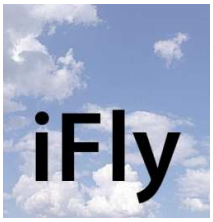

Project no. TREN/07/FP6AE/S07.71574/037180 IFLY

iFly

Safety, Complexity and Responsibility based design and validation of highly automated Air Traffic Management

Specific Targeted Research Projects (STREP)

Thematic Priority 1.3.1.4.g Aeronautics and Space

iFly Deliverable D6.2
Institutional and Organizational analysis for the implementation of the autonomous aircraft operations

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Executive Summary

According to E-OCVM, the identification of any operational, technological or institutional feasibility issues arising from the implementation of an operational concept in V1 phase constitutes a major validation objective. The objective of Task 6.2 "Institutional and Organizational Issues" of the iFLY project is to assess the feasibility of the ATM changes emerging from the implementation of the A^3 ConOps within the currently prevailing ATM regulatory framework.

This target is achieved through the identification of the institutional and organizational enablers and barriers to the implementation of the A^3 ConOps. The A^3 ConOps aims to provide a solution to the efficient management of the expected radical increase of air traffic in the forthcoming years. The major features of the A^3 ConOps relate to the following issues: i) 4D trajectory-based flight planning and management, ii) delegation of the separation task from the Air Traffic Controllers (ATC) to the flight crew for a defined part of the airspace, iii) pre-flight strategic avoidance of conflicts, iv) collaborative decision making, and v) advanced surveillance and traffic awareness through the establishment of the System Wide Information Management System (SWIM). The implementation of the A^3 ConOps involves a set of major operational, organizational, institutional, and technological changes to the existing ATM system. Thus, the feasibility of the proposed A^3 ConOps should be assessed in terms of complying with the ATM changes under development or envisaged by the SES legislation and the associated operational changes included in the European Air Traffic Management Master Plan.

A methodological framework has been developed for achieving the above objective. The proposed methodological framework aims to determine the major ATM operational and organizational changes arising from the deployment of the A^3 ConOps and analyse their compliance with the prevailing ATM institutional framework. The major steps of the proposed framework involved: i) the determination of the ATM system changes associated to the implementation of the A^3 ConOps, ii) the specification of the legislation and the regulatory issues pertinent to the A^3 ConOps, and iii) determination of the enablers and inconsistencies of the A^3 ConOps with the existing institutional framework. This document presents in detail the methodological framework for performing the abovementioned type of assessment of the A^3 ConOps and outlines the major results that were determined from the assessment of the A^3 ConOps compliance with the existing institutional framework.

The implementation of the A^3 ConOps requires substantial institutional changes, including adaptation of the ATM legislation, regulative updates, and reform of the existing conventional role of the ATM stakeholders. Based on the findings of this document, the Single European Sky (SES) framework and the framework for the flexible use of the airspace will be mostly affected in an effort to introduce the A^3 ConOps. Moreover, the changes required in the ATM systems and technologies associated with the A^3 ConOps implementation imply substantial revision of the ICAO Annexes relevant to the rules of the air, the navigation systems, and the role of the ANSPs. In addition, significant implementation regulations (guidelines and rules)

will be required for the delegation of the separation task to the flight crew (which is the cornerstone of the A^3 ConOps) and the remaining elements of the A^3 ConOps supporting this task (e.g. Autonomous Flight Rules). The implementation of the A^3 ConOps is expected to have significant implications on the roles of the stakeholders as perceived in the existing ATM system. In particular, ANSPs will not be responsible for the separation of the traffic within the SSA. In this new ATM system the role of ANSPs will be basically focused on the assessment of 4D trajectories at the non-SSA phases phase of a flight, and the coordination of the collaborative decision making process for fixing trajectories. On the other, hand the flight crew will not only safely fly the aircraft but it will have the total control of the flight execution, route changes, and conflict resolution process. Finally, new stakeholders may also arise from the A^3 ConOps such as the organization/actor responsible for SWIM and the organization having the final call to decide regarding the conflicting trajectories at the pre-flight phase.

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1 Introduction

1.1 Background and Objectives of the Document

According to E-OCVM [1] (in tasks 8.2.3 “Definition of Benefit and Cost Mechanisms: Initial Justification for R&D” and 8.2.4 “Identification of R&D Needs”), the identification of the costs, benefits and any operational, technological, or institutional feasibility issues associated to the implementation of an operational concept (like A^3 ConOps) in V1 phase constitutes a major validation objective. The objective of WP6 “Cost Benefit Analysis[1]” is to validate the economic and institutional feasibility of the Autonomous Aircraft Advanced (A^3) Concept of Operations (ConOps) [19]. The proposed work for achieving the above goals is divided into the following sub-WPs: i) WP6.1 Development of a methodological framework for cost-effectiveness analysis, ii) WP6.2 Institutional and Organizational analysis for the implementation of the autonomous aircraft operations, iii) WP6.3 Data collection for cost-effectiveness analysis, iv) WP6.4 Cost effectiveness analysis and results assessment. This document presents the results of the work in Task WP6.2, where the Air Traffic Management (ATM) institutional and organizational issues arsing from the potential implementation of the A^3 ConOps are studied.

The terms “institutional” and “organizational” used in this document refer to any issues related to changes of institutions and organizations associated to the ATM System. The most prevailing definition of the term institution describes it as the “humanly devised constraints that structure human interaction. They are made up of formal constraints (such as rules, laws, constitutions), informal constraints (such as norms of behaviour, conventions, self-imposed codes of conduct), and their enforcement characteristics”[2]. Moreover, the term organization is defined as “a group of individuals bound by some common purpose to achieve objectives. Organizations include political bodies (political parties, regulatory agencies), economic bodies (firms, trade unions), social bodies (churches, clubs), and educational bodies (schools, universities)” [3]. Adopting the formal definitions for institution and organization for the ATM system, it is concluded that the term "institution" refers to the rules prevailing in the ATM system whereas "organization" refers to players (actors) participating on the ATM system. In this context, the institutional issues arising from the introduction of the A^3 ConOps relate to the changes in terms of (high level) rules and regulations setting the regulatory mechanism and framework for the implementation of the A^3 ConOps. Moreover, the organizational issues relate to changes that should be performed in terms of the role of the stakeholders and their operations in the ATM system in order to facilitate the implementation of the A^3 ConOps.

The A^3 ConOps aims to provide a solution to the efficient management of the expected radical increase of air traffic in the forthcoming years. The major features of the A^3 ConOps relate to the following issues: i) 4D trajectory-based flight planning and management, ii) delegation of

[1] Renamed from the title “Cost-Effectiveness Analysis” used in the initial iFLY Description of Work.

the separation task from the Air Traffic Controllers (ATC) to the flight crew for a defined part of the airspace named Self Separating Airspace, iii) pre-flight strategic avoidance of flight trajectories conflicts (deconfliction), iv) collaborative decision making, and v) advanced surveillance and traffic awareness through the establishment of the System Wide Information Management System (SWIM)[21]. It is evident that the implementation of the A^3 ConOps involves a set of major operational, organizational, institutional, and technological changes to the existing ATM system.

In this context, the objective of Task 6.2 of the iFLY project is to assess the feasibility of the ATM changes emerging from the A^3 ConOps within the currently prevailing ATM regulatory framework. This target is achieved through the identification of the institutional and organizational enablers and barriers to the implementation of the A^3 ConOps [19].

The existing European ATM regulatory, operational, and technological framework is in a transition phase initiated by the Single European Sky (SES) initiative. Thus, the feasibility of the proposed A^3 ConOps should also be assessed in terms of complying with the ATM changes under development or envisaged by the SES legislation and the associated operational changes included in the European Air Traffic Management Master Plan (i.e., SESAR D5 endorsed by the European Commission (EC) [23]).

A methodological framework has been developed for achieving the above objective. The proposed methodological framework aims to determine the major ATM operational and organizational changes arising from the deployment of the A^3 ConOps and analyse their compliance with the prevailing and the envisaged ATM institutional framework. This document presents the methodological framework for performing the abovementioned type of assessment of the A^3 ConOps and outlines the major results that were determined from the relevant analysis of the existing and envisaged institutional framework.

Substantial input for determining the ATM operational and organization changes is received from WP1 related to the A^3 operational concept description provided through the reports D1.1 "A^3 High Level ConOps"[20], and D1.3 "A^3 ConOps"[21]. Moreover, the specification of the existing ATM institutional framework pertinent to the A^3 ConOps was based on the collection and analysis of the relevant European Commission Regulations, the European ATM Master Plan [23], the ICAO regulations, and the SESAR developments [22]. The expected outcome of the assessment of the institutional feasibility of the A^3 ConOps is a set of potential enablers and barriers for implementing the proposed concept and the development of a set of preliminary changes/enhancements of the regulatory framework that could facilitate the implementation of the proposed concept.

1.2 Organisation of report

The remainder of this report consists of five sections and one annex (at the end of this report). Section two presents the methodological approach developed for identifying the major institutional and organizational issues for implementation of the A^3 Concept of Operations (ConOps). Section three is devoted to the presentation of an overview of the changes proposed in the Air Traffic Management (ATM) operations by the A^3 ConOps. Section four provides the results from the analysis of the ATM regulatory framework pertinent to the implementation of the A^3 ConOps and section five provides a set of recommendations for the potential changes in the existing ATM regulatory framework in order to tackle the institutional and organizational issues arising from the implementation of the A^3 ConOps. Finally Annex I includes the completed templates analysing the regulations pertinent to the A^3 ConOps.

2 Methodological Approach

The determination of the institutional and organizational issues arising from the introduction of the proposed A^3 Concept of Operations (ConOps) involves the assessment of the compatibility of the A^3 ConOps operational changes with the existing institutional framework. The Air Traffic Management (ATM) institutional framework involves the ATM European Union (EU) legislation and bundles of regulations issued by authorised organizations for the: i) establishment of the objectives and priorities of the ATM system, ii) identification of the role of the involved stakeholders, and iii) specification of the major operational and technological requirements needed for the provision of the ATM services. Thus, the objective of this study relates to the assessment of the A^3 ConOps elements in terms of compliance with the relevant ATM legislation and regulations. The expected outcome of this type of assessment relates to the determination of the institutional issues that could potentially endorse or create inconsistencies/impediments for the implementation of the A^3 ConOps elements (institutional enablers and inconsistencies, respectively). In addition, the proposed study should identify the gaps of the existing institutional framework in covering the new ATM operations proposed in the A^3 ConOps.

