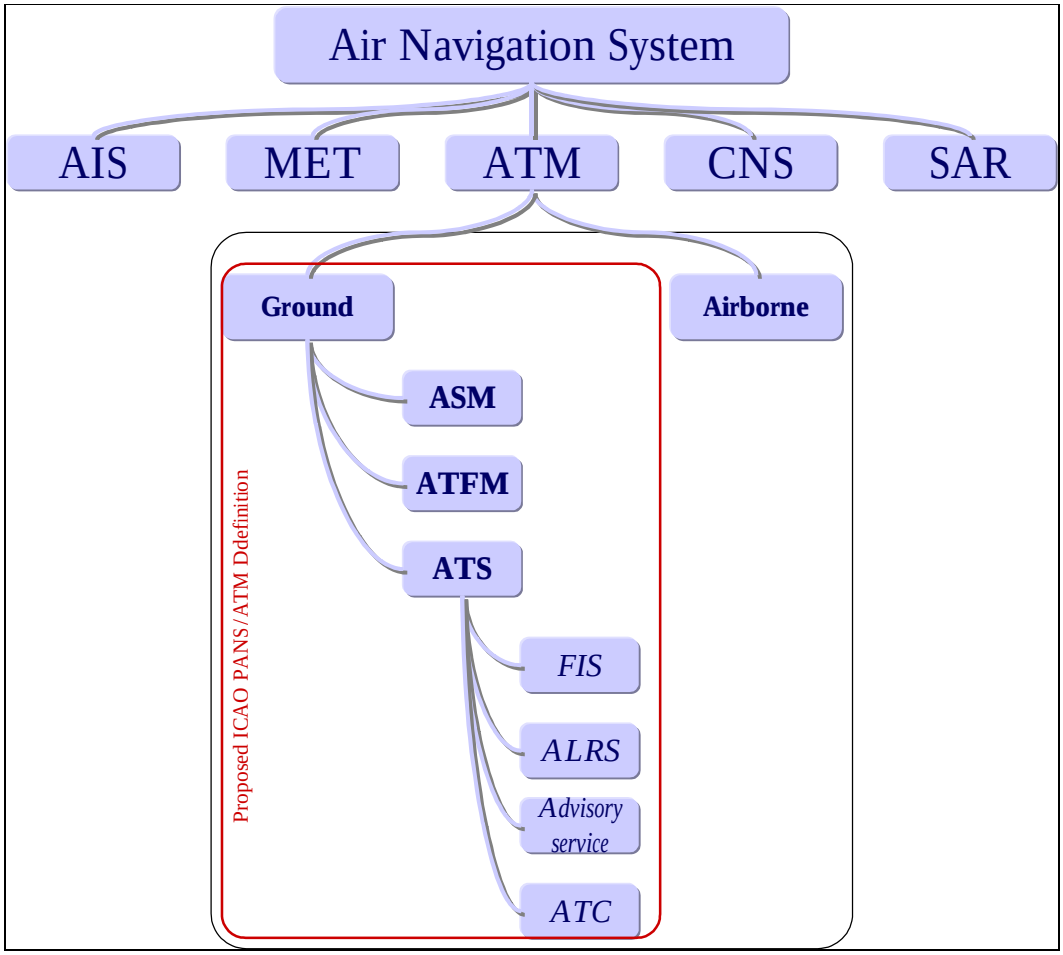
ENCLOSURE 5

5. Air Traffic Management

5.1 Current situation in ATM

ATM is seen as the sum of Air Traffic Services (ATS), Air Traffic Flow Management (ATFM) and Airspace Management (ASM). This can be summarised within the following diagram



ATM issues with respect to military OAT operations are expected to be considered by the relevant military authorities on an as required basis. The interactions of eventual military UAV operations, outside reserved airspace, with civil ATM would be addressed as a function of such military concept for military UAV operations.

ATM provisions for civil UAVs already exist in the context of ASM. Where civil UAVs are being contemplated for domestic operations outside reserved airspace, this could only be undertaken within the frame of a national ATM regulatory framework. For international civil UAV operations outside reserved airspace, such ATM regulatory framework would require ICAO compliance, for which no possibility currently exists. Development of ATM regulations specific to civil UAVs, beyond those already existing, can only be expected on the basis of clear operational airspace

requirements, stemming from civil/commercial UAV users, clearly indicating where existing ATM regulations cannot meet such airspace requirements

5.2 Summary of ATM related issues identified within working groups (WG 1, WG 2 and WG 3)

5.2.1 Issues under General, Safety and Security (WG1)

5.2.1.1 System overview

Any future regulatory approach of UAVs within the ATM system must be seen within the perspective of a total system approach (people, equipment and procedures) for both airborne and ground components.

For the ATM system transparency must be one of the principles governing any regulatory approach.

ESARRs provide a basis for any future development of the UAV regulations together with ICAO SARPs. Should new procedures be developed to ensure the integration of the UAVs within the airspace this must be undertaken within the appropriate fora.

