

# **SINGLE EUROPEAN SKY – THE SOLUTION FOR AN AIR TRAFFIC MANAGEMENT ADAPTED TO THE CHALLENGES OF THIS CENTURY**

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***Abstract:** At the beginning of this century has become obvious that the European air traffic management system has to be reformed in order to support the increasing number and diversity of airspace users within same limits. Thus, European Commission launched a legislative package – Single European Sky Initiative – with the intention of covering legal, economic, safety, environmental, operational, technological and institutional aspects of aviation with the aim of ensuring safe conditions for operating the aircraft. As to reach the envisioned level of ambition has been created an appropriate framework – Single European Sky ATM Research Program – to develop and implement a pan-European airspace management system that will enable tripling air traffic while reducing delays, improving air safety, reducing the environmental impacts and ATC cost. Moreover, has been agreed upon a continuous updated roadmap – the ATM Master Plan – with the aim to make possible the transformation of ATM operational concept in order to support SES objectives. The responsibility for the coordination and management of research and development of all necessary projects is SESAR Joint Undertaking which organizes, coordinates and ensures the necessary financing activities, ensures the involvement of European ATM sector stakeholders, organizes technical research and development, validation and study activities, and supervises activities related to the development of common products properly identified in the ATM Master Plan.*

***Keywords:** Air Traffic Management, ATM Master Plan, Single European Sky, SESAR*

## **1. INTRODUCTION**

It could be soundly affirmed that the twentieth century was a period of challenges for aviation from several points of view. If the detachment from the earth proved to be the biggest challenge in the dawn of this era and the ongoing desire for higher, further, and faster continued to be a target, we have got to witness at the beginning of this millennium a large amount of air space users within same limited air space and the new challenge proves to be the implementation of an effective air traffic management. It is obvious that the diversity of aerial platforms and the pace at which they were developed exceeded the capacity of the airspace management system that has evolved technologically and operationally more slowly.

The desire to provide quality services to the general public in order to improve trade and travel conditions was highlighted by the attention paid to specific means that allow airplanes navigate safely without delays or incidents.

The aviation safety system, based on a set of rules and procedures for airspace management and considering the necessity of maintaining the sovereignty of national

airspace has been developed simultaneously with the Air Traffic Control (ATC) and led to the creation and development of dedicated organizations to provide air traffic services – Air Navigation Service Provider (ANSP).

Air traffic management (ATM) is defined by ICAO as „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. Nowadays those who provide these services are constantly pressured to tailor themselves in respect of organization, operating capacity, outlook on the rapid evolution of the socio-political business environment and surrounding technological progress. All these pressure aims at improving the quality of services.

The Single European Sky (SES) initiative launched in 2000 and the legislative package adopted in 2004 brought ATM under the competence of the European Union (EU) as to increase the capacity of European airspace and to reduce its fragmentation. However, the first legislative framework was necessary but not enough. Thus, a second package (SES II) proposed in June 2008 was adopted in November 2009 by the Council and Parliament with the objective of accelerating the establishment of a really single European sky beginning 2012. This is based on five pillars: performance, safety, technology, airports and the human factor. It was found that the performance objectives proposed cannot be achieved without an adequate institutional structure and in January 2013 SES II package was revised resulting package SES II+ which regulates the activity in certain areas covered by previous legislation and states clearly the roles and responsibilities of the institutions involved in the process.

During the economic crisis of recent years, the support of the entire ATM community was reaffirmed confirming the need of an urgent reform of ATM sector. This reform of European ATM will be achieved within the framework of Single European Sky ATM Research (SESAR) program. European Commission aims that SESAR program to develop and implement a system of airspace management in Europe that will enable tripling air traffic while reducing delays, improving air safety, reducing the environmental impacts and ATC cost. SESAR brings together key stakeholders to develop a new vision on European airspace management to be applicable from 2020.

Therefore, as the air transport plays a major role in the nowadays European Union economy and security, the European airspace must be continuous, safe and responsive to the requirements of civilian or military air operators alike. To achieve that it is essential to have an integrated European air traffic management to address in parallel the challenges of competitiveness, safety and durability.

## **2. SINGLE EUROPEAN SKY INITIATIVE**

As one of the conditions for expansion of the European Union was to ensure unrestricted freedom of movement of goods and persons, the upgrade and expansion of transport networks has been recognized as a pivotal factor to achieve progress in all fields expected.