A methodological framework has been developed in order to identify the above potential institutional issues emerging from the implementation of the A^3 ConOps. The major steps of the proposed framework are presented in Figure 2-1. A major prerequisite for performing the proposed assessment of the ATM institutional framework relates to the determination of the changes in ATM proposed through A^3 ConOps. The objective of this task is to identify the operations of the ATM process affected by the A^3 ConOps, and specify the associated changes. The determination of the existing regulatory and institutional framework of the ATM operations affected by the A^3 ConOps involves the following tasks: i) specification of the regulations that dominate the existing ATM system, and ii) assessment of the collected regulation in terms of affecting any of the A^3 ConOps elements. This step involves the identification of the international and European regulations which rule the ATM operations, including the Single European Sky framework, the ICAO annexes, and the European ATM Master Plan. A long list of regulations emerges by considering the above institutional issues. Thus a screening process is needed in order to identify the regulations that are relevant to the A^3 ConOps. The determination of the regulations which are relevant to the A^3 ConOps is facilitated by grouping the various A^3 ConOps elements on the basis of the International Civil Aircraft Association (ICAO) Operational Concept Components, i.e., Airspace organization and management, Demand/capacity balancing, Traffic synchronization, Conflict management, Airspace user operations, ATM service delivery management, and Aerodrome operations. Thus, the screening process involves only the assessment of the relevance of each ATM regulation with any of the A^3 ConOps components.

Following the identification of the regulations relevant to the A^3 ConOps, the core part of the proposed analysis involves the assessment of the A^3 operational changes in ATM in terms of complying with the associated prevailing institutional framework. This step aims at identifying the following issues: i) the operational changes in the ATM system that are inconsistent or they contravene with any of existing regulations, ii) the elements (regulation or bundle of regulations) of the institutional framework could potentially expedite and facilitate the implementation of the A^3 ConOps changes, and iii) the elements of the A^3 ConOps not envisaged by the existing institutional framework.

The results of the above analysis will lead to conclusions and recommendations about the bundles of regulations that should be updated and the issues that they should cover in order to accommodate the implementation of the A^3 ConOps.

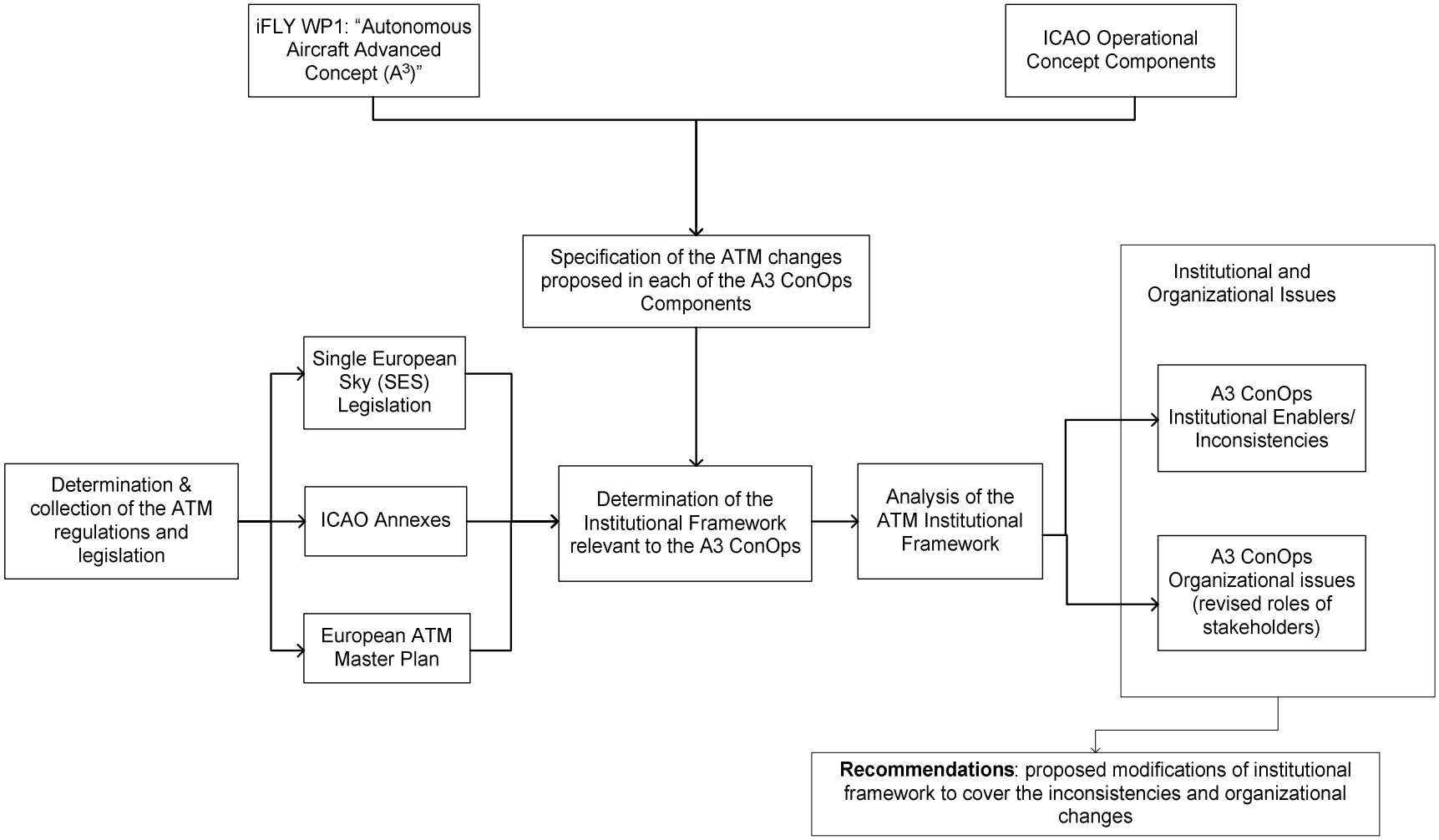

Figure 2-1. Methodological framework for determining the institutional and organizational issues emerging from the introduction of the A^3 ConOps in the ATM system.

3 Overview of the *A³ ConOps related ATM changes*

The objective of the Advanced Autonomous Aircraft (A^3) Concept of Operations (ConOps) is to prescribe the new or modified Air Traffic Management (ATM) operations and technologies needed in order to implement the self separation airspace concept within the en-route phase of a flight. This section aims to highlight the potential operational and organizational changes signified by the implementation of the A^3 ConOps. Deliverable D1.3 "Advanced Autonomous Aircraft (A^3) ConOps" was used as the basis for identifying the elements of the ATM affected by the A^3 ConOps.

The determination of the potential operational and organization changes in the ATM system emerging from the introduction of the A^3 ConOps was based on identifying and grouping the major elements of the A^3 ConOps within the following International Civil Aviation Organization (ICAO) Operational Concept components [17]: i) Airspace organization and management, ii) Demand/capacity balancing, iii) Traffic synchronization, iv) Conflict management, v) Airspace user operations, vi) ATM service delivery management, and vii) Aerodrome operations. This type of analysis simplifies the process of identifying the ATM changes introduced by the A^3 ConOps and facilitates the screening of the ATM regulations in terms of relevance to the A^3 ConOps (more on the latter issue is provided in the Section 4).

The core of the A^3 ConOps relates to the delegation of the en-route separation tasks and responsibilities from the Air Traffic Control Centres (ATCC) to the flight crew. In particular, the proposed ConOps applies to ATM operations pertinent to the en-route phase of a flight. As indicated in D1.1 and D1.3, the en-route phase of a flight is defined (by the ICAO Common Taxonomy Team) as the phase between the completion of "Initial Climb through Cruise Altitude" and the completion of "Controlled Descent to the Initial Approach". Thus, the A^3 ConOps does not cover the potential changes that would emerge for aerodrome operations. Given this limitation in the scope of the A^3 ConOps, no reference to the Aerodrome Operations component is included in the analysis that follows.

Before the presentation of the major operational and organizational changes in the ATM system proposed by the A^3 ConOps, an overview of the major features of the concept is provided:

- The time frame for the A^3 ConOps is expected to be beyond the SESAR scope, i.e. beyond 2025. This is in compliance with the European ATM Master Plan that envisages the implementation of the delegation of the separation task from the Air Traffic Controller (ATC) to the pilot, at 2025 [23].
- The A^3 ConOps covers only the ATM services provided en-route (i.e. between Terminal Areas)

- The flights are planned in the form of 4D trajectories (with no specific route structure) optimizing the airspace users criteria
- The separation task (including conflict detection, processing, and resolutions) of A^3 flights is delegated to the flight crew
- The resolution of any conflict between aircraft is based on a set of Autonomous Flight Rules (though not fully specified in the D1.3 document)
- The ATM system proposed in A^3 ConOps capitalizes on the System Wide Information Management (SWIM) concept proposed in SESAR.

The remainder of this section includes the presentation of the changes in the ATM system proposed within each of the A^3 ConOps Components.

3.1 A^3 ConOps Changes in the Airspace organization and management

The major changes in terms of airspace organization and management relate to the following elements of the Air Traffic Management (ATM) system: i) the Airspace Organization Classes, ii) the Airspace Boundaries, and iii) the Route Network structures.

Concerning the airspace organization, three categories of airspace are recognized in A^3: Managed (MA), Unmanaged (UA), and Self Separating Airspace (SSA). The boundaries of the SSA are specified dynamically by the corresponding boundaries of the Managed and Unmanaged parts of the airspace. In particular, the allocation of airspace among the SSA, MA, and UA will be dynamic, issued by the Air Navigation Service Providers (ANSPs) in collaboration with the Flight Operations Centres (FOCs). Although the Managed Airspace is not excluded from the ATM envisioned within the A^3 ConOps its existence is basically assumed over congested areas (e.g. airports). The SSA will be the part of the airspace where the en-route phase of any flight will be executed. However, no further information is provided regarding the dimensions, coverage areas, or structure of the managed airspace. It should be pointed out that although the Air Navigation Service Providers (ANSPs) may not be entitled to intervene in the control (separation) of an A^3 flight in the SSA, they may still monitor its trajectory. Separation is required from Restricted Airspace Areas and Weather Hazard Areas. No separation services will be provided from the Air Traffic Controllers (ATC) within the SSA while all aircraft flying within SSA are assumed to comply with the AFR requirements. The aircraft could enter/leave MA through specific entry/exit points constrained by the Controlled Time of Arrival (CTA). No further details are provided regarding the structure and management of the transition airspace.

No route structure is assumed for the SSA where user preferred aircraft routing is allowed. The flight plans will be based on 4D trajectories that will be built by the FOCs and approved through a collaborative decision making process handled by the ANSPs, without taking into account any specific airspace route network.