5.2.1.2 Safety

For the time being, EUROCONTROL Safety Regulation Commission has developed ATM high level safety regulatory requirements, objective based, that are used by ECAC States within their regulatory processes. The EUROCONTROL Safety Regulatory Requirements available as release issue are:

- ESARR 2 – Reporting and Assessment of Safety Occurrences in ATM;
- ESARR 3 – Use of Safety Management Systems by ATM Service Providers;
- ESARR 4 – Risk Assessment and Mitigation in ATM;
- ESARR 5 – ATM Services' Personnel;

ESARR 1 (National ATM Safety Regulatory Framework and ESARR 6 (Software in ATM) are still to be approved by the Permanent Commission of EUROCONTROL.

All ESARRs are linked between them as described below:

- ESARR 3 (Use of Safety Management Systems by ATM Service Providers) requires that safety management systems shall be implemented for the ATM service providers, including risk assessment and mitigation to ensure that changes to the ATM system are assessed for their significance and all ATM system functions are classified according with their severity. It also requires the assurance of appropriate mitigation of risks where assessment has shown this to be necessary due to the significance of the change.

- ESARR 4 (Risk Assessment and Mitigation in ATM) expands ESARR 3 requirements on Risk Assessment and Mitigation, and provides for a comprehensive process to address people, procedures and equipment (software and hardware), their interactions and their interactions with other parts of the ATM system when introducing and/or planning changes to the ATM System.

- ESARR 5 (ATM Services' Personnel) expands ESARR 3 requirement on Competency and provides for detailed list of requirements to be implemented by the Designated Authority, ATS Providers/Operating Organisations and Individuals.

The diagram (Fig 1) is provided to illustrate clearly the links between all ESARRs.

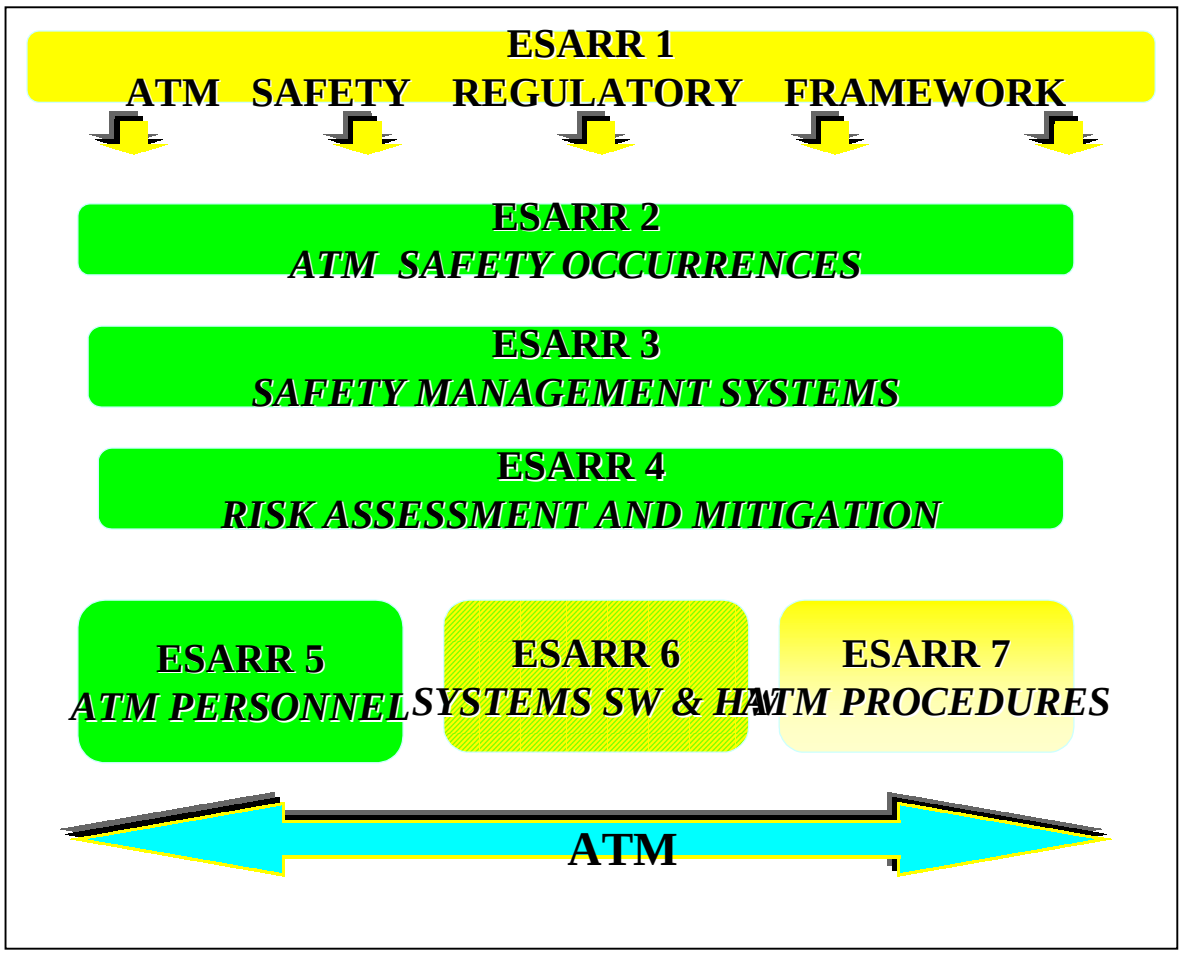


Fig 1

5.2.1.3 Terminology

It is of great importance for the whole work within this document to have a common terminology. Therefore the Terminology and Definitions proposed within the core report try to establish common grounds for further developments within the area of UAVs, despite the differences encountered within Enclosures 2, 3 and 4.