In terms of aviation, opening up the EU market in 1993 has made air travel more accessible and affordable, stimulating the growth of air services. Nevertheless, the use of a traditional air traffic management system within an unchanged air space volume but used concurrently by more and more civilian and military operators has inevitable conducted to various restrictions mainly reflected in noticeable delays.

## 2.1. The Down of Single European Sky Initiative

Since its establishment in 1960, European Organization for the safety of air navigation (Eurocontrol) has proposed eliminating national borders in European airspace but only after nearly half a century this idea took shape. Thus, in response to major flights delays recorded in 1999, the European Commission (EC) launched in 2000 the Single European Sky Initiative. EC proposed a legislative package on the ATM which covers legal, economic, safety, environmental, operational, technological and institutional aspects of aviation with the aim of ensuring safe conditions for operating the aircraft. This package is addressed to all airspace users and to those interested in air traffic control requesting their involvement in making possible the reformation of air traffic in the European Union to increase flight safety.

The package includes proposals on the creation of SES as of 31<sup>st</sup> of December 2004 and establishes the objectives and its operational principles together with other plans for specific regulations concerning the provision of air navigation services, organization and use of airspace and interoperability of equipment and procedures.

Following the counselling procedures between the representatives of the Council and the European Parliament in Brussels, on the 9<sup>th</sup> of December 2004 was signed the agreement on creating a single European airspace for the benefit of both civilian and military users setting goals and operating principles for SES.

SES initiative introduces a new organization regarding the provision of air navigation services independent of national borders, restructures the airspace at regional level, and presents an airspace management more integrated and complemented by the development of new concepts and procedures for ATM aiming to improve services, to comply with aviation security requirements, to reduce delays, and to increase the economic efficiency of services and environment protection. Thus, the airspace will be considered a common resource for all categories of airspace users which requires flexible use by all of them, ensuring fairness and transparency upon taking into account the security issues of Member States. Therefore, these countries have declared their willingness to cooperate, taking into account national military requirements, in order to implement completely and evenly the concept of flexible use of airspace in all Member States and by all airspace users.

The objectives proposed by the European Commission when created SES were:

- to develop the air traffic control capacity; the estimated air traffic annual growth rate will be about 5%;
- to improve safety; ATC in Europe is one of the safest in the world but it is differently organized from a Member State to another, therefore in response to an increased traffic a common and systematic approach has to be developed;
- to reduce fragmentation in ATC; a different ATC setup and organizational arrangements among Member States create inconsistencies which have harmful effects on fluency and regularity of air traffic;
- to ensure the involvement of the military sector in the organization of ATC and decision-making process;
- to facilitate the introduction of new technologies; it should be encouraged the cooperation between ATC services, equipment manufacturers and air companies in respect of introducing new and more performant equipment.

## **2.2. Single European Sky II – The Updated Regulations Package**

In 2009 the European Commission adopted the second SES legislative package (SES II) which mainly targeted the increased safety, the reduced costs and delays, with positive effects on less fuel consumption, the reduced carbon dioxide emissions and costs. These measures meet the estimated growth of air traffic by 2020, two times more compared with the air traffic in 2008.

The SES II package brings a number of improvements to the SES initial regulations. It includes compulsory performance targets for the Air Navigation Service Providers, a European network management function to ensure convergence between national networks and an ultimate date for Member States to improve their performance, starting with a cross border cooperative approach, known as Functional Airspace Block (FAB).

Thus, the Single European Sky reform proposed by the Commission pursues in parallel:

- performance regulation – the air traffic management has to be improved together with the integration of service provision in order to transform FABs into genuine instruments of regional integration, to strengthen the network management function, which encompasses a series of tasks to be performed by various players including the design of European route network, slot coordination and allocation and the implementation of SESAR technologies and procedures;
- creation of a unique safety framework – the increased air traffic, overcrowded airspace and airfields and the use of new technologies all call for a common approach to developing and implementing harmonized rules to improve the safety of air transport and to extend the European Aviation Safety Agency (EASA) responsibilities in key areas as aerodromes, air traffic management and air navigation services;
- use of new technologies – the current ATC system is about to reach its limits working with obsolescent technologies and suffering from fragmentation. Therefore, it is recommended to accelerate the development of control system by implementing SESAR solutions in order to increase safety and traffic control capacity;
- management of ground capacity – it has to be made all necessary investments to adapt airports capacity to the air traffic management capacity with the aim of maintaining the overall efficiency of the network.