ATM System Elements	Current Situation	A³ ConOps Proposal
Airspace Organization Classes	Classes A-G in which the role of the ATC varies for IFR and VFR flights. Each class is defined based on the ATS provided to IFR and VFR flights.	**Three classes** are identified: Managed, Unmanaged, and Self Separating Airspace (SSA).
Airspace Areas Boundaries	Any restricted airspace area is currently specified and fixed by the member states in a static way.	The use of **airspace** will be **dynamic**, i.e. any restricted of prohibited areas (due to bad weather, high complexity, or military activity) will be temporary and will have dynamic airspace boundaries.
Aircraft Route Network	The flight paths are specified on the existing route network.	**Free routing** (4D trajectories) will be implemented within the Self Separating Airspace

Table 3-1. Airspace Organization and Management changes proposed by the A^3 ConOps.

3.2 A^3 ConOps changes for Demand/capacity balancing

The major changes in terms of the ATM services for balancing the demand vs. capacity relate to the introduction of the pre-flight strategic flow management process where the flight trajectories are determined through the collaborative decision making between the Flight Operations Centres (FOCs) and the Air Navigation Service Providers (ANSPs). The FOCs design the preferred trajectories for a specific day (free of conflict and separated from areas with expected high air traffic complexity or unacceptable air traffic congestion) and provide them to the relevant ANSP unit. Then the ANSP assesses the trajectories and the final commonly agreed trajectories are specified through a collaborative decision making process. This process falls within the Network Operations Plan mentioned in SESAR. The Collaborative Decision Making process involves the ANSPs, the FOCs and Non-FOC airspace users. The outcome of this process leads to the Reference Business Trajectories, free from any conflict from Terminal Area (TMA) exit to TMA entry. The current version of the concept does not provide any additional details regarding the Collaborative Decision Making (CDM) process for fixing the Reference Business Trajectory (RBT) (process, role of each participant, criteria for reaching resolving conflicts).

ATM System Elements	Current Situation	A^3 ConOps Proposal
Air Traffic Flow Management	ATFM is performed by the Central Flow Management Unit (CFMU). The CFMU allocates and updates slots, offer individual re-routings, re-route flows on an ad-hoc basis and continually seek to balance capacity and demand	Preflight strategic flow management: in A^3 the objective is to issue conflict free trajectories through strategic pre-flight planning. The airspace users design the preferred trajectories for a specific day (free of conflict and separated from areas with expected high air traffic complexity or unacceptable air traffic congestion) and provide them to the relevant ANSP unit. Then the ANSP assesses the trajectories and the final commonly agreed trajectories are specified through a collaborative decision making process. Based on the current version of A^3 ConOps, the ANSP will be the air traffic authority to decide on conflicting SBTs. No further information regarding the above decision making process is provided.
En-route Rerouting	ATC suggests and commands routes in order to avoid airspace areas (e.g. with high air traffic complexity). The pilot and the controller can negotiate the path, but the final orders are provided by the controller.	The flight crew receives on board (from SWIM) the areas that should be avoided and replans the RBT accordingly.

Table 3-2. Demand/ Capacity Balancing changes proposed by the A^3 ConOps.

3.3 A^3 ConOps changes for Traffic Synchronization and Conflict Management

Although the Air Navigation Service Providers (ANSPs) are not involved in the separation task during the en-route phase of the flight, they provide the following type of support to the airspace users:

- Transition Operations from the Self Separating Airspace to the Managed Airspace. These operations related to the provision of Traffic-to-follow and spacing information in order to achieve the smooth entrance of the aircraft to the Terminal Manoeuvring Area (TMA). However, the current version of the A^3 ConOps description does not provide any details regarding the operations for the aircraft transition from the Self Separating Airspace (SSA) to the Managed Airspace (MA) (and the opposite).
- Controlled Time of Arrival (CTA) for TMA and departure time from the TMA exit.

The Air Traffic Control Centres (ATCCs) provide separation services to the aircraft only upon entrance in the managed airspace or until their exit from the TMA. Additional ground support (not necessarily provided by the ANSPs) will be provided through the Complexity Predictor system that will determine airspace areas with high complexity that should be avoided by the aircraft. This type of areas will be uploaded to the aircraft by System Wide Information

Management (SWIM). It is not specified in the current version of the A^3 ConOps, the actor that will be responsible for managing the Complexity Predictor system.

The separation task in the (SSA) is performed by the flight crew. In order to achieve this task, the Autonomous Flight Rules (AFR) aircraft should be equipped with Airborne Separation Assistance System (ASAS) and airborne surveillance systems. The surveillance system should form two awareness zones around the aircraft: i) the medium term awareness zone that covers the area for a medium term (10-20 min) time frame of its flight and ii) the long term (more than 30 min) timeframe of its flight. Both types of awareness zones emerge by processing the surrounding traffic information based on the state and the intent information available to the aircraft from air to air communication and the SWIM.

The conflict detection and resolution is performed by the flight crew based on the medium term awareness zone. A conflict is created if the comfort zone of the aircraft is about to be violated by another aircraft or other obstacle. The comfort zone surrounds the safety zone which should not be violated at any time. Specific values are proposed for the dimensions of each of the protected area zones. The Flight crew is responsible for resolving any conflict, with the support of ASAS application. A major issue in resolving a conflict relates to the priority rules. However, the current version of A^3 ConOps (as described in D1.3 [21]) does not fully specify a set of specific priority rules.

Table 3-4 provides the major changes in the ATM system regarding the traffic synchronization and the conflict management provided in the current version of the A^3 ConOps (D1.3).

ATM System Elements	Current Situation	A^3 ConOps Proposal
Aircraft Separation	The task of separation for any controlled flight is performed by the ATC.	The flight crew is the separator for any flight operating within the SSA.
Separation minima	As defined by ICAO	New reduced airborne separation minima may be applied. The new separation minima could be identified by ICAO. Target values are specified in the current version of the A^3 ConOps.
Airborne Separation Assistance System (ASAS)	None	Advanced Airborne Separation Assistance System
Ground- Air Communication	Voice communication and limited use of data link	Data link communication
Airborne Surveillance	ATC	Traffic Proximity Detection system
Transition between sectors	Transition between ATC units (e.g. TMA to ACC).	Transition from the Managed airspace to the SSA and the opposite.
ANSP role during the en-	Air Traffic Services (Control, Flight	No Air Traffic Control apart from: i) specifying the Controlled Time of Arrival,

ATM System Elements	Current Situation	A^3 ConOps Proposal
route phase of the flight	information, Alerting)	ii) traffic-to-follow and spacing information in order to achieve the smooth entrance of the aircraft to the TMA, iii) Upload restricted areas, hazard areas, military restricted areas through the System Wide Information Management (SWIM).
Conflict Detection	Any conflict is detected by the ATC	Conflicts are detected by the flight crew through ASAS applications
Conflict Resolution	ATC resolves conflict for any controlled flight by providing the flight crew with the appropriate manoeuvres	Conflicts are resolved by the flight crew with the support of the on-board ASAS applications
Airborne Collision Avoidance System (ACAS)	Airborne Collision Avoidance System	Not affected.
Flight Rules	IFR and VFR flight rules	AFR flight rules (a list of rules is included in the current version of the A^3 ConOps)
Airspace Areas to Avoid	Specified and uploaded by ATC	Complexity Predictor system.

Table 3-3. Traffic Synchronization and Conflict Management changes proposed by the A^3 ConOps.

3.4 A^3 ConOps changes for Airspace user operations

The Flight Operations Centres (FOCs) are permitted to monitor the operations of the aircraft under their jurisdiction (through the SWIM) while they perform the following tasks:

i) FOCs build the Shared Business Trajectory for each flight (given the Controlled Time of Arrival issued by the relevant Air Navigation Service Providers (ANSPs) and negotiate departures and arrivals (from and to TMAs) with the ANSPs. They cooperate with the ANSPs in order to issue conflict free Reference Business Trajectories (pre-flight strategic deconfliction).

ii) FOCs provide the aircraft with support for avoiding congested areas, i.e., they calculate and upload updates of the Reference Business Trajectory based on long term situation awareness information.

iii) The communication of the FOCs with the flight crew (en-route) will be primarily performed through data link. Voice communication will be used only in emergency situations.

Each aircraft in A^3 ConOps will broadcast state and intent data to other aircraft and SWIM. Any revised version of the Reference Business Trajectory will be transmitted to SWIM and FOC. Each aircraft should be provided constantly with information regarding its environment (i.e. position in place and time of other aircraft or restricted areas). Given the availability of

this type of information, the flight crew performs the management of their own aircraft trajectory by changing the RBT is order to avoid conflicts or restricted/hazard areas.

ATM System Elements	Current Situation	A^3 ConOps Proposal
Flight Planning	Each airline submits a flight plan before the flight execution. CFMU validates the consistency of the information provided.	Strategic deconfliction: the airlines (through the FOCs) cooperate with the ANSPs in order to issue conflict free 4D trajectories within the SSA (named Reference Business Trajectories-RBT). Although the current version of the A^3 ConOps does not provide any additional information regarding the decision making process for building the RBTs, it is evident that flight planning process will be substantially changed in the A^3 ConOps.
Flight Execution	Flight executed by the flight crew. Any change in the flight plan is subject to clearance from the ATC.	Strategic trajectory management performed by the flight crew.
Air-Air Communication	No data exchange between aircraft, but the aircrafts, can listen the communication of other pilots with the ATC, in the same sector	Aircraft exchange state and intent data

Table 3-4. Airspace User Operations changes proposed by the A^3 ConOps.

4 Critical Review and Analysis of the Current ATM Regulations

4.1 iFly Relevant Regulations and Guidelines

The institutional and organizational issues arising from the introduction of the A^3 ConOps were specified by assessing the level of compliance of the A^3 operational and organizational changes with the regulations that currently dominate the relevant Air Traffic Management (ATM) services and operations. An intermediate step in order to achieve this target was to explore the ATM regulatory framework in order to identify the regulations relevant to the A^3 ConOps. For this purpose, the following legislation and regulations sources were investigated: i) the Annexes (2, 10, 11) of the International Civil Aircraft Association (ICAO), ii) the Legislation of the European Commission (Single European Sky I), iii) the European ATM Master Plan (recently endorsed by the European Commission), and iv) SESAR Target Concept.

