SESAR consortium

SESAR Definition Phase

The Market

D1

Air Transport Framework The Current Situation

Version 3.0

JULY 2006

SESAR
Air Transport Framework
The Current Situation

SESAR Definition Phase - Milestone Deliverable 1

The SESAR Consortium joins the forces and expertise of 29 companies and organisations together with 20 associated partners: from Airspace Users, Air Navigation Service Providers, Airports, Supply Industry and many others, including Safety Regulators, Military, Pilots & Controllers Associations and Research Centres as well as significant expertise from EUROCONTROL.

Issued by the SESAR Consortium for the SESAR Definition Phase Project co-funded by the European Commission and EUROCONTROL

Version 3.0 / JULY 2006

SESAR Ex Com
6th Decision Note - Ref : MGT-0606-003-02-00

We, Representatives of the Global Consortium Members within the SESAR Executive Committee, hereby approve the following D1 document for submission to the Purchaser ("EUROCONTROL") by the Project Directorate:

Deliverable D1

Document Number: DLM-0602-001
Document Title: Air Transport Framework-The Current Situation

Brussels, 20th July 2006

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TABLE OF CONTENTS

PREFACE

The SESAR programme is the European Air Traffic Management (ATM) modernisation programme. It will combine technological, economic and regulatory aspects and will use the Single European Sky (SES) legislation to synchronise the plans and actions of the different stakeholders and federate resources for the development and implementation of the required improvements throughout Europe, in both airborne and ground systems.

The first phase of SESAR, the Definition Phase, is co-funded by EUROCONTROL and the European Commission under Trans European networks. The products of this Definition Phase will be the result of a 2 year study awarded to an industry wide consortium supplemented by EUROCONTROL's expertise. It will ultimately deliver a European ATM Master Plan covering the period up to 2020 and the accompanying Programme of Work for the first 6 years of the subsequent Development Phase

The SESAR Definition Phase will produce 6 main Deliverables over the 2 years covering all aspects of the future European ATM System, including its supporting institutional framework. The scope of the 6 Deliverables are.

- **D1** : Air Transport Framework - the current situation
- **D2** : ATM Performance Requirements
- **D3** : Definition of the future ATM Target Concept
- **D4** : Selection of the "Best" Deployment Scenario
- **D5** : Production of the SESAR ATM Master Plan
- **D6** : Programme of Work for the Implementation Programme.

The SESAR Consortium has been selected to carry out the Definition Phase study which, for the first time in European ATM history, has brought together the major stakeholders in European aviation to build the Master Plan; this is considered to be a major achievement. The SESAR Consortium draws upon the expertise of the major organisations within the aviation industry. This includes airspace users, air navigation service providers (ANSPs), airports & the supply industry, plus a number of associated partners, including safety regulators, military organisations, pilot and controller associations and research centres. Together with the significant expertise of EUROCONTROL, the first Deliverable, D1, has been produced in accordance with its Milestone Objective Plan (MOP) [Ref.1] and finalised, including acceptance and endorsement by all project partners.

NOTE :

The SESAR Consortium is composed of the following :

AEA (Association of European Airlines), Aéroports de Paris (ADP), AENA (Aeropuertos Espanoles y Navegacion Aérea), AIRBUS, Air France, Air Traffic Alliance E.I.G / G.I.E, Amsterdam Airport SCHIPHOL, Austro Control GmbH, BAA (UK airport group), BAE Systems, Deutsche Flugsicherung GmbH (DFS), Deutsche Lufthansa AG, DSNA (Direction des Services de Navigation Aérienne), EADS, ENAV, ERA (European Regions Airline Association), FRAPORT, IAOPA (International Council of Aircraft Owner and Pilot Association), IATA (International Air Transport Association), Iberia, INDRA, KLM, LFV (Luftfartsverket), LVNL (Air Traffic Control The Netherlands), Munich International Airport, NATS (National Air Traffic Services), NAV Portugal, SELEX Sistemi Integrati, THALES ATM, THALES AVIONICS.

The SESAR Associated Partners are:

ATC EUC, Boeing, CAA UK, ECA, ETF, EURAMID, IFATCA, IFATSEA, Honeywell, Rockwell-Collins, Dassault (representing EBAA). Research Centres: AENA, DFS, DLR, DSNA, INECO, ISDEFE, NLR, SICTA, SOFREAVIA

EXECUTIVE SUMMARY

The demand for air transport continues to grow. The European Commission's (EC) expectation for SESAR, expressed by EC Vice-President Jacques Barrot, is that it will deliver a future European Air Traffic Management (ATM) System for 2020 and beyond which can, relative to today's performance, enable up to a 3-fold increase in air traffic movements whilst reducing delays, improve the safety performance by a factor of 10, enable a 10% reduction in the effects aircraft have on the environment and provide ATM services at a cost to the airspace users which is at least 50% less. The challenge facing the air transport community is to meet these expectations and establish a sound, sustainable basis for the industry well into this century. For the first time ever major stakeholders have combined to define a shared vision on how to achieve these goals in a safe, expeditious, cost effective and well managed manner.

Much has been achieved to provide air navigation services (ANS) to facilitate the safe movement of all airspace users, but the current approach is reaching its limits and is now under severe pressure from the need to meet the future traffic demand, plus the political, economic, social and technological changes which are continually re-shaping the world of aviation today. Despite some promising initiatives, the ATM community has to undertake radical changes to modernise by making the much needed transition to perform more effective and efficient ATM from a basis which is driven by the business aspects relevant to all of its stakeholders.

This document is the first in a series of 6 which will progressively define a vision and plan of action for the way ahead. It contains a "snapshot" description of today's air transport industry, and ATM in particular. It is the first deliverable of the SESAR Definition Phase and is scoped to summarise the **key aspects** of the current situation, its strengths & weaknesses, outline some promising current developments and make an expression of future needs. It is the synthesis of the work performed by 20 tasks and presents the findings together with some overall recommendations upon which the tasks in the following stages of the SESAR Definition Phase shall be based.

A summary of the **principal conclusions** with **recommendations** resulting from them follows

AIR TRANSPORT

KEY ASPECTS

Aviation's Value to Europe's Economy

In 2004, the direct stakeholders accounted for about €220 Billion of added value and 4 Million jobs in the European economy, either directly or indirectly - i.e., approximately 1.5% of European Gross Domestic Product (GDP).

European Aviation Operations

Traffic in 2005 : 9.2 Million flights (up 3.7% on 2004, up 15% on 1999). On a peak day ATM controls ~30,000 Commercial flights operated by ~5,000 aircraft. Services are also provided to ~200,000 General Aviation (GA) flights operated by ~50,000 aircraft, plus numerous Military aircraft.

"Hub & spoke" and "point-to-point" concepts of operations are performed which together create a complex air transport network containing many rotations of aircraft to maximise their cost effectiveness to the business.

Growth Projections

By 2025, demand is expected to be 2.4 times higher than today, with important local variations, notably in the new European Union (EU) States.

Diversity in the types of airspace user (e.g., low-cost airlines, general & business aviation, unmanned aerial vehicles) is expected to continue to grow.

PRINCIPAL CONCLUSIONS

Aviation is a mature means of achieving mobility. It:

- offers its customers a safe means of transport at an excellent value for money price;
- makes a significant contribution to World and European GDPs;
- demonstrates an ability to recover quickly from periods of economic recession.

However, following recent World events and the significant rise in oil prices, the profitability of airlines is currently low. When considering the value chain of the principal stakeholders within the industry:

- the commercial airspace users are the most exposed link, since they are "pulled" between the need to compete for customers in a highly competitive business sector, whilst being faced with many fixed costs;
- their exposed position means they are the first to suffer the financial consequences of sudden falls in demand;
- this situation is a major risk to achieving the long-term economic sustainability of the whole chain.

Inherent incompatibilities between the way in which commercial and other airspace users need to operate have led to inefficiencies in the ATM System, and in particular, the use of airspace as it is divided today. For example, although some improvements in civil/military co-operation have been made in recent years, there is still much more which could be done to achieve the greater access both require.

RECOMMENDATIONS

Considering these characteristics, and to foster progress, it is recommended that:

- all stakeholders in the aviation value chain grow their businesses in a way which strengthens the links between them and accommodates the needs of the non-commercial airspace users as appropriate. For example, the military will continue to require access to all airspace in order that they can discharge their national and international defence and security commitments;
- the business plans of airspace users, airports and air navigation service providers (ANSP) be more closely aligned;
- a risk sharing mechanism and approach to business planning is developed based upon common values and goals;
- the industry is empowered to manage to these values and goals by being able to make its own decisions on what to invest in and how to finance the investments;
- incentives are created to which all stakeholders can respond;
- a standard mechanism is established for the industry which amortises the consequences across all stakeholders if a sudden fall in demand occurs.

These recommendations must form the basis of the future vision for the air transport industry in 2020 and beyond which will be developed in the next SESAR deliverables.

AIR TRAFFIC MANAGEMENT

KEY ASPECTS

ATM is a Network

Some 100 main European airport "nodes" which are linked together by ~600 airspace sector nodes operated by more than 36 ANSPs.

Performance

Safety: 1992 to 2003: ATM contribution to commercial aviation accidents 3.6%. No ATM accident since 2003.

Capacity: In 2005, delays due to flow restrictions down by 75% from 1999. Average delay per flight: 1.9 minutes (50% en-route, 50% airports). At present the lack of capacity at airports is the major constraint to growth.

Costs: average rate of 0.76€/km (en-route phase); €7 Billion annual total; average rates dropped by 13% from 2003 to 2006. Equivalent cost around twice as much as that in the United States (US).

ATM network inefficiencies are estimated to be :

- ~€2 Billion for cost effectiveness (€1.4Bn for ATM/CNS en-route fragmentation (worst case) & ~€0.6Bn for associated low productivity);
- ~€1.4 Billion associated with flight inefficiencies;
- ~€1 Billion associated with ground ATM delays.

PRINCIPAL CONCLUSIONS

Over the past decade ANSPs have coped with significant traffic growth in an acceptably safe and expeditious manner. However, the following characterises today's situation.

- ATM is predominantly a tactical air traffic control process supported by a number of traffic management planning functions.
- At present, capacity at airports (i.e., their infrastructure, environ mental and political constraints, together with the terminal airs pace around them) is primarily the limiting factor of overall ATM System capacity.
- Airport infrastructure developments at the “nodes” will have to keep pace with the capacity improvements in airspace as a result of the SESAR initiative.
- Delays in the en-route sector are at historically low levels, however, delays are concentrated in high air traffic density areas.
- The ATM System is historically fragmented leading to substantial inefficiencies.
- National infrastructures have low levels of interoperability, limited sharing of data and little co-operative planning in the way their assets are managed.
- The full cost recovery régime does not incentivise organisations to implement changes and make new investments.
- Much performance data is captured, but not used coherently to manage the business in a “closed-loop” sense.
- Today's ATM process is not adequately geared to maintaining the schedules of commercial airspace users and to supporting them in handling schedule changes.
- The adaptability of the current ATM System is limited, with many aspects fixed by design

RECOMMENDATIONS

To respond to these conclusions when developing the future European ATM System in the next stage of SESAR, it is recommended that:

- a consistent and explicit framework linking the economic, commercial and operational priorities of stakeholders within the ATM System be established;
- a change of political will is needed to put in place a financing régime which underpins the above framework, so enabling ANSPs to make decisions on service provision matters which are driven by meeting the business needs of their customers;
- a comprehensive ATM performance framework be developed for and applied across Europe as a whole, and that this be used as the basis upon which management decisions are made;
- fragmentation, at all levels, of the European ATM System will have to be eliminated prior to the implementation of SESAR defined ATM enhancements - present system inefficiencies shall not be compensated for by technological solutions alone;
- ANSPs, in conjunction with their systems' suppliers, address the lack of flexibility in their current systems to find ways of providing varying levels of operational ATM capacity in real-time to resolve potential demand / capacity imbalances;
- the relationship between airports and en-route be emphasised (e.g. to ensure delays in one are not “masking” potential delays in the other);
- the concept of a “Network Plan” be comprehensively developed and implemented, in conjunction with providing services which reflect the capabilities of all categories of airspace user in order to meet their specific needs;
- airspace users, airports and ANSPs create a more explicit set of relationships that specifies the services, requirements and obligations which need to exist between them so that they become integrated “partners” in the future ATM System;
- a more liberalised approach be taken to the provision of ANS;
- a more proactive approach be taken to the replacement of and investment in new infrastructure based upon the principles of asset management;
- interoperability be achieved at service and functional levels throughout a future ATM System through the development of and convergence to a single functional architecture.

INSTITUTIONAL ASPECTS

PRINCIPAL CONCLUSIONS

Legislation & Regulation

The stakeholders in the ATM industry have together successfully delivered the air transport network currently in operation based upon the fundamental principles of the ICAO framework. The following overall conclusions can be drawn regarding the legislative aspects.

- Even after 60 years, the ICAO framework is considered adequate for harmonising aviation globally.
- The time taken for ICAO to produce the standards, practices and procedures needed has become too long with respect to meeting the rapidly changing needs of the business.
- The Single European Sky (SES) regulatory framework complements the ICAO framework.
- It is unclear, because of the EU's limited remit in terms of defence and security issues, how military authorities can fully engage with EU institutions on ATM matters. This is considered to be a severe limitation to the implementation of the future European ATM Master Plan unless it is solved quickly.
- Whilst ensuring that safety remains a prime objective, the SES framework paves the way for the benefits to be brought to the ATM industry of having a more commercial approach to the way in which ANS are provided in the future.
- The SES regulation forces the separation of regulation from ATM service provision, but the detailed way in which these roles will be implemented and the benefits which will be realised are, as yet, not fully established.

Safety Regulation

ATM safety regulation has helped to deliver an acceptably safe ATM System across Europe despite rapidly growing traffic. However, the following conclusions can be made.

- There is still no precise measure of the overall level of safety throughout the ATM community.
- The safety management culture has, in general, been reactive, but has started to show some signs of becoming more pro-active.
- There is lack of clarity of accountabilities between different regulatory authorities and the participants in ATM.
- Despite European-wide safety regulations and a performance reporting régime having been established, the way they have been implemented in many States has been slower than planned and local customisation led to non- uniform implementation. The current management and enforcement approach to date has not induced States to implement the regulations.
- It is not clear how the regulatory framework will develop in the future.

Approach to Standardisation Process

Developing, defining, setting and implementing standards is a key activity needed to increase the current low-level of interoperability which exists between ATM systems and to open the market. Any substantial incompatibility between European regulations and the ICAO regulatory framework has been avoided to date, however:

- the approach being taken at present is, in general, complex, fragmented and unclear;
- there are too many organisations, authorities, agencies, etc., participating in the process with variable levels of effectiveness and no overall coordination;
- there is also a lack of a common understanding of the entire standardisation process and the relationships between these bodies;
- in some of the groups, aviation stakeholders have very little ability to influence the outcomes;
- it is not always evident that the consultation processes with all stakeholders have balanced interests, been timely, or focused on the needs of the airspace users as the customer for the final product.

Governance Arrangements & Decision-making Mechanisms

Fragmentation is again a characteristic of the governance and decision-making arrangements which prevail today across national, European and organisational boundaries. This:

- makes the delivery of the outputs from programmes inefficient and ineffective;
- results in a lack of timely and continuing engagement of the stakeholders needed to make programmes a success;
- means the necessary funding and resources to be provided by the stakeholders to support programmes are not available when needed;
- results in no effective monitoring being put in place, neither to ensure compliance with agreed decisions, nor to maintain progress.

Today's institutional framework, together with the governance, management structures and decision-making mechanisms, will not satisfy tomorrow's challenging demands. There are institutions with different objectives and organisations with conflicting business priorities and responsibilities. There are also States which lack the instruments to implement and manage the changes needed in their jurisdiction and the roles of the major stakeholder groups in the decision making processes are disconnected from their roles and responsibilities within the industry. The SES is an important step forward, however, there are still many challenges ahead. The legislation by itself cannot deliver the expected benefits fast enough without complementary action by the industry.

Overall, the institutional aspects are considered to be:

- a highly complex set of organisations and processes which sometimes overlap and even, at times, duplicate one another;
- continually changing and expanding, making it difficult to remain compliant with it in a cost effective way;
- necessary, but the benefits-to-cost ratio is, in general, unknown.

RECOMMENDATIONS

From the conclusions outlined above, the following are recommended:

- A simpler, coherent and consistent framework of legislation and regulation matched to the ATM industry's future business model must be developed.
- It is envisaged that the future European ATM System will more closely integrate the ground and airborne segments. Thus, the governance, management structures and decision making process must be designed concurrently with the future ATM System so that the "product and the production line" are matched.
- The ATM safety regulatory framework should be developed to provide a clear, unambiguous set of regulations across the whole of the air transport industry; improving upon the current situation is not only essential but a prerequisite for growth.
- Design the future European institutional framework together with a business framework such that "constructive tension" exists between the two, but that the whole has a set of clear and non-conflicting roles and responsibilities working for the overall benefit of the air transport industry.
- An effective solution must be found to be able to fully engage the military authorities.
- The future approach to be taken to developing standards must also be simpler, more focused and have much clearer objectives.
- The expectation is to have a future European ATM System with a single functional architecture based upon the supply and receipt of services.
- It is necessary to move away from developing prescriptive, technically-oriented regulation towards defining performance based regulation supported by appropriate standards. This would greatly improve service and functional interoperability (which is the level at which regulation should be applied) both throughout the ATM System and with military systems. This approach would also greatly ease being able to make the transition from today's System to the future design.
- The requirement for future interoperability on a Global scale has been well established. If due consideration is not given to existing processes, the evolving European standardisation and certification regulations can potentially introduce additional complexity and cost duplication.

There is a need for an organisational structure at European level which brings together those with the competence, breadth of understanding, power and imagination to lead the industry out of the current situation. Failure to address the aspects listed above will impose severe limitations on the implementation of the future European ATM Master Plan for 2020 and beyond unless they are solved quickly.

The current proposal for a Joint Undertaking (JU) for SESAR's Development Phase is largely aimed at coordinating and concentrating the research and development (R&D) activities in accordance with the ATM Master Plan. This represents progress, subject to further clarification of the management structure and process descriptions.

In addition to the organisation of R&D activities, an efficient and integrated approach is needed to fulfil the need for an "overarching" governance structure to fully implement the modernised European ATM System. An initial proposal, considering the draft JU regulation, will be developed in the next Deliverable D2 (December 2006) of SESAR's Definition Phase.

"SYSTEM" ASPECTS

PRINCIPAL CONCLUSIONS

The following conclusions cover the "System" in its broadest sense, addressing the operational, technical and human aspects.

- At a European level there is no common architectural design applied to the ATM System as a whole;
- Although plans have existed at a European level to harmonise the capabilities of existing systems and introduced some new functionality, there has not been an effective, coherent approach to asset management which has aligned these plans with national plans to sustain the systems in-service.
- The current ATM System has humans at the centre of virtually all activities and this has been at the heart of providing safe, high quality air navigation services. However, expectations are that the human will not be able to deal with the future level of traffic and its complexity in the same way as it is done today.
- There is a need for a paradigm shift in the current concept of operations to break through the "capacity barrier" predicted to occur between 2013 and 2015 and to meet the future business challenges. This shift will include an increased use of automation to do some tasks traditionally performed by humans.
- A better understanding of human factors has been developed in recent years, but the application of this insight is currently seen as "nice to have" rather than "must have" in systems development; however, the reasons why appear to be unknown.
- Effective resource planning still appears to be extremely difficult

despite legislation being put in place. The aim to achieve greater mobility of staff throughout Europe is still hampered by specific legal, social and operational factors which prevail at a national level.

- Research & Development (R&D) activities, in general, have:
  - been conducted in a fragmented manner;
  - not addressed an identifiable need;
  - lacked robust user requirements to support the work;
  - not done sufficient business planning analyses and/orsafety case work.
- Not having these aspects to support the results of the work has made it difficult to implement the products in a timely manner. Consequentially, there has been too many R&D programmes (some duplicating others) supporting too wide a variety of technological developments, leading to a distortion of the ability of the market to "naturally" select the best products.
- Today's ATM System is predominantly centred on the use of ground-based systems, but much information and functionality exists in systems on board the aircraft which can be significantly exploited to improve ATM performance both today and in the future.
- Access to and use of the radio spectrum is vital for the continued provision of safe ATM services. However, this is coming under severe commercial pressure from non aeronautical sectors. The risk is that aviation will lack the spectrum it requires to sustain growth unless a clear plan of future needs is put in place whilst continuously managing existing frequency allocations.
- The air transportation system and the enabling ATM services which support it are critical parts of Europe's infrastructure. To date, it has been resilient to attack by a low level of threat. However, as more modern data processing systems and communications protocols are used, coupled with the trend to network multiple systems, this will inherently increase its vulnerability to cyber attack.
- Notwithstanding the improvements to the environmental performance of new generation aircraft, the ATM community has an increasing role to play in contributing to air transport sustainability.

RECOMMENDATIONS

Based upon these conclusions, the following recommendations are made.

- The design of the future ATM System should:
  - have one functional architecture which defines the information flows needed between the principal entities which make up the System;
  - incorporate both the ground-based and airborne systems, treating them as a whole;
  - have an architectural design such that new functional applications can be added and others removed without the need for a major redesign each time;
  - clearly distinguish the ATM services, the supporting services (i.e., those derived mainly from the technical infrastructure) and the physical assets which make up the technical infrastructure.
- A single European ATM System "design authority" empowered to define, plan and manage the implementation of such a System should be established. Its modus operandi should be to couple, managerially, the R&D programmes, strategic planning, implementation programmes and in-service asset management activities to ensure coherence and consistency is achieved throughout them. This role will be especially important throughout the process of managing the transition to the future ATM System. However, it must be made very clear that the role does not make the business decisions on what shall be implemented, but informs of the consequences and/or what needs to be done and when.
  To complement this, a strong European standardisation and certification institutional framework must be carefully put in place which significantly reduces the current complexity and keeps the costs of doing these activities to the absolute minimum.
- In the future applied R&D must focus upon the applications needed to achieve System performance and then identify the technological solutions to deliver them. The aim is to evolve the capability of the future ATM System by using a business requirements planning process which continuously balances demand and capacity.
- As the role of the human in the ATM System starts to change, a proactive approach to change management must be established which:
  - is based upon the principles of collaboration, transparency and inclusiveness;
  - involves staff at all levels in order to achieve a period of transition which is smooth, harmonious and will lead to a successful outcome for all concerned;
  - is a significant improvement upon the approach taken today, which has traditionally been seen as slow, lacking incentives and has not kept pace with the dynamics of today's business environment;
  - considers resource planning from a greater forward looking perspective and supports it with models which have greater flexibility within them.
- The security aspects of the future ATM System must be significantly increased to combat the threat, but must also be commensurate with the risk.
- Whilst the polluting effect of aviation is still a relatively small contributor to climate change, proactive management action needs to be taken now to ensure the air transport industry minimises its contributions to the environment.

EXECUTIVE SUMMARY

OVERALL CONCLUSIONS

The air transport industry will continue supporting the mobility of citizens and economic growth in Europe. Air transport is a mature industry with promising capabilities for growth, though vulnerable to external events; hence the need to develop it in a sustainable manner.

The future European ATM System, implemented with a service-centric approach within a business framework, must be able to cope with the expected market growth and meet the societal requirements. It has to tackle the fragmentation associated with today's national structures and the associated restrictions which constrain the industry from responding effectively and efficiently to the evolving challenges. There is a need for one simplified European framework together with a performance based approach which satisfies all airspace user requirements. States and Industry all have a role to play in ensuring that Europe's ATM System is progressively modernised to cope safely with the expected traffic growth.

Business as usual is not an option.

1 INTRODUCTION

Born out of the technological advances in aircraft development throughout the latter half of the 20th century, civil aviation has evolved into a global means of transport and a multi-billion euro network of businesses. The desire to offer expeditious transport services to the general public for the purposes of enabling commerce and leisure travel resulted in the need to create a means of assisting aircraft to navigate safely, accurately and prevent collisions. In conjunction with service provision, a comprehensive system of safety and economic regulation of the industry, coupled with the need to safeguard national "sovereign" airspace interests, laid the basis for creating the service provider organisations and regulatory bodies which exist today.

Air Traffic Management (ATM) as defined by the International Civil Aviation Organisation (ICAO) is "the dynamic, integrated management of air traffic and airspace safely, economically and efficiently through the provision of facilities and seamless services in collaboration with all parties" [Ref.2]. Although the main stakeholders within the air transport industry purport to perform ATM, it is predominantly the provision of air traffic control (ATC) services which prevails. The methods by which these services are delivered have, in general, remained relatively unchanged since their inception. However, today the providers of these services are coming under severe pressure to make major changes to the way in which they are structured, the attitudes they adopt to the future scope and nature of their role and the skill sets needed to ensure success in the rapidly changing socio-political, business and technological environments in which they find themselves. All of these pressures are aimed at improving the quality and value for money of the services provided.

The European Commission's (EC) expectation for SESAR, expressed by EC Vice-President Jacques Barrot [Ref.3], is that it will deliver a future European Air Traffic Management (ATM) System for 2020 and beyond which can, relative to today's performance, enable up to a 3-fold increase in air traffic movements whilst reducing delays, improve the safety performance by a factor of 10, enable a 10% reduction in the effects aircraft have on the environment and provide ATM services at a cost to the airspace users which is at least 50% less. The challenge facing the air transport community is to meet these expectations and establish a sound, sustainable basis for the industry well into this century.

The principal aim of SESAR is to bring together the major stakeholder groups which make up the air transport industry today to develop a common vision for a European ATM System for 2020 and beyond. This document is the first in a series of 6 deliverables which will layout a vision of the way ahead, culminating in the production of a Master Plan of Actions to be taken by all stakeholders and a Programme of Work for the first part of the implementation phase. It is the first product of the SESAR project's definition phase and is scoped to summarise the key aspects of the current situation.