5.2.1.4 Principles

The set principles within this document enable a consistent approach within the whole document and should be used also for the ATM section. However, there are two principles that have to be looked carefully: Equivalence and Legal responsibility.

For today ATM environment the risk matrix proposed within ESARR 4 is still under development due to the lack of reliable and consistent safety data. The proposed

target level of safety for accidents within ESARR 4 cannot be extended simply to the UAVs for two reasons:

- the matrix addresses only the manned aircraft and operations to be performed by them

- there is not available a history of UAVs accident/incident (or generic occurrences) in order to be able to build a quantitative or qualitative risk matrix

Therefore, is difficult to build safety objectives and safety requirements to address the interaction with the ATM system. The generic ones proposed within the Terms of Reference of this Task Force cannot be considered enough to address the ATM environment and specialist work should be carried out to determine those objectives and requirements within the next future.

Equivalent operations can be addressed from an ATM perspective only when this is totally similar to the operations carried out by manned aircraft. However, it has been recognised that special procedures may address areas like SENSE and AVOID (within the manned aircraft is known as SEE and AVOID), special communications procedures, liability in terms of cross-border flights, etc.

Equivalent compliance shows that the rules under which UAV flights will be operated in future should be the same as for manned aircraft. It has to be demonstrated that UAV will comply with the flight rule for manned aircraft otherwise this will require modification to the existing Flight Planning procedures and to the Rules of the Air, for the sake of but one category of airspace user.

Legal responsibility has been identified as one key sensitive area to be scrutinised due the article 8 of the Chicago Convention addressing the Pilotless Aircraft. There is the need to establish separation when flight are undertaken under certain flight rules (VFR or IFR) and also to have the necessary equipment to protect themselves in certain categories of airspace based on the air traffic service offered. For reference, Appendix 4 – ATS Airspace Classes – Services provided and flight requirements from ICAO Annex 11 are inserted in Figure 2.

A clear definition of what will have to be considered under SENSE and AVOID should bring the necessary safety requirements in place that address the responsibility in the same manner as for manned aircraft: where the pilot-in-command is ultimately responsible for safely conducted operations.

Class	Type of flight	Separation provided	Service provided	Speed limitation*	Radio communication requirement	Subject to an ATC clearance
A	IFR only	All aircraft	Air traffic control service	Not applicable	Continuous two-way	Yes
B	IFR	All aircraft	Air traffic control service	Not applicable	Continuous two-way	Yes
	VFR	All aircraft	Air traffic control service	Not applicable	Continuous two-way	Yes
C	IFR	IFR from IFR IFR from VFR	Air traffic control service	Not applicable	Continuous two-way	Yes
	VFR	VFR from IFR	1) Air traffic control service for separation from IFR; 2) VFR/VFR traffic information (and traffic avoidance advice on request)	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
D	IFR	IFR from IFR	Air traffic control service, traffic information about VFR flights (and traffic avoidance advice on request)	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
	VFR	Nil	IFR/VFR and VFR/VFR traffic information (and traffic avoidance advice on request)	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
E	IFR	IFR from IFR	Air traffic control service and, as far as practical, traffic information about VFR flights	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
	VFR	Nil	Traffic information as far as practical	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No
F	IFR	IFR from IFR as far as practical	Air traffic advisory service; flight information service	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	No
	VFR	Nil	Flight information service	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No
G	IFR	Nil	Flight information service	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	No
	VFR	Nil	Flight information service	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No

* When the height of the transition altitude is lower than 3 050 m (10 000 ft) AMSL, FL 100 should be used in lieu of 10 000 ft.

Fig 2

5.2.1.5 Security

ICAO Annex 17 defines the aims and objectives for the security, as follows:

"2.1 Aims and objectives
2.1.1 The aim of aviation security shall be to safeguard international civil aviation operations against acts of unlawful interference.

2.1.2 Safety of passengers, crew, ground personnel and the general public shall be the primary objective of each Contracting State in all matters related to safeguarding against acts of unlawful interference with international civil aviation.

2.1.3 Each Contracting State shall establish an organisation, develop plans and implement procedures, which together provide a standardised level of security for the operation of international flights in normal operating conditions and which are capable of rapid expansion to meet any increased security threat."

The principles laid down previously apply to the manned aircraft and based on the transparency equivalence should apply to the UAVs system. Also, the ATM has been included within the aim and objectives of ICAO Annex 17 and as such the provisions within there should be completed by new identified risks to the security of the UAV system and its interface with the ATM system.

Organisation of security at national level taking into consideration international co-operation should be achieved according to the provision within ICAO Annex 17. Having said this, it is difficult to establish the responsible body or bodies when the operation of the UAV is within one State and the command of the UAV in another State. Bilateral or even regional agreements should have to be considered between States engaging UAV operations in order to secure the safe operations and the security of the systems involved in such operations.

5.2.2 Issues under Licensing of ATCOs (WG3)

Under the licensing of air traffic controllers a need for increased awareness of operational personnel about the UAV developments and mainly operations outside restricted airspace shall be achieved by all means possible. One means to achieve this goal is through the initial for the new air traffic controllers and through the continuation training for the air traffic controllers who maintain their competencies within the unit competence scheme. Therefore, the need to insert additional training objectives to cover the topic of UAV has to be performed at the same time the development for the UAV operations outside restricted airspace will be put in place.