## **2.3. Single European Sky II plus (SES II+) – The Streamlined Regulations**

Since the beginning of the ATM reform process existed the prerequisites for improvement. The suspension of the steady growth of ATM costs did not bring the expected cost reductions. It has been noticed a first evidence of slow decline of extra distances that aircraft were required to travel due to ATM restrictions. Moreover, was established the network administrator who managed in a very short time to gather together all stakeholders involved in the planning process to determine what will finally become a true European network of routes. Also, the regulatory framework has made some improvements with the implementation of the first rules SES and EASA but some Member States who are either owners or major shareholders of service providers, have a strong tendency to focus on recurring revenue stream generated by the air traffic control services financed by users and are therefore less willing to endorse a fundamental shift towards a more integrated operating airspace. In addition, SES decision-making processes still allow too easily the delaying progress by national decision makers.

For this reason, at the end of 2013 has been submitted for approval a new package of measures, SES II+, aiming to the structures and decision-making reforming processes to allow setting more ambitious targets, combined with greater flexibility where it is really needed, and increasing the enforcement. Approved by the European Commission on the 11<sup>th</sup> of March 2014, SES II+ package updates SES founding regulations and amends the rules governing EASA. The main updates concern the following areas:

- Improving safety and surveillance. National supervisory authorities set up in 2004 did not fully succeed to oversee the safety and performance of the air traffic control bodies and to ensure implementation of new rules. Therefore, as aviation safety remains the first priority, SES II + aims to remedy the situation by a complete institutional separation of authorities of entities they supervise to ensure a real decisional independence and by identifying a stable financing channel, to ensure financial independence.

- Performance objectives. The reform of the European air traffic management is driven by four key performance objectives: safety, cost efficiency, capacity and environmental protection. These objectives touch the core of the reform process and to meet them, air traffic control bodies must reform themselves and provide better services at lower prices. The Commission proposal will enhance the performance system since setting the targets will be done in a more independent and transparent way and subsequently can be more easily imposed. The proposal will strengthen the Commission's role in setting ambitious targets. The process of targeting will be shorter and will be based more on evidence in order to benefit from more recent and more accurate traffic forecasts.

- Support services. Support services normally generate most of the costs of air traffic management. Due to neutral reasons, air traffic control services are almost always assured by great service providers monopolists, and therefore their effectiveness must be based on careful economic regulation, namely on system performance. On the other hand, support services (meteorological services, communications, navigation, surveillance and aeronautical information) are different and could be provided under conditions of market competition. Commission proposal was to separate the support services, which could be the subject of competitive tendering in accordance with customary rules of public procurement to ensure transparency of the selection process and focus on quality and costs, instead of nationality.

- More customers oriented. Too many air traffic control bodies have transformed customer consultation – airspace users – a mere formality. SES II+ aims at establishing a of an increased client oriented attitude through introduction in legislation some of the best practices in the consultation sector and creating the possibility that different groups of airspace users should be involved in approving the investment plans of suppliers. This will ensure that users, representing *raison d'être* of the system are heard and that they in turn can provide synchronized introduction of new equipment and making other major investments both on the ground and in aircraft.

- Greater flexibility to allow industrial partnerships within FABs. The purpose of functional airspace blocks is to increase efficiency and reduce costs and emissions. However, these airspace blocks were rather prescriptive form of cooperation between states and service providers, aiming to create bigger entities in the provision of services and converted to fulfil administrative formalities in place to develop synergies. In the SES II+, FABs are transformed into more flexible industrial partnerships, which will allow also participating in several FABs, based on a necessary performance level.

- Enhanced Network Manager. SES II+ emphasizes the role of network manager making it a service provider for service providers which will focus on synergies at the network level and on industrial cooperation.