The structure of the document is as follows :

- Section 2 deals with the air transport industry as a whole, setting the context for ATM [Ref.4].
- Section 3 discusses the business of ATM, providing more specific details [Refs.5,6,7,8]
- The institutional framework within which ATM fits is addressed in Section 4, bringing together the legislative, regulatory, standardisation, governance and management decision making aspects which prevail today [Refs.9,10,11,12].
- Section 5 outlines the operational and technical aspects of the current System [Refs.13,14,15,16,17,18].
- Section 6 covers the human aspects which are embedded throughout ATM today [Refs.19,20,21].
- In addition to the fundamentals outlined above, there are a number of key subject areas which run transversally across many of the other subject areas. These are addressed in Section 7 [Refs.7,10,22,23].
- The document is completed by Section 8, which contains the overall set of major conclusions and recommendations which will inform the remaining phases of the SESAR project definition work.

Each section has, in general, been structured to provide an overview of the current situation, the strengths & weaknesses, current developments and future trends and expectations in the major subject areas. Throughout the document the data presented relates to activities in Europe unless otherwise stated. More details of the work performed by the 20 tasks which have contributed to the creation of this document can be found in Refs. 4 to 23.

2 THE AIR TRANSPORT FRAMEWORK

2.1 INTRODUCTION

Air Transport is defined as the full set of activities required to satisfy mobility needs by air. The principal direct stakeholder groups in today's air transport industry are the end-user customers (i.e., passengers and freight), the airspace users (i.e., scheduled & non-scheduled airlines, military, business & general aviation), the aerodrome community, the air navigation service providers (ANSPs) and the supply industry (i.e., aircraft manufacturers, suppliers of systems used for air traffic management and airport purposes, suppliers of other supporting systems). The scope of their activities is most often international, so their contributions to the economic, social and environmental spheres appear at local, regional and global levels. In addition, there are a number of indirect stakeholder groups, such as the authorities which regulate many aspects of the industry, ICAO, airspace providers in the form of sovereign governments and various pressure groups. Whilst these groups can influence the behaviour of the others by shaping the conditions for, or restricting their activities, they do not directly contribute to the creation of the end products.

In this study, the relationship between the stakeholder groups in air transport today has used value chain considerations [Ref.4] at the European and Global levels to highlight the links between them and the services and products they receive from and provide to one another. This will be the economic "anchor point" for the evaluation of the changes which will be proposed in the subsequent phases of the SESAR project definition work.

2.2 OVERVIEW OF CURRENT SITUATION

Air transport is a safe, mature and irreplaceable method of transport which creates substantial added value for its end-user customers and the European Community (EC). It plays a key role for Governments, local and global economies, not only in terms of increasing gross domestic products (GDPs) and employment, but also as a facilitator of World trade and global business. Air transport is also socially beneficial, enabling many communities to have improved standards of living and connecting remote parts of the World so that, for example, they can have access to improved medical facilities, access to high standards of education, etc. In Europe, it has a key role in supporting the enlargement of the EU and enabling it to become more cohesive.

Air transport contributes significantly to World and European GDPs. In 2004 the direct stakeholders accounted for about €220Bn of added value and 4 million jobs in the European economy [Ref.4], taking into account direct, indirect and induced effects. Additional value and job creation were supported by aviation through its catalytic effects, enabling other industries to operate and perform more efficiently. Fig.2-1 shows the percentage breakdown across the stakeholder groups of their contribution to GDP and employment.

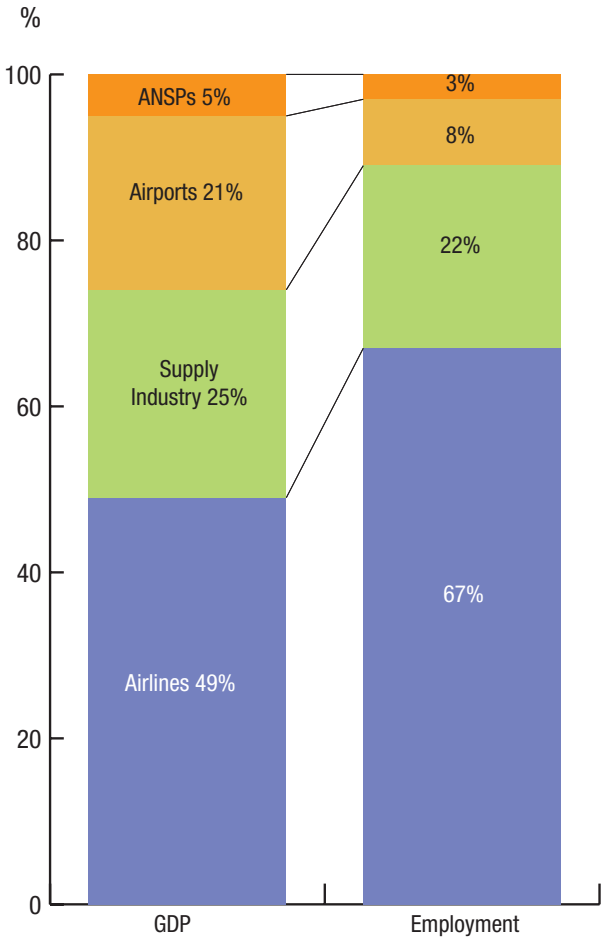

Fig.2-1 : Proportion of each Stakeholder Group's contribution to GDP & Employment

The main drivers of growth in the air transport industry are the continued globalisation of business and the growth in GDP. This strong correlation is illustrated in Fig.2-2. The industry is also highly sensitive to economic downturns, but remarkably robust in being able to recover from such recessions. Currently different sources of future traffic forecast information all predict significant growth, both Worldwide and in Europe, over the next 20 years. The European air transport demand in 2025 is forecast to be 2.4 times higher than in 2005 in terms of revenue passenger kilometres (RPK).

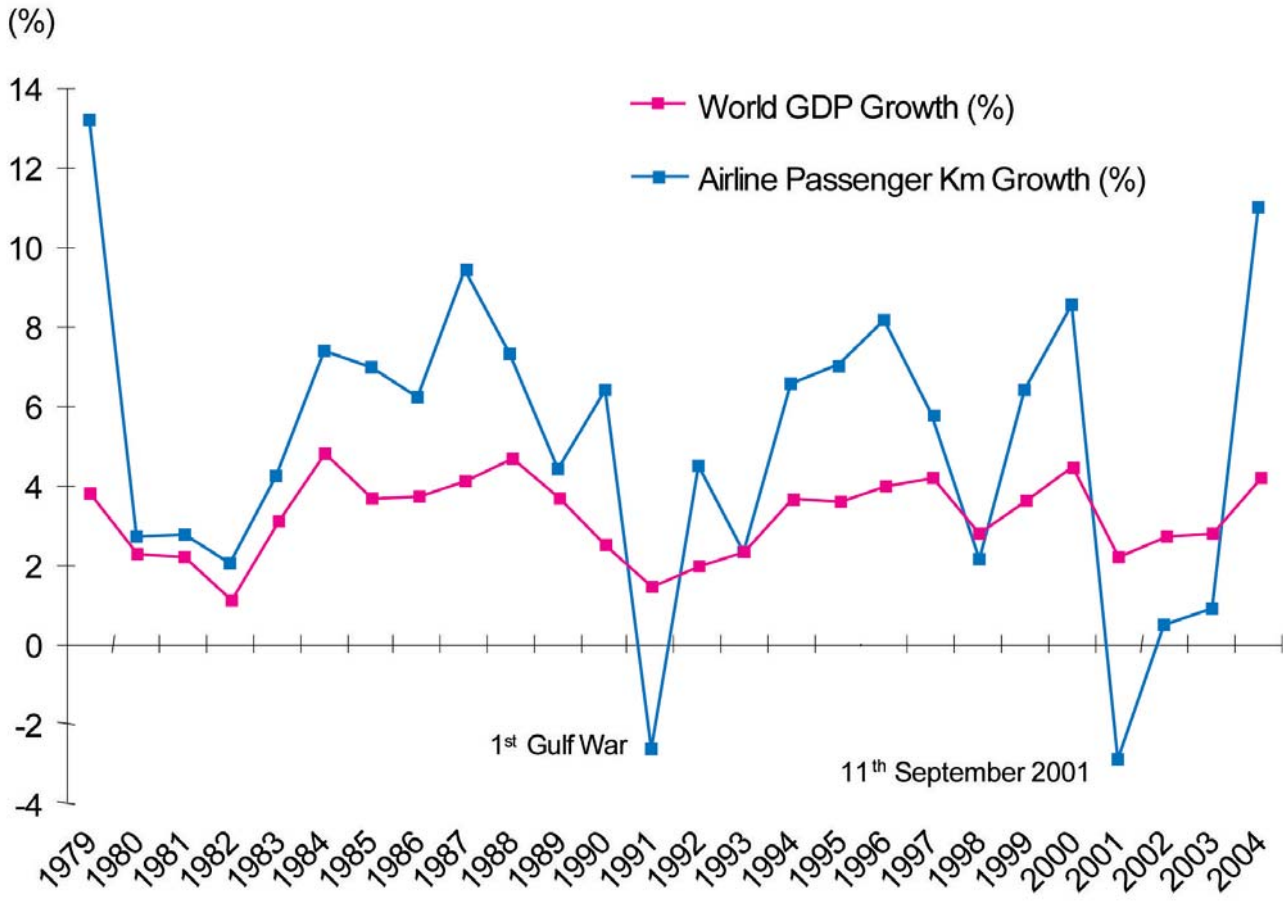

Fig.2-2 : Variation in % Growth of GDP & Airline Passengers over last 15 years

2.3 CONSIDERATION OF THE VALUE CHAIN

To understand the value chain considerations throughout the air transport industry, it is necessary to understand the individual markets and circumstances of each of the direct stakeholder groups and the way they interact. These are summarised in the following sections, the final end users' group having been merged within that of the airspace users since the latter needs to identify them as the "demand side" of their markets.

2.3.1 - Key Characteristics of Airspace Users

2.3.1.1 - Commercial Airlines

The air transport market within the EU is de-regulated, so encouraging competition. However, in the main, services into and out of the EU are still reliant on bilateral agreements between countries. Airline business models vary from those of the traditional "legacy carriers" to those of the "low-cost" airlines and those which offer very specific products. However, there is an increasing trend where traditional differences are becoming blurred, but all have one thing in common, they can be subjected to rapid changes in demand which can have a significant impact upon their businesses very quickly. Product differentiation and price are important. For indicative purposes, Table 2-1 shows some typical key business parameters to give an idea of scale [Ref.4].

In the current market, it could be argued that price is a more important criterion than product. However, this depends on the type of passenger (e.g., business traveller, leisure traveller, etc.), but there is no clear trend. Product price evolution varies between business models. The cost structure of an individual airline also varies considerably depending upon the business model operated, but typically, the business is characterised by high fixed operating and overhead costs. Revenues in the business are high (relative to other stakeholders in the value chain), but the equally high cost contributes to the poor performance and heavy industry losses in recent years following the events in 2001 are shown in Table 2-2. Again, these are typical figures shown for indicative purposes (Ref.4)

Number of commercial airlines	About 100 in Europe (900 Worldwide)
Production metric (in Europe)	650M Pax
	10.7M tonnes cargo
	8.9M Flights
Main assets (in Europe)	8,683 aircraft
Employees (in Europe)	709,272 direct jobs
Yield Index (100 in 2000)	85
Operating margin	1% - 3%
Revenue of European carriers	€100Bn
R&D expenses in Europe	Small
Market share of top 10 in Europe	75% of revenue
Capacity utilisation	75%

Table 2-1 : Business parameters for Commercial Airlines in Europe in 2004

	2000	2001	2002	2003	2004	2005F	2006F
REVENUES,€M	265,100	248,153	246,942	259,693	305,659	338,641	362,669
OPERATING PROFIT, €M	8,635	-9,523	-3,954	-1,211	2,631	2,588	6,510
NET PROFIT, €M	2,986	-10,491	-9,119	-6,101	-4,576	-4,861	-1,789

Table 2-2 : Commercial Airlines Financial Results (Worldwide) - Source IATA

2.3.1.2 - Military Aviation

Within the European Civil Aviation Conference (ECAC) States (excluding aircraft of the US) the military presently operates about 12,250 aircraft. The military aviation infrastructure consists of specific airfields and their associated facilities, together with the operation of air defence and air traffic units. These have the necessary dedicated technical infrastructure for surveillance, communications and information processing purposes to support the air navigation services provided by the military. Often these services are available to other airspace users and some military airfields are available for civilian co-use.

2.3.1.3 - General Aviation (GA)

GA includes all aircraft except those of airlines, business aviation and state-owned aircraft. The estimated total present value is approximately €15Bn representing 52,000 aircraft. GA activities that create and enable value creation relate to training flights, transport of persons and goods and aerial work (including crop-dusting, forest fire-fighting, rescue flights, emergency/disaster flights, environment protection flights, etc.).

2.3.1.4 - Business Aviation

In 2005, 6.9% of all instrument flight rules (IFR) flights in Europe were made by business aviation. Since 2001, this segment has grown twice as fast as the rest of the traffic, with business jet flights growing particularly strongly in 2005 by 8.9%. The forecast level of growth in European business aircraft over the next 10 years is, on average, expected to be about 4% growth per year.

Business aircraft are certified in accordance with the same regulations as airliners and operate to the same rules. Business Jets can operate at high altitude (above 41000ft.) and from both large and small airports (using runways from 4000ft.).

2.3.2 - Key Characteristics of Airports

The principal assets of the aerodrome community are airports and aerodromes, including major hub airports, regional airports, local aerodromes and military airfields. ICAO records 2,234 airports in 36 countries who are members of EUROCONTROL, of which 1,986 are in 25 countries of the EU. Of the total, 766 are recognised by IATA as commercial airports. The main airport operators operate more than one airport in Europe and/or Worldwide. Table 2-3 shows some key business parameters.

Number of actors in Europe	Less than 766 (as recognised by IATA)
Production metric (Europe)	1.23Bn pax
	15.5M tonnes of cargo
	17.7M movements
Main assets (Europe)	766 airports
Employees	135,000
2004 Yield (100 in 2000)	Not Available
Operating margin	Approx. 20%
Aeronautical Revenues	€11.22Bn
R&D expenses	Small
Concentration (Share of pax of top 10 actors)	Approx. 50% of passenger traffic
Capacity utilisation	Not available

Table 2-3 : Business parameters for Airports in Europe in 2004

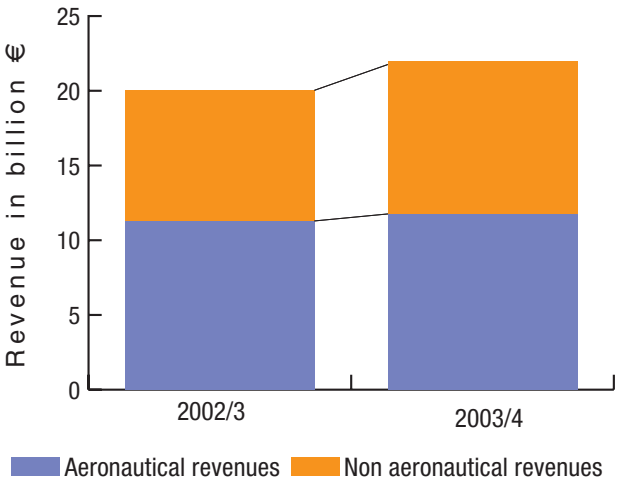

Fig.2-3 : Changes in Airport Revenues

Aeronautical and non-aeronautical revenues of airports in Europe are shown in Fig.2-3 for 2002/3 and 2003/4. They represent respectively 45% and 43% of airport revenue Worldwide. This revenue was adversely affected by the elimination of duty free sales and security driven modifications after the events of 2001, but has recovered due mainly to the innovation and entrepreneurial creativity of the airport operators.

Airport charges to airlines have been relatively stable as a percentage of the airline's operating costs, indicating that where there have been increases in airport charges due to, for example, increased security facilities, these are being charged directly to the passenger and freight traffic rather than to the carriers.

The total operating revenues for airports in Europe were around €23Bn in 2004. The total operating profit (based on average margin of 20% derived from a reduced airport sample) is estimated to be around €4.6Bn. The average return on invested capital between 1996 and 2004 for European airports was 7.8% with, in general, large airports achieving higher returns. The utilisation of airports varies significantly, some have capacity shortages whereas many do not.

2.3.3 - Key Characteristics of Air Navigation Service Providers

The air traffic control, airspace management and air traffic flow management services which make up ATM are, in the main, provided by National ANSPs, typically, one per State. The provision of some services has been delegated to a single European organisation, namely EUROCONTROL. Locally, some ATM services are provided by private companies, or by the Military. This section, unless otherwise specified, focuses mainly on the activities of National ANSPs.

Number of Actors in Europe	36 ANSPs in EUROCONTROL
Production metrics in 2004	8.9M IFR flights
	13.4M flight hours
	96.6M service units
Main assets (Europe)	68 ACC, 190 Appr. Units, 417 Towers, CNS infrastr. (€10Bn)
Employees	54,000
2004 Yield (100 in 2000)	110
Operating margin	Not applicable (cost recovery)
Revenue	€7Bn
R&D expenses	€0.05Bn
Share of revenue of top 10 ANSPs	76%
Capacity utilisation	95%

Table 2-4 : Business parameters for ANSPs in Europe in 2004

Within the air transport value chain, ATM is best thought of as an essential infrastructure of systems, people and procedures which, together with airports, enable air transport and other aerial movements to operate in a safe and expeditious manner. It is therefore

difficult to ascribe a precise "value" to ATM with respect to its contribution to the total economy of the air transport sector, but it is at least somewhere close to the current annual direct cost of approximately €7Bn. Table 2-4 gives some key business parameters. The principal financing mechanism of ANSPs is through the use of en-route charges derived from airspace users. These are based, in accordance with ICAO recommendations, on the product known as Service Units, which are defined as a function of the aircraft weight and distance flown. So, for example, an A320, with a maximum take-off weight of 74 tonnes flying 1000Km would be charged approximately 12 service units. The service unit is then used to generate a "unit rate" which is adjusted so as to allow ANSPs to fully recover their costs. One exception currently in Europe is in the UK, where an economic regulator operates to set a price-cap on the charges to airspace users and the ANSP may incur penalties for not providing agreed levels of service. In this case, although the principle is the same, the ANSP accepts a certain level of risk, mainly in the case when traffic levels fall.

In the main ANSPs are State-owned, vertically integrated monopolies operating within the limits of National borders. ANSPs' customers are in the hundreds covering all categories of airspace user. The top 10 airlines in terms of Instrument Flight Rules (IFR) flights generate approximately one-third share of the service units charged in Europe. Key financial data which summarises the current situation is as follows :

- ATM revenues in Europe were around €5.5Bn from en-route service provision and €1.5Bn from approach services in 2005. This represents approximately 25-30% of World ATM revenues;
- ANSPs include in their costs a financial remuneration for the capital employed at a rate established by their national government which should be similar to the remuneration for applications with identical low risk;

The average price paid by airspace users (i.e., the "unit cost") in 2005 was €0.76 per km. (ranging from €0.39 to €1.14 depending on the individual ANSP), this being 2.2% lower than in 2004. This figure is expected to decrease by 6% between 2004 and 2006, this being in line with a notional target of a 3% reduction per year between 2003 and 2008 as set by the EUROCONTROL Performance Review Commission (PRC).

2.3.4 - Key Characteristics of the Supply Industry

The activities of the supply industry cover production of aircraft, aircraft engines, on-board equipment and the data processing, communications, navigation and surveillance (CNS) infrastructure systems procured by ANSPs and airports.

The global ATM systems & equipment "market" including area control centre (ACC) systems and the enabling CNS infrastructure is estimated at about €1Bn per annum in Europe. It also includes avionics. The main suppliers are Raytheon, Thales, Lockheed-Martin, Selex, Honeywell, Rockwell-Collins and Indra.

In 2004, the total civil turnover of the European aerospace industry was €57Bn. There was a 4.7% growth in the total turnover compared to 2003 corresponding to an industry recovery after a number of years of downturn. In 2004, 66% of the civil turnover was realised from customers outside the EC.

2.3.5 - Main Relationships between the Major Stakeholder Groups

The principal interfaces for the exchange of goods, services and information between the direct stakeholder groups in the value chain is shown in Fig.2-4. A detailed explanation of these relationships can be found in Ref.4. The main conclusions which can be drawn from analysing these relationships are as follows.

- The value drivers for the end user customers (in no particular order of priority) are mobility, safety, security, punctuality, connectivity, accessibility, frequency and price.
- Airspace users are the most exposed to end-user customers' demand and "value" expectations, whilst at the same time being most dependent upon the others stakeholders.
- The aerodrome community is also close to the end-user customers, directly and indirectly through the airspace users.
- ANSPs provide a wide range of services, but mainly to one stakeholder group; that is the airspace users either through the supply of en-route ATM services and/or those at aerodromes. ANSPs are mainly dependent upon two other stakeholders, the supply industry and the indirect stakeholders (i.e., regulators).
- The supply industry has a key position where it is the only group selling essential inputs to the three other main stakeholders (i.e., the airspace users, aerodrome community and the ANSPs). Of course the diversity of what is supplied from the different companies which make up this group is different with respect to satisfying the needs of their respective customers.
- Information is an important value driver throughout the air transport value chain. At the planning as well as the operational level, strong information exchange between stakeholders on flight plans, flight schedules, delays, etc. is necessary to ensure the functioning of the air transport network, and the ATM System in particular, for the benefit of the end-user customers.

As the primary mode of long distance transport within and bet-

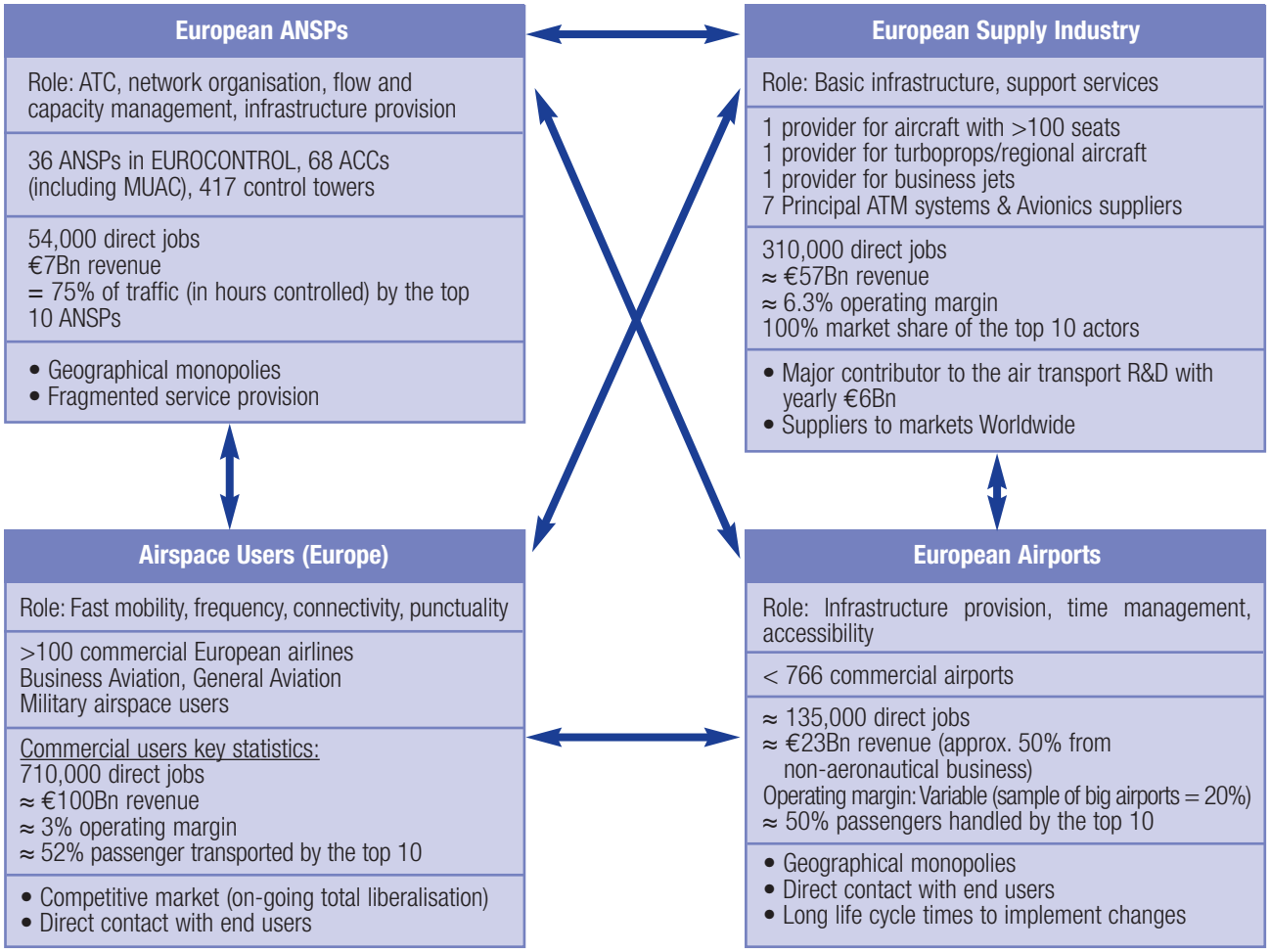

Fig.2-4 : The Relationships forming the Air Transport Value Chain (Data for 2004)

2.4 MARKET STRENGTHS

ween countries, air transport is a crucial facilitator of economic activity, creating or increasing accessibility to regions and essential facilities, plus enhancing social inclusion for remote communities and widening the access to more commodities, markets, etc. than ever before. In some cases, air transport competes successfully with and is a complement to other modes of transport.

As with other modes of transport, aviation makes use of non-renewable energy sources and produces unwanted external effects such as accidents, noise and pollution. However, when all external effects are considered, there is no evidence that air transport performs better or worse than the others. On the specific areas of accidents and land use requirements, air transport performs better than the other modes.

The liberalisation of air transport from an end users perspective, the advent of the "no-frills" operation and the subsequent competition in the airline market are seen as positive developments which have led to a wide range of choice and excellent value for money for the end-users.

It is noticeable that the current level of safety and security is being achieved as a result of the activities undertaken by all stakeholders in the value chain. The availability of military services for civil airspace users and the use of airfields is also a positive contribution. The adoption of concepts such as flexible use of airspace (FUA) have allowed a more optimized, efficient and flexible use of capacity, although it is considered that there are still more benefits to be realised.