A critical review of an extensive list of ICAO documents (identified within Deliverable D1.3 of the iFLY project) indicated that the following sources could potentially affect the introduction of the A^3 ConOps:

- ICAO Procedures for Air Navigation Services Air Traffic Management (Doc 4444), 14th edition, International Civil Aviation Organization, 2001 [16]
- ICAO Annex 11 to the Convention on International Civil Aviation, Air Traffic Services, 13th Edition, International Civil Aviation Organization, 2001 [15].
- ICAO Annex 10 Aeronautical Telecommunications, 6th edition, 2001, Vol. III & IV [13], [14]
- ICAO Annex 2 to the Convention on International Civil Aviation, Rules of the Air, 10th Edition, International Civil Aviation Organization, 2005. [17]

- Doc 4444-RAC/501 Procedures For Air Navigation Services rules Of The Air and Air Traffic Services.[16]

Concerning the SES legislation, the following regulations were taken into account:

- Commission Regulation (EC) No 549/2004 laying down the Framework for the Creation of the Single European Sky **[8].**
- Commission Regulation (EC) No 550/2004 on the Provision of Air Navigation Services in the Single European Sky **[9].**
- Commission Regulation (EC) No 551/2004 on the Organisation and use of Airspace in the Single European Sky **[10].**
- Commission Regulation (EC) No 552/2004 on the Interoperability of the European Air Traffic Management Network **[11].**
- Commission Regulation (EC) No 2096/2005 laying down Common Requirements for the Provision of Air Navigation Services **[7] .**

- Commission Regulation (EC) No 2150/2005 laying down Common Rules for the Flexible use of Airspace (FUA) **[6].**
- Commission Regulation (EC) No 730/2006 on Airspace Classification and Access of Flights Operated under Visual Flight Rules above Flight Level 195 **[4].**
- Commission Regulation (EC) No 1033/2006 laying down the Requirements on Procedures for Flight Plans in the Pre-flight Phase for the Single European Sky **[5].**
- Commission Regulation (EC) No 219/2007 on the Establishment of a Joint Undertaking to Develop the New Generation European Air Traffic Management System (SESAR) **[12].**

Recently the European Commission endorsed the SESAR D5 "The SESAR Master Plan" as the European Air Traffic Management Master Plan. Thus, the A^3 ConOps related ATM changes were also assessed in terms of compatibility with the envisaged ATM targets of the SESAR D5, and the SESAR ATM Target Concept (Deliverable D3 of SESAR).

The analysis of the regulations mentioned above involved the following steps: i) determination of the objectives and scope, ii) identification of the stakeholders affected, iii) specification of the major issues relevant to the A^3 ConOps, iv) critical assessment and determination of the potential impacts of the regulation to the various components of the A^3 ConOps. A template for identifying and organizing the above type of information was developed and completed for each of the above documents. The completed templates that emerged from this process are provided in Appendix I of this report. In what follows there is an overview of the objectives and major implications of the above regulations to the A^3 ConOps implementation. The results of this type of analysis constituted an intermediate step in order to specify the potential barriers and enablers for the A^3 ConOps.

4.2 Analysis of the Single European Sky (SES) I Framework

The SES Regulations issues from the European Commission (EC) 549-552/2004 establish a high level institutional mechanism for changing the currently fragmented ATM system to a flexible, safe and efficient European Air Traffic Management Network. Regulation (EC) No 549/2004 sets the framework for the creation of the Single European Sky. This regulation defines the objectives of the Single European Sky (SES) initiative and establishes the key stakeholders for developing and deploying the SES. The major goals of SES relate to the enhancement of the safety of the general European air traffic, the improvement of the capacity of the ATM system, and the minimization of delays. The harmonization and the standardization of ATM procedures and technologies is the initial step and the major means of the SES for resolving the ATM issues arising from the fragmented ATM system. Thus, the deployment of the SES initiative is achieved through the development and application of appropriate common implementing rules. EUROCONTROL is one of the stakeholders that would be developing the implementing rules, based on a relevant mandate issued by the European Commission. The application of the SES implementing rules in each Member State

is managed by the National Supervisory Authorities (authorised by the corresponding Member State). No inconsistency between the SES regulation 549/2004 and the ATM changes proposed in the A^3 ConOps is observed. To the contrary, the institutional framework established in this regulation could be used accordingly in order to produce the implementing rules required for the implementation of the ATM changes proposed in the A^3 ConOps.

The objective of the regulation EC 550/2004 is to set the common requirements for the provision of air navigation services in the Single European Sky framework. In particular this regulation establishes a set of common requirements that must be satisfied by the Air Navigation Service Providers (ANSPs), including: technical and operational competence, systems for safety and quality management, reporting systems, and security. According to this regulation, the air navigation services will be provided by certified organizations. A relevant certificate issued by the National Supervisory Authority is given to those ANSPs that fulfil the common requirements. Air navigation services are provided only by certified ANSPs. The certificates issued by one member state will be valid to any other member state. In addition this regulation proposes a common charging scheme. A point of this regulation relevant to the A^3 ConOps is traced in Article 13 (1) where the operational data (for the general air traffic) "shall be exchanged in real-time between all air navigation service providers, airspace users and airports to facilitate their operational needs". This part of the regulation facilitates the sharing of flight information among the ANSPs, which constitutes a basic feature envisaged for the System Wide Information Management (SWIM) proposed in the A^3 ConOps. In this way, this regulation constitutes an enabler for the implementation of the SWIM system included in A^3 ConOps.

The objective of the regulation EC 551/2004 is to establish common procedures for airspace organization and use that ensures efficient and safe ATM performance. The long-term target of this regulation is an integrated operating airspace throughout Europe. In particular, the points in the regulation relevant to the A^3 ConOps are the following:

- Article 9 (2c) implies that the implementing rules for the SES airspace organization will facilitate the flight planning of general air traffic and cover issues related to priority rules for access to airspace during periods of congestion or crisis. This part of the regulation provides the basis for introducing free routing and setting up the priority rules for autonomous flights as proposed in A^3 ConOps.
- Article 6 (1) implies that route design shall be established on the basis of ensuring safe and economically efficient airspace. This part of the regulation facilitates the introduction of the free routing which constitutes a major feature of the A^3 ConOps.

SES Regulation (EC) 552/2004 aims to provide the framework for achieving the interoperability of the European Air Traffic Management Network (EATMN), through the harmonization of the systems, constituents, and procedures employed in ATM. This target is achieved by setting essential requirements, implementing rules for establishing specific

common requirements, and European Community standards. The essential requirements proposed in this regulation relate to:

i) seamless operation, which implies that ATM systems and constituents should ensure the information sharing (for all phases of a flight) within the European ATM Network, while appropriate procedures should be in place in order to facilitate the comparable information processing performance,

ii) support for new concepts, implying that any new system and its constituents should support new (commonly agreed) ATM operational concepts,

iii) safety, any system and its constituents should achieve a specified level of safety achieved and this should be maintained through safety management systems and reporting methodologies,

iv) civil-military coordination, the ATM systems and their constituents should support the coordination between civil and military stakeholders,

v) environmental constraints,

vi) principles governing the logical architecture of systems, aiming at a coherent, harmonised, and evolutionary logical architecture of the European ATM network,

vii) principles governing the construction of systems (modularity, fault tolerance interchangeability of constituents).

The major points included in this regulation that relate to the A^3 ConOps are the following:

- Annex II of the regulation presents in detail the requirements for the ATM systems, constituents, and procedures. One of the general essential requirements refers to the need for ATM systems to support any new (commonly agreed and approved) concept of operation including the concept of collaborative decision making and the concept for increasing automation and applying alternative methods of delegation of separation responsibility. Thus, this part of the regulation facilitates the introduction of two major features of the A^3 ConOps: i) the collaborative decision making process for issuing and fixing the Shared Business Trajectories, and ii) the delegation of the separation task from Air Traffic Controllers (ATC) to the flight crew. However, it should be clarified that this part of the regulation implies that ATM systems, constituents, and procedures should support the introduction of the relevant A^3 ConOps features. It does not describe how these features should be supported.
- Annex II Part B, 1.1, refers to the seamless operation of air traffic flow management systems. A specific requirement for seamless operation of this type of systems is the sharing of correct and coherent flight information. However, sharing flight information is a major prerequisite for implementing the System Wide Management Information (SWIM) proposed in the A^3 ConOps. In particular, it is essential for the Flight Operations Centres to have access to flight information in order to build conflict free shared business

trajectories. Thus, this part of the regulation facilitates the implementation of SWIM and the pre-flight trajectory planning process proposed in the A^3 ConOps.

- Annex II Part B, 3.2.1, provides specific requirements for the seamless operation of surveillance data processing systems. One of these requirements relates to the timely sharing of information between ATC units in the EATMN. Moreover, in section 6.1, it is implied that surveillance data should be shared in to order to enhance operations through the EATMN. Thus, both issues constitute an enabler for the implementation of SWIM which is the basic enabler in A^3 ConOps, for sharing information among the various ATM stakeholders.

Regulation (EC) No 2150/2005 aims to set common rules for the implementation of the concept of flexible use of airspace. The major principle of the flexible use of airspace implies that the airspace is considered as a continuum where restrictions on use are permitted only temporarily. Along this line the current version of the rules for the flexible use of airspace relate to: i) the coordination between civil-military authorities for airspace management through agreements and procedures, and ii) the efficient and consistent application of the concept across national borders. . The most relevant issues of this regulation to the elements of the A^3 ConOps are the following:

- The concept of flexible use of the airspace assumes that the airspace structures are temporary. This concept is reflected in Article 4(h, i, j). This principle is in line with the A^3 ConOps which proposes the Self Separating Airspace (SSA) where no permanent airspace restrictions exist for the airspace users. Thus, the flexible use of airspace concept defines a framework from which the SSA could emerge.
- In Article 4 (d) it is stated that the Member States should “define temporary airspace structures and procedures to offer multiple airspace reservation and route options”. This issue sets the basis for providing the airspace users with more route options thus realising their goal to conduct optimal or near optimal flight trajectories. Given that free routing constitutes a basic feature of the A^3 ConOps this part of the regulation constitutes a potential enabler for the transition of the airspace route network to a free routing airspace.

Regulation EC 1033/2006 (laying down the requirements on procedures for flight plans in the pre-flight phase for the single European Sky) aims to provide the requirements for the submission, processing and distribution of the initial flight plan, during the pre-flight phase of a flight. The initial flight plan is submitted to, processed, and distributed by the Integrated Initial Flight Plan Processing System (IFPS). The objective of the flight plan processing is to assess the consistency of the flight plan submitted by the relevant authority (operator or agent). The establishment of the IFPS and its operation is under the responsibility of each Member State which lays down the requirements for flight plans in the Pre-Flight Phase for the Single European Sky. Regulation 1033/2006 was developed in order to refine and complement the specific requirement 3.1.1 (Seamless operation of the Flight data processing systems) of Regulation No 552/2004 on the provision of measures for ensuring the

interoperability of the European Air Traffic Management Network (EATMN). In relation to the A^3 ConOps, this regulation may have effect on the collaborative decision making process for setting up the shared business trajectory submitted to SWIM. In this context, this regulation may constitute a preliminary framework for applying the planning phase of the shared business trajectory. Note that in the A^3 ConOps, the flight plan will also include the 4D trajectory. In other words the IFPS could evolve in the A^3 ConOps as the collaborative decision making process for setting up the Shared Business Trajectories.