By 2017 Network Manager will implement and manage up to nine Centralized Services (CS) to the European ATM network, as follows:

- CS#1: Flight Plan and Airport Slot Consistency Service (FAS) – the synchronization of flight plans with times of arrival / departure to / from airports;
- CS#2: 4D Flight Trajectory Profiles Calculation Service for Planning Purposes (4DPP) – 4D trajectory profiles calculation and communication with greater precision;
- CS#3: European Tracker Service (ETKR) – producing a high-quality images of air situation at European level;
- CS#4: Advanced Flexible Use of Airspace Support Service (AFUAS) – ASM supply and data collection allowing a more efficient use of available airspace;
- CS#5: European ATM Information Management Service (EAIMS) – collecting, organizing and providing the ATM information at the network level as soon as possible using a variety of means;
- CS# 6: Management of Common Resources Network Service (CNR) – improved management at the network level to limited “resources” (ex. transponder codes, radio frequencies, etc.);
- CS#7: Network Infrastructure Performance Monitoring and Analysis Service (NIPS) – ensuring safe operation and resolve anomalies that may arise at Communications, Navigation and Surveillance (CNS) shared or distributed infrastructure;
- CS#8: Pan European Network Service (PENS) – providing terrestrial IP based communications between sites and partners;
- CS#9: Data Communication Service (DCS) – providing air-ground data communications in support of data links services, Airline Operation Centres, flight information services, airport coordination etc.

These services could be provided by the network administrator to local or regional ANSP which would lead to obtaining significant economies.

• EASA, Eurocontrol and the institutional landscape. Finally, the various bodies of the EU do not overlap, but their activities complement each other optimally and that the regulatory mechanism is able to provide high quality standards during the next stage of development of SES and SESAR. Eurocontrol must focus increasingly more on operational activities described above in connection with network administrator, using his considerable experience in the field and extensive operational knowledge. On the other hand, EASA should focus on coordinating the development of technical standards and ensure that they are subject to appropriate consultation and a high level of quality and consistency. Also, EASA must continue to fulfil its supervisory duties and to increase its support to Member States' authorities. Finally, the European Commission should focus on economic regulation (system performance, taxation, etc. FAB) and political strategy. This will prevent the waste of resources and ensure the possibility to avoid the implementation difficulties encountered in the past.

### **3. THE EUROPEAN AIR TRAFFIC MANAGEMENT MODERNIZATION PROGRAM**

The European air routes network being an amalgamation of national routes is not yet sufficiently adapted to the needs of a modern pan-European air traffic. This reality makes flights within European airspace to be less efficient than domestic flights. Moreover, the provided air navigation services are divided along the borders using procedures, equipment and different operational policies.

To remedy these shortcomings, the Single European Sky ATM Research (SESAR) program proposes a more efficient management of air traffic in Europe supported by leading technology.

### **3.1. The European Airspace and Air Navigation Services**

According to the Chicago Convention the European airspace is divided in air traffic controlled areas – Flight Information Regions (FIR) – airspace volumes which follow national borders and include air routes networks.

In the SES context, the legislation speaks about a single European Upper Flight Information Region (EUIR) which includes the upper airspace falling under the responsibility of Member States and additionally includes airspace adjacent to European countries but not EU members. Creating EUIR, above FL310 (9450 meters), allow this space to be reconfigured in defined control zones dissociated from national borders, thus ensuring a more efficient use of airspace, systems and specialized ATM personnel. Therefore, the European airspace will be reconfigured into several FABs.

The strategic objectives that must be met by a FAB are:

- Safety – ensuring an increasing level of safety despite the increasing civil air traffic;
- Capacity – requirements of civil air traffic is expected to increase significantly in the coming period;
- Cost effectiveness – achieving optimal and balanced costs to ensure operations inside FAB including ATC services;
- Flights efficiency – finding optimal continuous ascent / descent routes as to reduce flight distance and time;
- Environment – reducing environmental impact through optimal route selection, appropriate flight profile and reduced time in the air;
- The effectiveness of military missions – military flights executed within a FAB involves careful coordination between civil and military authorities of each country included in the block.

The term Air Navigation Services (ANS) comprises four main elements: communication, navigation and surveillance (CNS) services, meteorological services (MET), air traffic management (ATM) services and auxiliary aviation services like: search rescue (SAR) and aeronautical information (AIS) services.

Air Traffic Management (ATM) includes all services related to air navigation as follows: Air Space Management (ASM), Air Traffic Services (ATS) and Air Traffic Flow and Capacity Management (ATFCM).

Air Traffic Management is the set of functions provided on ground and in the air aiming to ensure safe and efficient movement of aircraft during all phases of operation. The general objective of ATM is to provide air operators with the appropriate information as they can maintain scheduled time for take-off and landing and the possibility of joining the preferred flight profiles with minimum constraints but without compromising agreed levels of safety.