There is a positive movement towards the corporatisation of ANSPs, allowing for a better alignment with the business imperatives of airspace users. Without the constraints of budget and governmental decision-making processes, ANSPs can take more appropriate decisions, in a more timely manner, to modernize and upgrade their infrastructure. Moreover, the network planning and

coordination services provided by EUROCONTROL on behalf of its members, plus the improved co-ordination between ANSPs, the supply industry and aircraft operators have all resulted in better provision of capacity and the use of the current capabilities of aircraft. At the airport level, continued efforts to maximize the throughput to handle the growth in air travel have been achieved. The growing level of coordination between the aerodrome community, ANSPs and airspace users, in order to better match existing capacity with demand and therefore maximize the use of available airport and airspace capacity, is also seen as positive and promising.

The biggest market strength which prevails today is the apparent continually increasing demand for air transport. Although very sensitive to disasters which may occur anywhere on the Globe, the underlying trend is upwards, with all traffic forecasts predicting significant and persistent growth both Worldwide and in Europe, as shown in Fig.2-5 and [Ref.4]; this combines information from the market forecasts of the aircraft manufacturers Airbus, Boeing and Embraer.

For the number of IFR flights, EUROCONTROL forecasts growth in Europe, under the most optimistic conditions and without airport capacity constraints, of approximately +150% over the same period.

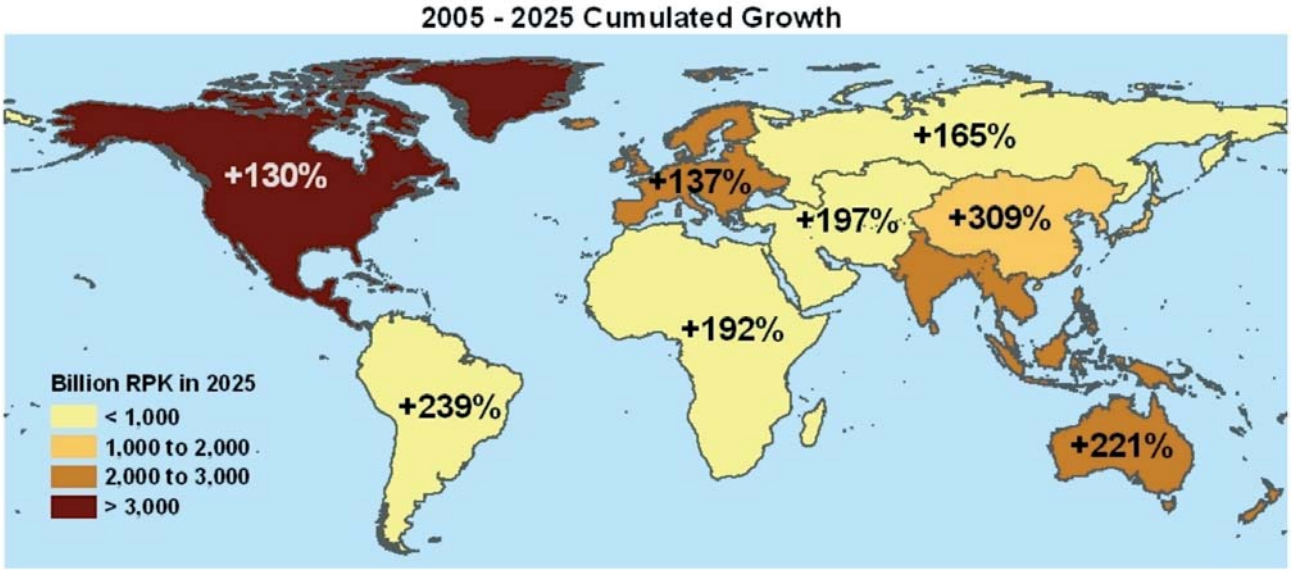

Fig.2-5 : Long-term Forecasts in Worldwide Traffic Growth

2.5 MARKET WEAKNESSES

The stakeholders are disparate in terms of value added composition (i.e., the proportion of internal costs such as wage bills and cost of capital, versus share of profit). The value added breakdown is the result of each stakeholder's power to determine its sales price, its labour productivity, its market power to set prices, etc. Only rough indications can be given here, but the following illustrates the current situation.

- Except in the UK, ANSPs operate under a full cost recovery régime so profit is not a meaningful indicator, but they are allowed to charge for a fair return on the capital employed.
- The Aerodrome community (which generates about a half of its revenue from non-aeronautical activities) and the supply industry (which achieved important productivity gains over the last 25 years) seem to create proportionally more value by their ability to generate profit.
- Airspace users rank first in the contribution of added value, but fail, on average, to achieve the same level of profitability as the others. However, further detailed analysis, using more accurate data, would be necessary to draw more robust conclusions.

Although the scope of impacts varies for different airlines depending on their market segment, sudden drops in demand affect airlines' profitability. On average, the poor financial performance of airspace users also results from a significant increase in the proportion of uncontrollable "external" costs (i.e., fuel, air navigation charges, costs of regulation, etc.). Now that most commercial airlines have gone through a period of cost rationalisation, further cost reduction becomes more difficult. On the revenue side, although load factors are historically high, competition drives down yield to the benefit of the end-user customers, but not without risks in terms of financial sustainability for the airspace users. The finan-

cial performance also affects the attractiveness for investing in air transport, finally influencing the cost of capital, which itself influences the financial performance, leading to a vicious circle.
Airspace users are also most affected by a decrease in air transport demand in times of economic downturn. All air transport stakeholders should be sharing the risk associated with variations in air traffic demand.
The market growth is expected to be high, but basic infrastructures of the air transport network (airport and ATM capacities) are already saturated in some local areas. High traffic growth in low traffic density areas will require building new infrastructure, but the traffic to and from these peripheral areas will create links to, from and over high traffic density areas. For example, the evolution of the traffic in the Central/Eastern part of the EU is dependent upon the ability of Western European airports and ATM to achieve an unprecedented shift in capacity, although traffic density is already high.
Furthermore, the fragmentation of the European ATM system is a source of extra cost without generating extra value. In addition to being a possible contributory factor to limiting air transport growth, it has been the cause of, and creates favourable conditions for, inefficient procurement, and unnecessary customisation.
Despite existing national FUA arrangements in many European States, there is a need for further co-ordination and co-operation between civil-military and military-military entities on a pan-European scale to achieve a higher level of efficient airspace use in Europe.

2.6 FUTURE EXPECTATIONS & NEEDS

Since European air transport is expected to grow and should be able to grow in a sustainable way, improvements in all performance areas will have to be found. The aim should be to strengthen the links between all stakeholder groups in a way which is mutually beneficial, but especially to the income generating link with the airspace users.
Air transport demand is subject to economic cycles. All stakeholders face, to varying degrees at various times, the risks related to fluctuating levels of demand and revenue. This limits their ability to invest. An enhanced value chain would enable more value creation if traffic risks could be amortised across the stakeholder groups.
Cost effectiveness enhancements throughout the whole value chain and performance driven efficiency strategies will be necessary to strengthen it, so eliminating rather than perpetuating today's deficiencies and inefficiencies. Strengthening the chain will be the prerequisite to generating the extra value required to raise the necessary finances to support the funding of the transition to the future ATM System.
Previous studies [Ref.24] suggest that, under the most optimistic of circumstances, existing airport capacity in Europe is capable of absorbing a maximum of twice the traffic demand of 2003. Other studies [Ref.4] suggest a traffic growth rate of between 4 & 5% per annum through to 2025 can be expected. At these rates, a total capacity barrier would be reached around 2017. Noting that this includes capacity filling at regional airports as well as current major hub airports, it is reasonable to assume that the practical capacity barrier will be reached well before the theoretical barrier. On this basis, it is reasonable to assume a practical capacity barrier will be reached between 2013 and 2015. Consequently, in order to meet the SESAR challenge [Ref.3] and break through this barrier, sufficient capacity in the basic ATM infrastructure of the air transport network (including airports) must be created, together with a concept of operations which makes it function as a true, single network and the political will to commit to achieving it - all with a planning horizon based upon the above.
The indirect stakeholders (in particular, the regulators) have an important role to play here by aligning regulation and standardisation in all subject areas (i.e., safety, environment, security, economic, employment, etc.) to avoid having multiple layers in a single area and local regulations duplicating international regulations. Excessive regulation causes an unnecessary cost burden, is a source of inefficiency and distorts competitiveness with other modes of transport.
Current pricing models do not give the right incentives to ANSPs and airspace users. To create a common playing-field between all modes of transportation, measures leading to singling out one mode with specific financial instruments should be avoided. The air transport industry must be treated fairly and on an equitable basis with other transport industries.

3 AIR TRAFFIC MANAGEMENT FROM A BUSINESS PERSPECTIVE

3.1 ROLE OF ATM WITHIN TODAY'S AIR TRANSPORT INDUSTRY

3.1.1 - Overview of Current Situation

The current role of ATM within the air transport value chain is to deliver air navigation services (via the ANSPs) directly to airspace users primarily in the form of en-route and airport ATC services. This is done using procedures, people and engineering systems located mainly within en-route ATC centres and at airports. At these locations data processing systems are connected to ground-based communications, navigation and surveillance (CNS) infrastructure systems which provide information support services that are functionally compatible with corresponding systems onboard the aircraft. The role of ATM is also to conduct, in conjunction with the airspace users, the airspace management process referred to as airspace organisation & management (AOM). This also embraces the "organisation" of airspace as determined by the airspace providers on behalf of their sovereign governments. This must balance the needs of commercial airspace users, with those of the Military, GA and others. ATM also provides the air traffic flow management (ATFM) process (which operates to support a régime of demand / capacity balancing (DCB)) as well as meteorological (MET) and aeronautical information services (AIS).

The ATM industry's structure is based upon national monopoly ANSPs (all at least partially Government owned) essentially supplying services within national boundaries. This stems from the Chicago Convention of 1944 [Ref.25] where States are responsible for their airspace. In Europe this has resulted in the fragmented situation which exists today and hence, the diseconomies of scale. For the most part, ATM operates on a cost recovery basis. The European ATM System is a network comprising some 25-30,000 commercial flights per day, operated by approximately 5,000 aircraft, flying between 100 major (and many more secondary) airports, using typically 600 airspace sectors. These all interconnect to deliver the air transport mobility demanded by the end-user customers. Many organisations within the "ATM world" interact on a "custom & practice" basis where services, their quality aspects, prices, reciprocal obligations, etc. are mostly not explicitly specified or agreed. In real-time, ATM provides services on a "first come, first served" basis without real reference to maintaining airline schedules. This limits its scope to help airspace users and airport operators manage punctuality performance. This contrasts with the commercial airline sector which is now, in general, very competitive. It is therefore essential for airlines to construct their individual schedules to satisfy their selected market, resulting in their competing needs not necessarily being aligned with some notion of overall network optimisation.

To further illustrate the business values of ATM service provision today Table 3-1 identifies 8 ATM values together with an outline quantification of each [Ref.5].

ATM Value	Illustrative Quantification
Safety : The fundamental basis for performing ATM	ANSPs' maximum financial exposure resulting from a mid-air collision has been estimated at ~€2Bn
Service Sustainment / Continuity : Avoiding significant degradation in services and maintaining a flexible response to external circumstances	A 1% reduction in traffic equates to ~€800M reduction in airline revenue
Growing Capacity : Fully exploiting physical airport capacities and safely handling the future growth in air transport	The corollary of that for service sustainment/continuity
Predictability : Assisting airlines to maintain robust schedules	5 mins. reduction in 50% of scheduled block times is worth ~€1Bn. 1.3 mins. per flight of en-route ATFM delay cost ~€1Bn.
Access to Airspace : Ensuring equity for all airspace users	This cannot be easily quantified. The gross value (to airlines) is tied up with growing capacity; net value requires consideration of the impacts on Military & GA users
Flight Efficiency : Enabling the use of efficient flight profiles, subject to meeting safety & capacity priorities	Eliminating all current en-route horizontal flight inefficiencies was estimated to be worth ~€1.4Bn in 2005
Security & Environment : Meeting expectations & standards	Not easily quantified, but the cost is embedded within a degraded image of the industry and the negative publicity received
Cost-effectiveness : Minimising the direct and the indirect costs	Elimination of fragmentation across European ATM is estimated to be worth approximately €2Bn per annum

Table 3-1 : Current Business Values of ATM

3.1.2 - Strengths

The following are considered to be the main strengths which prevail today.

• The reality and perception of the general and travelling public is that air travel, plus the ATM System which enables it, operate to an acceptable level of safety performance.

• The delivery of en-route capacity by ANSPs has been sustained in the face of significant traffic growth (of the order of 45%) over the last decade. Currently there is no en-route capacity crisis and as a result average en-route delays due to ATM remain historically low at 1.3 minutes per flight.

• Across much of Europe, civil-military co-ordination has become more effective, this being regarded by the EC and EUROCONTROL as a key enabler for a more effective ATM System in the future.

3.1.3 - Weaknesses

The following are considered to be the major weaknesses of the current situation.

• European ATM is considered to be expensive, due in part to the fragmented way in which air navigation services are provided on a State-by-State basis. For example, the number and size of area control centres (ACCs) is considered to be sub-optimal when compared with those in the US which handled comparable levels of traffic.

• The limited interconnectivity of ANSP services and systems, the limited data sharing and co-operative planning and less than full exploitation of the capabilities of the avionics on-board advanced aircraft all contribute to airspace capacity not being maximised and, in some circumstances, to excessive route distances and sub-optimal flight profiles being flown. Consequently, the associated savings in fuel-burn and the benefits to the environment are not realised.

• Achieving and maintaining airline schedules is at the heart of strengthening the air transport value chain, but the ATM System is not sufficiently geared to doing it.

• Airline schedules continue to include extended block times to improve schedule integrity, but with the consequence of significantly increasing the allocation of costly resources. This is mainly

necessitated by the effect of operating a network in the face of delays resulting from queues at and around airports associated with the use of limited resources such as the runway(s) and stand infrastructure.

• Although en-route delay is at a historically low level and since capacity at airports is primarily the limiting factor of overall System capacity, it is unclear whether the potential for additional delays in the en-route sector are being "masked" by other factors. This should be investigated.

• The ATM System is not sufficiently adaptive. Airspace capacity is designed to meet projected demand patterns using fixed routes and sectors, with controllers validated against these structures to handle the traffic. Differing configurations of these structures can be used on the day of operation, but these are also limited to certain pre-defined options and procedures.

• There is a significant mismatch between the planning lead-times for new ATM capacity (e.g., 2 to 3 years for new airspace developments), for new airports' infrastructure (e.g., between 10 and 15 years) and airline lead times to open new routes and services (typically a few months). This inherently promotes an imbalance whereby demand is always likely to exceed capacity when traffic levels are continually increasing.

• All of the above are exacerbated by the lack of a consistent and explicit framework linking the economic, commercial and operational priorities which all stakeholders within the industry can understand collectively.

3.1.4 - Current Developments

A number of joint procurement and maintenance initiatives by ANSPs are already contributing to a reduction in the costs and risks associated with investing in the development of new ATM systems. Examples of these are the iTEC and COFLIGHT flight data processing (FDP) systems replacement programmes. It is also expected that the development of functional airspace blocks (FABs) which will lead to less fragmentation in the future.

Some improved co-ordination between ANSPs (as facilitated in part by EUROCONTROL), and between ANSPs, the supply industry and airspace users, has started to result in the provision of more capacity. Some of these are also aiming to make more effective use of the aircraft's capabilities.

3.1.5 - Future Expectations & Needs

The following lists a number of expectations and needs which will be taken forward to enhance the value ATM contributes to the air transport industry, address some of the weaknesses and re-shape the industry in the future.

• Since the integrity of the airlines' schedules dominates achieving strong values for air transport, gearing the performance of the future European ATM System to enhancing it is a must. To do this the use of a "Network Plan" is considered to be fundamental, but this requires all stakeholders to have a common operating philosophy. The nature of the trade-offs that having such a Plan would entail need to be far better understood, recognised and interpreted in order to provide a meaningful basis for a future ATM concept of operation. However, the need is considered to be essential. This is now progressively introduced through DMEAN.

• Irrespective of the nature of an eventual Network Plan, the "ATM world" needs to create a more quantified set of explicit relationships that specify services, requirements and obligations on both service providers and airspace users so that they can be integrated "partners" in the future ATM System. This would underpin the establishment of an ATM performance framework based upon a sound 3-way understanding between airlines, busy airports and ANSPs.

• A future aim must be to be more responsive to the short-term fluctuations in the air transport industry which, in the air transport value system, are most quickly felt by the airspace users. ANSPs, in conjunction with their systems suppliers, must address the lack of real-time flexibility in being able to provide operational ATM capacity and reduce the lead times for being able to bring new capacity on stream. Doing this will improve their cost-effectiveness and reduce the risk of severe demand / capacity imbalances in the future.

• Given the current planning lead times for increasing and the limited flexibility for varying airspace capacity, ATM planning mechanisms should be established (or strengthened where they already exist) whereby stakeholders jointly identify and resolve potential demand / capacity imbalances, and agree on mutually acceptable trade-offs which then form the basis upon which they conduct their operations.

3.2 FINANCIAL MECHANISMS AND INVESTMENT RÉGIMES IN ATM TODAY

3.2.1 - Overview of Current Situation

The fundamental basis of the funding of the present ATM System is through the imposition of user charges. Fig.3-1 shows the main stakeholder groups and the principal money flows between them.

Most ANSPs recover all of their costs, including the pre-financing costs of undertaking R&D, through this mechanism. In Europe only one ANSP (i.e., NATS in the UK) is under an independent economic regulatory régime where efficiency and productivity factors are taken into account. In this case price indices are used to fix an upper limit to the charges over a fixed time interval (typically 5 years) which is

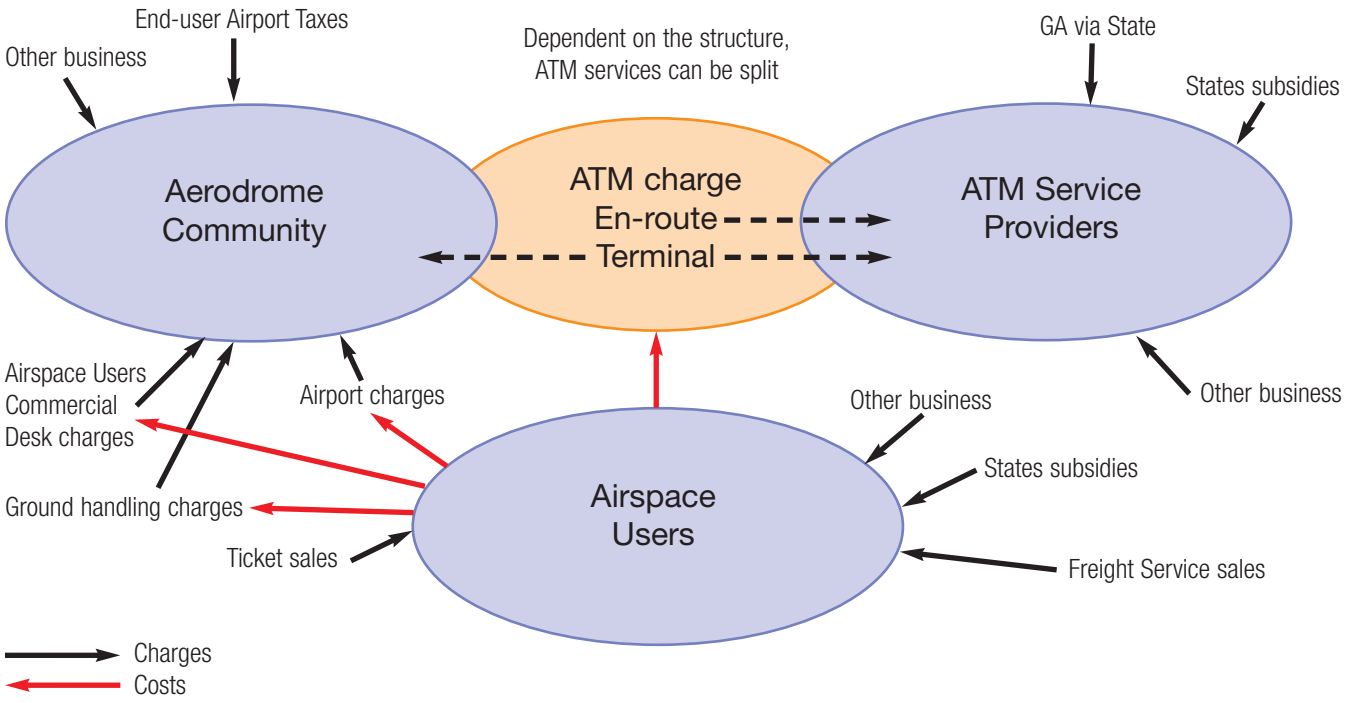

Fig.3-1 : Main Money Flows between Stakeholder Groups

then reviewed and adjustments made according to the market. Under this régime, an efficient service provider is allowed to retain any excess of revenue over cost within the limit set. Conversely if, due to unexpected economic developments, the revenues are inadequate to meet costs, the service provider is allowed to appeal to the regulator for a review of the price limits and a "pain sharing" mechanism is available for consideration.

Non-repayable grants, or subsidies can be provided by local or state Governments, or the EC to subsidise airports, ANSPs or projects.

Some airspace users or particular flights are exempt from paying the user charges. The ATM costs for these are met from "sundry sources" (e.g., subsidies, Government grants, subscriptions to flying clubs, fees charged by training schools).

Airports either provide the ATM services themselves, or using subcontractors, some of which are tendered through open competition. In such cases the physical assets are not necessarily owned by the service provider, so that the transition from one subcontractor to another can be made relatively easily. Also in this latter case, the airport, where appropriate, can collect terminal user charges to remunerate the cost of providing such services. In some cases, the airport ATM service charges do not reflect the true costs, but are maintained (despite the uneconomic situation) mainly through cross-subsidies. At the moment, only political decisions can change the situation to address the user requirement for transparent subsidies not funded by users.

3.2.2 - Current Developments

The new SES Implementing Rules (IRs) will facilitate the restructuring and consolidation of service provision. The supervisory and regulatory costs also have to be funded. As a result, the way in which all of these will be financed will become more transparent. However, the new IRs do not introduce new ATM funding mechanisms. There is strong pressure from the airspace users to improve the cost effectiveness of the system.

3.2.3 - Future Expectations & Needs

The future approach to financing has strong dependencies with the ownership, governance and organisational structures which will be put in place. In general, stakeholders use the following financing mechanisms to finance their investments:

- Loan or borrowing based;
- Institutional lending or subsidised loans;
- Grants or non-repayable loans;
- Equity based;
- Public / Private Initiatives.

The stakeholders select one mechanism according to their corporate structure, the type of investment and the financial situation they are in. Airports and civil airspace users use the general capital market in their financing. Airspace users require the costs of the financing of an investment to be spread throughout its lifecycle and strongly oppose pre-financing or front-loading the cost, to allow them to offset any benefits against expenditure incurred over the

lifecycle. Some ANSPs may not be in a position to do this due, for example, to the strong restrictions on them concerning the borrowing of funds.
Further investigation of which of the above mechanisms could be used as the financing schemes of future ATM investments is needed, but this will be heavily dependant upon the management structure which is to be put in place and the degree of public funding which might be available [Ref.6]. To give an outline of the scale, the expected amount of investment to realise the ATM2000+ strategy [Ref.26] is expected to be in the order of €22Bn, with 40% for the ATM ground segment and 60% for the airborne part. As a comparison, €200M is currently spent on ATM Research in Europe per year.
With very few exceptions current multinational initiatives (e.g., SES, Functional Airspace Blocks (FABs), etc.) have been slowed down or blocked by political interests. As long as there is no overruling authority, strong financial pressures, or real financial incentives, this is likely to continue. Financial, coupled with legal, measures should be put in place to support current and future co-operations.
If the above situation prevails, the nature and speed of implementing the future European ATM System will be much more dependent upon political will than on the creation of possible alternative financing or funding-models. As a main tendency, the goal to cover financing costs at the time when the benefit occurs in the user charging structure will present restrictions in financing SESAR. However, this may be compensated by a fairer allocation of risks in the overall financing system. No pre-financing alternative can be supported by direct contributions from user charges and significant questions remain of the longer term capability of airline operators to fund the scale of investment needed.

3.3 APPROACH TO ASSESSING PERFORMANCE OF THE CURRENT ATM SYSTEM

3.3.1 - Performance Framework considerations

An integrated performance framework [Ref.7] sets the foundation to direct the actions of all stakeholders within the ATM community towards implementing business driven, pragmatic solutions aimed at meeting required levels of performance and maintaining continuous improvements in them thereafter. The objectives of such a framework for an ATM System as established by ICAO [Ref.2] aims to measure performance in terms of outcomes in order to :

- Design, develop, operate and maintain a System that can meet the expectations of its users;
- Determine that the System is performing in accordance with its design;
- Determine when and where action needs to be taken to enhance the System's performance when it is not meeting, or is predicted not to meet, the users' expectations; and
- Enable those participants within the ATM System who are driven by a range of commercial imperatives, expectations and objectives (which are often manifest in contractually binding customer/supplier relationships) to meet their obligations.

In general, such a framework is made up of a number of performance elements, all of which are inter-dependant, some to a greater degree than others.

3.3.2 - Overview of Current Situation

There is a strong emphasis on the measurement of performance within the ATC part of today's ATM System in Europe [Refs.27,28], and whilst elements of a performance framework are in place throughout the European ATM community, there is still a considerable amount of work to be done to develop a consistent, formalised and integrated structure which is always cognisant of the interrelationships between the elements.