The objective of regulation EC 730/2006 (on airspace classification and access for flights operated under visual flight rules above flight level 195, entry into force 01/07/2007) is to establish a harmonised airspace classification (Class C) above flight level 195 for all member states. According to this regulation, the airspace of Member States above flight level 195 is characterised as class C airspace, i.e. IFR and VFR flights are permitted, IFR flights are separated from IFR and VFR (through ATC) and VFR flights are separated from IFR (through ATC). VFR flights are self separated from other VFR flights, based on traffic information received from the Air Traffic Services. From the perspective of the A^3 ConOps this regulation implies the following issues:

- It contributes to the harmonization of the airspace across the member states where mixed traffic (VFR and IFR) is permitted which is an enabler for establishing the Self Separating Airspace
- It allows, above FL 195, VFR flights to self-separate from other VFR flights. Although in its current form this regulation does not enable the introduction of the SSA, it could be modified/ enhanced in the future in order to include Autonomous Flight Rules (AFR) flights as well. Thus it could be considered as an enabler in establishing the aircraft self separation concept, proposed in the A^3 ConOps.

4.3 Analysis of the European ATM (SESAR) Master Plan

This is the SESAR ATM master plan which has been endorsed by the European Community as the European ATM Master Plan[2]. The objective of this plan is to provide the steps of the implementation of the SESAR ATM target operational concept [22]. The major features of the SESAR ATM Target concept are the following:

i) flights will be conducted in a trajectory based form so as to facilitate the optimum routing from the perspective of the airspace users,

ii) collaborative planning of all phases of a flight where the overall goal will be the optimum performance of the ATM system,

iii) dynamic airspace management based on the establishment and deployment of the concept of flexible use of airspace,

iv) new accurate airborne navigation and optimised spacing technologies to maximise airspace and airport capacity.

[2] Communication from the EC to the Council and the European Parliament, The Air Traffic Management Master Plan, Brussels, 14.11.2008., COM(2008) 750 final.

The transition from the current ATM system to the SESAR ATM system is planned into specific implementation steps each one leading to an upgraded ATM service level. The ATM Master plan defines the intended ATM service levels (0-5) and the underlying ATM capability level of the involved stakeholders. The ASAS systems used as a new separation mode (used in a mixed separation modes environment) are included in the highest ATM service level (5). According to the plan, the implementation of this separation mode will start after 2015, while it will be available for operation after 2024.

Given that the European ATM Master Plan is based on the implementation of the SESAR ATM target concept, substantial institutional issues may arise from assessing the compliance of the A^3 ConOps with the SESAR ATM target concept and the Lines of Change in ATM endorsed in the proposed ATM Master Plan.

The A^3 ConOps shares with the SESAR ATM target concept the following operational features:

- System Wide Information Management (SWIM)
- Flight planning processes based on 4D trajectories (from Shared Business Trajectories to Reference Business Trajectories)
- New separation modes including the delegation of the separation task
- Collaborative decision making for all phase of the flight

The A^3 ConOps can be considered as aligned with SESAR operational concept focused on en-route operations. The most significant element of deviation of the A^3 ConOps from SESAR ATM target concept relates to the delegation of the separation task to the flight crew, where in the SESAR it is practised only in unmanaged airspace while in the A^3 ConOps it is practised anywhere (in low or high complexity areas) within the SSA.

The implementation of the above mentioned elements of the A^3 ConOps is facilitated by the corresponding Lines of Change per ATM service level included in European (SESAR) ATM Master Plan. The Tables below presents the Lines of Change per ATM service level relevant to the A^3 ConOps elements. The assessment of the compliance of the A^3 ConOps elements with corresponding Lines of Change did not reveal any inconsistency between the European (SESAR) ATM Master Plan and the A^3 ConOps.

	ATM Service Level 1	ATM Service Level 2	ATM Service Level 3	ATM Service Level 4	ATM service Level 5	A³ ConOps Elements affected
LoC 2: Moving from airspace to trajectory based operations	Uniformed application of 7 airspace classes <= FL 195	Free Routing Cruise above a Certain Level independent from route network in cruise.	Free Routing from ToC to ToD: Deploy Free Routing from ToC to ToD Maintain Pre-defined ATS Routes Only When and Where Required Three airspace categories: Deploy the new model of airspace based on 3 categories: N (intended), K (Known), U (Unknown). Dynamic TMAs: Deploy dynamic adjustment of airspace boundaries of terminal airspace according to traffic patterns and runways in use.	2 airspace categories: Remove Category K (Known) airspace. Dynamic Mobile Area: Deploy temporary mobile airspace exclusion areas (Dynamic Mobile Areas (DMA)) Free routing outside TMA (not operating in high complexity airspace).	-	Airspace Organization Classes: Three classes, Managed, Unmanaged, and Self Separating Airspace Areas Boundaries: The use of airspace will be dynamic Aircraft Route Network: Free routing (4D trajectories) will be implemented within the SSA
LoC 3: Collaborative Planning using the Network Operations Planner	-	SWIM enabled NOP using RBT/SBT: Implement processes enabling the publication of SBT by airspace users. RBT are agreed through Collaborative Flight Planning.	-	-	-	Air Traffic Flow Management: Preflight strategic flow management: in A³ the objective is to issue conflict free trajectories through strategic pre-flight planning. The airspace users design the preferred trajectories for a specific day (free of conflict and separated from areas with expected high air traffic complexity or unacceptable air traffic congestion) and provide them to the relevant ANSP unit.

Table 4-1. Relation of the A³ ConOps with the Lines of Change proposed in the European (SESAR) ATM Master Plan (Part I/III).

	ATM Service Level 1	**ATM Service Level 2**	**ATM Service Level 3**	**ATM Service Level 4**	**ATM service Level 5**	**A^3 ConOps Elements affected**
LoC 4: Managing the ATM Network	-	SWIM enabled NOP using RBT/SBT: Implement processes enabling the publication of SBT by airspace users. RBT are agreed through Collaborative Flight Planning.	Dynamic ATFM using RBT: Use 4D trajectory updates in the ATFCM process in order to optimise the network usage. Dynamic ATFCM management objective is to take benefit of the 4D trajectory updates for using capacity opportunities and the achievement of the CTA.	-	-	En-route Rerouting: The flight crew receives on board (from SWIM) the areas that should be avoided and replans the RBT accordingly.
LoC 5: Managing Business Trajectory6 in real time	-	Automated Support For Complexity Assessment: Deploy ground systems to continuously monitor and evaluate traffic complexity	Management Revision of RBT using datalink: deploy digital data communication applications and services as the main means of communication even though there will remain circumstances in which clearances and instructions are issued by voice.			Airspace Areas to Avoid: Complexity Predictor system Ground- Air Communication: Data link communication
LoC 7: Queue Management Tools	-	CTA Optimisation Through Use of Datalink: All ATM partners work towards achieving Controlled Time of Arrival (CTA) through use of Datalink to Optimise arrival sequence				ANSP role during the en-route phase of the flight: No Air Traffic Control apart from specifying the Controlled Time of Arrival.

Table 4-2. Relation of the A^3 ConOps with the Lines of Change proposed in the European (SESAR) ATM Master Plan (Part II/III).

	ATM Service Level 1	**ATM Service Level 2**	**ATM Service Level 3**	**ATM Service Level 4**	**ATM service Level 5**	**A^3 ConOps Elements affected**
LoC 8: New separation modes	ATSAW in flight and on surface: Deploy Airborne Traffic Situation Awareness (ATSAW) in the cockpit by displaying surrounding traffic while airborne and on the airport surface. Manual ASAS S&M: Deploy ASAS Manually Controlled Sequencing & Merging operations in applicable TMAs, requiring the pilot to follow the speed commands manually.	ASPA-S&M: Introduce enhancements to arrival sequencing through the use of ASAS in its Sequencing and Merging application i.e. Airborne Spacing Sequencing and Merging (ASPA-S&M). The flight crew ensures a time or distance based spacing from designated aircraft as stipulated in new controller instructions.	-	3D-PTC User preferred trajectories: Deploy 3D Precision Trajectory Clearances (3D-PTC) for Aircraft flying User Preferred Trajectories (Dynamically applied 3D routes/profiles). ASEP C&P: Deploy delegation of the separation by the controller to an aircraft for Crossing and Passing manoeuvres relative to designated target aircraft.	ASEP WV spacing: Deploy Self-Adjustment of spacing depending on Wake Vortices. The spacing is adjusted dynamically by the pilot based on the actual position of the vortex of the predecessor. Self-separation: Deploy the delegation of the separation by the controller between an aircraft and all the other aircraft in mixed-mode environment through new air broadcast and reception of trajectory data and new onboard conflict detection and resolution functions. 4D-PTC: Deploy the 4D-PTC using longitudinal navigation performance management from the aircraft.	Aircraft Separation: The flight crew is the separator for any flight operating within the SSA. Conflict Detection: Conflicts are detected by the flight crew through ASAS applications Conflict Resolution: Conflicts are resolved by the flight crew with the support of the on-board ASAS applications

Table 4-3. Relation of the A^3 ConOps with the Lines of Change proposed in the European (SESAR) ATM Master Plan (Part III/III).

