot to the controller.

At present many controllers handle tasks linearly, (i.e. one at a time, and very quickly.) This is more skill or rule-based, and accounts for the very high level of service given to air traffic. With automation there is a good chance that some tasks will become more knowledge-based, requiring thinking and interpretation time.

It should be recognised that some of these skills that will become redundant through the introduction of automation are traditionally cherished skills, whilst some of the new skills may not be so highly regarded.

It is essential, therefore, that in the event of a system failure during peak traffic loads, where the capacity level is only possible through the use of automation, that the failure mode of the system must be capable of managing the capacity until such times as traffic loads are reduced to a level where manual control is possible. In order to retain the traditional controller skills to recover the traffic situation after system failure, the use of simulator training for controllers needs to be increased especially in the area of simulating system failure modes.
One of the major contributions of automation will be the possibility of accurately anticipating the future position of aircraft. This new possibility is seen as an important issue that will contribute to generating capacity and providing flexibility.

Additionally, the use of data link will also contribute to alter the means and substance of pilot/controller communications. Controllers will also have to adapt the mental models that drive their actions, as airspace restructuring progresses. Technological advancements will enable different hardware and software capabilities in the air and on the ground which all together will have new implications on the roles and responsibilities of the ATM staff. The team performance between Controllers, those supporting the Controllers, Pilots and other personnel like system designers and system operators will become essential for safety, efficiency and capacity.

4.6 Airport Operations

4.6.1 Operating Principles

Airport operations describe airport functionality within the ATM system in terms of such factors as information sharing, air-side facility access and utilisation, demand on airspace and limits on usability. There will be a dependency on landside operations where improvements will be needed to optimise airport airside capacity.

Airport operations will be considered from a gate-to-gate perspective in determining their role within the ATM system and thus include the turn-round phase of flight (the “Ground-Centric” approach).

Airport operations objectives include the following:

- Runway occupancy time will be reduced by the ability to enter and exit the runway at any designated location\(^\text{17}\);  
- The ability to maintain air-side capacity in all weather conditions without compromising safety;  
- Any activities that take place on the movement area will be considered as having a direct influence on ATM;  
- The position (to an appropriate level of accuracy) and intent of all vehicles and aircraft operating on the movement area will be known and available to the appropriate members of the ATM community.

\(^{17}\) Entering the runway for departing traffic at any point other than where the full runway length is available, will only be permitted when the runway criteria (i.e. Accelerate Stop Distance Available (ASDA), Take Off Run Available (TORA) and Take Off Distance Available (TODA)) are available from the authorised point of take off.
Landside activities are not directly related to the ATM system but have an impact on airport operations. These activities include, inter alia, airport access, customs, security, baggage handling, fuel supply, etc. and will be optimised through a pro-active collaborative process.

Improved planning procedures and early and continuous dialogue between the Airport Operators and ATC (airport and en-route) and ATFM stemming from enhanced Information Management and more integrated systems will help to ensure that resources at capacity constrained airports are used more efficiently. Longer-term planning processes will seek to balance Aircraft Operator schedules and forecast airport capacity. Timely and shared information on real-time events will enable faster and more informed decision making on how to fill potential gaps in take-off and landing slots, and allow traffic to be adjusted to meet the new requirements.

At some major airports common coordination cells have been installed to improve the management of airport resources to respond more flexibly to user demands and changing situations.

Automated system support is presently under development in order to provide all airport stakeholders with a common situational awareness as a prerequisite for improving common resource management. These common support systems will allow the viewing of all airport resources as a whole by collecting and analysing data from all automated systems already available at airport stakeholder sites and serve as a tool for an overall Collaborative Decision Making network.

Environmental issues such as noise, gaseous emissions and architectural aesthetics will be considered in the design, development and operation of airports. Restrictions on airside operations may occur due to environmental constraints and public concerns.

4.6.2 Challenges to Capacity

Arriving at an acceptable common solution for airports is currently difficult because each airport is physically different, the sophistication of airport systems is not consistent, landside infrastructure varies, and each airport operates under different environmental, commercial, political and weather conditions. Additionally, the organisation and division of responsibilities can be significantly different, causing different operational priorities at different airports. For these reasons, airports has been considered as separate entities in the past. However, in the future system, airports have to be seen as an integral part of ATM and as nodes of the air transport system, for which a common assessment of airside capacity is required.