Performance categories have been established by a number of States and organizations but, with the exception of some primary categories (mainly safety, capacity and cost-effectiveness), there is inconsistency in the determination of key performance areas [Ref.7]. Most of the measurements are focused on a relatively large set of parameters within the ATC domain, but a limited set of performance areas. Further, the approach was reactive (that is, attempts to measure past performance in terms of activity with a view to enhancing it), with recent but limited efforts to take a proactive approach by identifying and establishing targets for future System performance and using these to drive changes to meet them.
There is also inconsistency in the definition, understanding and application of the various performance areas and the performance indicators associated with them. This is, however, being addressed by the EUROCONTROL Performance Review Commission (PRC) and the Safety Regulation Commission (SRC).
A variety of additional performance objectives & goals have been, or are being, established and implemented across the European ATM community, some set at the highest level by the member States of EUROCONTROL's Provisional Council (PC). These cover such subject areas as environment, aviation security and access & equity (to airspace). Also some ANSPs have established collaborative commercial objectives. However, in many cases, there is no clear link between the performance objective/goal, the actions which have been established to work towards achieving them and the desired outcome with respect to the total System's performance.
Performance of the ATM System in Europe is currently fundamentally measured against the 3 primary categories of safety, capacity and cost effectiveness. With respect to safety, the highest-level

performance indicator, as perceived by the public, is hull loss and fatal accidents. In the years 1992 to 2003, there were 284 accidents, 3.6% of which had an ATM contribution. In each of the years 2000, 2001 and 2002, there was one fatal accident (involving commercial aircraft) attributed to the European ATM System. This has set a "de-facto standard" which must be considered as being one too many. Counting the number of accidents and serious incidents is, in itself, insufficient to give confidence about the true level of safety performance. The PRC is seeking to broaden the measurement of safety, the next logical level being the measurement of incidents and causal factors. Some safety reporting based on occurrences investigated in Europe is already being done. Several indicators are used to estimate the level of risk of various aviation hazards, such as AIRPROX, Runway Incursions and Level Busts. The data collected allows major key risks related to ATM to be identified and this is used as the basis to initiate safety improvement initiatives. However, today, at a European level overall, reporting is limited to measures of reporting "compliance", rather than "content". Hence, the PRC's 2005 European performance review [Ref.28] stated *"… some progress is noted concerning incident reporting and transparency issues, but much remains to be done to implement agreed plans. Only 15 States out of 34 have provided good quality information concerning events occurring in their airspace. Information concerning runway incursions is even less reliable…"*.

The provision of safe capacity is a key expectation of the ATM System and is currently reported in 3 components, traffic demand, ATFM delay and effective capacity. ATFM delay is generally considered as the de-facto indicator of the lack of capacity in any particular volume of airspace or location. To illustrate these relationships, Fig.3-2 shows how traffic demand, capacity and en-route ATFM delay have varied over the last 10 to 15 years. The PRC reported that in 2005, "*... en-route ATFM delays (1.3 minutes per flight) increased, but met the agreed target (1.4 minutes per flight). This is a significant achievement in view of traffic growth. Airport ATFM delays are getting close to en-route delays and exceed them at certain times. This warrants special attention…"*. The PRC translated the cost of this delay as approximately €1Bn per annum.

The most representative overall indicator of European cost-effectiveness comes from the PRC 2005 performance review report which states *"…unit costs were nearly two times higher in Europe than in the USA in 2004…"*. The report sees room for improvement by acting in three directions, by :

- progressively raising productivity in every ANSP to "best practice";
- reducing the degree of fragmentation in the provision air navigation services throughout Europe, since this contributes to high support costs and inefficiencies;
- managing the employment costs more effectively.

Cost effectiveness planning processes were implemented by EUROCONTROL in a co-operative approach with ANSPs and airspace users.

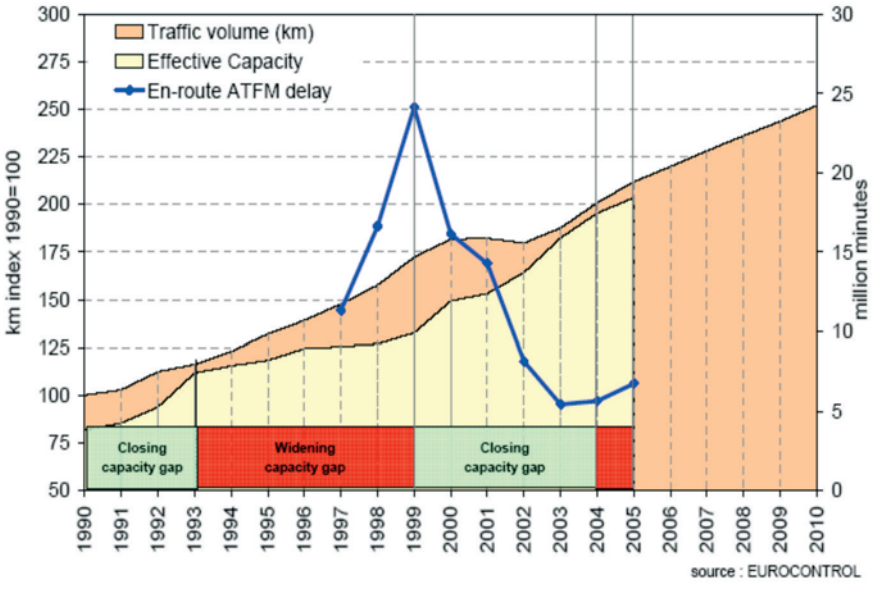

Fig.3-2: Summer Demand, Capacity & Delay from 1990-2010

3.3.3 - Future Expectations & Needs

Many of the elements present in today's European performance régime are consistent with, or adaptable to, international best practice as embodied in the emerging ICAO global performance-based approach to ATM [Ref.7]. Data collection is well established in a number of areas and in many cases is in a form that would allow causal factor analyses to develop indicators which would allow performance to be monitored in a leading rather than lagging sense. Fig.3-3 shows a first qualitative assessment of the degree to which the current performance measurement régime matches the ICAO proposed framework (which is also being proposed for SESAR). In the KPA column, the KPAs used today and those coming from the ICAO framework are shown. Comparing these KPAs shows that there is a very close match between the categories. Each KPA has associated with it a performance objective (PO), key performance indicators (KPIs), metrics (PM) and targets (PT). The table then shows whether today such parameters exist. For example, the KPA currently identified as "Uniformity, common standards" is, in the ICAO proposed framework, termed "Global interoperability". In this case, a PO is established for this KPA, some KPIs are in place, there are very few PMs and no identifiable PTs.

Key Performance Area - KPA		Performance Objective PO	Key Performance Indicators KPI	Performance Metric(s) PM	Performance Target(s) PT
Current Régime	ICAO Proposed				
Access	Access & Equity				
Delay, Capacity, Airport Capacity	Capacity				
Cost Effectiveness					
Flight Efficiency	Efficiency				
Environment					
Flexibility					
Uniformity, Common Standards	Global Interoperability				
Nil	Participation by ATM Community				
Punctuality & Predictability	Predictability				
Safety					
National Security & Defence Rqts.	Security				

= Well Defined = Established = Some in place = Very few = None evident

BASED ON A « WHOLE OF ATM SYSTEM » ASSESSMENT
(« End-to-End », including En-route, Terminal Manoeuvring Area, Airports & Airspace Users)

Fig.3-3 : Qualitative Comparison between Current Performance Régime & ICAO Proposed Framework

This summary assessment, notwithstanding the need to align the key performance areas, indicates that there appears to be a solid basis in terms of established performance objectives upon which to build, with less evidence that key performance indicators, performance metrics and targets are in place. However, it would appear that the use of such a framework to drive the definition of the future European ATM System is appropriate and would build upon the data collection approach which has been established to date.

3.4 COST BENEFIT ANALYSIS CONSIDERATIONS

3.4.1 - Overview of Current Situation

In order to make informed and balanced decisions about investing in the aviation infrastructure all stakeholder groups need to be convinced of the economic viability of such investments. This is particularly important when such investments can have a significant financial impact upon the viability of the stakeholders' businesses.

In the ATM community, Cost Benefit Analysis (CBA) is one of a set of business decision tools which has been used to assess investment proposals. The main difficulty is to create a CBA model which adequately takes into account the values, expectations, business priorities, etc. of the wide range of stakeholders in the ATM industry. In relation to the work done to date in this area, EUROCONTROL, together with its stakeholders, has developed a common approach called EMOSIA [Ref.8] together with an associated toolset. This approach is relevant for use in SESAR. However, to produce meaningful results there is still room for improvement regarding the credibility of the input data used and the relevance of the assumptions made. The weaknesses of CBA modelling are too often that :

- the input data is a “guestimate” with little justification;
- it is difficult to establish links between specific situations and the generic analyses.
- decision makers are not fully engaged in the generation of the CBA model.

To improve upon the current situation the following principles need to be followed.

- Economic and financial values (i.e., revenues, paybacks, cost-effectiveness, goodwill, etc.) need to be carefully defined and agreed by the stakeholders.
- The CBA process must lead to a shared belief, whether the outcome is positive or not. To achieve this shared belief, a well managed and constructive dialogue must take place between all stakeholders involved in the decision making process and, in the absence of facts about the future, such uncertainty must be managed so that decisions based upon such outcomes are made which incorporate the uncertainty.
- The CBA process needs to be supported by performing sensitivity and risk analyses.

3.4.2 - Recommendations & Next Steps

The following recommendations are made.

- Given the nature of SESAR the EMOSIA approach is considered suitable to support the project definition work.
- Some aspects of the EMOSIA toolset need to be strengthened [Ref.8] in order to support the high level analysis needed to develop the future ATM Target Concept.
- The toolset will need to be enhanced to support the development of possible transition deployment scenarios.
- Other enhancements may be needed on a case-by-case basis.

4 THE INSTITUTIONAL VIEW OF ATM

4.1 INTRODUCTION

Today's ATM is an international, multi-stakeholder business with a high level of Governmental involvement by virtue of the Chicago Convention. Despite advances made by the adoption of the recent Single European Sky (SES) legislation, fragmentation in Europe remains a key issue and will affect the ability of the current regulatory and organisational framework to transform the performance of Europe's ATM System by 2020. A sound, coherent legal and regulatory framework ensuring the continued growth of European aviation, whilst meeting the highest standards in the areas of safety, security and the environment is essential for the success of the SES initiative.

4.2 LEGISLATIVE & REGULATORY ASPECTS APPLICABLE TO ATM TODAY

4.2.1 - Overview of Current Situation

The ICAO Regulatory Framework is built upon the Convention on International Civil Aviation, (Chicago Convention) [Ref.25] and its Annexes. The provisions of the Chicago Convention itself are binding on each contracting State. While each contracting State is required *"to collaborate in securing the highest practical degree of uniformity in regulations, standards, procedures, and organisation"* for all matters falling within the scope of the Chicago Convention, the provisions of the Annexes are not absolutely binding on contracting States, in the sense that they are allowed to notify differences between their national laws and the mandatory provisions of the Annexes.

EUROCONTROL was set up in 1963 through the International Convention relating to Cooperation for the Safety of Air Navigation. It currently has 36 member States. Eurocontrol works to harmonise and develop air traffic management across its member States. Decisions of the Eurocontrol Permanent Commission are binding on member States, but they must be implemented through national legislation or regulation.

The main objective of the SES legislation is to create a new EC ATM institutional and regulatory framework improving and reinforcing safety, restructuring European airspace as a function of air traffic flow (rather than according to national borders), creating additional capacity and increasing the overall efficiency of the ATM System. The initial legislative package comprises four regulations establishing the new institutional framework and covering the essential elements for a seamless European ATM System. The SES Framework Regulation No. 549/2004 explicitly states in its preamble that *"The single European sky initiative should be developed in line with the obligations stemming from the membership of the Community and its Member States of EUROCONTROL, and* in line with the principles laid down by the 1944 Chicago Convention on International Civil Aviation."

The European Aviation Safety Agency (EASA) was set up in 2003 and is an agency of the EC. Currently EASA addresses the initial certification and continuing airworthiness of aircraft and related products, plus the licensing of aircraft maintenance organisations and their personnel.

4.2.2 - Strengths

- The SES legislative package adopted in 2004 provides the basic regulatory tools for the development of Europe's Single Sky and has laid the foundations for change in Europe. It is too early to gauge the success of the legislation, but it is a step in the right direction to reduce fragmentation of ATM in Europe. The framework Regulation, service provision Regulation, airspace Regulation and interoperability Regulation (see also section 4.4) are gradually being supplemented by Implementing Rules (IRs) and Community Specifications (CSs). Further political initiatives are ongoing and additional ones will be required to ensure full SES implementation.
- There appears to be no fundamental impediments in the ICAO Framework for the SES Regulations and their implementation. This, coupled with the explicit intention of the European legislator to comply with ICAO, will assist in ensuring that the SES will fit, in a consistent manner, within the global aviation context. The separation of functions and cross-border service provision (which are two main pillars of the SES initiative) are supported by the ICAO Framework.
- Existing EC law relating to competition and mergers is probably sufficient to accommodate the extent to which the SES legislation contemplates a single market for the provision of at least some air navigation services.
- Legislation is already in place for the harmonised training and licensing of Air Traffic Controllers which should contribute greatly to improved safety levels. Similarly, legislation to ensure proper training and assessment of the competence of Air Traffic Safety Electronics Personnel (ATSEP) is in place, as is legislation ensuring

that service providers have safety management systems.

• Global initiatives and EC legislation are in place regarding the environment. There are references in the SES legislation relating to the need to minimise the impact aviation has on the environment in accordance with EC legislation and for route and sector designs to ensure the establishment of environmentally friendly airspace. In air transport, legislative obligations are coming to the fore regarding the necessity to assess possible environmental impacts. No additional specific legislative action in the Environment domain is envisaged at this juncture for SES implementation.

4.2.3 - Weaknesses

• The main weakness of the ICAO regulatory framework derives not from the ICAO rules themselves, but from the way States have elected to interpret and apply them in practice. Interpretation and implementation by States of ICAO regulations focus on sovereignty and national interests; this limits the prospects for optimum separation of functions and cross-border service provision.

• The European ATM regulatory framework will still need some years to be complete and is becoming increasingly complex due to differences in the legal bases and competences, membership constituencies, governance frameworks, mission and roles. New bodies such as EASA and the proposed SESAR Joint Undertaking [Ref.29] may add to this complexity.

• Whilst a high degree of cooperation already exists between military and civil authorities, even greater cooperation and an appropriate level of transparency of military regulations is necessary for the future.

4.2.4 - Current Developments

• EUROCONTROL is providing active support to the implementation of the SES package through specific SES mandates to draft implementing rules given by the EC on the basis of Article 8 of the Framework Regulation. To date, over 15 mandates have been given to EUROCONTROL, which will all result in new pieces of legislation, either regulations or directives.

• Under the EC's Common Requirements Regulation (Number 2096/2005) ANSPs are required, by 21st December 2006, to be certified in accordance with the rules laid down in the SES Regulations and specifically the Common Requirements Implementation Regulation. At this stage it is too early to state whether the full process will be completed in time.

• The Service Provision Regulation No 550/2004 heralds an opportunity to draft common requirements for the provision of air navigation services in the field of ATM security. Close cooperation exists with NATO through the NATO EUROCONTROL Aviation Security Coordination group (NEASCOG).

• The Service Provision Regulation No 550/2004 foresees the development of a Community charging scheme for air navigation services. The EC issued a mandate to EUROCONTROL to draft a Charging Regulation with a view to evolving the current air navigation charges, including the EUROCONTROL route charges system, into a charging scheme encompassing all phases of flight. The debates in the Single Sky Committee on the draft Charging Regulation highlight the vast differences of opinion within Europe on this topic.

• Although Global Navigation Satellite Systems (GNSS) are already used in many different modes of transport, including aviation, no overarching regulatory framework is in place at an international (e.g., in the form of a GNSS Treaty), European or national level, in particular, regarding liability. The regulatory framework for the SES does not contain a specific reference to GNSS, however, the EC Regulations regarding the SES (in particular the interoperability regulation) will have an impact on GNSS related equipment and certification. Further, in providing a service based on GNSS in Europe, the provider (in addition to being a CNS provider, and hence, subject to the SES certification régime as per EC Regulation N° 2096/2005) will have to take into account a complex set of regulatory instruments at international and European level, and in multiple jurisdictions. A harmonised regulatory framework for the operation of GNSS for air navigation purposes would clarify matters and is currently being examined in the global context.

• The developments in the other regions of the World are being monitored to draw lessons learned for Europe. From an evaluation of the situation in North America, some initial observations can be made.

- There is currently a well accepted consensus in these jurisdictions that a full separation of functions improves the efficiency of the regulator and the safety performance of the service provider.
- Financing based on user fees, subject to the supervision of an economic regulator, provides more certainty and flexibility than a tax-based financing régime, which is subject to governmental appropriation.

4.2.5 - Future Expectations & Needs

• All European States, through a variety of different national laws, have legal provisions applicable to the liability of their air navigation services. Inevitably this can lead to conflict of legal considerations, particularly given the prospects of greater cross-border service provision under the SES régime (e.g., in the case of FABs). As new technology emerges (e.g., based on the use of GNSS) and new procedures unfold (e.g., the use of greater automation) liability issues need constantly to be (re-)examined. It may not be crucial to SES, yet SES should provide the impetus to establish common rules regarding the liability of ATM service provision.

4.3 SAFETY REGULATION APPLICABLE TO ATM TODAY

4.3.1 - Overview of Current Situation

In order to help ensure that the global ATM System is acceptably safe, a range of organisations and institutions has been set up to develop common standards and procedures for ATM. Together these function as the safety regulatory framework for ATM, with the three basic layers of Global, European and National Regulatory arrangements. In addition, individual organisations also introduce their own safety processes and procedures to meet the regulatory requirements.

As all issues of national security and defence are placed under sovereign national authority and regulations, this induces military regulatory fragmentation across Europe with respect to the SES implementation. In order to appropriately adapt the military towards the SES environment, Member States' military authorities requested EUROCONTROL to develop proposals to overcome the present national military regulatory fragmentation by harmonising Operational Air Traffic (OAT) rules and regulations relevant for the SES airspace. Compliance with Eurocontrol safety regulatory requirements (ESARRs) by the military is not considered mandatory in all States. However, in general, ESARRs are complied with, or a military equivalence is demonstrated.

4.3.2 - Strengths

• The ICAO, European and National ATM safety regulatory framework, in conjunction with the ATM industry, has been successful in helping to deliver an effective and acceptably safe ATM System to date.

• The safety regulatory framework is complete and comprehensive. It provides common standards and procedures that successfully define the roles of the many disparate organisations involved in ATM.

• The current regulatory framework allows for considerable flexibility in local application. This flexibility has allowed new procedures and technologies to be developed on a local scale before being applied more widely. However, this can also be considered as a weakness, since it has also led to a fragmented and complex system of regulatory requirements (see the next section).

4.3.3 - Weaknesses

The weaknesses related to the current situation, in order of importance, are summarised here.

• Across Europe there is diversity in the interpretation, application and rigour of enforcement of safety regulation. This fragmentation and variability has contributed to the variability of safety performance across Europe (although inconsistent safety reporting makes this difficult to determine).

• The complex safety regulatory framework can result in uncertainty over safety accountability and subsequent inefficiencies in the ATM System.

• In some cases the Global, European and national regulatory requirements overlap, or are even contradictory. This duplication of regulation is leading to confusion and difficulties across the industry in meeting the different regulations. This is manifest in additional costs for the ATM industry and delays in the implementation of safety improvements due to the need for increased coordination.

• The quantity and complexity of ATM safety regulatory material produced by the various regulatory bodies is an issue. Identifying all of the appropriate requirements and determining what actions need to be taken to comply with them can be difficult, particularly for smaller organisations which need to maintain the same high levels of safety performance.

• ATM safety regulations have sometimes little traceability between the requirements and the safety objectives that they are trying to achieve (e.g., if the safety regulation is bound to specific technologies). Such a lack of traceability presents difficulties when introducing innovative solutions, as it is not straightforward to demonstrate that the new solution delivers equivalent or better safety performance.

• ATM safety is only a small element of the safety of air transport and safety is only one part of the overall regulatory and legislative framework that applies to ATM. There is a lack of harmonisation in safety regulation between different segments of industry, especially between the ground-based and airborne segments. This includes having un-coordinated safety targets, different approaches to making safety assessments and different classification schemes or causal factors schemes in incidents. The interfaces between safety regulations should be clarified to avoid conflicts in regulatory requirements that could lead to safety performance being compromised.

• All of the above make it unclear to determine whether ATM safety regulation is cost-effective. Such costs are rising through, for example, the setting up of National Supervisory Authorities (NSAs). Further the uncertainty of the future regulatory framework makes it difficult and costly to plan for future developments.

4.3.4 - Current Developments

The ATM regulatory framework in Europe is currently subject to major development through the application of the ESARRs and SES legislation. The implementation of the ESARRs is proving to be a slow process as they have proven more difficult to implement than originally envisaged. The expectations are that this work should result in a harmonised safety regulatory framework for ATM service providers across Europe.

EC Member States are required, under the SES framework Regulation, to nominate or establish a body or bodies (which are independent of air navigation service provision) as their national supervisory authority (NSA). The tasks assigned to an NSA include

supervision, liaison and publishing. However the final division of tasks is the responsibility of the State and so the role of NSAs does vary between States. States are facing challenges in setting up effective NSAs due to difficulties in staffing and financing the necessary activities.

4.3.5 - Future Expectations & Needs

Proposals for the extension of the competence of EASA to include ANS provision and airports are being developed. There is a need for clarity on the future relationship between NSAs and other European regulatory organisations, particularly that of EASA. In order to encourage the development of consistent standards in regulation, peer reviews between NSAs are expected to be implemented in the future. Furthermore, military authorities are considering how best to interface with EASA once it adopts greater responsibility for ATM.

Any future ATM safety regulatory framework should also seek to build on existing "best practices", taking advantage of the "best fit" approach to conducting safety regulatory activities to meet the regulatory objective.

4.4 APPROACH USED TO DEFINE & SET STANDARDS IN ATM TODAY

4.4.1 - Overview of Current Situation

Standardisation is only a means to achieving the objective of interoperability and global harmonisation. It is a vast subject which encompasses many technical, economic and political aspects. Interoperability is one of the biggest issues confronting ATM in Europe today as, for example, demonstrated between the current iTEC and COFLIGHT FDP systems replacement programmes. The current level of interoperability between ATM Systems within Europe is low, especially in ground systems. This is due to the current fragmentation of systems, inconsistencies in the definition and use of data and the overall lack of a common understanding of what needs to be standardised.

Some successes, such as the creation of the ASTERIX standard, show what can be achieved, but overall ATM standardisation is seen to be complex, fragmented and unclear. There are too many organisations, authorities, agencies, etc., participating in the standardisation process in different subject areas and with varying degrees of effectiveness.

To ensure Global harmonisation, it is paramount that the standardisation activities of airborne systems between Europe, the US and others parts of the World are maintained and improved.

4.4.2 - Standardisation principles

The standardisation development has to be based upon the following principles:

4.4.2.1 - Standards need to be developed with Respect to a reference Operational Concept and System Architecture

- Setting an operational vision and associated implementation plans are key drivers for a federated and consistent approach towards implementation (i.e., achieving standardisation, certification, regulation, operational approval, etc.) by all stakeholders. Therefore, the operational concept and supporting architecture are required to be used as unique references for the development of standards for the supporting elements.
- Standards addressing Worldwide requirements are essential for airspace users and consequently, for aircraft manufacturers.

4.4.2.2 - The Communication of the Requirement for the Development of a Standard

- The main benefits of achieving standardisation are to achieve interoperability and reduce development and procurement costs. These benefits have to be explicitly communicated to and understood by all stakeholders.

4.4.2.3 - Operational & technical Development of a Standard

- Standardisation must be seen as a transversal activity, considered as a whole (i.e., from concept definition to certification process) and embrace all ATM aspects.
- The voluntary nature of industry participation in the development of standards has the potential to cause delay and/or create standards which are sub-optimal.
- Recent initiatives (e.g., the Flight Object Interoperability Proposed Standard (FOIPS)) demonstrate that a combination of highly focussed preparatory activities which are funded and global consolidation are beneficial for developing the content and increasing the speed of the development of standards.
- The resources and skills needed to manage standardisation working groups must not be underestimated.

4.4.2.4 - Adoption & Publication of a Standard

- ATM-related organisations are not involved at the appropriate level in the adoption or publication of ATM standards by the European Standardisation Organisations [Ref.11]. ATM-related organisations should have a preferential position, which is not the case today.

4.4.2.5 - Application of Standards

- There is a lack of consistent and harmonised application of operational standards and working methods (e.g., the use of a common language and phraseology) which may have an impact on safety.
- Standardisation bodies are tasked to develop standards to meet operational and/or technical needs, but the way they are applied

(i.e., sometimes fully, partially, or not at all) is not always consistent. Addressing this is a regulatory issue.

4.4.2.6 - Standardisation & Validation

• To ensure that cost-effective standardisation delivers the operational benefits, the process must be accompanied by operational and technical validation plans & programmes, supported by a validation reference platform. These allow the maturity levels of the operational concepts, the technical feasibility of the solutions and the business benefits to be assessed. A good example of this is contained within the Link2000+ Programme [Ref.13].

4.4.2.7 - Standardisation & Certification

• There is a lack of involvement of Certification bodies (e.g., EASA) within the standardisation process, which can often hinder the ultimate recognition of the standard.

4.4.3 - Current Developments

The SES Interoperability Regulation provides the framework for legislative implementation rules and specifications for ATM ground equipment. However, without a holistic approach, fragmentation with regard to interoperability between the aircraft systems, airport facilities and the ATM System will continue to exist. The "buy-in" to the Interoperability Regulation and derived standards and/or specifications in isolation from the other systems may risk adding to that fragmentation and being counterproductive to the objectives of the SESAR project.

The interoperability between aircraft, airports and ATM systems and operations is the only cost-effective way forward. In its application it will improve safe operations and give the possibility to optimize the capacity of the ATM System as a whole. The development and use of the SES legislation in this way would be one of the main achievements for aviation and allow a true Single European Sky to become a reality.

European standardisation must be coordinated at both the regulatory and technical levels to ensure that the standards will meet the needs of the business and will be implemented. The recently created Air Traffic Management Standards Co-ordination Group (ATMSCG) [Ref.11] is a first attempt at doing this.

Moving away (except in justified specific circumstances) from prescriptive and/or technically-oriented regulatory provisions towards performance-based regulatory provisions assisted by technology standardisation could help transition and would also improve the interoperability with military systems.