4.4 Analysis of ICAO Regulations relevant to the A³ ConOps

Annex 2 to the Convention on International Civil Aviation- Rules of the Air [17], provides the general rules for the use of airspace. This set of rules aims to address the following issues: i) protection of persons and property from aircraft activity, ii) avoidance of collisions between aircraft or aircraft and vessels, iii) flight plan content, iv) the role of the Air Traffic Controllers (ATC), and v) VFR and IFR specific rules. ICAO Annex 2 specifies a set of general rules for aircraft operations throughout the entire lifecycle of a flight, within controlled and uncontrolled airspace, under IFR or VFR. Obviously, no reference is included regarding the Autonomous Flight Rules (AFR) flights within the Self Separating Airspace (SSA). If the A^3 ConOps is introduced into the existing ATM system, ICAO Annex 2 should be enhanced in order to address the following issues:

- Priority rules for AFR flights. The priority rules already included in the ICAO Annex could be used as the basis for the AFR flights. Definitely these rules should be further enhanced in order to deal with all possible conflicts arising in SSA
- Airspace Boundaries of the SSA. In this type of rules the AFR flight levels (FL), the cruising levels, and the upper and lower FL of the SSA should be included
- Given that no intervention by ATC is assumed for AFR flights, the communication of the flight crew with ATC should be clarified
- Transition between Instrument Flight Rules (IFR) & Autonomous Flight Rules (AFR) and Visual Flight Rules (VFR) & AFR
- Contents of the flight plan in the light of the Reference Business Trajectory (RBT) built for AFR flights
- How a route should be flown by an AFR aircraft operating within the SSA (deviation from route)

Annex 11 to the Convention on International Civil Aviation "Air Traffic Services" [15] aims to define Air Traffic Services (ATS) and provide the role of ATC units. In particular, this Annex addresses the following major issues:

- The air traffic services are divided to air traffic control, flight information services, and alerting services. According to the annex, the air traffic control services consist of the area control services, approach control services (associated to departure & arrival), and aerodrome control services. The goal of air traffic control services is to ensure the safe, orderly and expeditious flow of air traffic. The flight information services include only the provision to the flight crew of information (and whenever possible advise, not clearance) in order to operate a safe flight. The alerting service aims only to notify the appropriate organization for providing search and rescue aids to aircraft.
- Classification of airspaces with respect to the types of ATS provided. Classes A to G are provided where class A implies that the corresponding airspace is permitted only to IFR flights, controlled by ATC and G implies that the corresponding airspace is permitted to IFR or VFR flights receiving only flight information services upon request. The intermediate classes imply a slow degradation of the control services for IFR and VFR flights.

- The air traffic services shall make available to the operators any information or messages (regarding the aircraft) that may support them to carry out their tasks.
- Major operations of the air traffic control units: i) get information regarding the intended movement of aircraft (including any intended deviation from it) and get current information regarding the progress of each flight, ii) determine the aircraft positions based on the relevant information collected, iii) prevent collisions and expedite flow of air traffic by issuing clearances (including separation), iv) coordinate clearances with other flights
- Types of aircraft separation methods performed: vertical, horizontal, composite.
- The Air Traffic Services (ATS) air-to-ground communication involves radiotelephony and/or data link.
- Information required by the ATS: i) meteorological, ii) aerodrome conditions and operational status of the associated facilities, iii) operational status of navigation aids, iv) unmanned balloons positions, and v) volcanic activity and radioactive materials and toxic chemical clouds.

The scope of the regulations provided in ICAO annex 11 relates to the operations performed by the air traffic services providers. However, a major assumption in the A^3 ConOps is that the tasks of conflict prevention and separation assurance (currently performed by air traffic controllers) will be performed by the flight crew. Moreover, the management of the flight trajectory will be also performed by the flight crew. Note that the management of controlled flights in order to expedite the orderly flow of air traffic is currently performed by air traffic controllers. Thus, it is implicitly assumed that in the A^3 airspace, there are no air traffic control services. In addition, the A^3 ConOps does not make any exemption for the flight information services or the alerting services. In this context, the current rules of Annex 11 do not constitute a potential barrier to implementing the A^3 ConOps.

Finally, ICAO document 4444 [16] addresses the separation methods and minima. Given that the separation minima within A^3 ConOps are aimed to be reduced over those prevailing in the controlled airspace (target values are proposed in A^3 ConOps), appropriate changes may be required to this ICAO document.

5 Institutional and Organizational Inconsistencies and Enablers for the A^3 ConOps Elements

The objective of the analysis of the ATM institutional framework is to determine the relevant enablers and inconsistencies arising from the implementation of the ATM changes proposed in the existing A^3 ConOps. The enablers for the implementation of the A^3 ConOps relate to regulative issues (e.g. articles of regulations) or sections/parts of the European ATM Master Plan that may facilitate the introduction of one or more A^3 ConOps elements (changes of the existing ATM system). The determination of the potential A^3 ConOps enablers aims to reveal the level of maturity and the associated gaps of the existing institutional framework for the introduction of the A^3 ConOps elements. On the other hand, the potential inconsistencies relate to the regulative issues or the elements of the EATM Master Plan that are not compatible with the ATM changes proposed in the A^3 ConOps. This section aims to present the major enablers and inconsistencies that were identified from the analysis of the institutional framework, for each ATM change proposed in the A^3 ConOps.

Thus, based on the airspace organization changes proposed in the A^3 ConOps, three classes are proposed (instead of seven currently applied, A-G): Managed, Unmanaged and Self Separating. This type of change is compatible with the airspace classification envisaged by the SESAR ATM target concept [22], where two classes are included (Managed vs. Unmanaged). In this context, the SSA could be considered as part of the unmanaged. Class G of the existing airspace classification, where IFR and VFR flights only receive flight information services upon request, is the one closest to the SSA. Moreover, the reduction of the number of airspace classes is facilitated by Regulation (EC) No 730/2006 [4], where Member States are prompted to classify the airspace above flight level 195, as class C airspace. On the other hand the existing airspace classification, as provided in the ICAO Annex 11 to the Convention on International Civil Aviation "Air Traffic Services" [15] is inconsistent with the classification proposed by SESAR [22] and the A^3 ConOps [21].

Dynamic airspace management is a major feature of the ATM system within the A^3 ConOps. This feature implies that any airspace area is allocated for a special use only temporarily, while the boundaries of the SSA, MA, and UA are dynamic as well. Along this line, the Commission Regulation (EC) No 2150/200 [6] (laying common rules for the flexible use of airspace) implies dynamic airspace management with respect to the allocation of airspace for military purposes. In addition, the European ATM Master Plan [23] endorses the implementation of the establishment and deployment of the concept of the flexible use of the airspace.

The A^3 ConOps assumes free routing within the SSA. Any flight within the SSA will be planned in the form of a 4D trajectory (the Reference Business Trajectory). This feature of A^3 ConOps is totally compatible with the corresponding Reference Business Trajectory

considered within the SESAR ATM target concept. The transition from ATS routes to 4D trajectories is facilitated by the concept of the flexible use of airspace. In Commission Regulation (EC) No 2150/200 [6], article 4(d)m the flexible use of airspace involves the definition of temporary airspace structures to offer multiple route options. However, it should be pointed out that as indicated in ICAO Annex 11, (Chapter 2, section 2.14) any flight (IFR) is planned and executed on ATS routes (built upon designation points).

Air Traffic Flow Management in the existing European ATM system is performed by the Central Flow Management Unit (CFMU), which assesses the submitted flight plans in terms of sector workload. Accordingly, the CFMU aims to balance capacity and demand by updating slots, aircraft re-routings, or re-routing flows on an ad-hoc basis. This process is further enhanced in the A^3 ConOps where the objective is to issue conflict free trajectories through strategic pre-flight planning. The airspace users design the preferred trajectories for a specific day (free of conflict and separated from areas with expected high air traffic complexity or unacceptable air traffic congestion) and provide them to the relevant ANSP unit. Then the ANSP assesses the trajectories and the final commonly agreed trajectories are specified through a collaborative decision making process. This new process in issuing the flight plans is fully compliant with the corresponding process proposed in the SESAR ATM Target Concept. In addition, it has been included in the lines of change in the European ATM Master Plan (LoC 3, Collaborative Planning using the NOP). A preliminary version of this process has been established through the EC Regulation No 1033/2006 [5], laying down the requirements on procedures for flight plans in the pre-flight phase for the single European Sky where the initial flight plan is submitted to, processed, and distributed by the Integrated Initial Flight Plan Processing System. However, the current implementation of this regulation is focused on checking the consistency of the information included in the submitted flight plans.

In the SSA the flight crew could modify the RBT (e.g. in order to avoid conflicts or follow a more beneficial trajectory) without the need to ask for any clearance from ATC. Currently, this course of en-route rerouting operations is not facilitated by any type of regulation or the ATM Master Plan. In the existing framework, ATC is responsible for expediting the orderly flow of air traffic (according to section 2.2 of Annex 11 to the Convention on International Civil Aviation “Air Traffic Services”).

The major feature of the A^3 ConOps relates to the delegation of the separation task from the ATC to the flight crew. According to the current description of the A^3 ConOps, this type of change in the ATM system will be supported with the implementation of the appropriate airborne and ground system including ASAS applications, air-air data link communication systems, and airborne surveillance systems. The European ATM Master Plan envisions this type of change to be applied gradually up to 2025 where the implementation of the delegation of the separation task will start. The introduction of supporting airborne and ground technologies is also included in the European ATM Master Plan. However, for the time being

no specifications or performance requirements for these technologies are included in the SES regulation for the interoperability of the ATM systems and constituents (EC 552/2004) [11].

The role of the ANSP regarding AFR flights, (within the A^3 ConOps) includes only the provision of control services before entering and after exiting the PBA. No control services are provided in the SSA. In addition, ANSPs specify the point and time for departing the TMA and the point and time arriving in the destination TMA. However, the current institutional framework does not facilitate this new role of ANSPs.

Conflict Detection and resolution for AFR flights are delegated to the flight crew. However, according to the ICAO Annex 2 "Rules of the Air" [17], conflict detection and resolution is a task performed by the ATC for the controlled flights while advice is also provided for uncontrolled flights. This change in the ATM system is not currently facilitated by the existing institutional framework.

Tables 5-1 to 5-5 provide an overview of the potential institutional enablers and inconsistencies arising from the implementation of the ATM changes proposed in the A^3 ConOps. In addition, Table 5-6 provides an overview of the role assigned to each stakeholder involved in the each phase of a flight. This determination of the revised roles of the involved stakeholders arises directly from the ATM changes identified within the A^3 ConOps. The information provided in Table 5-6 provide the basis for specifying the organizational issues that should be covered by the potential revision of the existing institutional framework in order to facilitate and endorse the A^3 ConOps.

ATM System Elements	Current Situation	A³ ConOps Proposal	Potential Enablers	Potential Inconsistencies
Airspace Organization Classes	Classes A-G in which the role of ATC varies for IFR and VFR flights.	Three classes are identified: Managed, Unmanaged, and Self Separating.	SESAR: airspace is viewed and managed and unmanaged (self separation mode) (D3-2.2.4.1.2) Commission Regulation (EC) No 730/2006, on airspace classification and access of flights operated under visual flight rules above flight level 195. Class G, of the airspace classification includes no Air Traffic Control Services for either IFR or VFR flights (ICAO Annex 11)	Existing airspace classification (Annex 11 to the Convention on International Civil Aviation "Air Traffic Services")
Airspace Areas Boundaries	Any restricted airspace area is currently specified and fixed by the member states in a static way.	The use of airspace will be dynamic, i.e. any restricted of prohibited areas (due to bad weather of high complexity) will be temporary and will have dynamic boundaries.	Flexible use of airspace involves the definition of temporary airspace structures (Commission Regulation EC No 2150/200) Dynamic airspace management based on the establishment and deployment of the concept of the flexible use of the airspace (European ATM Master Plan, SESAR D3)	-
Aircraft Route Network	The flight paths are specified on the existing route network.	Free routing (4D trajectories) will be implemented within the SSA	Flexible use of airspace involves the definition of temporary airspace structures to offer multiple route options (Commission Regulation (EC) No 2150/200, article 4(d)) This is compatible with the SESAR Reference Business Trajectory (SESAR D3, 2.2.3)	Controlled flights are planned and executed in the of ATS routes (build upon designation points) ICAO Annex 11, Ch2, 2,14

Table 5-1. Potential institutional enablers and inconsistencies arising from the implementation of the ATM changes proposed in A³ ConOps (Part I/V).