5.3 AIRSPACE and CNS STRATEGIES

All strategies that will be included within this enclosure raise additional issues that will have to be considered by the airspace users of the UAV technology and will influence the equipment on board.
The transparency guiding principle states that

> **"The provision of an Air Traffic Service (ATS) to a UAV must be transparent to the Air Traffic Control (ATC) controller and other airspace users."**

and as such the level of equipage for UAV could vary taking into account the development within the airspace, communications, navigation and surveillance areas and according to the flight rules the UAV will fly.

The sections below illustrate what are the development envisaged under each area and sometimes what are the requirements that have to be fulfilled by different airspace users.

5.3.1 AIRSPACE DEVELOPMENTS FROM THE EUROCONTROL AIRSPACE STARTEGY FOR THE ECAC STATES

The increased demand for airspace usage from all airspace user groups (denote ALL users of airspace, including, military air, sea and ground forces, airlines, General Aviation, Aerial Work and Sports Aviation) is expected to continue. Current forecasts show a more than doubling of commercial air transport flights throughout Europe by

2015 based on 1995 traffic levels. The existing ATM Systems in Europe are unlikely to cope with such a demand. In consequence, a comprehensive, 'gate-to-gate' oriented ATM Strategy for the years 2000+ has been developed as a follow-up to the En-Route and Airport Strategies for the 1990s.

One of the main areas for change highlighted in the ATM 2000+ Strategy concerns the organisation and use of airspace. A major obstacle to producing more en-route capacity is that effective use of European airspace has not been optimised to date.

Present European airspace structures are complex and disparate, and the development of a EUROCONTROL Airspace Strategy for the ECAC States for the millennium will provide an opportunity for simplification and harmonisation. Future national ATM strategies cannot realistically be developed in isolation, as each Individual State is an integral element of the European ATM system.

The requirements of the users and ATM providers were the main drivers in the development of the Strategy. The main objective of the Strategy is to deliver a set of strategic objectives and actions necessary to provide a harmonised framework for airspace planning for the entire ECAC airspace up to 2015 and beyond. The Strategy will seek to describe a simplified airspace organisation based on new or adapted airspace structures which permit their uniform application and leading to an optimised and harmonised organisation throughout Europe.

The proposed evolution of the ECAC airspace organisation follows closely the strategic principles and objectives of the ATM 2000+ Strategy and is in line with the ICAO Global Air Navigation Plan for CNS/ATM systems.

The main strategic actions described in the Airspace Strategy are aimed at:

- developing new or adapted airspace structures to better respond to users' needs for the provision of ATM services;
- establishing an ECAC Airspace Guidance Document for a common airspace design and change process;
- achieving uniform application of airspace structures and classification throughout Europe;
- promoting the fully flexible use of airspace, not constrained by national boundaries;
- extending freedom of movement for all airspace users;
- pursuing current airspace-related developments and introducing new initiatives.

The Airspace Strategy considers directions for change already addressed in the Target ATM Operational Concept (OCD) and ATM 2000+ Strategy and in particular the future role of the proposed OCD airspace model in a global ATM environment based on the three airspace regimes: Unmanaged Airspace (UMAS), Managed Airspace (MAS) and Free Flight Airspace (FFAS).

However, it is considered that a new airspace organisation based upon knowledge of traffic will better meet the expressed requirements of the airspace users and ATM providers. A new "Traffic Environment Model" is therefore proposed for adoption throughout Europe with the aim of providing a harmonised and simplified airspace organisation using three different airspace categories which will be gradually reduced to two. In addition, it enables the establishment of common rules and procedures for the different environments.

Adoption of this model will also facilitate dynamic adaptation of ATS services in response to the traffic evolution. It is initially based upon the current ICAO ATS Airspace Classification.

In accordance with the Strategic Objectives for developing new or adapted airspace structures permitting their uniform application and leading to an optimised airspace structure organisation, the following "Traffic Environment Model" is proposed for adoption throughout Europe. This Model describes the overall airspace organisation, as simply as possible, from the users' perception. In addition, it enables the establishment of common rules and procedures for airspace users and the service providers which have to accommodate legitimate access to the different environments.

TRAFFIC ENVIRONMENT MODEL

A model of the airspace organisation which refers to three categories of environment in accordance with the ATS level of knowledge of traffic operating within them:

U **Unknown Traffic Environment** is an environment within which not all traffic is known to ATS.

K **Known Traffic Environment** is an environment within which all traffic is known to ATS either with position only or with flight intentions[1] as well.

N **iNtended Traffic Environment** is an environment within which all traffic is known to ATS, both with position and with flight intentions.

In order to provide ATS with the required knowledge of traffic for the corresponding environment, the following elements will be requested (airspace requirements):

Unknown Traffic Environment:

– Continuous two-way communication not always required;
– Transponder not always required;
– Traffic not always subject to ATC clearance.

Known Traffic Environment:

– Continuous two-way communication may be required;
– Transponder always required[9];
– Not all traffic subject to ATC clearance.

iNtended Traffic Environment:

– Continuous two-way communication always required;
– Transponder always required[9];
– All traffic subject to ATC clearance.