4.4.4 - Future Expectations & Needs

The future standardisation process, to be both effective and efficient, must:

• have clear objectives;

• be more effective, focused, funded and synchronised to when its products are needed;

• support a clear intention to implement the standards, so avoiding the development of those which are not based upon any operational concept or implementation plan;

• be managed as a programme, with adequate resources that empower the process and enable it to deliver the products when the market requires them;

• rationalise the number of standardisation organisations and/or clarify their terms of reference, including their roles and responsibilities.

4.5 GOVERNANCE, MANAGEMENT STRUCTURES & ASSOCIATED DECISION-MAKING MECHANISMS RELEVANT TO ATM TODAY

4.5.1 - Overview of Current Situation

In the fragmented and complex European institutional landscape decisions often have to be passed through many different levels of decision-making bodies, with different individuals, national and international organisations involved at different points. Fig.4.1 illustrates, in a simplified manner, the bodies currently involved.

This adds to the complexity of the process and often the time it takes to make a decision.

Clear governance arrangements within European ATM allowing efficient decision making and reporting are considered to be crucial for the success of large scale programmes, or initiatives.

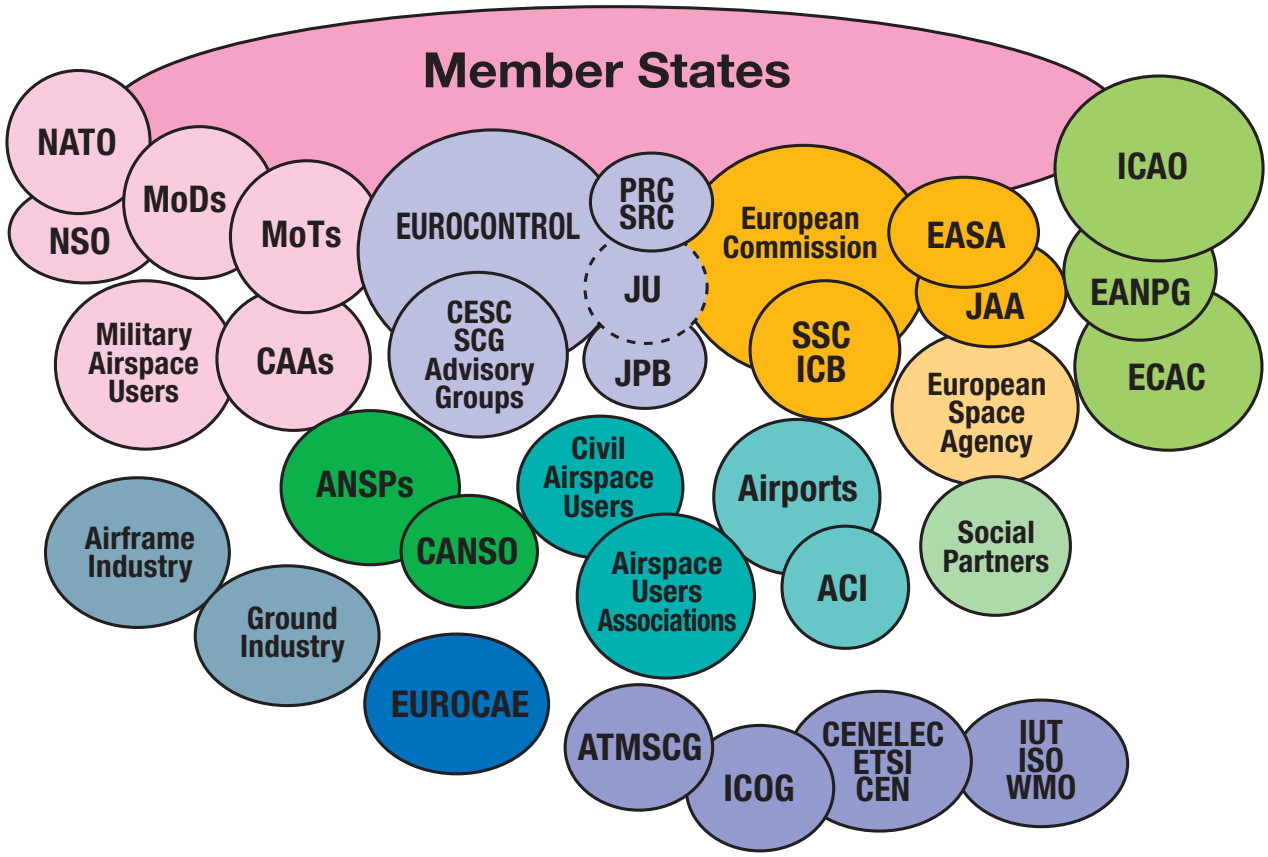

Fig.4-1 : Simplified Overview of Bodies in the Existing European ATM Framework

4.5.2 - Strengths

- Europe has, in EUROCONTROL, an established expert intergovernmental body working across the ATM industry. The involvement of the key stakeholders in this process has produced benefits through the :
  - coordination of the strategic development of Europe's ATM System;
  - developing and implementing regional pan-European services;
  - managing major European programmes;
  - ensuring civil/military co-ordination.
- Collaborative projects amongst regional groupings of ANSPs have contributed to capacity increase and reductions in delays.
- Good cooperation between EU, EUROCONTROL and ICAO has contributed to the development and application of common standards globally and within Europe, and has avoided any substantial incompatibility between European Regulations and the ICAO regulatory framework.
- The European Community brings a robust legislative and regulatory framework with full enforcement powers against non-compliant States and third parties.
- Industry has provided the products and solutions where there have been the necessary mandates and incentives.

4.5.3 - Weaknesses

• The European institutional framework is increasingly complex due to differences in the legal bases, competencies, membership constituencies, governance frameworks, missions and roles. Solutions that have introduced new institutional elements have often generated additional complexity.

• The governance and consultation process does not always balance the inputs and interests from all stakeholders and specifically the needs of the airspace users as the customer for the final product.

• Fragmented decision-making across national, European and organization boundaries is inefficient and ineffective for programme delivery. It can result in :

- a lack of timely, continuing and fixed engagement of stakeholders in the ATM process;
- project and programme managers who are often not empowered and have not been delegated the necessary resources in order to provide timely delivery of the agreed products and services;
- no effective monitoring to ensure compliance with agreed decisions.

• Regulatory activity does not always take fully into account the interests and rights of small users.

• Despite the efforts of the SES, the current governance structure and decision-making processes remains heavily linked to national and, in the case of airports, local Governments.

• The current regulatory framework treats air and ground as mutually exclusive, rather than as an integrated system.

• There is not a common playing field for regulation between different ICAO regions.

• The current "same service to all businesses" and full cost recovery model inhibits innovation and is detrimental to the development of products, as there is no agreed mechanism to reward early implementers for their investment.

4.5.4 - Current Developments

The complexity inherent in the system and its processes are borne from the need to accommodate the large number of interested parties from private organisations to governments, users and regulators. However, it is generally accepted that complexity and duplication of processes and bodies is leading to unacceptable delays in making decisions and, in some cases, denial of making a decision. This can, in part, be attributed to the perceived need by groups such as lobbying bodies, trade unions, etc., to "build" new bodies in order to "counteract" what is managed in others.

ANSPs are now becoming increasingly separated from their governing State bodies and are held directly accountable for the performance of their operations. However, States retain ultimate responsibility for the provision of ANS in their territory. This has important consequences on the relationship between EUROCONTROL and the service providers. The ANSPs wish to be more involved in decision-making in activities where EUROCONTROL provides the central support role. The airspace users recommend active involvement and engagement in those bodies preparing the proposals for Provisional Council decision on matters involving air navigation services (including networking issues) and the related regulatory aspects. Within EUROCONTROL significant changes to the Director General's stakeholder consultation and involvement processes have been implemented, but these have still to demonstrate sustainable improvements in decision-making.

4.5.5 - Future Expectations & Needs

Whilst the current system of decision-making, with its inherent complexity, has worked by delivering a number of successful projects, a number of projects have also failed to achieve uniform implementation (e.g., PRNAV approaches), or to progress in a timely manner according to the expectations (e.g., CEATS). With greater requirements for regulatory, operational and technical integration bringing together the air and ground segments, it is considered that the existing processes are not suitable for delivering the design, development, implementation and deployment of a future European ATM System which contains seamless interoperability. All of the above issues need to be addressed in a coherent and consistent manner if the future European ATM Master Plan is to be a success

5 OPERATIONAL AND TECHNICAL VIEW OF THE CURRENT ATM NETWORK

5.1 INTRODUCTION

The current provision of ANS is based on the concept of ATC being provided by ground ANSP services. The evolving ATM System of today has over time maintained this basic concept and introduced improvements to it to supply capacity whilst maintaining safe operation. However, in general, these improvements have been made in a piecemeal manner. In Europe there are numerous ATM/CNS legacy systems and operational procedures in service today, which have varying capabilities and various degrees of complexity. They are deployed to meet the growing demand for ANS, but without any overarching ATM concept or functional architectural design involving all ATM stakeholders, or the framework to create an efficient, performance based ATM System. This fragmented approach to making changes to such a System is insufficient to cope with the current and future traffic needs as laid down in the ICAO Global ATM Operational Concept Document [Ref.2] which was endorsed by the global ATM community at the ANC/11.

The requirement is that the future ATM System consists of both the airborne and ground segments being designed to be integral parts of it, so enabling an holistic approach to be taken to grow air traffic safely and efficiently. Expectations are that significant capacity gains will be obtained with the efficient use of existing technology and improved airspace management. This will then enable the paradigm shift needed in ATM to break through the capacity barrier to be developed whereby the shifting of roles and responsibilities within the ATM System can be made to match the strengths of the human operator with the power of automation in a well-balanced and carefully managed manner.

It is considered that quite a number of short-term solutions can be found to overcome many current shortcomings (see Annex 3), but for the medium and long-term it is essential to rejuvenate the ATM concept of operation according to performance needs and expectations by the air transport industry as a whole. However, this must also be done within a revised institutional framework, the two being designed to be mutually supportive. The main object of the new concept of operations must be not only to continue the safe conduct of air transport, but also to provide the necessary flexibility to enable the effective interaction between all stakeholders. The future ATM System must not only allow capacity to be grown efficiently, but also to be more adaptable, and so enable it to dynamically respond to changes in aircraft performance and capabilities to exploit the operational benefits on offer.

5.2 CURRENT ATM SYSTEM FROM AN OPERATIONAL PERSPECTIVE

5.2.1 - General

The ATM System, from an operational viewpoint, is characterised by a number of ATM elements. These are depicted in Fig.5-1 as defined by the ICAO Global ATM Operational Concept Document (OCD) [Ref.2]. Each element is summarised as follows.

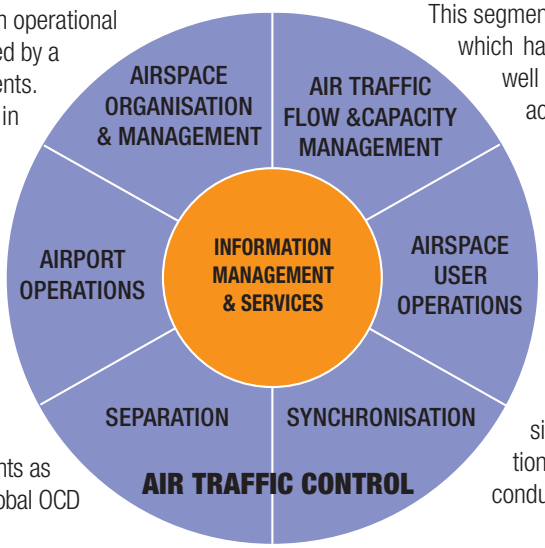

Fig.5-1 : ATM Elements as defined by ICAO in the Global OCD

• Airspace User Operations

This segment refers to the ATM related aspects of flight operations which have differences in planning horizons from “scheduled well in advance” to “just prior to the flight becoming active”. The ATM System accommodates diverse types of vehicle characteristics and capabilities most of which are today manned. However, expectations are that in the future unmanned aerial vehicles (UAVs) will become more numerous, so a mix will have to be accommodated. Mission planning is performed by the airspace users, but only partly performed as a collaborative exercise with the air traffic flow and capacity management segment to ensure that the ATM System will be able to accommodate the missions. The airspace users' operational control is a function they perform to exercise authority over initiating, conducting and terminating missions.

• Airport Operations

Airport operations shall be seen from an ATM "en-route to en-route" perspective, to better capture the turn-around process which interacts with other actors rather than just ATM, but which nevertheless impact upon ATM. As an integral part of the ATM System the aerodrome provides and manages the ground infrastructure (i.e., runways, taxiways, lighting, surface guidance systems and other support equipment) needed to ensure safety and the efficient use of the aerodrome's airside infrastructure, so enabling the maximum use of its capacity in all weather conditions.

• Airspace Organisation & Management (AOM)

Airspace organization establishes airspace structures in order to accommodate the different types of air activity, the volume of traffic and the differing levels of service. Airspace management is the process by which the airspace options are selected and applied to meet the needs of the ATM community.

• Air Traffic Flow and Capacity Management (ATFCM)

Air Traffic Flow and Capacity Management pre-tactically evaluates traffic flows to balanced capacity according to a demand baseline in order for ATC to create an orderly flow of air traffic. The airspace users then determine when, where and how they operate, whilst mitigating conflicting needs for airspace and aerodrome capacity.

• Air Traffic Control (comprised of Separation and Synchronisation)

Synchronisation refers to the tactical establishment and maintenance of a safe, orderly and efficient flow of air traffic. Separation minimises, to an acceptable level of performance, the risk of collision between aircraft and hazards. Aircraft must be separated from other aircraft, terrain, bad weather, wake turbulence, incompatible airspace activities and, when the aircraft is on the ground, surface vehicles and other obstructions on aprons and other manoeuvring areas.

• Information Management & Services

Information management covers the logistics and distribution of accredited, quality-assured and timely information used to support all the ATM elements, so forming the "glue" between them. It is the basis for being able to perform collaborative decision making. In the not too distant future information management will be required to monitor and control the quality of the shared information, as well as providing information-sharing mechanisms that support the ATM community. This will enable all to assemble the best possible integrated picture of the historical, actual and expected state of the ATM System to be available in real-time.

5.2.2 - Interactions between ATM Elements

In general, the AOM and ATFCM elements co-operate to address the strategic operational planning aspects. However, sometimes they also interact to solve pre-tactical and even tactical issues. In addition to the main ATM stakeholders, States, Military Authorities and EUROCONTROL are involved in these processes. The increasing implementation of effective civil/military co-operation highlights the potential to efficiently redesign airspace in several States to cope with the traffic demand and to increase flight efficiency. However, the simple implementation of Airspace Management Cells (AMC) is not sufficient. There are examples of excellent AMCs, but very inefficient civil/military airspace designs. The current ATFCM complements the local traffic picture developed by stakeholders, providing an overview of the air traffic situation within European airspace. The potential benefits from these tools, however, cannot be realised in many cases, as there is fragmented responsibility and complex co-ordination of the design of airspace. This is, in particular, the case for cross-border areas and routes whereby effective en-route to en-route planning is prevented as these aspects are not covered by the current decision making processes.

The Airspace User Operations, Airport Operations and Air Traffic Control elements form the current core of the daily tactical operation of the ATM System. The present capacity is highly dependent upon the role of the controller, their ability and the level of technical system support provided to them. Current automation levels are limited in their functional capability to support the human operator to build a 4-D traffic picture; it is left to the controller and their skills and training to reach the performance levels required. Without the appropriate supporting tools the human's ability to build 4-D traffic pictures is limited. The distribution of the responsibilities is clearly defined between qualified and trained professionals. Initial steps have been taken to improve coordination between controllers and the ATC ground systems and facilities. The operation is hindered by the limited availability of information and constraints in the sharing of information between the stakeholders, as well as the fragmentation of airspaces and the excessive co-ordination needed between all participants. This is particularly true for airport and airspace users supporting services such as ground handling, de-icing and others which need to form an integral part of the overall collaborative decision making process. It limits the coordination between the parties on prioritising the allocation of resources. The result is an inefficient and non-collaborative use of the available capacity and a lack of flexibility to cope with unusual occurrences.

Information management, together with collaborative decision making mechanisms at all levels, is a key to enabling the ATM elements to co-operate, so creating a networked environment. With possibly some minor exceptions, a complete ATM/CNS infrastructure is in place. Apart from establishing an appropriately defined set of information services, there is the urgent need to establish a common information model between all stakeholders. Irrespective of the concept of operations for different areas and functions, efficient information management and collaborative processes will contribute to the optimum use of the assets within the ATM network and improve the effectiveness of all stakeholders, both now and in the future.

5.2.3 - Current Developments

The present European ATM network is increasingly showing operational blocking points to improving performance. Annex 3 provides an inventory of the shortcomings as currently identified. Several initiatives (e.g., DMEAN) are currently addressing, through increased co-operation between all stakeholders, some of these shortcomings. These initiatives will surely contribute to the improvement of the performance of the European ATM network, enabling some increase in capacity in the short and medium terms [Refs.17,18]. However, the success rate is likely to be rather limited in some cases, as past and current projects initiated by various stakeholders, in particular the EC FP5 & 6 programmes, EATMP, ICAO, and FAA/EUROCONTROL, aimed at resolving specific blocking points, have not necessarily been fully co-ordinated with others, especially in terms of implementing the end products.
At the same time incentives to change, and thereby improving the will of stakeholders to implement proposed solutions, is missing and in these cases it is evident that company policies linked to individual company investment plans do not coincide. This comes from the lack of a visible overall Future ATM Target Concept, a clear understanding of the end goal for the complete ATM System and, most importantly, the collective benefits to be realised by the stakeholders involved. The net result is a limited implementation.
The need is to establish and clarify to all stakeholders in the ATM community the overall vision of creating a future European ATM System which is in accordance with the ICAO Global ATM Operational Concept Document, together with a more integrated and coherent approach to managing both R&D and implementation programmes in the same System context. Failing to do this will perpetuate the current situation where, for example, improvements in reducing en-route delays are not complemented by reductions in ATM delays at airports. This is illustrated in Fig.5-2.
Not having such a coordinated approach means, potentially, bottlenecks are shifted rather than the fundamental shortcomings in the current System being resolved.

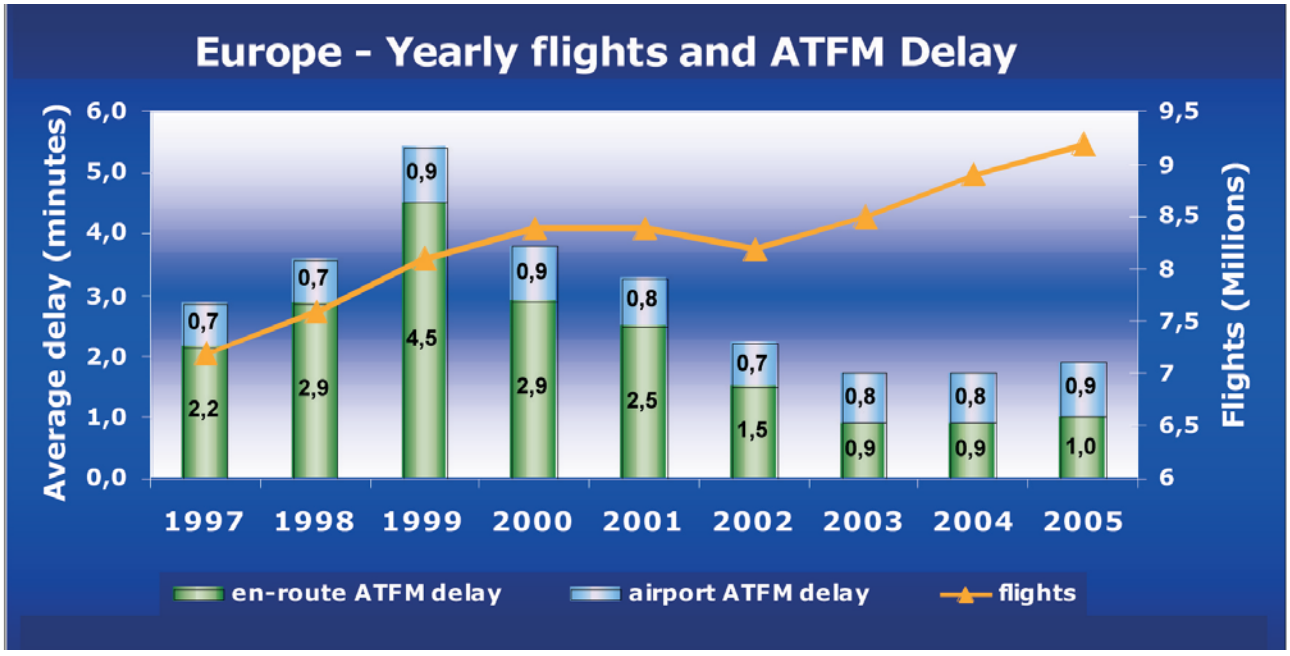

Fig.5-2 : Number of Flights in Europe & Average ATFM Delays over past 10 years

5.2.4 - Summary of Findings

All human actors in today's European ATM Network are highly skilled, which contributes to achieving safe operations within the current paradigm. The ongoing evolution of ATM, with the trend to improve the operations planning, will increase the multiplicity of actors involved in the various processes and the complexity of the sharing and exchange of the information needed by each actor to perform as required. A well-balanced approach is required.
An effective collaborative process between airports, airspace management and the ATFCM element is essential to increase and ensure an optimised use of the gate-to-gate capacity of the European ATM network. For each of these processes, the appropriate actors should be identified within the stakeholder organisations. An appropriate level of automation in order to reduce complexity and increase efficiency should support this. This would prevent another increase in ATM delays, both in en-route operations and at airports. The lack of a clear collaborative and information sharing process is one of the reasons that there is an increase of ATM delays at airports which,

in 2005, totalled some 8.7 Million minutes.
Overall poor information sharing and management prevents proper coordination between all stakeholders resulting in the less effective use of available assets and thereby hidden costs to the airspace users in the form of operating inefficiencies, such as a non-optimised turn-around process.
In the timeframe covered by SESAR, and especially in the short term, the ATM network could significantly benefit from an improved, integrated approach to pan-European planning and coordination between all stakeholders, both at the strategic and tactical levels. One way to support this is to make use of the already agreed and endorsed view of the ICAO Global ATM Operational Concept.
Additionally, in the long-term, to cope with the increasing complexity of the coordination needed between the stakeholders to supply an optimum capacity to meet future air traffic demand, the increased use of automated tools is considered essential. These tools can only be applied effectively if they are steered by the concept of operations, a consistent redesign of the airspace based on the service expected and the de-fragmentation of organisational and institutional structures. Thus, specific attention should be given to :

- fully integrating Airports operations in an ATM "en-route to en-route" context to optimise the turn-around performance and safe and orderly flow of traffic on the ground and along the routes to and from the airport to optimise the capacity of the ATM network;
- simplifying and increasing the transparency of collaborative decision making processes;
- consider all ATM stakeholders as ATM partners of a shared ATM System, bearing in mind that their respective roles, business drivers and the services they need and supply affect the overall performance of the ATM System.

5.3 CURRENT ATM SYSTEMS FROM A TECHNICAL & TECHNOLOGICAL PERSPECTIVE

5.3.1 - Overview of Current Situation

Various technology solutions, sometimes with overlapping capabilities, are in today's ATM System as enablers for the provision of ATM services. The only way aviation can benefit from the technological developments on offer to support the steady growing demand for air transport, whilst optimising the supporting infrastructure architecture, is to coordinate and rationalise their selection. To maintain the benefit of global interoperable systems, all technical solutions must prove their compliance with the functional and regulatory requirements. Proliferation of technology solutions will then be kept to the minimum number required, leaving options for a "best choice" according to ATM System-wide business cases, or different stakeholders CBAs.

Although no overall architectural design exists at the European level today, Fig. 5-3 shows the principal inter-relationships and connectivity between the major processing entities and systems in today's ATM System. It is shown here for indicative purposes. The current CNS/ATM "architecture" is characterised by a set of diverse systems which have evolved individually. Although some international standards have been agreed primarily in the CNS areas (where COTS products exist since there is a wider market place for them than just in civil aviation), developments in ATM data processing systems have tended to be of a bespoke nature since the availability of COTS products is very limited due to the limited market place for them. Hence, the scope for achieving widerspread interoperability based upon the premise of using COTS products is very limited.

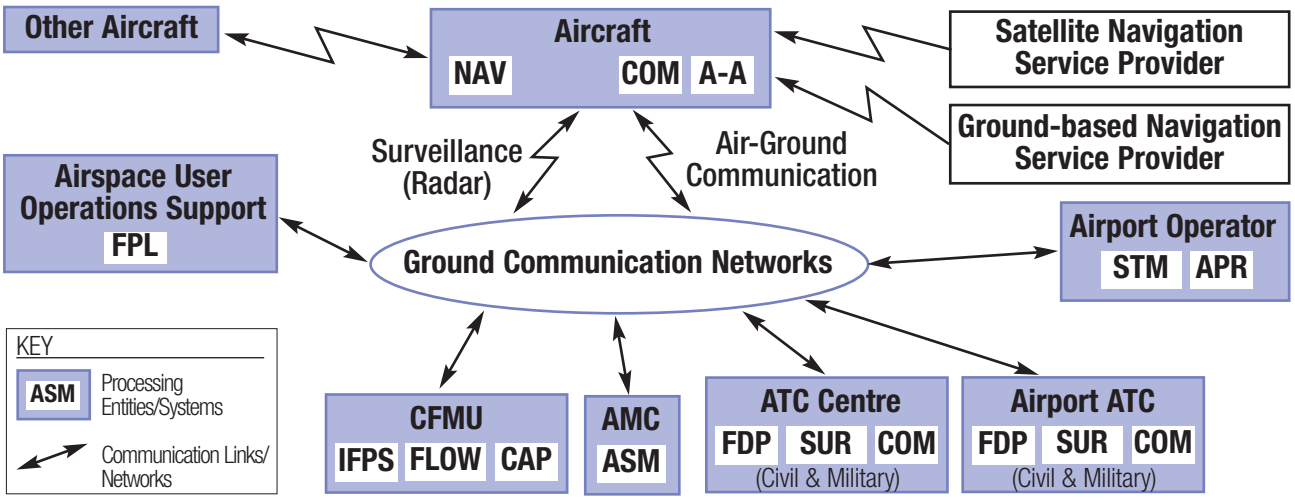

Fig.5-3 : Principal Inter-relationships between Major Processing Entities/Systems in Today's ATM System

5.3.2 - An Inventory of the Present Architecture and Technological Considerations

5.3.2.1 - General

The following is a list of technologically orientated considerations which identify concerns associated with the current ATM System coupled with future expectations and needs.