The future ATM System will ensure that en-route ATC is not a constraint on future air transport growth. On the other hand, not all airports will be able to cope with the increase in demand. Therefore, best practice for maximising the airport capacity must be used in a systematic way across Europe. Failure to do so will result in the potential negation of capacity gains in the en route sector.

A particular challenge will be to match capacity in low-visibility conditions to that in good weather conditions at all major airports in Europe. The down linking of Flight Parameters to the ATM System, plus automated ground support tools, will allow for the dynamic spacing and sequencing of arriving and departing aircraft thereby minimising wake vortex constraints on runway capacity. In addition, the application of reduced vortex separation minima in certain defined conditions will increase the runway throughput. Measures, such as enhanced and synthetic vision systems, both in the cockpit and in the Tower, supported by new concepts and procedures based on emerging technology will be applied.

A pro-active collaborative process between the States, airspace users, airport operating authorities, service providers and manufacturing industry will be the rule. Improved planning procedures and early and continuous dialogue between the Airport Operators and ATC (airport and en-route) and ATFCM stemming from enhanced Information Management and more integrated systems will help to ensure that resources at capacity constrained airports are used more efficiently. Longer-term planning processes will seek to balance aircraft operator schedules and forecast airport capacity. Timely and shared information on real-time events will enable faster and more informed decision making on how to fill potential gaps in take-off and landing slots, and allow traffic to be adjusted to meet the new requirements.

4.7 Airspace Users Operations

Aircraft operations are concerned with the airspace users operations and from the concept perspective refer to the ATM-related aspect of flight operations. Key conceptual considerations are:

- Accommodation of mixed capabilities aircraft with implementation needs to be addressed in order to enhance safety and efficiency;
Relevant ATM data fused for an airspace user’s general, tactical and strategic situational awareness and conflict management;

Relevant airspace user operational information will be made available to the ATM System;

Individual aircraft performance, flight conditions, and available ATM resources will allow dynamically-optimised 4-D trajectory planning;

Collaborative decision-making will ensure that the impact of aircraft and airspace user system design on ATM are taken into account in a timely manner; and

Aircraft should be designed taking into consideration the ATM system.

Whether a flight can be performed - in operational and technical terms - depends on a number of factors: the flight environment, wind, weather at destination and en-route, navigation aids and equipment, airport facilities, the aircraft technical condition and performance, fuel uplift needs and more. The Airline Operations Centre (AOC) co-ordinates all these variables to ensure that flight operation is conducted as safely and economically as possible. Airline Operations Centres in liaison with the Flight Crews exercise Operational Control, Flight Planning, and In-flight Assistance.

Within the time frame of the OCD it is expected that Airline Operations Centres will become more proactive in their contribution, through System-Wide Information Management and Collaborative Decision Making, in the overall efficiency of ATM. It is assumed that military agencies and General Aviation will have an equivalent set-up to an airline’s Airline Operations Centres. Indeed, it could be foreseen within the context of System-Wide Information Management and Collaborative Decision Making those airlines, and perhaps other airspace users, without a dedicated Airline Operations Centres could collaborate in a co-operative Airline Operations Centres. In Europe, Airline Operations Centres also participate in slot co-ordination.

In general terms an Airline Operations Centre is responsible for the management of day to day flight operations;

- Evaluating meteorological information to determine potential hazards to management of flight and to select the most desirable and economic route of flight; computing the amount of fuel required for the safe completion of flight according to type of aircraft, distance of flight, maintenance limitations, weather conditions and minimum fuel requirements prescribed;
- Preparing flight plans containing information such as maximum allowable takeoff and landing weights, weather reports, field conditions, NOTAMS and other information and components required for the management of flight;
- Delaying or cancelling flights if certain conditions can be considered to threaten the safe management of aircraft;
- Monitoring weather conditions, aircraft position reports, and aeronautical navigation charts to evaluate the progress of flight;
- Updating the flight crews of significant changes to weather or flight plan and recommending flight plan alternates, such as changing course, altitude and, if required, en-route landings in the interest of safety and economy;
- Originating and disseminating flight information to others as appropriate. This can be the source of information provided to the travelling public.