Airspace management is a planning function with the main objective to maximize the use of available airspace within a defined airspace structure through a dynamic allocation process based on time and temporary airspace segregation between different categories of users upon their requirements. ASM task is to design and make known the airspace structure, airspace management, air routes and reserved areas for military activities and airports, while ensuring safety and traffic fluidity.

Air Traffic Flow Management and Capacity is a service that aims to ensure an optimum flow of air traffic in time and space in case of the demand exceeds available capacity of the ATC system and airport infrastructure.

### **3.2. Single European Sky ATM Research Program**

Single European Sky ATM Research (SESAR) program is one of the most important research and development ATM projects ever launched by the EU. SES provides the legal framework for more efficient, better performing, safer and greener ATM procedures. SESAR will provide technological solutions, functionalities, systems and proposals for standards that would achieve performance objectives relating to SES aimed at tripling capacity, halving ATM costs, improving safety and reducing the environmental impact of each flight.

SESAR brings together airspace users, service providers, airlines, airport operators, industry representatives, partner institutions, regulators, military organizations, professional associations, research centres, all of them making its contribution under Eurocontrol expertise in defining and SES implementation of regulations in this pan-European program.

SESAR program is the technological pillar of the Single European Sky which provides the legal framework to meet future needs in terms of safety, capacity and efficiency at European level rather than nationally. SESAR concept is based on the principle that airspace users and controllers define together through a collaborative processes and information exchange, the most appropriate route of flight for an aircraft, predictable and without delay. This concept is founded on new innovative technologies and operational procedures resulted from a cycle of three interrelated continuous and evolutionary processes: definition of the content and priorities through an agreed roadmap, namely the ATM Master Plan; research, development and validation of technological systems, components and necessary operational procedures and, implementing the new systems and operational procedures, eventually.

Main features of SESAR concept of operation are:

- The transfer of operations based on airspace to trajectory based operations, so that each aircraft achieves its preferred route and time of arrival;
- Collaborative planning so that all parties involved in flight management from departure gate to arrival gate, can plan their activities based on the performance the system will deliver;
- Set up the Dynamic Management of the European Airspace Network (DMEAN) to help increase traffic capacity and flight efficiency by enhancing coordination between civil and military authorities;
- New technologies that provide greater precision navigation applications on board and an optimized scheduling between aircraft to maximize airspace and airports capacity. New technologies will be embedded into a harmonized and interoperable technical architecture that also come to support the needs of all European regions;
- Preponderant role of the human factor, largely based on advanced tools to work safely and without undue pressure.

SESAR program consists of three phases:

- The definition phase (2005–2008) – it has been defined the roadmap (SESAR ATM Master Plan) for achieving performance levels in terms of ATM and establishing a high level work plan that defines the content of the new generation of ATM systems by identifying the necessary elements to achieve it.



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- The development phase (2009–2013) – it has been based on the definition phase and has been focused on developing the necessary elements. The SESAR Joint Undertaking has been designated to be responsible for the management of this phase. Research and development activities were launched immediately after the adoption of the ATM Master Plan. SJU's work program, consisting of 19 modules and implemented through around 300 projects carried out by the SJU members and their associates, is divided into the following areas as research on the operational air traffic route management, systems research (aircraft systems, management systems, en-route or approach air traffic operations, civil and military operational centres, airport systems, management systems, network information and communication systems, navigation, surveillance), Wide Information Management System, transversal activities (infrastructure validation, security, safety, environmental and human performance files development, the ATM Master Plan management and update, the target concept and its architecture).

- The deployment phase (2014–2020) aims at large-scale production and implementation of new ATM infrastructure. This infrastructure will be based on new technologies and procedures resulting from the development stage and will contribute to achieving SES objectives that will lead to high performance in European air transport.

The responsibility for the coordination and management of research and development of the SESAR projects is SESAR Joint Undertaking (SJU). This enterprise is a public-private partnership with the statute of an EU body established. SJU is made up of two founding members – EU and Eurocontrol – and 15 other members representing all stakeholders in ATM: civil and military ANSPs, aircraft and equipment manufacturers and airports. In addition, SJU involves airspace users, professional organizations, scientific institutions and a number of associated partners, whose activities complement the program. It was initially decided that the SJU cease to exist eight years after the approval by the Council of the ATM Master Plan but later its lifetime has been extended until 31<sup>st</sup> of December 2024. SJU aim is to ensure the modernization of European ATM system by coordinating and concentrating all relevant research, development and validation activities within SESAR project. Moreover, it is responsible for implementing the ATM Master Plan having a double role: custodian and executor.