- A blueprint of a commonly accepted European ATM/CNS architecture that enables different implementation teams to build compatible and interoperable systems based on different technical enablers is missing. Individual systems are increasingly built using commercial off-the-shelf (COTS) hardware, together with already developed software and application products. With such a blueprint, the present fragmented ATM environment can be technically supported in the transition towards the ICAO Global ATM Operational Concept with a sharing, seamless, desirable ATM environment and still be able to maintain diversity in the implementation of technology, so reducing the risk of common mode design failures and gaining the benefits of procuring systems competitively.
- To increase the flexible use of civil and military airspace, the military must be part of the process to define the future European ATM System and to ensure the civil/military interoperability regarding aircraft flying under IFR and those flying as GAT.
- When the current ATM System is driven to near total capacity there is an impact on the ability of it to provide margins for fallback under exceptional conditions. In this context if the increased reliance on technology is unable to provide graceful degradation, a strong operational and procedural back-up to provide contingency is required. Points of failure that were previously contained with a limited geographical or functional boundary may, in this context, now be propagated throughout the System.
- The current technologies in operation can, to a limited extent, support growth within the current ATC paradigm, but the implementation of new technologies, together with a change of paradigm to perform ATM, is considered essential to support future traffic growth to the level expected. The legacy information architecture and technology can neither adapt easily to using upto date methods for data exchange, nor were they designed with the security requirements in mind which are now considered necessary to meet today's threat from cyber attack. Available technologies to fulfil the short and medium term needs are already identified and partially implemented. Investment decisions are delicate and often steered by company aims rather than having the overall efficiency of the ATM System in mind. This is partially because the aviation systems market is small, so exacerbating the choice of contending solutions.
- Understanding the overall aim and using a proficient process to obtain commitment through performing validation, standardisation and certification activities, can significantly reduce investment risks, transition costs and shorten the technology development lifecycle. Traditionally the long lifecycle to develop aviation solutions is becoming increasingly out-of-step with developments in the mass markets of other high technology driven industries.
- Radio spectrum is a scarce resource and the aeronautical community has to increase its influence in the regulated ITU world to ensure at the WRC 2007 that access to adequate radio spectrum is assured and protected for the long-term accordingly. The EU must ensure that aviation interests are protected and seek to provide the aeronautical sector with sufficient spectrum to plan and deliver the required capacity growth, whilst increasing safety performance and, at the same time, promoting the timely introduction of more spectrum-efficient technologies in this business sector.
- Concurrent with the above, the air transport industry as a whole must learn to effectively manage the allocated radio spectrum and the associated aspects to transition to new allocations in order to reuse and/or release spectrum the air transport community has already acquired for systems deployed in the early days of establishing ATM.
- When reviewing the current principle upon which the role of the "last resort safety nets" used to avoid collisions is based - namely that they function independently from those functions used to routinely provide safe separation as part of the main concept of operations - care must be taken to ensure any changes to this principle are very carefully considered. Potential developments of safety oriented systems and functions, such as ACAS, functioning independently from the ATM network fall into this category.
- The effect on new systems from the introduction of new type of aeroplanes, such as UAVs, shall be addressed as soon as their concept of operations is known to ATM.
- Within the future ATM architecture a possible integration of the alert & aircraft position fixing element could be considered.

5.3.2.2 - ATM Architecture

The information exchange between ATM systems has significantly improved due to local solutions developed, but this has been done without considering the need for global interoperability. For example, information sharing with airports in support of the ATM processes is very limited. This in turn limits the optimum use of airport capacity. The ATM System lacks a standardised information format and model. This is manifest in the lack of consistency of the information contained in various databases. It is also a severe weakness for a network which aims to share information to improve services and introduce advanced automation. A well-defined, consistent information structure which enables a cohesive set of databases to be used is needed.

Ground ATC Controller operating systems with different capabilities cannot deliver the same required operational services, which unnecessarily increase the workload for crosscenter routine functions such as handovers between ground ATC providers.

Capacity and load balancing tools and procedures are not homogeneously implemented among ground ATC providers areas of responsibility, providing incompatibilities resulting in inefficient use of available capacity.

Without having procedures and tools for airspace users, airport operators and ANSPs to use when exceptional events (e.g., runway

closure, adverse weather conditions, etc.) occur, the current heuristic approach for solving these unexpected events is not adapted to a planned, predictable overall ATM process. Recent runway incursions and the knock-on effects of delays during peak traffic periods has demonstrated that surface movement support functionality must be improved.

5.3.2.3 - Communication Infrastructure

The aeronautical communications infrastructure is traditionally divided into two parts, the air-to- ground and ground-to-ground infrastructure, also characterized as fixed and mobile communications. The local nature of fixed communication does not require a high degree of system standardisation, which led to an overall network approach using common protocols such as AFTN or CIDIN. There is ongoing work on an Aeronautical Telecommunication Network to connect all aviation end systems within one virtual network, although this has not been highly successful due to the time taken (in the order of 15 years) to develop it despite suitable communications protocols being readily available. COTS products, compatible with service providers/operators market technologies, are being used for ground information and communication networks.

For Europe, the main air-ground voice communication system is the VHF analogue system operating in steps of 25 and 8.33 kHz channels. VDL2/ATN is chosen as the initial data communication standard (supporting datalink services - e.g. CPDLC). The implementation of datalink technology must be accelerated and focused on time critical issues, as this is essential for the migration to the provision of ATC datalink services. It is also needed as a complementary means to support growth and provide extra capacity. Finally it is a prerequisite for future ATC automation. CPDLC can be used in Europe for equipped aircraft.

Despite the introduction of more spectrum efficient data link services, it is predicted that within 10 years the ongoing demand for voice channels cannot be satisfied in the presently allocated VHF band even after full deployment of the 8.33 kHz spacing.

Commercial satellite services are used for both mobile and fixed voice and data communication. The mobile satellite and high frequency communication data and voice services are supporting data and voice services in oceanic and remote areas. Before the use of mobile satellite in higher density areas can be considered, several issues need to be resolved concerning the provision of the services such as its performance, cost, the associated institutional aspects, liability, sustainability, guarantee of operations and availability.

5.3.2.4 - Navigation Infrastructure

En-route Navigation is currently provided by a large range of navigation services using conventional terrestrial systems and more recently GNSS. A large range of airborne navigation capability also exists, usually based on multi-sensor navigation systems. Conventional, terrestrial navaids are currently required to provide a back-up capability to mitigate the current vulnerability of GPS (although they are, at present, not well-sited to do this in an optimal manner), but there are also other means of doing it. They are also a service requirement in airspace where RNAV is not mandatory and for use below certain FLs. Non-Precision Approaches make use of conventional navigation means, or the combination of GNSS & ABAS. Lower minima operations are attainable through lower RNP. PRNAV can be used for more flexible and accurate initial approach routes (e.g. curved and segmented approaches). There is also a trend to achieving near CAT I operations when augmenting the aircraft's capability using the IRS with Baro-Nav coupled with GNSS information. For aircraft not equipped with IRS, APV I/II and RNAV will be potentially enabled by SBAS, but this requires appropriate capabilities to be on the aircraft and on the ground. Precision Approach (CAT I to CAT III) is supported mainly by proven ILS, which is widely implemented. Capacity reduction during Low Visibility operations is caused by multiple factors including such factors as ILS sensitive areas, and runway occupancy times. To sustain the low visibility at its present level the feasibility for Category II-III GBAS-based approaches are being investigated. GNSS improvements are initiated, e.g. adding constellations (i.e. Galileo) to the present operating GPS, SBAS (i.e. EGNOS) or multiple signals in space to improve availability, continuity, accuracy and integrity. MLS is anticipated where economically justified as an alternative to ILS for Cat II/III operations.

In order to maximise the use of current aircraft capabilities, performance-based navigation concepts are being implemented. BRNAV (5NM) is mandatory in Europe and is based on multi-sensor navigation systems. PRNAV capability is increasingly being fitted in aircraft, but PRNAV procedures are not implemented on a large scale due to lack of commitment on a local scale. Transport category aircraft will be increasingly capable of a 4D trajectory navigation performance with a predictable containment and updated by the actual external flight environment. However, at present the ground systems cannot exploit this capability.

Developments in airport navigation are ongoing, supported by GNSS which includes the use of possibly augmentation systems.

5.3.2.5 - Surveillance Infrastructure

There is in most areas of Europe adequate surveillance radar coverage based on SSR and complemented by PSR. The radar infrastructure is expected to remain over the entire SESAR implementation timeframe. SSR-Mode S ground stations will, in the core area of Europe, be increasingly deployed to overcome the shortcomings of conventional SSR and can provide benefits to ground ATC service provision from increased air-ground data exchange capabilities. The increasing carriage of Mode-S Airborne XPDR will be the catalyst for Multilateration and for ADS-B-out when the 1090 ES capability is included. Multilateration and ADS-B enhances the current ground ATC systems ability with dependent and independent surveillance to rationalise the radar infrastructure and providing surveillance in non-radar airspace. Potential for additional introduction of PSRs regarding safety, or security needs to be considered in conjunction with the needs of the military.

To overcome the current lack of situational awareness the Air Traffic Situation AWareness (ATSAW) and anticipated ASAS applications, and to act on runway and airspace incursions without clearance the aircraft are and will increasingly be fitted with an ADS-B IN and OUT capability.
Plans for TIS-B and the overall ADS-B architecture will depend upon the future ATM Target Concept when clarity is brought to the concept of the sharing of tasks between air and ground. On the aerodromes, surface movement radar is the basic means today for ground ATC surface surveillance. Multilateration techniques based on multiple sensors, surveillance data processing and distribution and ADS-B datalink applications are increasingly being implemented at airports, on one hand as an ATC tool to mitigate against runway incursions, and for ADS-B to increase situational awareness to all aircraft and vehicles to avoid possible runway incursion incidents and accidents.
The following steps are currently anticipated in the deployment of ADS-B within the SESAR timeframe :

- Initially ADS-B OUT for various ground surveillance applications.
- ADS-B IN/OUT for surface surveillance (aircraft and ground vehicle use).
- ATSAW to improve situational awareness as aircraft get fitted with ADS-B IN.
- ADS-B IN to be deployed as the enabler of the ATM concept elements through ASAS applications.

5.3.3 - New Technologies & Resolving Blocking Points.

Many of the identified blocking points can be resolved with a coordinated introduction of new technologies that are mature, ready for implementation and could be deployed more rapidly. They can contribute to short-term capacity and efficiency enhancements for the benefit of all ATM stakeholders.
Particular attention should be given to the implementation of RNP/PRNAV, Link 2000+, Enhanced Mode-Surveillance applications and other mature data-link applications such as ADS-B, enhanced FDP systems and new controller tools. The contribution of these initiatives to ATM safety, capacity and efficiency are increasing as aircraft and ANSP ground systems are becoming more capable, but care must be taken to consider them in conjunction with satisfying the need for an overall functional architecture for the future ATM System.

5.3.4 - Summary of Findings

There are a variety of systems with various capabilities and complexities operating in Europe today which are deployed to meet local needs. The current introduction of new systems, procedures and capabilities sometimes make it difficult to draw a complete picture of the capabilities presently available, in particular on the airborne side, complicating the development of a stakeholder collaborated and an agreed transition plan towards the ICAO Global ATM OCD [Ref.2]. New technologies identified to improve the quality of services in the CNS field have reached such a maturity that they can be implemented with a rather low technological risk. To facilitate the technology decisions an overall functional ATM architecture needs to be visible and accepted by all ATM stakeholders so that the present system can transit towards a fully interoperable ATM/CNS architecture.

6 ROLE OF THE HUMAN IN ATM TODAY

6.1 INTRODUCTION

Humans are the source of creativity, reliability and flexibility that lies at the heart of today's air transport industry. They are also a significant source of error within the aviation system. This paradox lies at the centre of the human factors (HF) challenge in aviation. At the most basic level the subject of human factors is concerned with the performance of the human in acquiring and maintaining the required operational competence. At another level the challenge involves social factors, ranging from the organisation and performance of small teams through to the corporate culture and work climate associated with managing change.

The provision of ATM services today depends heavily upon the performance of humans at all levels within stakeholder organisations which design, develop, procure, operate and maintain the operational and technical aspects of the ATM System from which the services are delivered. Consequently, the social and legal structures of States have a very significant influence on the way in which ATM service provision is organised, managed and delivered. Throughout the wide-range of human centred tasks involved with doing this, many of which have already been touched upon prior to this point in this document, the :

- human factors aspects associated with systems (in their widest sense);
- recruitment, training, licensing and resource planning;
- social aspects related to the nature of the air transport industry

are considered to be of significant importance to be specifically addressed in this section

6.2 HUMAN FACTORS

6.2.1 - Overview of Current Situation

State-of-the-art ATM human factors products [Ref.19] have been developed by EUROCONTROL together with its members and stakeholders (i.e., States, ANSPs and professional associations such as IFATCA and IFATSEA) and also at national level. Similar developments have taken place on the airborne side.

The deployment and implementation of this human factors material has been adopted by some ANSPs with positive operational benefits. However, many ATM related projects are using HF only as a reactive countermeasure when operational staff do not accept their products.

6.2.2 - Strengths

A HF Case process [Ref.19] has been developed which offers a simple, practical and effective process to systematically integrate human factors into ATM development projects. The HF Case identifies human factors issues before the design of a new entity has started. It identifies 4 stages; stage 1 is concerned with HF fact finding, stage 2 is analysis of the HF Issues, stage 3 defines an HF action/mitigation plan and Stage 4, the monitoring of the HF Case. Experience has shown there are clear benefits to be gained by addressing the human factors aspects as early as possible in the development lifecycle when making changes to procedures, systems, etc. and maintaining the appropriate level of involvement through the procurement and implementation stages. In general, the later a change is made in the lifecycle, the more costly it is to include.

6.2.3 - Weaknesses

The direct benefits of HF work are difficult to quantify which means gaining management acceptance is difficult. An additional factor to hamper getting the necessary expertise at the right time is the continuing shortage of operational staff in some ANSPs. Further, there is a lack of sufficient European regulation to enforce the necessary implementation of HF. Few human factors requirements have been transposed into the ATM regulatory framework. All of this often leaves human factors interventions as “nice to have” rather than “must have” items.

6.2.4 - Current Developments

Analysis of the current status of ATM in Europe indicates that consideration of the human factors aspects as proposed by European guidelines and recommendations is not well applied to the extent considered appropriate for the application and importance of the subject matter.

6.2.5 - Future Expectations & Needs

Expectations are that the development and deployment of human factors knowledge, guidelines, methods and tools towards improving error management and developing user friendly technology

solutions will remain a key enabler for business success in ATM in the future.
The aviation system must be designed to reduce the potential for error, to optimise error detection and mitigation, and support error recovery. This must be closely coupled with aligning safety cultures, occurrence reporting systems and training so that a strong organisational learning culture is developed.
For the future there is a need for an integrated approach to learn and benefit from human factors best practice, both in the air and on the ground. This will determine the best way in which the respective roles and responsibilities of pilots, controllers and other staff in the aviation industry shall be designed in the future European ATM System.
Investments over the last decade within ATM have been biased towards promoting technological solutions. In order to manage the safe and cost efficient implementation of human factors products with respect to new ATM technological developments, it is extremely important to invest time and money in human capital to optimise the role and capability of the human in the future ATM System.

6.3 RECRUITMENT, TRAINING, LICENCING & RESOURCE PLANNING

6.3.1 - Overview of Current Situation

In the area of operational airborne staff, the harmonisation of training and licensing is developed to a much greater degree than that for operational ATM staff. The training and licensing of pilots is harmonised on a Worldwide basis. Comparing the different areas analysed, licensing and training of operational staff are subject to regulation to a higher degree than recruitment and resource planning.
One of the major challenges in the ATM and airline business is resource planning. Staff shortages amongst pilots and ATCOs has resulted in severe capacity restrictions in recent years.
Efficiency and economic issues are increasingly affecting the recruitment, training, licensing and resource planning of staff. For example, the harmonisation of the competence requirements and the conditions to enable greater mobility of ATCOs throughout Europe is developing slowly and is still hampered by many legal, social and operational factors.

6.3.2 - Strengths

In aviation and ATM systems implementation, training and licensing are main contributors to transition safely and successfully. ESARRs and the EC Directive on ATCO Licensing have ensured the ongoing harmonisation of the ATCO licensing processes in Europe.
The fact that the European ATM System coped with significant increases in traffic over the past two decades can be attributed to the performance of a well-trained and flexible ATCO workforce.
Systematic selection procedures for ATCOs are more and more perceived as enhancing the efficiency of managing human resources.
Much exchange of expertise and the benchmarking of activities in the training, recruitment and licensing area are taking place across Europe [Ref.20] and support harmonisation and quality enhancement. The same is valid for a variety of support material developed in the context of EATM.

6.3.3 - Weaknesses

Resource planning remains one of the most critical issues. The methods and strategies are sometimes ill-defined. Further, the lack of a systematic follow up approach to analyse the processes involved in recruiting, selecting, training and planning means lessons to be learnt from past experiences are either missed, or not fed back in a timely manner to the overall cycle of resource management.

6.3.4 - Current Developments

A variety of comprehensive harmonisation activities concerning operational competence of ATM staff has been launched and implemented in recent years. However harmonisation progresses slowly and there still remains much variability in the regulations and the way they are interpreted and implemented.
The issue of licensing, at a European level, technical personnel in ATM (ATSEPs) is currently being discussed.
Resource planning is a key issue and a big risk for not being able to meet traffic demand. Predicting traffic developments and staffing needs, adjusting staffing levels flexibly and efficiently to meet fluctuations in demand remain significant challenges. The pressures created by efficiency considerations make the situation even more difficult as human resources are a major cost factor in the ATM industry today.
There is an increased awareness of a strategic view for resource planning and an increased investment in rostering tools and methods can be observed.

6.3.5 - Future Expectations & Needs

The proactive management of operational competence is a key business success factor for the development and implementation of harmonised operational concepts and systems.
In any future ATM System there should be regulations ensuring the appropriate level of competence of all staff involved in the development, operation and maintenance of the System is achieved; this to ensure that safety performance and harmonisation principles are not compromised by the negative aspects associated with operating in a competitive business environment.
When changing roles, responsibilities and tasks of human operators in future concepts and systems, it should be considered that due to the high degree of regulation in the area of operational competence, implementing changes needs much time and will be costly.

Appropriate working and communication structures to achieve an early, active and continuous management of the recruitment, training, licensing and resource planning needs for the future ATM Target Concept are essential if the transition to the future European ATM System is to be achieved in a timely manner.

6.4 SOCIAL FACTORS

6.4.1 - Overview of Current Situation

The massive change associated with the implementation of the SES is currently the major theme of discussion between social partners. Through deregulation of the air transport industry, employers and employees in the companies of commercial airspace users have been closely subjected for some time to the market forces which now drive their industry, whereas such forces, through this deregulation and the combined challenge of the SES initiative, have only recently started to impact upon the ATM industry. Social partners acknowledge that to successfully meet the major challenges which face the industry, an inclusive, open and collaborative approach to managing change will be the key, with effective communication, consultation, imaginative management and strong leadership being essential.

6.4.2 - Strengths

To date, the creation and promotion of a "just culture" in ATM [Ref.21] is a key strength developed by the social partners to the benefit of all in the aviation industry.

The consultation between the social partners with respect to the development of functional airspace blocks (FABs) is also seen as a strong example of "best practice" to the way in which the consequential changes need to be confronted and handled.

In general, staff in the civil aviation and ATM industries have good working conditions and salaries thanks to the highly qualified, competent persons who take personal pride in their respective professions.

6.4.3 - Weaknesses

The working culture of ATM is based upon following definitive rules and the adherence to detailed procedures. These strongly bind it to the safety regulatory régime. This is at the heart of the safety conscious, team-orientated organisational culture which prevails. From a change perspective, this culture is perceived to be conservative and reactive, rather than dynamic, progressive and proactive to changes.

Transferability and mobility of ATCOs and ATSEPs inside the EU, and even at national and local levels, is limited and has not yet improved. The new EC Licence will be of little practical value for overcoming HR bottlenecks due to European, national and/or local barriers. This relates to the non-harmonised European taxation and social/pension systems, the eligibility criteria for a transfer and the local unit endorsement requirements asking for substantial on-site training as part of the allocation and posting of ATM staff.

6.4.4 - Current Developments

The social dialogue concerned with airline cockpit personnel has already been undergoing a radical change away from a traditional social dialogue and partnership model in which the practices and philosophies of the "national carriers" set a standard for the aviation industry.

It is already a widely shared view that consultation of social partners at the early stages of making changes based upon a clearly defined concept and process is key to addressing and finding flexible, commonly agreed solutions in a timely manner.

6.4.5 - Future Expectations & Needs

The dependency of the ATM industry on a single, large, highly skilled and professional group of staff having a significant impact upon service provision is a critical factor and requires specific measures to be taken to increase flexibility and productivity in a change process. The most important factors for making sustainable changes are to create understanding and acceptance, achieve commitment and motivation and to reduce the level of uncertainty related to implementing changes.

In view of the potential magnitude of some future changes, new ways and means are required to conduct the social dialogue. This means being more effective in achieving broad consultation, high participation of staff, collective management commitment and strong leadership. There is a need to develop more advanced approaches and methods for the dialogue at European, national and local levels, a process that has already started in the ATM industry, but has by no means reached an acceptable level of maturity.

7 TRANSVERSAL ASPECTS IN ATM

7.1 INTRODUCTION

This section summarizes the situation about the following aspects which impact upon the conduct of ATM today in a transversal manner to the aspects previously analysed. These are the :

- Safety aspects in addition to those addressed in section 4;
- Environmental aspects;
- Security aspects;
- Approach used for transition.

7.2 CONDUCT OF ATM TODAY WITH RESPECT TO THE SAFETY ASPECTS

7.2.1 - Overview of the Current Situation

ATM Safety can be considered from 3 different points of view, safety regulation, safety performance assessment and safety management. Safety regulation develops common standards and procedures and oversees their implementation across all stakeholders. Safety regulation is addressed in sub-section 4.3.

The current safety performance is summarised in sub-section 3.3. This identifies the weaknesses and inconsistencies, which leads to an unclear measure of the current level of ATM safety.

The deployment of a safety management infrastructure on the ground segment is far from being complete. Only 50% of the ANSPs and 60% of the NSAs have reached the target level of maturity for their safety system in the EUROCONTROL 2006 ATM Safety Maturity Assessment. The main reason is a lack of experienced safety staff. The need to recruit and train high quality ATM safety personnel remains a major issue in many States. The air segment is covered by the certification process.

Corrective programmes have been launched to solve the causes of incidents/accidents such as runway incursions, level busts, air-ground voice communication misunderstanding, unauthorised penetration of airspace and call-sign confusion. These programmes have been launched more in a reactive manner than a proactive one, although there is some evidence that this is changing.

Due to the human centric nature of the current ATM network, the human operators are up to now the only intelligent, flexible and real time adaptable component of the ATM System and therefore an essential safety enabler in it. Training programmes ensure that the crew and staff are able to execute their safety role in the ATM System (see section 6). Nevertheless, there is a trend to increase the use of automation and to develop safety nets such that the best allocation to overall safety performance is achieved through the balanced contributions from automation and the human.

The achievement of an acceptable level of safety is a necessary pre-requisite for any change of the ATM systems or procedures. Safety risk assessment and mitigation methods have been applied since in the airborne ATM segment and are under deployment in the ground segment. The consideration of the human factors aspects early in the process to make changes to aspects of ATM is a safety risk mitigation that maintains and underlines the safety role of the human in the ATM.

Due to the fact that safety impacts and is addressed in almost all activities concerned with ATM, it is very difficult to specifically extract the information needed to assess the overall cost of safety.

7.2.2 - Strengths

- There is a well-elaborated safety culture in the ATM industry despite the current deficiencies in safety management systems.
- The first results of the corrective programmes launched to improve the above situation are positive.

7.2.3 - Weaknesses

- Lack of inter-organisational safety management in Europe, in particular, incomplete assessment of the current level of overall safety.
- Increasing costs and duration of system changes (including training) that address the safety requirements, with difficulty to trace the costs to the safety benefits.
- Safety management activities must address a significant number of the outstanding issues, in particular, the different procedures being used due to fragmented airspace designs, the inconsistent operational data provided by stakeholders and the use of national language instead of the English language.

7.2.4 - Current Developments

- Progress of the implementation of the safety management systems
- Changes to the European ATM system that improve the safety (i.e. safety nets, ATFCM developments to prevent over delivery to ACC sectors)

7.2.5 - Future Expectations & Needs

• More accurate measurement of the current level of safety with possibly improved incident detection and analysis.
• Meeting future safety requirements (risk to quadruple when traffic doubles) will put a strong emphasis on safety design criteria.
• The importance of the human in ATM will require that safety assessments are conducted in an holistic manner. This must cover the human, their situation awareness, the procedures they are conducting/monitoring and the technical infrastructure (including support and assistance tools) they use under various degraded / failure modes, as approved with ESARR4. This must be done, building upon "best practices" used in the air and ground segments of the industry.