ATM System Elements	Current Situation	A³ ConOps Proposal	Potential Enablers	Potential Inconsistencies
Air Traffic Flow Management	ATFM is performed by the Central Flow Management Unit (CFMU). The CFMU allocates and updates slots, offer individual re-routings, re-route flows on an ad-hoc basis and continually seek to balance capacity and demand	Preflight strategic flow management: in A³ the objective is to issue conflict free trajectories through strategic pre-flight planning. The airspace users design the preferred trajectories for a specific day (free of conflict and separated from areas with expected high air traffic complexity or unacceptable air traffic congestion) and provide them to the relevant ANSP unit. Then the ANSP assesses the trajectories and the final commonly agreed trajectories are specified through a collaborative decision making process.	This process is totally compatible with SESAR, SESAR D3, 2.3.3) A preliminary version of this process has been established through the EC Regulation No 1033/2006, laying down the requirements on procedures for flight plans in the pre-flight phase for the single European Sky where the initial flight plan is submitted to, processed, and distributed by the Integrated Initial Flight Plan Processing System.	
En-route Rerouting	ATC suggests alternative routes in order to avoid airspace areas (e.g. with high air traffic complexity).	The flight crew receives on board the areas that should be avoided and replans the RBT accordingly.	-	The ATC is responsible for expediting the orderly flow of air traffic (according to section 2.2 of Annex 11 to the Convention on International Civil Aviation "Air Traffic Services")
Aircraft Separation	The task of separation for any controlled flight is performed by the ATC.	The flight crew is the separator for any flight operating within in the SSA.	According to the EATM Master Plan, the delegation of the separation task to the flight crew will be implemented after 2025.	Based on Regulation EC 730/2006, the airspace above FL 195 is characterised as class C airspace, which implies that any IFR flight is controlled.
Separation Minima	As defined by ICAO	New reduced airborne separation minima may be applied. Target values are included in the current version of the A³ ConOps.	-	Separation minima specified in PANS-ATM 4444, issued by ICAO.

Table 5-2. Potential institutional enablers and inconsistencies arising from the implementation of the ATM changes proposed in A³ ConOps (Part II/V).

ATM System Elements	Current Situation	A³ ConOps Proposal	Potential Enablers	Potential Inconsistencies
ASAS	None	Advanced ASAS applications	The implementation of ASAS applications are envisioned in the EATM Master Plan.	
Ground- Air Communication	Voice communication and limited use of data link	Data link communication, Voice commutation used for back-up	-	-
Airborne Surveillance	ATC	Traffic Proximity Detection system	-	-
Transition between sectors	Transition between ATC units (e.g. TMA to ACC).	Transition from the Managed airspace to the Self Separating Airspace and the opposite.	-	-
ANSP role during the en-route phase of the flight	Air Traffic Services (Control, Flight information, Alerting)	No Air Traffic Control apart from: i) specifying the Controlled Time of Arrival, ii) traffic-to-follow and spacing information in order to achieve the smooth entrance of the aircraft to the TMA	-	Role of ATC according to the Annex 11 to the Convention on International Civil Aviation "Air Traffic Services"

Table 5-3. Potential institutional enablers and inconsistencies arising from the implementation of the ATM changes proposed in A³ ConOps (Part III/V).

ATM System Elements	Current Situation	A³ ConOps Proposal	Potential Enablers	Potential Inconsistencies
Conflict Detection	Any conflict is detected by ATC	Conflicts are detected by the flight crew through ASAS applications	-	According to the ICAO Annex 2 Rules of the Air, the conflict detection and resolution is a task performed by the ATC for the controlled flights while advise is also provided for the uncontrolled flights Conflicts are detected by the ATC according to the ICAO Annex 11 to the Convention on International Civil Aviation "Air Traffic Services"
Conflict Resolution	ATC resolves conflict for any controlled flight by providing the flight crew with the appropriate manoeuvres	Conflicts are resolved by the flight crew with the support of the on-board ASAS applications	-	According to the ICAO Annex 2 Rules of the Air, the conflict detection and resolution is a task performed by the ATC for the controlled flights while advice is also provided for the uncontrolled flights.
Flight Rules	IFR and VFR flight rules	AFR flight rules (not specified in the current version of the A³ ConOps)	-	-
Airspace Areas to Avoid	Specified and uploaded by ATC	i) Complexity Predictor system, ii) Upload restricted areas, hazard areas, military restricted areas through the System Wide Information Management (SWIM).	-	This type of information is currently part of the ATS services (ICAO Annex 11 to the Convention on International Civil Aviation "Air Traffic Services")

Table 5-4. Potential institutional enablers and inconsistencies arising from the implementation of the ATM changes proposed in A³ ConOps (Part IV/V).

ATM System Elements	Current Situation	A³ ConOps Proposal	Potential Enablers	Potential Inconsistencies
Flight Planning	Each airline submits a flight plan before the flight execution. CFMU validates the consistency of the information provided.	Strategic deconfliction: the airlines (through the FOCs) cooperate with the ANSPs in order to issue conflict free 4D trajectories within the Self Separating Airspace	4D trajectories is envisaged within the EATM Master Plan	ICAO Annex 2 "Rules of the Air" provide a specific form for a flight plan.
Flight Execution	Flight executed by the flight crew. Any change in the flight plan is subject to clearance from the ATC.	Strategic trajectory management performed by the flight crew. FOCs monitor the flight trajectory.	Regulation EC 1033/2006 aims to provide the requirements for the submission, processing and distribution of the initial flight plan, performed by the Integrated Initial Flight Plan Processing System (IFPS) Annex II Part B, 1.1, refers to the seamless operation for the air traffic flow management systems. A specific requirement for seamless operation of this type of systems is the sharing of correct and coherent flight information. Annex II Part B, 3.2.1, provides specific requirements for the seamless operation of the surveillance data processing systems. One of these requirements relates to the timely sharing of information between the ATC units in the EATMN. Moreover, in section 6.1, it is implied that the surveillance data should be shared in to order to enhance the operations through the EATMN.	-
Air-Air Communication	No data exchange between aircraft.	Aircraft exchange state and intent data	-	-

Table 5-5. Potential institutional enablers and inconsistencies arising from the implementation of the ATM changes proposed in A³ ConOps (Part V/V).

	Pre-Flight Operations	Departure (from stand to TMA exit)	Transition (from MA to SSA)	En-route Operations			Transition (from SSA to MA)	Arrival (From TMA entry to stand
				Flight Execution & Management	Separation	Conflict resolution		
Planning	FOCs: build SBT, negotiate departure from TMA exit and arrival at TMA entry	Out of A^3 Scope	ANSPs: specify TMA exit and the departure time from TMA exit FOCs: negotiate departure time from TMA exit	Flight Crew: determination of the optimum RBT (Strategic Trajectory Management)	Flight Crew: conflict avoidance (strategic deconfliction)	Flight crew: potential conflict detection	Out of A^3 Scope	Out of A^3 Scope
Execution	ANSP: issues RFT, and departure and arrival times from the TMA exit and TMA entry points.		Flight crew: exit from TMA at the specified point and start conformance procedure with the RBT	Flight Crew: Update the RBT and send it to SWIM.	Flight crew: separate from other air traffic	Flight crew: select and perform the resolution manoeuvres (manually or through the Flight Management System)		
Monitoring	ANSP: Coordinate Collaborative DM for SBTs		ANSPs: Monitor the departure time from the TMA exit point Revise CTA according to the revised RBT	Flight Crew: FOCs monitor the RBT trajectory execution	Flight Crew: medium term and short term surveillance	Flight Crew: monitors the conformance aircraft conformance on the updated (conflict free) trajectory		
Control	ANSP: Decide on the SBT in case of conflicts		ANSPs: Assign the departure time from TMA exit points to aircraft	Flight crew: control over the trajectory followed. FOCs: notify the flight crew regarding areas to avoid	Flight crew: own aircraft separation	Flight crew: selects the most appropriate solution out of the alternative provided by the ASAS.		

Table 5-6. Overview of the roles of each stakeholders involved in the flight planning and execution within the A^3 ConOps .

6 Recommendations for A^3 ConOps Implementation

The assessment of the A^3 ConOps elements in terms of compliance with the current ATM institutional framework has led to the determination of the relevant institutional enablers, inconsistencies, and gaps pertinent to its implementation. This analysis indicated the following major institutional and organizational issues that need to be tackled for the implementation of the A^3 ConOps:

- The Self Separating Airspace (SSA) envisaged in the A^3 ConOps is not currently covered in any legislative document. Thus, once the validity of the concept has been established, EU legislation should be enhanced in order to define this type of airspace. It is within the objective of SESAR to eventually establish two classes of airspace Managed vs. Unmanaged [22]. In this context, the SSA should be defined as a separate class of airspace (in addition to managed and unmanaged).
- The delegation of the separation responsibility from ATC to the flight crew (given the support of Airborne Separation Assistance Systems-ASAS) is a basic feature of the A^3 ConOps, currently out of the scope of the ATM regulatory framework. Substantial legislation and regulations will be required for introducing this separation mode in the ATM system. The SES framework should be enhanced in order to establish the procedure of delegating the separation task from the ATC to the flight crew. The relevant regulations should provide specifications for the airborne procedures executed by the flight crew for performing the separation task from the surrounding traffic and restricted areas, and the relevant supporting ground procedures. Apart from the enhancement of the Regulation EC 552/2004 on interoperability [11] (where specific requirements for the ASAS applications should be included) and the ICAO Annex 2 (Rules of the air) [17], implementing rules should be also provided regarding the ASAS applications, and the accuracy of navigation systems and data link communication systems.
- A significant operational element of the A^3 ConOps relates to the Autonomous Flight Rules. This is an issue that could be covered by enhancing the ICAO Annex 2 Rules of the Air (where the IFR and VFR flight rules are included) with the Autonomous Flight Rules.
- The exploitation of SWIM constitutes a major objective in SESAR and the A^3 ConOps. Based on the European ATM Master Plan [23], the institutional establishment of SWIM constitutes a continuous process starting on 2009 up to 2020. The major issues that should be covered by the relevant regulatory framework should be the determination of the entity that will manage the SWIM, the responsibilities and requirements of the stakeholders having access to SWIM, and the requirement for the technology supporting its operation.
- The inconsistency (traced in the ICAO annex 11 “Air traffic Services”) between the A^3 ConOps airspace classification and the existing airspace classes [15] implies that substantial EC regulations should be provided in order to achieve the introduction of the

SSA and the deterioration of the alternative airspace classes. Moreover, the ICAO Annex 11 should be revised in order to account for the Air Traffic Services (Ground Services) provided to the AFR, IFR, VFR flights in the SSA and the remaining envisaged airspace classes (i.e. Managed , Unmanaged).