4.8 Information Management and Services

The progression towards a harmonised and integrated European ATM system requires the implementation of a concept of operation based on the most effective interaction between Airspace Management (ASM), Air Traffic Flow Management (ATFM), and Air Traffic Services (ATS) with the objective of achieving:

- A coherent and efficient airspace structure;
- A pro-active management of sectorisation and military areas;
- Flexibility in their route selection for aircraft operators;

The outcome will be a higher level of capacity and efficiency while enhancing safety.
Integral to such a flexible system is the need for full information on airspace availability status and user trajectory preferences. These will require enhanced flight data processing systems encompassing Strategic, Pre-Tactical and Tactical operations in support of a move towards a more integrated collaborative decision making process.

Although a process, Collaborative Decision Making is essentially a concept that interfaces the need for active collaboration of all the actors. The goal of Collaborative Decision Making is to enable the corresponding actors to improve mutual knowledge of the forecast/current situations, of each others constraints, preferences and capabilities, so as to pro-actively resolve any areas of potential conflicts of interest, in which the actor best able to make the decision is the one who does so.

The need for a rapid access to accurate information on airspace status with sufficient advance notice will evolve, from the limitations of the current semi-manual mechanisms (fixed set of messages) for the dissemination of information updates, into a fully integrated data pool (open system updated in real time and accessible to all stakeholders) to support effective dynamic management of airspace and flight operations.

Access to this common airspace data pool, will be available to all ATM actors through System-Wide Information Management who will benefit from a standard source of consolidated, consistent and up-to-date information for the automatic processing of the same digital airspace information. It will ensure that all ATM actors have a better understanding of the impact of their decisions.

The aim of System-Wide Information Management is to combine the forces of all suppliers of ATM information so as to assemble the best possible integrated picture of the past, present and (planned) future state of the ATM situation, as a basis for improved decision making by all ATM stakeholders, including the military, during their strategic, pre-tactical and tactical planning processes, as well as real-time operations and post-flight activities.

Successfully managing the quality, integrity and accessibility of the complex, growing web of distributed, fast-changing, shared ATM information, is the main operational enabler for the target concept. System-Wide Information Management, in turn, depends on a number of technical enablers, one of them being an adequate CNS infrastructure.

System-Wide Information Management will ensure the delivery of timely and accurate data to support the flexible management of airspace, capacity management and to initiate the optimisation of user preferred trajectories. The system will be accessible by all stakeholders, provide full airspace information to users and will be updated in real time by civil and military organisations.

Information about the past, present and future status of airspace including information on routes, associated scenarios as well as sectors and area relationships will no longer be kept as separate inconsistent pieces of information, but rather as different data elements of the same logical set of information which could be operated from different systems nodes, as convenient. The management of data will be the responsibility of the appropriate level of Airspace Management depending on their responsibility for the maintenance of the information in regard to the dynamism required for its use.
Such method of notification and dissemination of ATM status in good time and continuously available to all will provide a very accurate visibility of the gate-to-gate operation. It will enable a new relationship among all ATM partners in which each one has the possibility to assume its own role while identifying existing shortcomings of the system and initiating own mitigation at own discretion with full visibility to all other elements of the ATM System.

Airspace users will be able to better exploit available CNS technologies and cost-effective application of potential new technology; to be able of making best use of their capabilities for the selection of preferred trajectory in total knowledge of accurate and up-to-date information on the airspace environment with minimum constraints. They will benefit from enhanced Flexible Use of Airspace (FUA) Concept by taking advantage of the more dynamic and pro-active airspace management processes through the inter-operability between civil and military systems for the sharing of information.

Air Navigation Service Providers will be able to provide a flexible ATM network to meet the increased demand while improving safety levels. They will be globally inter-operable, and operate to uniform principles and provide more integrated and collaborative ATM concepts that can fully exploit aircraft capabilities and provide the scope to offer airspace users greater flexibility.