7.3 CONSIDERATION OF THE ENVIRONMENTAL ASPECTS ASSOCIATED WITH ATM TODAY

7.3.1 - Overview of Current Situation

Like any other mode of transport, aviation has adverse social and environmental impacts, making its benefits more fragile and imposing an economic burden on European society and the Aviation industry. Aviation through the years, has significantly improved its environmental performance, sometimes as an unclaimed by-product of ATM efficiency.
Existing and emerging EU sustainable development policy and environmental legislation, reflect the need for aviation to respond ever more effectively to this challenge. The adverse environmental impacts are constraining the ATM system and stimulating the proliferation of local dissimilar and often counterproductive rules.
It is recognised at international level that ATM can continue to play a significant role in improving aviation's environmental performance even further, as stated in the ICAO resolution A33-7 on the "Balanced Approach to Noise Management". In the near term it is unlikely that a single 'step-change' technological improvement will solve this challenge.
Local communities around airports are increasingly able to challenge, constrain or delay airport expansion and airspace changes. Effective community engagement and maintaining trust will be critical to delivering future ATM system capacity and efficiency and indeed ATM's licence to operate.
The main environmental impacts that are related to ATM can be expressed using the following sub-areas that refine the ATM Performance Framework "Environment" KPA:
• Climate change: (side effect of aircraft gaseous emissions on climate and other effects of flights altitudes).
• Noise: (Noise exposure of people in the airport surroundings).
• Third party risk: (side-effect of accidents in the vicinity of airports,)
• Land-use: (planning and management of land around airports related to noise and third-party risk mitigation)
• Local Air quality: (the effect of air traffic on local Air quality)
• Water quality: side effect of various airport airside operations (de-icing, refuelling, etc.)
• Human travelling time: (relates to efficiency of airport airside operations and airborne flight efficiency from an ATM point of view).
• Fuel use (relates to the flight efficiency in ground and airborne phases and in particular to trajectories).
Generally speaking, ATM contributes to the performance in most of the above areas by imposing or relaxing constraints on the 2D route and vertical profile of a flight and on the routing of an aircraft on the ground with engine on. However, ATM is dependent on the airport airside infrastructure and cannot mitigate deficiencies related to the infrastructure itself.

7.3.2 - Strengths

• A wide variety of International and European environmental legislation are now available. It covers most of the environmental aspects linked to and influenced by air transport.
• ATM can play an important role in an environmentally sustainable air transport system.
• Some solutions and best practices to reduce the impact of air transport on the environment already exist. These take into account all the components of the ICAO "balanced approach": noise at source, restrictions, operational improvement and land use planning.

7.3.3 - Weaknesses

• Besides International and European legislation, a wide variety of local regulations are in force that regulate and impose constraints at different levels all over Europe. This imposes additional local adaptation requirements on air transport stakeholders.
• There is presently no central source of guidance or practical support to help ATM operational stakeholders to effectively respond to the environmental challenge.
• Best practices are only implemented in a limited number of airports or states (i.e. PRNAV approaches).
• Restrictions are easy to implement by political decisions, but without other actions they will affect air traffic growth.

7.3.4 - Current Developments

• ICAO has developed guidance on noise abatement departure procedures and on operational opportunities to reduce fuel consumption (ICAO Circular 303). ICAO working groups are also currently developing general guidance on noise management.
• The EC has an emissions trading expert group evaluating options for the entry of aviation into the EU Emissions Trading Scheme (EU ETS), due to report in September 2006.
• An EC aircraft noise working group will make recommendations

to the European Council (2007) on implementing and perhaps further developing directives 2002-49 (noise mapping and planning) and 2002-30 (noise restrictions and the balanced approach).
• EC funded research into the reduction of the environmental impact of aviation is ongoing (e.g. the EC FP6 "Environmentally Responsible Air Transport" (ERAT) project will identify how to embed environmentally responsible procedures into the ATM system).
• EUROCONTROL has an initiative to develop pan European harmonising guidance material on Collaborative Environmental Management at airports and are also developing pan European Continuous Descent Approach guidance material.
• Airframe and engine manufacturers, driven by customer environmental requirements are continually developing cleaner technologies (in particular the "Clean Sky" programme [Ref.23]).

7.3.5 - Future Expectations & Needs

• It is required to enforce the harmonisation of the legislative/regulatory process, avoiding the proliferation of local regulations, but allowing a degree of flexibility.
• A framework for sharing and disseminating environmental best practices should be identified in the ATM Master Plan.
• In an ATM performance-based transition approach, interdependencies between environmental aspects and other aspects (e.g., capacity and efficiency) and between the environmental aspects themselves have to be taken into account.
• Before adopting local regulations, focus should be put on effective operational solutions (e.g. noise abatement procedures), increasing their implementation throughout Europe and, whenever possible, contribute to the other balanced approach pillars, especially effective land use planning by coordinating with local authorities. Before local solutions are adopted, transparent impact assessments (including the interdependencies) should be performed.
• ATM should adopt solutions where possible to optimise environmental performance improvements and be capable of improving the "gate to gate" efficiency (e.g. taxi time optimization to slow down "Landing Take-Off cycle" emissions).
• The buy-in process and communication policies should target the residents and the politics to address their expectations and to avoid any blocking points at the time of the SESAR implementation phase.
• The direct contribution of ATM to Air Transport sustainability and in particular its capability to support the traffic growth while limiting the environmental impact will be made explicit within the performance framework.
• ATM should be better able to identify and gain recognition for its positive contributions to European sustainable development, including the socio-economic benefits and the environment efficiency gains.

7.4 CONDUCT OF ATM TODAY WITH RESPECT TO SECURITY ASPECTS

7.4.1 - Overview of Current Situation

Within the ATM community, the understanding and application of security is, culturally, not equivalent to that of safety, although the consequences of a disruptive event can be similar. Whilst ICAO has recognised the need for stronger regulation mainly focused on airlines and airport security (Article 37 and Annex 17), there is no common framework applying to ATM security. However, the SES framework may go some way to addressing this need.
Member States have implemented civil aviation security programmes in accordance with the provisions of ICAO Regulations and such other EC and national level imperatives which have been determined as being appropriate to their national situations. ANSPs are required to implement and maintain a security management system.
Conceptually, security is designed to protect assets whether they be people, buildings, equipment, information, ideas or reputation. Security is concerned with confidentiality (limiting access to, or knowledge of an asset to those authorised), integrity (ensuring that the asset is not unintentionally changed and continues to perform as expected) and availability (ensuring the asset is always operating as required). To be effective, security needs to combine a range of measures embracing organisational, procedural, technical, physical and human controls. Security is only as good as the weakest link in the collective chain, but there is no such thing as 100% security.
ATM security is focusing on the :
• Self-protection of ATM, particularly the integrity and availability of the innovative information system in the ATM network with regard to the vulnerability of new information technologies;
• Co-ordination with security authorities for the exchange of information and assistance in case of an aviation security incident.
Linking with other security initiatives (e.g., in the work of EUROCAE), the SESAR contribution to ATM security should be concerned with prevention, preparedness, response and recovery. Security, along with other risks, needs to be factored into the overall risk model. In this process, it is important to recognise and take account of the different stakeholders within the broad spectrum of aviation. All will be involved at different stages in the life cycle of an asset and it is essential to identify critical linkages between the various components
.

7.4.2 - Strengths

Today the security of ATM relies upon the use of :
• Private ground networks for communication between ATM facilities; the closed systems reducing the risk to cyber attack;
• Voice communications between humans being reasonably resilient to being corrupted in a credible manner;
• A network of independent terrestrial navaid beacons;
• An independent means to survey the air situation.

7.4.3 - Weaknesses

Up to now, the security aspects have not been fully taken into account in the development of the organisations, centres, facilities, data, regulations and procedures that form the ATM System. Security is perceived as very expensive, uncomfortable and never entirely efficient. The setting of standards related to the security of personnel are variable due to the fragmentation of ATM.

The main vulnerability is the lack of coordination between all stakeholders to ensure that security risk assessments and mitigation measures are complementary and globally consistent. This would require significant effort from each stakeholder to develop a comprehensive set of security measures.

The following other weaknesses have been identified :

- Variable levels of information exchange between civil and military agencies.
- Difficulties regarding secure aircraft authentication and the integrity and availability of pilot/controller communications; this needs attention.
- Tendency to use COTS products (e.g., wireless connections, TCP/IP, Intel based hardware) which can easily be the subject of security attacks if not protected. Lack of interoperability and standardisation of security means (e.g., COMSEC, encryption, data protection, on-board warning systems, self-protection countermeasures).

7.4.4 - Current Developments

Links need to be established between the SESAR Master Plan and the following research projects focused on security, as well as with the EUROCAE WG 72, and should build on outcomes and conclusions of these projects.

- ACARE Strategic Research Agenda SR2 identified ATM systems' functionalities which could support the air transport security. The subsequent activities will have to be coordinated with SESAR.
- SAFEE (Security of Aircraft in the Future European Environment): The ongoing EU SAFEE project focused on security of aircraft in flight.
- PATIN (Protection of Air Transportation and Infrastructure): The PATIN project will focus on protection against terrorism and specifically the protection of the air transportation and infrastructure (airport terminal buildings, airport operations, aircraft, and the communication network).
- ERRIDS (European Regional Renegade Information Distribution): The ERRIDS objectives include the distribution of information to all organizations involved in response to unlawful acts, on a need-to-know basis, and the support of civil-military authorities in decision-making, in coordination with existing national or international systems.

7.4.5 - Future Expectations & Needs

After the events of 11th September 2001 which revealed the vulnerability and lack of preparation of ATM, there is a consensus to recognise that security aspects need to be improved for the sake of the present and future of the ATM System. It could be done by:

- Introducing shared and global security considerations at the overall design level of the systems;
- Adopting a “universal” security-risk assessment method;
- Developing “security metrics” to compare the effectiveness of security measures;
- Harmonising security standards and procedures between Member States.

7.5 CONSIDERATION OF THE TRANSITION ASPECTS ASSOCIATED WITH CHANGING TODAY'S ATM SYSTEM

7.5.1 - Overview of Current Situation

A change in the ATM System implies the synchronised change of a combination of procedures, crew and staff working methods, airborne and/or ground systems, legislative and regulatory framework and supporting aeronautical data such as AIP/AIC. The transition is the focal point of all the elementary changes in each domain described in this document and any identified weakness on an elementary domain contribution can jeopardize the whole change. The key factor for a successful change is the clear commitment to the change by all stakeholders (see sub-section 4.5) and the management of the change with the involved actors.

Over and above general industrial practices, there is a requirement for exhaustive safety assurance during the transition. Larger changes take many years of simulations and trials, needing the active involvement of human resources and especially Air Traffic Controllers (thus putting an even heavier burden on these already scarce human resources). Certification (for the airborne systems and if required in the future for the ground systems as well) is also a major factor affecting the time to market of new functions.

Three approaches are possible to change systems, maintenance, modernisation (renewal of large parts of the system), or complete replacement. Due to the lack of modular design, the change of old systems generally implies complete replacement or important modernisation with higher associated risks. This is a blocking point for the improvement of the overall ATM network.

The ground system transition generally implies parallel operation of the new and the old system, specific procedures during the transition period and fast possibility to come back to the previous situation in case of problem. The ground system transition can only happen in a specific operational time window (natural low traffic period and/or imposed reduced capacity). The airborne system upgrades are first certified and then made available for new air-

crafts. Existing aircraft will be retrofitted, when it is suitable for the aircraft owner, if the change is mandated or beneficial. Considering the large number and differences of the ground ATM systems and aircrafts flying in Europe, the ATM network can and will never change in one step but in a continuous manner system by system. The backward compatibility and standardisation are of paramount importance to ensure the continuity of service with modified and unmodified systems.
The human aspects for a transition must be considered through the human factor analysis of the transition, the crew and/or staff training and the management of the social aspects of the changes. The difficulty to allocate the extra human resources necessary to support a transition limits the number and/or the extent of changes.

7.5.2 - Strengths

• The continuity of service has always been assured with the same level of safety.
• The recent transition to RVSM has been implemented quickly.

7.5.3 - Weaknesses

• The ATM network change cycle is too long due to the large number of different ground and airborne systems and the impact on the human resources. The ATM network change pace is too low to cope with the capacity and safety needs.
• Important costs of the transition (parallel operations and return solutions, trainings, capacity reduction).

7.5.4 - Current Developments

• The changes are synchronised and optimised through the ECIP/LCIP process.
• New system architectures with a modular design ease transition by maintenance and renovations, so minimizing the transition risks and the amount of training needed since a major part of the overall system is maintained.

7.5.5 - Future Expectations & Needs

• The SESAR ATM Master Plan will improve the visibility on long term change and the partners commitment for the change (the ATM system will be considered as whole)
• The ATM systems in a region should be compatible and should have common transition logic, with solutions for different regions occurring at different times, depending on the base rate of operations and expected growth.
• The trend should be to use more COTS products overall wherever possible. The use of standardised modular systems supported by modern COTS middleware will simplify the system changes and the approach needed to make the transition. The general trend to interconnect and integrate systems is calling not only for more transversal activities at the System Engineering level, but also for more interoperable reference test platforms. Such cooperation between all the actors involved in the development process should be improved to decrease the time to market.
• Safety case support - it should become standard procedure to support safety cases by implementing new procedures in a verification phase in low traffic conditions (with selected qualified cockpit and ground personnel). This way valuable data can be collected more easily, more quickly and in a realistic environment.
An improved local social dialogue of a partnership nature must be established to create a climate of trust and information and solution sharing. This dialogue will permit the adjustments of the working conditions and organisations required by the changes.

8 OVERALL CONCLUSIONS & RECOMMENDATIONS

This document contains a "snapshot" description of today's air transport industry, and ATM in particular. It is the synthesis of the work performed by 20 tasks which affect the industry at present. In the following the sub-sections entitled conclusions contain the findings from the work in summary form. These have then been taken and, together with some recommendations coming from the tasks themselves, combined to form some overall recommendations upon which the tasks in the following stages of SESAR's project definition work shall be based.

8.1 AIR TRANSPORT

8.1.1 - Conclusions

• Aviation is mature and offers its customers a safe means of achieving the mobility and services they need at excellent value for money prices.

• It makes a significant contribution to World and European GDPs and demonstrates an ability to recover quickly from periods of economic recession.

• Of the main stakeholder groups which make up the air transport value chain, it is the commercial airspace users which are the most exposed link in the chain since they are "pulled" between the need to compete for customers in a highly competitive business sector, whilst being faced with many fixed costs, of which some originate from others in the chain who operate under more monopolistic type conditions. This exposed position also means they are the first to suffer the financial consequences of major events which can have an adverse impact upon World trade and/or the aviation industry in particular. This must be changed if the long-term economic sustainability of the whole chain is to be achieved in the future.

• Inherent incompatibilities between the way in which commercial and other airspace users need to operate and the way in which the scarce resource of airspace is divided today has led to inefficiencies in its use. For example, although some improvements in civil/military co-operation have been made in recent years, there is still much more which could be done to achieve the greater access both require.

8.1.2 - Recommendations

• All stakeholders in the chain must grow their businesses in a way which strengthens the links between them, also accommodate the needs of the non-commercial airspace users and create a value system which can be sustained well into the future.

• To achieve the above, the business plans of airspace users, airports and ANSPs must be more closely aligned to provide and receive services to and from one another. This needs to be explicitly definable, predictable, consistent and have a service value placed upon them. Thence, a risk sharing mechanism and a coherent, meaningful approach to business planning must be developed which are based upon common values and goals associated with the exchange of these services.

• The industry must then be empowered to manage to these values and goals by being able to make its own decisions on what to invest in and how to finance the investments.

• A stronger value system must be facilitated by the creation of incentives to which all stakeholders can respond. This must form the basis of the future vision for the air transport industry in 2020 and beyond which will be developed in the next SESAR deliverable, D2, and thence, in D3 to D6.

8.2 AIR TRAFFIC MANAGEMENT

8.2.1 - Conclusions

• ATM today is predominantly a tactical air traffic control process supported by a number of management planning functions.

• It is primarily the measurement of safety, capacity (which is manifest in the delay to and possible cancellation of flights) and cost which characterises an ANSP's performance. Over the past decade ANSPs have coped with significant traffic growth in an acceptably safe and expeditious manner. At present, capacity at airports (i.e., their infrastructure and consequentially, TMAs) is primarily the limiting factor of overall System capacity, with delays in the en-route sector at historically low levels.

• ATM service provision in Europe is considered to be expensive, especially when compared to the US. This is due to the fragmented nature of the way in which the terms of the 1944 Chicago

Convention have been implemented on a State-by-State basis. This has led to the development of national infrastructures which have low levels of interoperability, limited sharing of data, little co-operative planning in the way their assets are managed, replaced and upgraded and many area control centres which are considered to be sub-optimal in size with respect to the levels of traffic they handle.

• The full cost recovery régime whereby most ANSPs derive their financing does not incentivise organisations to implement changes and make new investments in conjunction with others who are driven by the imperatives of their business models.

• Much performance data is captured, but it is clear that the information is not used coherently to manage the business in a "closed-loop" sense.

• Today's ATM process is based upon a "first come, first served" principle, so accommodating the needs and providing ANS to all airspace users. However, this is not adequately geared to maintaining the schedules of commercial airspace users.

• The adaptability of the current ATM System is limited. Many aspects, such as route structures, airspace sector structures, controller validations, procedures, the functionality of the ground systems, etc., have, in the past, been fixed by design. As a result there is an inherent mismatch between the long lead times it takes to bring new ATM capacity into operation and the shorter time it takes for airlines to open new routes and services. Thus, in the main, demand has always exceeded capacity.

8.2.2 - Recommendations

The following recommendations are drawn from the conclusions and should be taken forward in the subsequent stages of SESAR's project definition phase.

• There is the need for a consistent and explicit framework which links the economic, commercial and operational priorities of stakeholders within the ATM System such that all can understand and manage their activities accordingly. This must be the basis upon which the vision for ATM in 2020 and beyond is formulated in D2.

• A change of political will is needed to enable having a financing régime which underpins the above mentioned framework. Thence, ANSPs must be able to make decisions on service provision matters which are driven by meeting the business needs of their customers.

• A comprehensive ATM performance framework must be developed for and applied across Europe as a whole. This needs to deliver far greater consistency and transparency of the current performance. It must be used as the basis upon which management decisions are made and allow the prioritisation of the key sources to proactively address all risks if future traffic levels are to be accommodated safely.

• ANSPs, in conjunction with their systems' suppliers who provide in-service support, should address the lack of flexibility in their current systems to find ways of providing varying levels of operational ATM capacity in real-time. They should also address ways of shortening the lead times needed for bringing new capacity into service. In the short-term, given the current planning lead times and limited flexibility in adapting airspace, ATM planning processes with a tactical horizon should be established to allow stakeholders to jointly identify and resolve potential demand / capacity imbalances.

• Although en-route delay is at a historically low level and since capacity at airports is primarily the limiting factor of overall System capacity, it is unclear whether the potential for additional delays in the en-route sector are being "masked" by other factors. This should be investigated.

• In order to respond to the importance attached to maintaining the integrity of airlines' schedules and because of their many interactions, the concept of a "Network Plan" should be comprehensively developed and implemented.

• To facilitate the Network Plan, the airspace users, airports and ANSPs need to create a more explicit set of relationships that specifies the services, requirements and obligations which need to exist between them so that they become integrated "partners" in the future ATM System. Thence, the ATM performance framework would apply to all of them.

• Based upon the service model outlined above, consideration should be given to a more liberalised approach being taken to the provision of ANS and a more proactive approach taken to the replacement of and investment in new infrastructure based upon the principles of asset management. Competitive procurement of the physical assets should be a key aim, with interoperability being achieved at service and functional levels throughout a future ATM System. This will require one functional architecture to be designed, developed and maintained which has the flexibility to enable new functional applications to be added and others to be removed without the need for a major redesign each time

8.3 INSTITUTIONAL ASPECTS

8.3.1 - Conclusions

• The stakeholders in the ATM industry have together successfully delivered the air transport network currently in operation based upon the fundamental principles of the ICAO framework which, even after 60 years, are still adequate for creating Standards And Recommended Practices (SARPs) and Procedures for Air Navigation Services (PANS) to facilitate the global harmonisation of aviation. However, the time taken to produce them is too long with respect to meeting the rapidly changing needs of the business. It is very easy for individual States to file differences against the SARPS, and since ICAO does not have the remit to cover commercial aspects of aviation, the collective benefits potentially on offer by all stakehol-

der groups using the same SARPs are dissipated. Consequently, the resultant implementation at a national level is variable and a contributing factor to the European "patchwork" which exists today.

• The SES regulatory framework recently put in place now complements the ICAO framework. Whilst ensuring that safety remains a prime objective, it paves the way for a more closely harmonised European sky which can bring the benefits to the ATM industry of having a more commercial approach to the way in which ANS are provided in the future by forcing the separation of regulation from ATM service provision. However, the way in which these roles will be implemented is as yet unclear, as are the benefits which will be realised.

• ATM safety regulation has helped to deliver an acceptably safe ATM System across Europe despite rapidly growing traffic and has been able to incorporate new technologies, processes and procedures as they have emerged. However, there is still no clear measure of the level of safety throughout the ATM industry and the safety management culture is, in general, more reactive than proactive. There are also many issues with the way the current arrangements are working, especially concerning the clarity of accountabilities between different regulatory authorities and the different participants in ATM.

• In recent years a new layer of ATM safety regulation has been developed by the EUROCONTROL Safety Regulation Commission and the SES framework. Despite European-wide safety regulations and a performance reporting régime having been established, the way they have been implemented in many States has been inconsistent and very slow. This must change. The current management and enforcement approach to date has not induced States to implement the regulations. Further, it is still not clear how this regulatory framework will develop in the coming years.

• Overall the legislation and regulation is considered to be a highly complex set of institutional organisations and processes which sometimes overlap and even, at times, duplicate one another. It is continually being changed and expanded. The key challenge is keeping abreast of developments, understanding the consequences and remaining compliant with it in a cost effective way. In fact the cost of doing so with respect to the benefits realised is, in general, unknown, but perceived to be increasing.

• The EC's lack of formal competence in defence and security matters prevents military authorities from engaging fully with European Union (EU) institutions. This is considered to be a severe limitation to the implementation of the future European ATM Master Plan for 2020 and beyond unless it is solved quickly.

• Developing, defining, setting and implementing standards is a key activity needed to increase the current low-level of interoperability which exists between ATM systems. However, the current approach is, in general, complex, fragmented and unclear. There are too many organisations, authorities, agencies, etc., participating in the process with variable levels of effectiveness and no overall coordination. There is also a lack of common understanding of the entire standardisation process and the relationships between these bodies. Also, in some, aviation stakeholders have very little ability to influence the outcomes.

• Close cooperation between the EU, EUROCONTROL and ICAO has contributed to the development and application of common standards globally and within Europe. It has avoided any substantial incompatibility between European regulations and the ICAO regulatory framework. However, it is not always evident that the consultation processes with all stakeholders have balanced their interests, been timely, or focused on the needs of the airspace users as the customer for the final product.

• Fragmented decision-making across national, European and organisational boundaries is inefficient and ineffective for programme delivery. This results in :

- a lack of timely and continuing engagement of the stakeholders needed to make the programme a success;
- the necessary funding and resources to be provided by the stakeholders not being available in a timely manner;
- no effective monitoring being put in-place, either to ensure compliance with agreed decisions, or to maintain progress.

8.3.2 - Recommendations

• Achieving a simpler, coherent and consistent framework of legislation and regulation matched to the ATM industry's future business model must be the goal.

• It is very unlikely that all States will be willing to give up their policy making independence in the areas of defence and national security by granting this to the EU. However, the consequence of this, which prevents military authorities from engaging fully with EU institutions, must be overcome if the SES is to be fully implemented.

• From a number of significant pan-European successes and failures it is clear that with the right political support, significant improvements can be made to the European ATM System network. The need in Europe is for an institutional framework which is less diverse and fragmented than today's situation. Such a framework must be designed together with a business framework such that "constructive tension" exists between the two, but that the whole has a set of clear and non-conflicting roles and responsibilities whereby all are working for the overall benefit of the air transport industry.

• It is envisaged that the future European ATM System will more closely integrate the ground and airborne segments. Thus, all stakeholders will need to work more closely together to a common plan of what, how and when changes will need to be made to the System. This will need to be managed using a mechanism based around a decision making process which is much simpler than the one which is in place today. The governance, management structures and decision making process must be designed concurrently with the future ATM System so that the "product and the production line" are matched.

• Developing the ATM safety regulatory framework to provide a clear, unambiguous set of regulations across the whole of the air transport industry will be crucial. Improving upon the current situation is essential.

• The future approach to be taken to developing standards must also be simpler, more focused and have much clearer objectives than that which exists at present. It must be co-ordinated at both the regulatory and business levels to ensure that the most appropriate standards are developed to meet the right needs and that they will be implemented.
• Finding the most appropriate body to manage the development of standards is crucial. It is also recommended that for the process to be effective and deliver the products needed at the right time, it should be managed as a funded programme.
• The expectation is to have a future European ATM System with a single functional architecture based upon the supply and receipt of services. Therefore it is necessary to move away from developing prescriptive, technically-oriented regulation (except in some very specific and well justified cases) towards defining performance-based regulation supported by appropriate standards. This would greatly improve service and functional interoperability (which is the level at which regulation should be applied) both throughout the ATM System and with military systems. The use of such standards would then also support the equivalent certification of military assets for ATM use as required. Further, this approach would greatly ease the transition from today's System to the future design.

8.4 SYSTEM ASPECTS

The "System" in its broadest sense is covered in this sub-section by summarising the main conclusions of the work which has addressed the operational, technical and human aspects, plus some key subjects which impact all areas.

8.4.1 - Conclusions

• At European level there is no clear architectural design or notion of an ATM System. That which exists in operational service today is predominantly a plethora of legacy systems which have been designed, procured and implemented from a national perspective and are often widely distributed over large geographic areas. Any integration of these systems has been done, in design terms, from a "bottom-up" perspective.
• Although plans have existed at European level to harmonise the capabilities of existing systems and introduce some new functionality, there has not been an effective, coherent approach to asset management which has aligned these plans with national plans to sustain the systems in-service in the future. This has meant that the time taken to put new products into operation is too slow, the products do not necessarily have the correct scope and often miss the optimal point at which the necessary business benefits can be obtained from using them.
• The current ATM System has humans at the centre of virtually all activities and this has been at the heart of providing safe, high quality air navigation services. However, expectations are that in some cases the human will not be able to deal with the future level of traffic and its complexity in the same way as is done today. There is a need for a paradigm shift in the current concept of operations to break through the "capacity barrier" predicted to occur between 2013 and 2015 and to meet the future business challenges. This shift will include an increased use of automation to do some tasks traditionally performed by humans.
• Much progress has been made in recent years on getting a better understanding of and developing techniques for how human factors need to be taken into consideration early in the design and development lifecycle of systems, so minimising the cost of having to do so in the later stages. However, the application of such techniques is currently seen as "nice to have" rather than "must have" in such activities, but the reasons why appear to be unknown.
• Effective resource planning still appears to be extremely difficult despite legislation being put in place to achieve greater homogeneity in the recruitment, training and licensing of operational staff. The aim to achieve greater mobility of such staff throughout Europe is still hampered by specific legal, social and operational factors which prevail at a national level.
• Research & Development (R&D) activities, in general, have :
  - been conducted in a fragmented manner;
  - not addressed an identifiable need;
  - lacked robust user requirements to support the work;
  - not done sufficient business planning analyses and/or safety case work.