[1] up-to-date flight data related to intended flight path.

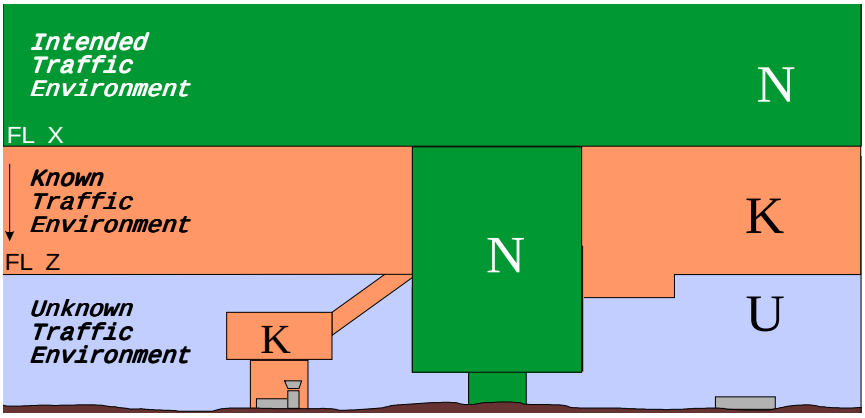
Adoption of such a new airspace organisation based on knowledge of traffic will no longer require the differentiation between controlled airspace and outside controlled airspace. The type of ATS service provided will then be announced in another way than through the type of airspace itself, e.g. through adequate communications procedures. This will also allow the required ATS service to be provided in response to the traffic evolution without the need to change the airspace status accordingly.

Controlled Airspace	**NO LONGER REQUIRED**[10]
Outside Controlled Airspace	

In a similar way, a phased evolution of ICAO ATS classification towards the Traffic Environment Model can be anticipated as again the type of ATS service provided may no longer be a criterion for differentiating categories of airspace. Current ICAO ATS classification may be applied as follows within the three categories of environment:

Classes A, B, C, D	N **iNtended Traffic Environment**
Classes E, F	**K Known Traffic Environment**
Classes E, F, G	**U Unknown Traffic Environment**

The application of the new "Traffic Environment Model" will therefore lead to the following simplified airspace organisation



The strategy sets the requirements for Test flights and Unmanned Aerial Vehicles (UAVs) as follows:

Test Flights for both civil and military purposes require special handling, but represent a relatively small airspace user community.

Unmanned Aerial Vehicles (UAVs), formerly known as 'drones' or RPVs (Remotely Piloted Vehicles) have been in the realm of military operations and recreation (model flying) since more than 50 years. In the last decade, there has been a serious interest in extending this technology to various aerial applications in civil use.

In many cases, UAV technology is seen as a more cost effective solution than the use of conventional aircraft or helicopters.

In the past, the ATM community has always assumed that UAVs were a military

phenomenon which would be flying only in reserved airspace. A requirement for non-segregated operations of UAVs has now been identified.

No uniform regulatory framework for UAVs exists as of today, but it could be assumed that the Test Flights & UAVs community seeks mainly:

- provisions for the accommodation of their operations, based on shared use of airspace rather than on strict segregation;
- definition of standards for additional equipment capabilities so that UAVs can be designed to achieve compatibility with the airspace they are expected to operate in.

5.3.2 NAVIGATION DEVELOPMENTS FROM ECAC NAVIGATION STRATEGY

The existing Air Navigation System and its sub-systems suffer from shortcomings in technical, operational and economic aspects. Despite the success of EUROCONTROL EATM Programmes, and the measures already in hand to provide further improvements, the current system is unlikely to be able to cope with traffic increases of the predicted magnitude. New advanced systems and concepts can offer potential improvements in terms of safety, efficiency and/or economy of flight, provided that their implementation is based on a fully co-ordinated, harmonised, evolutionary and flexible planning process.

This Navigation Strategy has been developed to answer to this need. The user requirements have been the main driver in its development.

The main objective of this Air Navigation Strategy is to provide a harmonised and integrated common framework which will allow a cost-effective, customer oriented evolution of the European Air Navigation Systems during the period 2000-2015. The evolution of the air navigation systems is described in terms of performance, functionality and corresponding infrastructure, taking due account of the principle of global interoperability.

The Navigation Strategy supports the operational developments proposed by the ATM 2000+ Strategy towards the implementation of a uniform European Air Traffic Management system. It is in line with the implementation of the ICAO Global Air Navigation Plan for CNS/ATM systems in ECAC.

The time horizon of this Navigation Strategy is split into three phases: short-term (2000-2005), medium-term (2005-2010) and long-term (2010-2015 and beyond), and it is in line with other EUROCONTROL strategies.

The main strategic streams described in this Navigation Strategy are aimed at:

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

- a judicious deployment of the space-based infrastructure and a rationalisation of supporting ground-based infrastructure for all phases of flight, ensuring the transition to GNSS, in line with ICAO recommendations.

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

This Navigation Strategy recognises the emergence of satellite technology and its future role in the global navigation environment. However, it is expected (based on current knowledge) that the rate of technological development of the system and the time needed for the resolution of institutional limitations will result in the need for a ground-based back-up system for GNSS for the foreseeable future for all phases of flight.