4.8.1 Flight Planning

ATM currently relies on the timely availability data on the progress of flights and aircraft intentions. The ICAO Flight Plan is today the basic source for such data, which is essential for planning and a vital link for the determination of the conduct and progress of flights. The amount and detail of specific data which ATS currently needs to obtain from Flight Plan is dependent on the corresponding performed functions, additionally flight plan data is essential for Air Traffic Flow and Capacity Management.

The Flight Plan represents the requirement of the airspace user to operate a flight from take-off to landing and is a draft contract that becomes an actual one at the moment of acceptance (including the tacit one). It contains information regarding the requested flight profile, aircraft capabilities, complementary information of the nature of the flight and supplementary information necessary in case of emergency. Through time the Flight Plan data and associated messages are also being used by ATM support services and other services (e.g. statistics, route charges etc). These several and
diverse expectations from the same information generate on it an unsolved complex set of conflicts of interests that keeps all users in a situation of accepting continuous compromising unsatisfactory data.

Additionally, in order to reduce the number of Flight Plan messages for frequently recurring pre-planned Flights with identical characteristics for a certain period of time Aircraft Operators can submit Repetitive Flight Plans (RPL).

In order to satisfy the gate-to-gate, collaborative decision-making and network management concepts, more precise information about the flight, including trajectory data, needs to be shared between stakeholder systems. This goes beyond the limitations of the current ICAO Flight Plan, to include information about trajectories, actual take-off times, etc. Technical advances in networking and database servers will be the essential enablers of the new flight data sharing environment.

Aircraft operators and pilots in general are the originators of Flight Plans and in some cases in order to respond to commercial orientations, weather constraints or heavy traffic demand, need to amend Flight Plans at the last minute. Conversely, the ATM system may have cause to change the Flight Plan during flight to manage unplanned ATM constraints. These events, in the majority of the cases, have a network impact on the ATS and Air Traffic Flow and Capacity Management planning. Thus, the dynamics of the flight planning regime may result in situations where data concerning an individual flight may be modified several times in stakeholder systems. The new information sharing environment will ensure that such modifications are consistently made available to all stakeholder systems which need it. There should always be only one reference set of flight data for a specific flight, accessible to all eligible stakeholders.

4.8.2 Flight Data Management

The challenge is, therefore, to either replace or to adapt the present Flight Plan system to one which is dynamically adaptable, consistent in quality, verifiable in real-time, and meets interoperability standards for the transfer of flight data within the European ATM community.

The goal of an evolved Flight Planning system will be to meet the following objectives:

- provide specified information to Air Traffic Services units, related to an intended flight or portions of a flight of an aircraft as specified by ICAO;
- contribute towards the production of the Operations Plan throughout the Air Traffic Flow and Capacity Management process;
- universal access to common flight data including the profile of the flight through interaction and Collaborative Decision Making between Airspace Users and Air Traffic Flow and Capacity Management 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 Air Traffic Flow and Capacity Management to assist the airspace user to optimise the flight planning;
- when any event is seen to require modification to the ATM Operations Plan, the effects of this change will be investigated collaboratively, and solutions agreed;
- 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.

The objectives will be met through a common pool for the exchange and dissemination of up-to-date and verifiable data between Airspace Users and ATM providers, (i.e. a System-Wide Information Management Environment (SWIM))... Depending on the need, data can be retrieved on demand or delivered automatically to stakeholders.

This entails more than just establishing a suitable CNS infrastructure or making systems interoperable. Without advanced Information Management at the overall system level, the present lack of ATM integration will be perpetuated.

Introduction of System-Wide Information Management principles and mechanisms will provide the capabilities that will ensure the common, up-to-date shared view of all relevant ATM information (the ATM pool) is maintained in a distributed stakeholder environment, in accordance with defined scope, quality and integrity requirements.
4.8.3 Meteorological Information Services

High quality meteorological information is a pre-requisite for a safe and efficient ATM. The function of meteorological services will be to provide aviation weather information for all ATM operations. Sources of meteorological information range from space-based, ground-based and airborne sensors. Automated meteorological measurements provided by airborne sensors will represent a significant source of data. This information will provide timely notification of weather conditions that can be deemed pertinent to air and ground operations. The meteorological community will remain the backbone for the provision of meteorological products to the aviation community.