SESAR Joint Undertaking organizes, coordinates and ensures the necessary financing activities during SESAR deployment phase, ensures the involvement of European ATM sector stakeholders, organizes technical research and development, validation and study activities, and supervises activities related to the development of common products properly identified in the ATM Master Plan.

The SJU modus operandi has the advantage that all relevant stakeholders are involved in decision making processes having shared responsibilities therefore the research and innovation can be continuous and undivided. Relations of mutual interdependence and coordination mechanisms between participants and projects are integrated into a comprehensive European concept and the architecture of the system is ensured through a multilateral contractual agreements.

At the end of 2011, when it was proposed that its lifetime to be extended, the main achievements the SESAR Joint Undertaking were: the management of 4D trajectories, System Wide Information Management (SWIM) infrastructure which introduces a completely new way to manage the information throughout the European ATM system, a functional remote control tower, etc.

The foundation for SJU working program is the ATM Master Plan which organizes the deployment of SESAR concept in three progressive stages: Stage 1 – it aims to provide the necessary technologies for synchronizing European ATM system through an efficient exchange of information between all stakeholders, Stage 2 – it will achieve a more efficient planning of flight paths, and Stage 3 – it aims to achieve the highest level of performance through a seamless integrated air / ground system.

### **3.3. The European Air Traffic Management Master Plan**

The ATM Master Plan is the agreed roadmap updated and applied by the SJU with the aim to transition to a new ATM operational concept to support SES objectives. It should be considered as the European reference for a stable and credible planning, which allows stakeholders to anticipate new functionalities aligning them with investment cycles and planning retrofit activities. The definition phase of SESAR has been the basis for developing and implementing a new ATM concept, addressing research and development and validation activities which resulted in a total of six reports. One of these reports, *D5 - Production of the SESAR Master Plan* is considered as the first ATM Master Plan that integrates areas of performance improvements, elements of the new ATM concept, cost benefit analysis and lays out the roadmap for operational improvements into a coherent work program.

ATM Master Plan was first approved by the Board on the 30<sup>th</sup> of March 2009 and the Board of the SJU it adopted on the 12<sup>th</sup> of June 2009. It connects ATM research and innovation activities with the deployment scenarios, facilitating the achievement of SES performance targets helped by modernization of technologies and ATM procedures. ATM Master Plan is a living document that guides the work program for the development phase and also will be a key tool for the SESAR deployment phase. Coordination and interaction between development and deployment is essential for the success of SESAR project and full implementation of SES.

An updated version of the ATM Master Plan, Edition 2, approved in October 2012, has identified the most important operational changes to be implemented throughout three main stages in order to contribute to the full implementation of the new concept SESAR by 2030. Thus, during the first stage the work will focus on activating dormant capacity, notably by improving the exchange of information to optimize the network effects, in the second phase there will be developed information management concepts at system level and initial trajectory as to increase efficiency and in the third stage it will be introduced a comprehensive and integrated management of the initial trajectory, which will include new separation modes with the intention of achieving long-term political objective of SES.

A second valuable update, approved on the 15<sup>th</sup> of December 2015, improves the concept getting together performance and technology with an extended horizon up to 2035. It references to the key features of the SESAR 2020 Research and Innovation program and to the Pilot Common Project. The role of the human and the attitude to change management are emphasised whilst two precise topics affecting ATM are introduced: cyber security and drones. It also fosters a broader military involvement.

The deployment of new ATM operational concept proposed by SESAR will be accomplished in accordance with the ATM Master Plan. It is performance oriented following four key areas of performance: environmental protection, cost-effectiveness, safety and capacity.

To achieve this performance, the ATM Master Plan proposes ways forward for the essential operational changes grouped into six key characteristics, chosen for their

capacity to provide performance benefits in one or more operating media (airport, airways, terminal areas, and network). These operational changes will evolve over three complementary steps leading to achieving the target concept.