The feasibility of some options is still surrounded by many uncertainties and requires additional study (safety, R&D, CBA). Since all phases of flight are interrelated, constraints solved in one phase will not necessarily deliver the entire expected benefits, because of unsolved (or newly-generated) constraints for the other phases. CBAs will help to avoid the development of purely technology-driven solutions.

This Navigation Strategy aims to achieve a harmonised evolution of the overall Navigation System. In the framework of this strategy States may give preference to one implementation option or another in order to reflect sub-regional and local differences and to provide tangible and early benefits to the users. The availability of benefits will encourage the agreement and commitment of the users to the implementation plans. Furthermore, it will help the smooth transition to new systems and will minimise the period when support of both existing and new functionality will be necessary.

Objective of the strategy

The main objective of this Navigation Strategy is to provide a harmonised and integrated common framework which will allow a cost-effective, customer oriented evolution of the European air navigation systems during the period 2000-2015. The evolution of the air navigation systems is described in terms of performance, functionality and corresponding infrastructure, taking due account of the principle of global interoperability.

The Navigation aims to achieve a harmonised evolution of the air navigation system, to support the operational developments proposed by the EUROCONTROL ATM 2000+ Strategy towards the implementation of a uniform future European Air Traffic Management system. It also supports as far as practicable the implementation of the ICAO Global Air Navigation Plan for CNS/ATM systems in ECAC.

The following general principles have governed the development of this Navigation Strategy:

- to identify and evolve from the needs and priorities of both users and providers of the navigation systems and/or services;
- to take due account of institutional arrangements and legal regulations;
- to accommodate geographical differences in capabilities, performance requirements, and in the existing and required infrastructure;
- to enable coherent development plans to be made, both within ECAC and with neighbouring regions

The strategy must remain sensitive to the evolution and continued recognition of the needs and priorities of both users and providers of the navigation systems and/or services and the consequences and benefits of the available system options, as they emerge during the period.

The methodology used to derive the Navigation Strategy took into consideration the following:

- aircraft operators' requirements;
- known European and global policies and plans for Air Navigation Systems
- infrastructure and services in use, being introduced and/or planned for introduction

The Navigation Strategy has considered the aircraft operators' expressed requirements the main driver for operational improvements in the European Air Navigation System. Due to the wide range of aircraft operator groups, having diverse, specific and sometimes conflicting needs and expectations, trade-offs between conflicting requirements have been necessary.

Users requirements

Users

In the context of this Navigation Strategy the aviation users community encompasses a wide range of interest groups including aircraft operators, airport operators and Air Traffic Services Organisations.

Aircraft operators are the prime users of the Air Navigation System. They encompass commercial air transport (passenger and cargo), State aircraft, business and general aviation, aerial work.

Airport operators are the managers of airport operations. Airports are operated as (commercial) businesses providing services to passengers and airspace users. Their requirements are addressed here in the context of operations on the runway (e.g. runway guidance for take off or landing and SMGCS).

Air Traffic Services Organisations (ATSO) refer to the providers of national and sub-regional air traffic services (ATS), aeronautical information services (AIS), and airspace management (ASM).

Aircraft Operators Requirements

Users have stated the following requirements:

- to support the ATM 2000+ Strategy and the Target Operational Concept;
- to exploit the full benefits of B-RNAV implementation both en-route and in TMA;
- to continue the optimisation of the ECAC airspace structure based on operational requirements;
- to implement RVSM and free routes, in order to increase airspace capacity and, along with RNAV to improve user preferred trajectories in all phases of flight;
- to investigate the benefits of RNP 1 (or better) RNAV application;
- to take advantage of advanced navigation capability of modern aircraft and to examine the potential to implement 4D RNAV;
- to maximise the freedom of movement by exploiting new technological opportunities;
- to accommodate a wide variety of capabilities and to provide differing levels of service according to the users' business needs;
- to provide real-time or near real-time aeronautical information of sufficient quality (accuracy, integrity) to support the required application;
- to facilitate the implementation of advanced ground-based data processing systems and air-ground integration;
- to reduce infrastructure costs and improve ATM productivity;
- to increase user involvement in real-time decision-making for flexibility increase and to keep aircraft operators as the final decision-makers for the conduct of flight;
- to develop sound and transparent business cases at each stage of decision-making;
- to avoid making new equipment mandatory, without prior consultation and co-ordination with the users;
- to facilitate the redistribution of responsibilities between aircraft and ATC

The military aviation authorities will continue efforts to make military aircraft, and in particular military transport aircraft, compliant with civil aviation requirements for the conduct of GAT operations. However it must be foreseen that a great number of aircraft cannot or cannot completely be equipped to the required standard. Nevertheless these aircraft may be required to operate as GAT in the performance of their tasks. Procedures to accommodate these flights without compliance to the civil air navigation equipment requirements are to be established and infrastructure support for the conduct of such flights is to be maintained.

General Aviation and Air Work consists of many varieties of aircraft and capabilities. It is foreseen that a great number of aircraft cannot or cannot completely be equipped to a required standard on the basis of currently available equipment. Procedures to accommodate these flights may be required or infrastructure support for the conduct of such flights may have to be maintained as long as operationally feasible

ATM requirements

The future European Air Traffic Management system [ref.1,2] will have to provide adequate solutions to determine the optimum ways in which the ECAC airspace could be used. These solutions will require appropriate support and evolution of the Air Navigation Systems as well as of the Communications and Surveillance systems. These systems are considered enablers to ATM. Their functions become increasingly interdependent and require a higher and more predictable quality of service.