Hazardous conditions created by convective weather are a major driver behind the development of many components of the aviation weather system. For flight operations in the terminal area, including airports, the main threats posed by convective storms include microbursts and accompanying low-level wind shear, severe turbulence, lightning, and dangerous levels of precipitation (extremely heavy rain, large hail). In the en route environment, convective storms can create regions of severe turbulence, not only in the storm complexes themselves, but also tens of miles downstream from the anvil region of the storm in the clear air. The term convective weather covers a wide range of possible storm environments, which range from mesoalpha scale, single-cell, air mass-type thunderstorms to synoptic scale lines of convective storms extending along the leading edge of a cold front, dry line, or other region of low-level convergence. Convective storms seriously disrupt ATC operations, especially in the TMA and airport environments. The major constraints created by convective storms are delays, diversions, and cancellations when airport operations are curtailed. Accurately forecasting the onset and dissipation of convective weather is a major challenge facing the meteorological community.

Improved accuracy and timeliness of meteorological information will optimise flight trajectory prediction, thus improving efficiency of ATM and aircraft operations. Textual as well as graphical weather information will be up-linked via datalink to the aircraft. The data will be integrated with other information in the cockpit and complement the data coming from on-board weather sensors. On the ground (Airline Operations Centres, ATFCM, ATC, airports), the improved availability and delivery of accurate weather data and forecasts will permit ATM system to provide more precise information to flight crews and lead to more optimised decision making by the users.
### Definitions