Not having these aspects to support the results of the work has made it difficult to implement the products in a timely manner. These factors have resulted in there being too many R&D programmes (some duplicating others) supporting too wide a variety of technological developments, leading to a distortion of the ability of the market to "naturally" select the best products.
• Today's ATM System is predominantly centred on the use of ground-based systems, but much information and functionality exists in systems on board the aircraft which can be significantly exploited to improve ATM performance both today and in the future.
• Access to and use of the radio spectrum is vital for the continued provision of safe ATM services, these being based upon the ability to derive and exchange high integrity information between the various infrastructure systems which underpin them. However, this is coming under ever increasing pressure from the wide variety of commercial companies which need greater allocations throughout the spectrum to satisfy their needs. The risk is that frequency allocations traditionally assigned for exclusive aeronautical use, and/or to protect other critical allocations, will become either a shared resource, or even re-allocated completely.

• The air transportation system and the enabling ATM services which support it are critical parts of Europe's infrastructure. To date, the closed, bespoke design of the engineering systems and operational procedures has meant it has not been easy to corrupt the ATM System in a credible manner. Thus, it has been resilient to attack by a low level of threat. The concern is that the increasing use of more modern data processing systems and communications protocols, coupled with the trend to network multiple systems which have been designed and procured in a fragmented manner, will increase their overall vulnerability to cyber attack.

• Technology-based improvements to the environmental performance of aircraft alone will not offset the impact of the expected growth in air traffic movements. Therefore, the ATM community has an increasing role to play in improving the situation through the use of environmentally sensitive airspace designs, efficient flight profiles in the vicinity of airports and balanced regulations which enable capacity needs to be fulfilled and environmental targets to be met.

8.4.2 - Recommendations

• It is anticipated that the design of the future ATM System will, when viewed from the top down, have a functional architecture which defines the information flows needed between the principal entities which make up the System. Thus, there will be one System design which incorporates both the ground-based and airborne systems, treating them as a whole. This should be the basis upon which the future ATM System is developed whereby a clear distinction can be made between the ATM services, the supporting services (i.e., those derived mainly from the technical infrastructure) and the physical assets which make up the technical infrastructure.

• To complement this a strong European standardisation and certification institutional framework must be carefully put in-place which minimises complexity, avoids duplication and keeps the cost of undertaking standardisation and certification activities to the absolute minimum needed. This will ensure a high level of ATM interoperability and flexibility will be achieved both Globally and throughout Europe.

• A single European ATM System "design authority" empowered to define, plan and manage the implementation of such a System should be established. The modus operandi of such a role needs to be coupled managerially to the plethora of legacy systems in operational service today so that a coherent and proactive approach to asset management is also established in the same System context. However, it must be made very clear that the role does not make the business decisions on what shall be implemented, but informs of the consequences and/or what needs to be done and when.

• In the future applied R&D must focus upon the applications needed to achieve System performance and then identify the technological solutions to deliver them. Future product development and in-service support asset management lifecycles must be coupled by more comprehensive investment decision making processes which have a common aim. The aim is to evolve the capability of the future ATM System by using a business requirements planning process which continuously balances demand and capacity. This must be done during the transition from using old technology which has reached the end of its design life to using new technologies which can be readily supported by the supply industries in a cost effective manner.

• As the role of the human in the ATM System starts to change, a proactive, collaborative, transparent and inclusive approach to change management must be put in place with the early involvement of staff at all levels in order to achieve a smooth, harmonious and successful outcome for all concerned. This will require a significant improvement upon the approach taken today, which has traditionally been seen as slow, lacking incentives and has not kept pace with the dynamics of today's business environment. Resource planning should be considered which has a greater forward looking perspective and be supported with models which have greater flexibility within them.

• Currently the threat of cyber attacks on critical national infrastructure is low, but World events suggest it is likely to rise. Therefore the security aspects of the future ATM systems must be significantly increased to combat the threat, but must also be commensurate with the risk.

• Proactive management action needs to be taken now to ensure the air transport industry minimises its contributions to the effects aviation has on the environment, with ATM playing an important role in helping to achieve this aim.

All of the recommendations made in this section of the document should be used as a basis upon which to inform and create the next deliverables from SESAR so that continuity is maintained throughout the complete project definition phase.

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Identification of existing mechanisms and triggers for Decision Making

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Identification of limits / blocking points for airspace environment

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29 JU Paper

10 LIST OF ABBREVIATIONS

1090 ES	1090 Mode S Extended Squitter
2D	Two dimensional trajectory
4D	Four dimensional trajectory
A 33-7	ICAO resolution A 33-7
A/C	Aircraft
ABAS	Aircraft Based Augmentation System
ABAS-IRS	Aircraft-based Augmentation System-B89
ACARE	Advisory Council for Aeronautics in Europe
ACARS	Aircraft Communications, Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ACC	Area Control Centre
ADS-B	Automatic Dependent Surveillance-Broadcast
AFTN	Aeronautical Fixed Telecommunication Network
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AIRPROX	Air Proximity Report
AIS	Aeronautical Information Services
AMC	Airspace Management Cells
ANC	Air Navigation Commission / Conference (ICAO)
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
AOM	Airspace Organisation & Management
APU I/II	Auxiliary Power Unit
ARO	Air Traffic Service Reporting Office
ASAS	Airborne Separation Assistance System
ASM	AirSpace Management
ASTERIX	Standard: All purpose STructured EUROCONTROL Radar Information eXchange
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATM 2000+	ATM Strategy for the Years 2000+
ATMSCG	Air Traffic Management Standards Co-ordination Group
ATR	Avion de Transport Regional (Regional Transport Aircraft)
ATSAW	Air Traffic Situational Awareness
ATSEP	Air Traffic Safety Electronics Personnel
Bn	Billion
BRNAV	Basic Area Navigation / RNAV de base
CAA	Civil Aviation Authority
CANSO	Civil Air Navigation Services Organisation
CAT I/II/III	ILS Precision Approach Categories
CBA	Cost Benefit Analysis
CDM	Collaborate (Cooperative) Decision Making
CEATS	Central European Air Traffic Services
CEATS CG	CGSO CEATS Group of Senior Officials
CENELEC	Committee for European Normalisation in the Electrotechnical Field
CESC	Chief Executive Standing Conference
CFMU	Central Flow Management Unit
CIDIN	Common ICAO Data Interchange Network
CIT	(SESAR) Content Integration Team
CNS	Communications, Navigation & Surveillance
COFLIGHT	Flight Data Processing System
COMSEC	Communications Security
COSPAS	Space system for the search of vessels in distress (translated from Russian)
COTS	Commercial Off The Shelf
CPDLC	Controller Pilot Data Link Communications
CS	(Single European Sky) Community Specifications

CTOT	Calculated Take Off Time
D1, D2, D3, D4, D5, D6	SESAR's 6 Milestone Deliverables
DCB	Demand / Capacity Balancing
DMEAN	Dynamic Management of the European ATM Network
EADS	European Aerospace Defence Systems Company
EANPG	European Air Navigation Planning Group (ICAO)
EASA	European Aviation Safety Authority
EATM	European Air Traffic Management
EATMP	European Air Traffic Management Programme
EC	European Commission / European Community
ECAC	European Civil Aviation Conference
ECIP/LCIP	European / Local Convergence and Implementation Plan
EEC	EUROCONTROL Experimental Centre
EGNOS	European Geostationary Overlay Service
EMOSIA	European Model for ATM Strategic Investment Analysis
EOBT	Estimated Off Block Time
ER	En-route
ERAT	Environmentally Responsible Air Transport
ERRIDS	European Regional Renegade Information Distribution
ESARR	EUROCONTROL Safety Regulatory Requirement
ETS	Emissions Trading Scheme
ETSI	European Telecommunications Standard (isation) Institute
EU	European Union
EUIR	European Upper Flight Information Region
EURAMID	European ATM Military Directors
EUROCAE	European Organisation for Civil Aviation Equipment
EUROCAE ED 99	European Organisation for Civil Aviation Equipment manufacturers / European Datum 1999
FAA	Federal Aviation Administration
FAB	Functional Airspace Block
FDP	Flight Data Processing / Flight-plan Data Processor
FL	Flight Level
FOIPS	Flight Object Interoperability Proposed Standard
FP5/FP6	Fifth & Sixth Framework Programmes of the EC for Research, Technological Development and Demonstration
FPL	(Filed) Flight Plan
FUA	Flexible Use of Airspace
GA	General Aviation
GAT	General Air Traffic
GBAS	Ground Based Augmentation System
GDP	Gross Domestic Product
GNSS	Global Navigation Satellite Systems
GNSS ABAS	GNSS Airborne Based Augmentation System
GPS	Global Positioning System
HF	Human Factors, High Frequency
HIRO	High Intensity Runway Operations
IATA	International Air Transport Association
IC = II + SI	Interrogator Code = Interrogator Identity + Selective Interrogator
ICAO	International Civil Aviation Organisation
IFATCA	International Federation of Air Traffic Controllers Associations
IFATSEA	International Federation of Air Traffic Safety Electronic Associations
IFR	Instrument Flights Rules
ILS	Instrument Landing System
IP	Internet Protocol
IPR	Intellectual Property Rights
IR	(Single European Sky) Implementing Rules
IRS	Inertial Reference System
iTEC	Interoperability Through European Collaboration - FDP
ITU	International Telecommunications Union
JU	Joint Undertaking
KPA	Key Performance Area
KPI	Key Performance Indicator

LAST	Light Aircraft Transponder
LCC	Lifetime Cycle Costing
Link2000+	(EUROCONTROL) LINK 2000+ Programme
LoA	Line of Action
LVP	Low Visibility Procedures
MET	Meteorological (Information Services)
MLS	Microwave Landing System
MoD	Ministry of Defence
MoT	Ministry of Transport
MTCD	Medium Term Conflict Detection
MUAC	Maastricht Upper Area control Centre
NATO	North Atlantic Treaty Organisation
NATS	National Air Traffic Services (UK)
NEASCOG	NATO EUROCONTROL Aviation Security Co-Ordination Group
NLA	New Large Aircraft
NSA	National Supervisory Authorities
OAT	Operational Air Traffic
OCD	Operational Concept Document
OLDI	On-Line Data Interchange
PANS	Procedures for Air Navigation Services
PATIN	Protection of Air Transportation and Infrastructure
PAX	Passengers
PC	(EUROCONTROL) Provisional Council
PM	Performance Metrics
PO	Performance Objective
PRC	(EUROCONTROL) Performance Review Commission
PRNAV	Precision Area Navigation
PSR	Primary Surveillance Radar
PT	Performance Target
R&D	Research & Development
RET	Rapid Exit Taxi Way
RNAV	Area Navigation
RNP	Required Navigation Performance
RPK	Revenue Passenger Kilometre
RVSM	Reduced Vertical Separation Minimum
SAFEE	Security of Aircraft in the Future European Environment
SARP	Signal Automatic Radar Processing (NL)
SARSAT	Search and Rescue Satellite Aided Tracking
SATCOM	Satellite Communications
SBAS	Space/Satellite Based Augmentation System
SCG	System Concept Group
SES	Single European Sky
SESAR	Single European Sky ATM Research
SR2	Study Report
SRC	(EUROCONTROL) Safety Regulation Commission
SSR	Secondary Surveillance Radar
SSR-Mode S	Selective Address SSR
STCA	Short-Term Conflict Alert
TCP/IP	Transmission Control Protocol / Internet Protocol
TIS-B	Traffic Information Service - Broadcast
TMA	Terminal Manoeuvring Area
UAV	Unmanned Aerial Vehicle
UK	United Kingdom
US	United States (of America)
VDL2/ATN	VHF Digital Link Mode 2/Aeronautical Telecommunication Network
VHF DSB-AM	Very High Frequency / Double Side Band / Amplitude Modulation
WG 75	Working Group
WMO	World Meteorological Organisation
WRC	World Radio-communications Conferences
XPDR	Transponder

11 LIST OF FIGURES & TABLES

ANNEXES

A.1 SUSTAINABILITY IMPACT ASSESSMENT

This section conforms to PART I /Section A/ heading 1 paragraph of the Initial Impact Assessment Screening, entitled "Problem analysis: What are the main problems identified?"
Air Transport is recognised for its direct (e.g. 1.5 million jobs in Europe in 2004), indirect (1.8 million jobs), and induced (0.8 million jobs), social benefits. Moreover, catalytic benefits of Air Transport (effect on incomes, government finances, etc.) are estimated to amount to 6 times the direct benefits.
However, Air Transport is not sustainable under the current operating and societal conditions, according to the observed economic performance of European airlines. Moreover, the traffic growth forecast shows that the airport infrastructure in Europe will become a major bottleneck if no additional runways are made available. On the other hand there is a growing pressure put on Air Transport to reduce its environmental impact, especially in the vicinity of airports.
ATM is an actor of the value chain of Air Transport and as such, can improve its own processes to contribute to the sustainability of Air Transport by:

- Acting on the efficiency of flights and optimizing the usage of the bounded capacity of airspace and airport surface.
- While mitigating the environmental impact of operations.

This ATM improvement will address all sectors of ATM, including institutional, operational and technical aspects. A performance-based approach will be followed, starting from performance gap identification and appropriate analysis of solutions. The ICAO performance framework will be used to ensure balancing performance areas, including capacity, cost efficiency and environment.

A.2 SOLUTION RISKS

This annex presents the synthesis of the possible SESAR solution risks identified at M1. SESAR solution risks are defined as those risks which, if not appropriately mitigated, could prevent the SESAR ATM Master Plan from achieving its objectives. The risks have been identified as part of the assessment of the current situation, together with some mitigation actions. These will be reviewed regularly as part of the project risk management process.

No.	Risk	Impact	Probability	Mitigation Action
D1/R1	Lack of a solution to break the capacity barrier (See section 2.6)	High	High	1. Enhancing stakeholder involvement in the business decision processes through the applicable governance structure. 2. Better direction and management of activities related to R&D, validation and operational trials. 3. Securing involvement of operational staff in the design and validation processes. 4. Pooling of resources and planning as outlined in the proposed JU. 5. More efficient use of airspace in Europe by enhancing civil-military and military-military coordination and cooperation. 6. Review current funding models to give the right incentives to ANSPs, airports and airspace users.
D1/R2	Not possible to address the fragmentation issue with respect to the cost effectiveness objectives (See section 3.1)	High	Medium	1. Enhance flight efficiency. 2. Establish a "network plan". 3. Enhance real-time operational flexibility. 4. Develop a framework for services and obligations to be agreed between ANSPs, airport operators and airspace users.

No.	Risk	Impact	Probability	Mitigation Action
D1/R3	Lack of an assessment of the scope and content of the Master Plan due to business planning & CBA modelling limitations (See section 3.4)	Medium	Medium	1. Adapt the approach to business planning & the CBA model to the business structure and the stakeholder expectations. 2. Ensure business and stakeholder data quality provision.
D1/R4	Failure to address the enforcement of a common regulatory framework (See sections 4.2, 4.3 & 4.4)	High	Medium	1. Eliminate duplication of regulations. 2. Ensure that all future standards and regulations clearly state their safety objectives. 3. Clarify interfaces with safety regulation to avoid conflicting regulatory requirements.
D1/R5	Lack of a clear governance structure (including leadership, political & decision making arrangements) (See section 4.5)	High	High	1. Establish clear governance structure with clear roles and responsibilities. 2. Eliminate fragmented decision making across national, European and organisational boundaries.
D1/R6	Lack of credible ATM performance assessment and monitoring. (See section 3.3)	Medium	Medium	1. Implement a cultural paradigm change to the reporting of performance. 2. Establish an ATM performance framework and monitor it.
D1/R7	Lack of interoperability in a global context. (See section 4.4)	Medium	Medium	1. Ensure that the future standardisation structure addresses the global interoperability aspects. 2. Incorporate the global interoperability concerns in the interoperability KPA of the ATM performance framework.
D1/R8	Lack of acceptance of the ATM Master Plan by all actors (See sections 6.4 & 7.5)	High	Medium	1. Proactively manage the buy-in of the ATM Master Plan by the represented consortium social partners at each milestone. 2. Use it as the basis for the social dialogue, taking into account in the future institutional framework.
D1/R9	Lack of standardised and modular systems to facilitate the transition (See section 7.5)	High	Medium	1. Put in place a European ATM System design authority. 2. Proactively manage the scope and content of the standardisation process, ensuring the products will fit the architecture of the future ATM System.

A.3 SHORTCOMINGS OF CURRENT ATM SYSTEM

This annex captures, in headline form, aspects of the current ATM System which are considered to be shortcomings from an airspace design perspective [Ref.17] and from an airports perspective [Ref.18]. It is considered that quite a number of short-term solutions can be found to overcome many of these shortcomings and so improve the performance of the current ATM System in this timeframe. They are included here to supplement the information provided in the main body of the document and to maintain continuity with the next stage of the SESAR Definition Phase.

Airspace Design Category	Operational Shortcomings
Safety	Runway Incursions
	Level Bust
	Air-Ground Communications
	Unauthorized Penetration of Airspace
	Different level of maturity in safety management system implementation
	Lack of incident reporting and sharing of safety information
	Mobility of ATCOs
	Harmonisation of agreements with staff on working conditions
	Different / inconsistent working practices
	Resource Planning / Staffing / Recruitment practices of ATCOs
	Lack of qualified resources in Safety Management
	Limitations in training capabilities for Safety Management
	Lack of expertise for safety assessment of changes to the ATM system
	Lack of investment in safety
	Different level of maturity in safety regulation implementation
	Lack of qualified resources in Safety Regulation
	Limitations in training capabilities for Safety Regulation
Cost Effectiveness	Horizontal and vertical flight efficiency
	ATM/CNS Fragmentation
	Cost effectiveness planning
Design of Airspace Structures	Lengthy approval process of airspace changes at local level
	Preference given to local airspace solutions ignoring network effects
	High impact of charges on route network design and utilization
	Commitment to implement network optimal airspace solutions
	Lack of cross-border airspace structures
	Appropriate development of TMA structures
	Lengthy procedures for the implementation of ATS delegation
	Lack of dynamic sectorisation and sector opening schemes
	Flexible LoAs
	ATM system support for airspace and sectorisation changes
	Availability of detailed data on future airspace changes, including sectors and sector capacities

Airspace Design Category	Operational Shortcomings
Civil/Military co-ordination	Rigid ASM procedures
	Planning of military airspace
	Planning of military activities
	Definition and use of FUA airspace structures
	Different FUA procedures
	Real-time civil-military co-ordination
	Civil-military planning at local/network level
	Harmonisation of OAT rules
	Development of interoperability and performance-based specifications
Forecasting of Traffic Demand	Traffic forecast quality
	Traffic forecast accuracy due to routeings impact
	Data exchange with airspace users on expected demand
	Dynamic traffic forecasts
	Common format for traffic samples
	Involvement of airport slot co-ordinators
	Involvement of LCCs
	Dynamic data exchange at network level (airspace and flight data)
	Transparency of airport capacity plans
Operational Planning and Management of Network	Options for flight planning
	Different levels of co-operation in ATFCM processes
	Involvement of airspace users in CDM processes at network level
	Respect of ATFCM measures
	Integration of ASM and ATFCM functions at local and network level
	Consistency of flight data after EOBT
	Discrepancy between filed flight plan and on-board flight plan before departure
	Consistency between flight plans/airspace situation
	Balanced approach between ATFM and capacity management
	Involvement of airports in data exchange and CDM processes, including for en-route
	Reaction to sudden operational conditions changes
	Management of bad weather situation at airports
	Management of disruptions
	Standard network archives
	Facilities for the AROs
	Current FPL format (ATM)
	Traffic synchronization
	Global approach to ATFCM
	Full implementation of local plans
	Lack of dynamic Network Operational Plan

Airspace Design Category	Operational Shortcomings
	Commitment to agreed network plan
	Network effects and interactions
	Full transparency on past, current and expected operational performance
	Lack of network regulatory body
	Integration of MET data in ATFCM processes
Technical Limitations	Limited potential of traditional means to achieve required capacity targets in for the European ATM network
	Controller efficiency limited by time spent on routine voice communications
	Misunderstandings between pilots and controllers in conducting routine tasks
	Saturation of VHF voice frequencies
	Lack of interoperable datalink solutions
	Delayed commitment in implementing datalink
	Lack of Harmonised Controller Tools to extend the Controller's planning horizon
	Lack of reliable and accurate conflict detection
	Lack of reliable and accurate Controller Monitoring Aids
	Inefficient controller co-ordination between ACC
	Lack automated and up to date information in the cockpit
	Limited use of datalink at Airports
	No situational awareness in the cockpit in the air or on the surface
	No automated aircraft sequencing or spacing services
	Poor altitude reporting quantification
	Ambiguous aircraft identification
	Inadequate surveillance data quality
	Inefficient use of Mode A codes
	Tracking and data for safety nets (e.g. STCA) requires improvement
	Separation errors with risk of collision
	Poor airborne situational awareness
	Availability of Mode S Interrogator Codes, IC = II + SI
	Non-availability of low power "LAST" (transponders)
	Limited surveillance capability in high density airspace
	Absence of /limited surveillance at secondary airports
	Spectrum protection
Technical Limitations	Allocation of 8.33 kHz frequencies
	Full implementation of OLDI
	Implementation of MTCD
	Implementation of P-RNAV
	Common AIS reference
	Airspace data sharing
	AIP evolutions and AIS publication

Airspace Design Category	Operational Shortcomings
	Dynamic AIS standard
	Lack of updated on-board AIS data
	Aeronautical information fragmentation issued on a national basis
	Pan-European & global interoperability of aeronautical information including the geospatial dimension
	Absence of accurate terrain & obstacle data
	Absence of comprehensive and exchangeable airport geospatial data (according to EUROCAE ED99a)
	Airspace structure updates in non-computer processable format (free text format)
	Accuracy & integrity of aeronautical information available to ATM
Human Resources	Lack of timely consideration of human factors aspects in system development
	Lack of integration of human factors in safety management
	Inflexible rostering practices
	Unreliable mid- and long-term resource planning
	Slow progress on harmonising training and licensing aspects
	Mobility of staff hampered by differences in national regulations, working arrangements and operational infrastructure
	Fragmented social dialogue structures
	Duration to reach social dialogue agreements too long
	Preparation and motivation for change limited
	Change management skills at management level limited

The following captures shortcomings of the current situation from the perspective of the processes performed at airports.

Airport Process		Operational Shortcomings
Arrival Process	Arrival Flow	First come first served principle in network operation vs. Airport schedule
		Poor information of expected arrival time leading to tardy arrival of agents, and handling equipment, at gate
		The effective reduction in the arrival stream density when operating into a headwind
	Runway Capacity and Infrastructure	Runway arrival capacity (especially for converging runways)
		Lack or wrong position of Rapid Exit Taxiways (RET) for High Intensity Runway Operations (HIRO)
		Highly variable runway occupancy times
	Technological Enablers and Procedures	Substantial reduction of runway capacity in bad weather when operating under CAT-II and CAT-III procedures
		Quality of surveillance and wake-vortex-prediction limiting in-trail and diagonal separation especially in low visibility
		Absence of arrival sequencing tools reduces runway capacity and increases airborne holding
Taxi and Turnaround Process	Airport Ground Infrastructure	Insufficient apron capacity (stand & gate)
		Inadequate taxiway layout leading to delays
		Aircraft taxi or towing movements involving crossing of active runways
	Taxi Management	No advance planning for taxi process
		Poor predictability of taxi process
		No recognition of the preferences of airport operators and airlines in taxi process
	Turnaround and terminal	No integration of turnaround in overall planning process
		Stand and Gate allocation process
		Deficiencies in passenger and baggage process (check-in, screening, border control, boarding)
	Accommodation of NLA	Complex and costly adaptation of airside and landside infrastructure (incl. Terminal) to accommodate NLA
		Complex traffic management procedures for NLA traffic

Airport Process		Operational Shortcomings
Departure Process	Pushback Process	Insufficient warning time for pushback due short notice calls on pushback frequency
		No adequate pushback planning to optimise departure sequence due to 'first come first served' principle
	Taxi out	Increased line-up times due to ILS holding points during LVP
	Departure Capacity / Infrastructure	Lack of space and multiple line-up points at runways to allow sequence changes
		Poor departure sequencing tools producing unnecessary high separation and thus delay
Safety Related Issues	Situational Awareness	Lack or bad quality of surveillance
		Congestion of ground voice communication frequencies
		Lack of situational awareness in the cockpit
		Insufficient Runway Incursion prevention measures
	Harmonization	Lack of compliancy with ICAO provisions
		Lack of harmonized signage
		Lack of harmonized stand entry guidance systems
General	Planned Runway Capacity	Incorrect assumptions in planned runway capacity leading to operational delay
	Tactical Runway Capacity	Insufficient coordination between airport ground processes and CTOT
		Unplanned ad-hoc traffic leading to delays
	Departure runway - demand characteristics	Demand out of balance with departure runway capacity
		Inconsistent use of slots (e.g. slots planned for Medium aircraft suddenly used by Heavy aircraft)
	Adverse Weather and other disruption	Lack of collaborative contingency planning for different disruption scenarios (severe weather, incidents, accidents, security, etc.)
		No contingency planning for network effects
		Poor prediction of bad weather duration leads to excessive regulation reported to CFMU

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The SESAR Definition Phase is funded by the European Commission's TEN-T Programme and EUROCONTROL.