The future European ATM environment will require improved navigation accuracy, and more reliable navigation systems. The navigation infrastructure must be capable of providing, ECAC-wide, accurate, reliable, seamless and gate-to-gate position determination.

The ECAC area is not uniform in terms of ATM complexity and this may result in different and changing requirements on air navigation systems. The degree of complexity is dependent on current and expected capacity requirements and on supporting technology.

The required improvements in the Navigation function will enable improvements in airspace design (structure, sectorisation, associated route network, applicable route spacing, separation minima and responsibilities, etc.). Ultimately, all these elements, together with appropriate ATM tools will enable operators to conduct their flights in accordance with their preferred trajectories, dynamically adjusted, in an optimum and cost-efficient manner.

Communication Dependencies

The technological developments of modern air navigation systems and their evolution towards the future European ATM system create a specific requirement for data link. The Communications function will allow the routine exchange of necessary information between air-ground and ground-ground elements of integrated Navigation and Surveillance systems.

Emerging ground- or satellite-based augmentation systems for satellite navigation require specific communication links among their various components. Air-to-air data link is another service required from the Communications domain, to serve the navigation, the surveillance and the aeronautical information services functions.

Surveillance Dependencies

The application of the ADS concept in the future air navigation environment supported by a “sole means” of GNSS derived position will require the availability of high quality navigation data from aircraft systems for all phases of flight. Until then ADS will continue to be supported by a ground based surveillance function which can provide independent verification of the position information provided in the ADS messages. The EUROCONTROL Surveillance Strategy [ref.13] indicates that in the period up to 2015, a “sole means” ADS surveillance implementation is not expected.

Aeronautical Information Services Dependencies

The role and importance of aeronautical information/data and charts systems has changed significantly with the implementation of RNAV and RNP concepts. AIS has become a crucial and critical enabler for the implementation of the future European ATM system. The global requirement for precise navigation capability will require high quality (accuracy, resolution and integrity) aeronautical databases. The integrity values are required to be raised from the current value of 10^{-3} to 10^{-8} (ICAO Annex 15) to enable the implementation of CNS/ATM. Moreover, it is anticipated that an integrity value for aeronautical co-ordinate data of 10^{-9} will be required to support RNP≤1 procedures in the terminal area.

For the safe performance of operations the coordinate data has to be published in the a common geodetic reference system (WGS-84) as of 1 January 1998. For future developments it is essential that electronic storage, provision, update and

interrogation of aeronautical databases and charts (including terrain and obstacle information) are implemented. Global standardisation of the communication and display of these data are necessary. These improvements will allow on-line, real time, high quality aeronautical information to the users.

5.3.3 SURVEILLANCE DEVELOPMENTS FROM SURVEILLANCE STRATEGY for ECAC

The Surveillance Strategy will enable Air Traffic Management (ATM) service providers, airspace users and industry to plan ahead for the introduction of new technologies as they mature, together with the corresponding evolution of new procedures. It is proposed that the Strategy should cover a time period from the present to the current time horizon for EATMS work i.e. 2015, but with the flexibility to evolve as circumstances change through exploitation of the benefits of new technologies as they become available.

High level objectives of the strategy

The objective of the Surveillance Strategy is to develop a safe, efficient and cost effective surveillance solution(s) for ECAC to the year 2015 that will:

- Accommodate the expected traffic increase while meeting the objectives of the ECAC Safety Policy.

- Continue the harmonisation and integration of the Surveillance Infrastructure throughout the ECAC area, in order to achieve the separation minima dictated by traffic density and complexity.

- Take account of operational requirements being developed within EATCHIP phase III and concepts being developed for EATMS.

- Capitalise upon existing investments made by both airspace users and ATM service providers.

- Exploit the benefits of new technologies as they become available, in the most cost effective way, and have the flexibility to include, in due time, the necessary enhancements as a result of the anticipated future requirements.

- Cater for the military requirements.

- Have the flexibility to apply technologies according to geographical regions and traffic demand.

- Provide means for the introduction of cost effective surveillance in areas where the introduction of radar is impracticable or not economically justifiable.

Scope

The Surveillance Strategy is based on the use of various technological surveillance solutions, each tailored to the airspace and capacity requirements in a particular geographic area. The Strategy recognises PSR, Monopulse Secondary Surveillance Radar (MSSR), Mode S, ADS-B and ADS-C as technologies that can provide adequate surveillance and that are all embraced within the one Strategy.

The Surveillance Strategy shall be consistent with the gate to gate concept which embraces all phases of flight from the moment that the user interacts with the ATM system until the switch off of engines.

The long term objective is that ADS-B, in the period covered by the Strategy up to 2015, will be developed to become a major element of the surveillance infrastructure in Europe.

Nevertheless, it is recognised that in the period covered by the Strategy, a “sole means” ADS surveillance implementation is not expected (except for areas such as the Mediterranean or remote areas without surveillance infrastructure). Additionally, the Strategy is fully consistent with the evolution of Airborne Separation Assurance System (ASAS) functionality.