<table>
<thead>
<tr>
<th>Definition</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>Actor</td>
<td>An actor is anything with behaviour. It might be a person, an organisation, a computer system.</td>
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<tr>
<td>Aerodrome</td>
<td>A defined area on land or water (including buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft. (ICAO)</td>
</tr>
<tr>
<td>Airport Capacity:</td>
<td>The “Declared Capacity” of an Airport is the maximum number of runway movements per unit of time. However, although Declared Capacity may be considered in a strategic sense for planning purposes, this value may shift according to the tactical element of airside operations such as the usage pattern dictated by hub and–spoke operations.</td>
</tr>
<tr>
<td>Air-side</td>
<td>That part of the Aerodrome outside of the terminal buildings set aside for the operation of aircraft.</td>
</tr>
<tr>
<td>Airspace Management Cell</td>
<td>An AMC collects airspace requests, negotiate and resolve conflicting requirements, allocate airspace portions and disseminates airspace allocation information.</td>
</tr>
<tr>
<td>Airspace User</td>
<td>Any authority, organisation or individual that requires access to airspace. It may involve aircraft operations, military requirements (e.g. artillery rangers) and environmental protection (e.g. the protection of national heritage sites, bird sanctuaries)</td>
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<tr>
<td>Area Navigation (RNAV)</td>
<td>A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of both. (ICAO)</td>
</tr>
<tr>
<td>ATM</td>
<td>Defined by ICAO as: &quot;The aggregation of the airborne functions and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations.&quot;</td>
</tr>
<tr>
<td>ATM System</td>
<td>A system that provides ATM through the collaborative integration of humans, information, technology, facilities and services, supported by air, ground and/or space-based communications, navigation and surveillance. (ATMCP)</td>
</tr>
<tr>
<td>Autonomous Operations (Autops)</td>
<td>Aircraft Operations based on airborne separation assistance (autonomous separation) and on freedom to effect trajectory changes in any direction.</td>
</tr>
<tr>
<td>Autonomous Separation</td>
<td>The rule applied when a suitably equipped aircraft allows the pilot to assume responsibility for his/her own safe separation from other aircraft.</td>
</tr>
<tr>
<td>Collaborative Decision Making</td>
<td>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.</td>
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<td>Definition</td>
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<tr>
<td>Concept of Operations</td>
<td>A detailed description of how an operational concept is applied. It identifies the functions and processes, and their corresponding interactions and information flows; concerned actors, their roles and responsibilities.</td>
</tr>
<tr>
<td>Operational Concept</td>
<td>A high-level description of a set of defined ATM components and the manner in which they are organised and operated which meet a given set of high-level user requirements.</td>
</tr>
<tr>
<td>Dynamic Resectorisation</td>
<td>Dynamic resectorisation will allow a tactical response to changing situations in traffic patterns and/or 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.</td>
</tr>
<tr>
<td>Free Routing</td>
<td>A concept of aircraft operations which gives freedom for operators to plan and fly user-preferred routing between two points.</td>
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<tr>
<td>Gate-to-Gate</td>
<td>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.</td>
</tr>
<tr>
<td>General Air Traffic (GAT)</td>
<td>All flights, which are conducted in accordance with the rules and procedures of ICAO and/or the national civil aviation regulations and legislation&quot;,(Decision of the Commission (ref. GS.2/App./PC/00-32 of 13/10/00).</td>
</tr>
<tr>
<td>Harmonised</td>
<td>Comparable levels of performance.</td>
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<tr>
<td>Information Management</td>
<td>The timely distribution of relevant, up-to-date and validated data to those who have the necessary authorisation to access it.</td>
</tr>
<tr>
<td>Integrated</td>
<td>Systems or procedures which are, or which appear to the end user to function as, a single entity.</td>
</tr>
<tr>
<td>Invariant Process</td>
<td>A function which remains unchanged when a specific transformation is required.</td>
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<tr>
<td>Land-side</td>
<td>The part of the Aerodrome other than the air-side, but may also include inter-modal links.</td>
</tr>
<tr>
<td>Nominal</td>
<td>Routine, no unexpected or unplanned events will take place.</td>
</tr>
<tr>
<td>Non-Nominal</td>
<td>Unexpected situation(s) that arise or are forecast in the short-term.</td>
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| Operational Air Traffic (OAT)| All flights which do not comply with the provisions stated for GAT and for which rules and procedures have been specified by appropriate national authorities”. OAT can be divided into OAT-compatible (OAT-C) and OAT-special(OAT-S):  
  • OAT-C is in nature like GAT, however the technical requirements of aircraft operating as GAT can not be met due to the characteristics of the military aircraft in question. Special handling by ATC is necessary, preferably by harmonised procedures across Europe.  
  • OAT-S requires special handling and the key word is the military operating principle of self-determination. OAT operations are a crucial element of military activity and they should be able to be conducted in any of the proposed airspace regimes. the missions must be separated from other traffic, and in most cases it is necessary to communicate with tactical support units. There is a need to be able to operate under VFR in EUROPEAN airspace. (Decision of the Commission (ref. GS.2/App./PC/00-32 of 13/10/00). |
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<tr>
<td>Operations Plan</td>
<td>The output of the Pre-Tactical Phase of ATM Planning in which all Stakeholders, either in this Phase and/or in the Tactical Phase, have coordinated, through a collaborative decision making process, their actions or intent. During the Tactical Phase the plan will be dynamically updated in real time in a collaborative and transparent manner.</td>
</tr>
<tr>
<td>Scenarios</td>
<td>Within the context of an operational concept scenarios are a description of how a future system should work. Each scenario describes the behaviour of users and the future system, interaction between the two, and the wider context of use. From a detailed scenario a user should be able to identify user requirements and potential business cases.</td>
</tr>
<tr>
<td>Situational Awareness</td>
<td>Involved actors will have a better understanding of the tactical ATC traffic management in progress through increased operator’s situational awareness of movements both in the air and on the ground. This understanding of the traffic by the pilot might allow him / her to adapt the manoeuvring to suit a timely and smooth flow.</td>
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<tr>
<td>Stakeholder</td>
<td>A stakeholder is someone or something that has a vested interest in a topic. For EUROCONTROL generally, the term stakeholder is used for organisations and individuals that have a vested interest in European ATM and whose support, cooperation and advice is important in ensuring that a proposed operational concept can be brought into service.</td>
</tr>
<tr>
<td>Special Use of Airspace (SUA)</td>
<td>A block of airspace of defined dimensions established on a temporary or a permanent basis for use under specified conditions.</td>
</tr>
<tr>
<td>Temporary Segregated Area</td>
<td>Airspace of defined dimensions within which activities require the reservation of airspace for the exclusive use of specific users during a determined period of time.</td>
</tr>
<tr>
<td>Traffic Synchronisation</td>
<td>Traffic synchronisation refers to the tactical establishment and maintenance of a safe, orderly and efficient flow of air traffic. Key conceptual changes:</td>
</tr>
<tr>
<td></td>
<td>• there will be dynamic 4-D trajectory control and negotiated conflict-free trajectories;</td>
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<tr>
<td></td>
<td>• chokepoints will be eliminated; and</td>
</tr>
<tr>
<td></td>
<td>• optimisation of traffic sequencing will achieve maximisation of runway throughput. (ICAO ATMCP)</td>
</tr>
<tr>
<td>Trajectory</td>
<td>The description of movement of an aircraft, both in the air and on the ground, including position, time, and at least via calculation, speed and acceleration. (ATMCP)</td>
</tr>
<tr>
<td>Unmanned Aerial Vehicle</td>
<td>Unmanned aerial vehicle (UAV). An unmanned aerial vehicle is a pilotless aircraft in the sense of Article 8 of the ICAO Convention which is flown without a pilot-in-command on board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous.</td>
</tr>
</tbody>
</table>