These steps are based on achieving capabilities and have no fixed terms of completion. So every once completed, will bring the system closer to the ATM target concept, as follows:

- Step 1 – Time-based operations. This step underpins the implementation of SESAR concept and focuses on flight efficiency, predictability and environment. The purpose of this phase is a synchronized European ATM system where partners are aware of ongoing operations and are working together to optimize the network. During this phase it is initiated that air traffic arrivals at airports to be orderly achieved. Will be widely used data links and will be run the first trajectory-based operations using aerial trajectories (by ground systems) and controlled time of arrival (for ordering and managing traffic queues).

- Step 2 – Trajectory-based operations. It focuses on a more advanced flight efficiency, predictability, environment protection and capacity which become an important goal. The goal of step 2 is to provide an ATM system based on the trajectory that optimizes partners' trajectories using shared information about 4D trajectories and users define priorities in the network. Trajectory-based operations initiate the management of 4D trajectory using SWIM and ground and air data exchange about the trajectory to allow tactical planning and identifying portions of routes without conflicts.

- Step 3 – Performance-based operations. At this stage all requirements of required high performance will be achieved to meet the SESAR concept target. The goal of this stage is to implement a high-performance European ATM system, integrated, network-based, collaborative, air and ground continuous. Performance-based operations are achieved by using SWIM performances and network-wide operations collaborative planning throughout the ordering process led by the user.

To trigger the deployment phase in 2012, it was necessary a new document – SESAR Concept of Operations-Step 1 – detailing specific actions to be performed during first step of deployment phase and defines the required final stage to be reach for commencing the new step. Thus, for initiating the deployment process, SJU has launched a pilot project carried out jointly – Pilot Common Project (PCP) – in order to coordinate and synchronize the implementation of the most important ATM functionalities (AF) developed by SESAR. This constitutes the starting point for implementing future joint projects. PCP contains a first package of technical and/ or operational changes to be introduced during 2014 – 2024, grouped as follows:

- AF#1: Extended AMAN and PBN in high density TMAs;
- AF#2: Throughput Airport and functionalities Integration;
- AF#3: Flexible Route Airspace Management and Free;
- AF#4: Network Management Collaborative (Flow & NOP);
- AF#5: Ground-ground integration and aeronautical data management and sharing;
- AF # 6: Initial Trajectory Information Sharing: Towards i4D air-ground integration with enhanced performances Flight Data Processing;

Moreover, the centralized services proposed by SES II+ legislation prove to be the perfect vehicle for the implementation of the six PCP AF packages at pan-European level. This approach will lead to achieving the proposed performance levels in a faster pace than if the changes would be introduced separate at regional level.

## CONCLUSIONS

Identifying the operational and technological limitations of the European air traffic management system directed to a new approach on the topic. Thus, in 2000 was launched the Single European Sky Initiative with the aim to standardize ATM practices through legislative packages proposed in 2004 and completed later in 2008 and 2013. If the initial goal was to increase the capacity of European airspace and to reduce fragmentation subsequently other goals were added, all aimed at increasing performance, improving safety, development of technologies and improved airport capacity.

The need to reform the ATM industry was mentioned constantly at different levels but now, backed by an appropriate legislative framework at European level and with the support of the entire ATM community, the reform of air traffic management in Europe will take place in the context of Single European Sky ATM Research Program.

SESAR program, the technological and industrial dimension of Single European Sky will develop and implement a new airspace management system in Europe that will enable tripling air traffic while reducing delays, improving air safety, reduce environmental impacts and ATC cost. The deployment of SESAR operational changes will be made in accordance with the ATM Master Plan aiming to produce benefits in one or more operating environments (airports, airways, terminal areas or entire network).

The ATM Master Plan connects ATM research and innovation activities with deployment scenarios, helping to achieve SES performance targets through the ATM modernization technologies and procedures. Responsible for implementing the ATM Master Plan is a public-private enterprise with the statute of an EU body, SESAR Joint Undertaking who aims to ensure modernization of the European ATM system by coordinating and concentrating all relevant research, development and validation SESAR projects.

Even if the envisioned horizon to deploy all SESAR innovations was 2035 we should imagine beyond this timeline towards 2050 when performance-based operations will be implemented all over Europe, continuous coordination between ANSPs or full end-to-end service will be provided at network level, and the flight will be considered as a whole within a flow and network context. Afterward, the vision will become reality across the whole ATM system.

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