Conclusions from the Strategy

1 The principal areas where work must be focused in order to consolidate the Strategy have been identified from the considerations discussed above and are summarised below.

2 The objective of the Surveillance Strategy is to develop a safe, efficient and cost effective surveillance solution for ECAC to the year 2015. It will enable ATM service providers, airspace users and industry to plan ahead for introduction of new technologies as they mature, together with the corresponding evolution of new procedures. The baseline for the Strategy is the ECAC Strategy for the 90s, EATCHIP Phase 3 and the EATMS OCD.

3 The Surveillance Strategy embraces PSR, MSSR, Mode S and ADS as technologies that can, separately or in combination, be tailored to particular airspace requirements to provide adequate surveillance. The long term objective is that ADS-B, in the period covered by the Strategy up to 2015, will be developed to become a major element of the surveillance infrastructure in Europe. The Strategy possesses the flexibility to evolve as circumstances change through exploitation of the benefits of new technologies as they become available.

4 There are areas of ECAC where the increasing traffic density means that the capacity of existing MSSR systems will be exceeded before 2015. Until ADS is considered operationally available and cost effective, Mode S is the solution to overcome these shortcomings.

5 In areas where MSSR can cope with the traffic demand it can remain in place. ADS may be used to complement MSSR or to relieve the traffic load from the MSSR based system, once fully validated for operational use and shown to be cost effective. Furthermore, ADS may be a suitable technology to provide surveillance data where currently no radar infrastructure exists or is not practicable. Finally, in the gate-to-gate context of the Strategy, ADS-B and multilateration are foreseen as technologies capable of supporting A-SMGCS.

5.3.4 COMMUNICATION DEVELOPMENTS FROM COMMUNICATION STRATEGY

Objectives of the strategy

The business drivers for the Communication Strategy correspond to the major strategic objectives identified in the EUROCONTROL ATM strategy for the years 2000+, namely:

1**. Safety** - to deploy in a timely manner communications services and infrastructure which are reliable, secure and consistent with the new functionality required to support the operating concepts which are necessary to achieve the overall safety targets.

2. **Security** – to adopt communications techniques in support of new mechanisms and procedures to enhance the response of ATM to security threats and events affecting flights or the ATM itself.
3. **Economy (Cost Effectiveness)** - to adopt communications techniques that reflect the best business practices and utilise appropriate technical solutions for best use of resources. (Business efficiency and airline competitiveness makes it essential that services are provided in the most economic manner.)

4. **Capacity** - to improve use of communications resources and support operational improvements and new operating concepts which are dependent on increased use of data, and interoperability between distributed systems components.

5. **National Security and Defence Requirements** - to ensure interoperability and integration of civil and military ATM while preserving the confidentiality of sensitive data.

6. **Environment** - to provide better communications as an enabler to improved flight planning, thereby achieving environmental benefits through improved flight effectiveness.

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

8. **Uniformity** - to ensure that common standards are adopted and implemented globally for aeronautical communications, and to continue the harmonisation and integration of the communications infrastructure throughout the ECAC area.

9. **Service Quality** - "To foster, promote and enhance the use of ISO9000 or similar recognised quality standards in the provision of gate-to-gate ATM services."

The primary objective of the COM Strategy is therefore to provide the framework for the development of a safe, efficient and cost-effective set of interoperable communications solutions which support, in a globally compatible manner and with due regard for backward compatibility, the evolution of European Air Traffic Management (ATM) and other identified air navigation services for the ECAC area to the year 2020. Improved communications solutions are seen as enabler for the operational improvements necessary to meet the performance targets derived in accordance with the Strategic Performance Framework.

The strategy also recognises that co-ordination will be necessary with external bodies (EU, ICAO, FAA, EASA, JAA etc.).

Components of the Communication Strategy

The communication strategy addresses communication services, subdivided into:

- Data communications services, providing end-to-end connectivity (application to application) and broadcast capability for air-ground, air-air, and ground-ground application purposes between ATSPs, aircraft, airlines, airports and external organisations e.g. military.

- Voice communications services, providing the end-to-end and broadcast voice capability for air-ground, air-air and ground-ground purposes between ATSPs, aircraft, airlines, airports and external organisations e.g. military, using terrestrial and/or wireless technology

and the supporting network services, subdivided into:

- The Pan-European Fixed Network Services, (PENS) providing the international ground telecommunications infrastructure by the interconnection of national infrastructures, including connections to airlines, airports and external organisations, for voice and for data. PENS scope includes network systems management, end-to –end integrity, switching and routing, multiplexing and message handling.

- The Mobile Network Services, (MNS) providing the communications means between mobiles (aircraft or vehicles) and between mobiles and ground elements, for data and voice over wireless links (radio, satellite and other), including network systems management.

Conclusions from the strategies:

1. The strategies have to be seen as developments that will bring both technology and procedures and will affect the current operations
2. This will affect also the requirements for UAV operated outside restricted airspace and probably will increase the safety requirements on them
3. The relevant bodies identified to take action on different UAV issues shall take into account the new technologies and their implications on airspace, navigation, communication and surveillance when dealing with ATM matters.
4. Procedures will be affected by the introduction of the new technology. The operations for manned aircraft will be affected and also those for UAVs.