**Descriptions/Explanations**

**Airport:** used in the OCD in a generic sense to mean aerodromes whether large or small irrespective of the type, quantity or role of the aircraft that operate from them.

**Flexibility:** Flexibility, in the context of the target concept is (subject to aircraft and ground capabilities and periods or zones of applicability):

- Access to airspace - freedom for airspace users to flight plan and enter airspace which is not normally available on a permanent basis, or to operate to and from airfields which are not the normal base or destination, at times that suit their needs within the observation of environmental constraints;
- Variations to departure time - freedom for users to vary their departure times according to their needs;
- Free routing - freedom for users to plan a flight using any user-preferred trajectories between two points;
Accommodating differing user capabilities (equipment, aircraft performance etc.) - the ability of ATM to match the service provided to the capabilities of the user by exploiting the capabilities of aircraft with advanced avionics, while also continuing to accommodate aircraft with less capable avionics fits;

Changing flight intentions - freedom for users to request or select a change of trajectory (route, routing, vertical profile, speed) in flight;

Autonomous operations - freedom for users to exercise the responsibility of separation from other traffic or hazards and to effect trajectory changes in any direction.

**Ground-centric**: Described in the EUROCONTROL Airport Operations Strategy as the “Ground Centric” approach in which arrival, surface movement and departure operations and automated supporting automated systems are integrated to effect the “on-time” turn-round phase of flight.

### Phases of Flight

<table>
<thead>
<tr>
<th>Gate to Gate Phases of Flight</th>
<th>Definition</th>
<th>Related Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic Flow &amp; Capacity Planning</strong></td>
<td>This Phase will aim to make a long term forecast of the demand and the availability of ATM and Airport resources.</td>
<td>Understanding the context</td>
</tr>
</tbody>
</table>
| **Optimised Capacity Management** | This Phase will aim at refining the forecast, as better demand information and user capability data become available, to refine the details over time in terms of the following objectives:  
  • Resource allocations;  
  • Projected trajectories;  
  • Airspace organisation;  
  • Allocation of entry/exit times for airports and airspace volumes to mitigate any imbalance | Context refinement |
| **Tactical Flow & Capacity Management** | This Phase will consist of considering real-time events and applying any refinements needed to the Plan in order to restore ATFCM stability. | Dynamic Operations Plan follow up |
| **Pre-Departure Phase** | All actions and communications from crew to off-blocks. | |
| **Departure Taxi** | Moving a/c from ramp to runway departure queue for launching in the airspace. | From off-blocks to engine start-up to commencement of take-off run |
| **Departure** | Dispersion, which objective is to synchronise the climb of a/c through the terminal airspace into the en-route structure. | From start off take-off run until the time of leaving terminal airspace |
| **En-Route** | Cruise in which a/c is at altitude and moving towards its destination, but still not executing actions related to its arrival phase. | The time between leaving terminal airspace and the top of descent |
| **Arrival** | Collection, the state in which a/c are sequenced and spaced into terminal airspace, assignment of runway and completion of arrival. | From top-of-descent to vacation of the runway |
| **Arrival Taxi** | Moving a/c off the runway, to the ramp and to gate. | From runway vacation to on-blocks |
| **Post-Flight Phase** | Processes terminating the flight operations after on-blocks. | Include charging for ATM services |