- Substantial regulations pertinent to the Flexible Use of the Airspace [6] should be provided in order to specify the rules and specifications for defining at any time the boundaries of the airspace classes i.e. SSA, MA, and UA, and prescribe the procedures for allocating airspace for special use (restricted areas, hazard areas, bad weather areas, etc.).
- The regulatory framework on the flexible use of airspace should be enriched with regulations on establishing route airspace structures that would enable 4D trajectories. The 4D trajectory definition should be followed with the associated navigation performance requirements, and the procedures for ATS provision covered by ICAO Annex 11 and PANS-ATM [16].
- Separation minima within Self Separation Airspace must be defined. The new separation minima could be identified by ICAO. Target values are specified in the current version of the A^3 ConOps.
- Additional regulations within the SES framework are required for the establishment of the collaborative decision making process for the pre-flight strategic flow management. The additional regulations should prescribe the procedures for establishing the Shared Business Trajectories and the associated negotiations between the Airspace Users and the ANSPs for establishing the Reference Business Trajectories. Moreover, the proposed regulatory enhancements should clarify the role and responsibilities of the participating actors.
- The Autonomous Flight Rules and/or the regulative framework for the flexible use of the airspace need to be enhanced with regulations covering the en-route free rerouting of the AFR aircraft, i.e. real time modification of the RBT by the flight crew. Note however, a major prerequisite for establishing this type of operations relates to the delegation of the aircraft separation task to the flight crew.
- The ICAO regulations (Annex 11 to the Convention on International Civil Aviation “Air Traffic Services”) should be enhanced in order to cover the details of the role of the ANSP for the AFR flights. Appropriate changes should also be made to EC regulation 551/2004 [10] regarding the role of ANSPs.
- Concerning the delegation of the conflict detection and resolution to the flight crew, the ICAO regulations in Annex 2 “Rules of the Air” need to be enhanced/ updated with the priority rules between AFR flights and between AFR flights and IFR or VFR flights. This is a major prerequisite for specifying priorities among the conflicting aircraft in order to solve conflicts (i.e., specify which of the aircraft should manoeuvre). Moreover the SES framework should be enhanced with regulations prescribing the procedures followed in detecting and resolving conflicts and assigning the responsibilities among the participating actors (Flight Crew, ANSPs, and Flight Operations Centres).

Table 6.1 presents an overview of the major institutional needs emerging from the introduction of the A^3 ConOps.

ATM element	A^3 ConOps Change	Institutional/Organizational Needs
Airspace Organization Classes	Three classes are identified: Managed, Unmanaged, and Self Separating	☑ EU legislation should be enhanced in order to define the SSA ☑ SSA could be defined as an additional airspace class to the SESAR airspace classes (Managed vs. Unmanaged) ☑ Update of ICAO Annex 11 "Air traffic Services"
Airspace Areas Boundaries	The use of airspace will be dynamic, i.e. any restricted of prohibited areas (due to bad weather of high complexity) will be temporary and will have dynamic boundaries.	☑ Substantial regulations pertinent to the Flexible Use of the Airspace
Aircraft Route Network	Free routing (4D trajectories) will be implemented within the Self Separating Airspace	☑ regulations on establishing route airspace structures that would enable the 4D trajectories ☑ The 4D trajectory definition should be followed with the associated navigation performance requirements, and the procedures for ATS provision covered by ICAO Annex 11 and PANS-ATM.
Flight Planning	Strategic deconfliction: the airlines (through the FOCs) cooperate with the ANSPs in order to issue conflict free 4D trajectories within the Self Separating Airspace.	
Air Traffic Flow Management	Preflight strategic flow management: in A^3 the objective is to issue conflict free trajectories through strategic pre-flight planning. The airspace users design the preferred trajectories for a specific day (free of conflict and separated from areas with expected high air traffic complexity or unacceptable air traffic congestion) and provide them to the relevant ANSP unit. Then the ANSP assesses the trajectories and the final commonly agreed trajectories are specified through a collaborative decision making process.	☑ Additional regulations within the SES framework for the collaborative decision making process for the pre-flight strategic flow management ☑ regulations establishing the Shared Business Trajectories and the associated negotiations between the Airspace Users and the ANSPs ☑ regulatory enhancements to clarify the role and responsibilities of the participating actors.

Table 6-1. Institutional & Organizational needs arising from the implementation of the A^3 ConOps (Part I/II).

ATM element	A^3 ConOps Change	Institutional/Organizational Needs
Aircraft Separation	The flight crew is the separator for any flight operating within in the Self Separating Airspace.	☑ Substantial legislation and regulations will be required for introducing this type of change ☑ enhancement of the Regulation EC 552/2004 on interoperability (where specific requirements for the ASAS applications should be included) ☑ the ICAO Annex 2 (Rules of the air) ☑ implementing rules should be also provided regarding the accuracy of the navigation systems, and data link communication systems. ☑ changes on EC regulation 551/2004 regarding the role of the ANSPs.
ANSP role during the en-route phase of the flight	No Air Traffic Control apart from: i) specifying the Controlled Time of Arrival, ii) traffic-to-follow and spacing information in order to achieve the smooth entrance of the aircraft to the TMA	
SWIM	Deployment of SWIM	☑ regulatory framework addressing: – of the entity the will manage the SWIM, – the responsibilities and requirements of the stakeholders having access to SWIM, – the requirement for the technology supporting its operation. – the en-route free rerouting of the AFR aircraft
En-route Rerouting	The flight crew receives on board the areas that should be avoided and replans the RBT accordingly.	
Conflict Detection	Conflicts are detected by the flight crew through ASAS applications	☑ ICAO regulations in Annex 2 "Rules of the Air" need to be enhanced/updated with priority rules between AFR flights and between AFR flights and IFR or VFR flight
Conflict Resolution	Conflicts are resolved by the flight crew with the support of the on-board ASAS applications. Autonomous Flight Priority Rules (not specified in the current version of the A^3 ConOps)	
Flight Rules	AFR flight rules (not specified in the current version of the A^3 ConOps)	☑ ICAO Annex 2 Rules of the Air, in addition to the IFR and VFR flight rules

Table 6-1 (cont.) Institutional & Organizational needs arising from the implementation of the A^3 ConOps (Part II/II).

Most of the basic features of the A^3 Con Ops (including the delegation of the separation task to the flight crew, the use of SWIM, the use of ASAS, flight planning on the basis of 4D trajectories, and the collaborative decision making process for flight planning) constitute fundamental elements of the SESAR ATM Target Concept as well. In this context, the transition of the ATM system from its current situation to the one prescribed in the A^3 ConOps is partially covered through the SESAR initiative and the corresponding SESAR ATM Master Plan.

In addition, the implementation of the A^3 ConOps requires substantial institutional changes, including adaptation of the ATM legislation, regulative updates, and reform of the existing conventional role of the ATM stakeholders. Based on the findings of this document, the SES framework and the framework for the flexible use of the airspace will be mostly affected in an effort to introduce the A^3 ConOps. Moreover, the changes required in the ATM systems and technologies associated with the A^3 ConOps implementation imply substantial revision of the ICAO Annexes relevant to the rules of the air, the navigation systems, and the role of the ANSPs. In addition, significant implementation regulations (guidelines and rules) will be required for the delegation of the separation task to the flight crew (which is the cornerstone of the A^3 ConOps) and the remaining elements of the A^3 ConOps supporting this task (e.g. AFR rules, ASAS applications). The implementation of the A^3 ConOps is expected to have significant implications on the roles of the stakeholders as perceived in the existing ATM system. In particular, ANSPs will not be responsible for the separation of the traffic within the SSA. In this new ATM system the role of ANSPs will be basically focused on the assessment of 4D trajectories at flight phases outside SSA, and the coordination of the collaborative decision making process for fixing RBTs. On the other, hand the flight crew will not only safely fly the aircraft but it will have the total control of the flight execution, route changes, and conflict resolution process. Finally, new stakeholders may also arise from the A^3 ConOps such as the organization/actor responsible for SWIM and the organization having the final call to decide regarding the conflicting RBTs at the pre-flight phase.

7 References

[1] EUROCONTROL (2010). European Operational Concept Validation Methodology -Version 3. European Air Traffic Management Programme.

[2] Douglass C. North (1994). Economic Performance Through Time, Nobel Prize lecture, December 19, 1993. Also published in The American Economic Review, 84 (3): 359-368, p. 360.

[3] Douglass North (1990). Institutions, Institutional Change and Economic Performance, Cambridge: Cambridge University Press, p. 5.

[4] European Commission Regulation (EC) 730/2006 on airspace classification and access for flights operated under visual flight rules above flight level 195

[5] European Commission Regulation (EC) No 1033/2006, laying down the requirements on procedures for flight plans in the pre-flight phase for the single European Sky.

[6] European Commission Regulation (EC) No 2150/2005, laying down common rules for the flexible use of airspace.

[7] European Commission Regulation (EC) No 2096/2005 laying down Common Requirements for the Provision of Air Navigation Services**.**

[8] European Commission Regulation (EC) No 549/2004 laying down the framework for the creation of the Single European Sky

[9] European Commission Regulation (EC) No 550/2004 on the provision of the air navigation services in the Single European Sky (& proposal for a regulation amending EC 550/2004, issued in 2008)

[10] European Commission Regulation (EC) No 551/2004, on the organization and use of the airspace in the single European sky (the airspace regulation)

[11] European Commission Regulation (EC) No 552/2004, on the interoperability of the European Air traffic Management Network.

[12] European Commission Regulation (EC) No 219/2007 on the Establishment of a Joint Undertaking to Develop the New Generation European Air Traffic Management System (SESAR)

[13] ICAO (2001). Annex 10 to the Convention on International Civil Aviation –Aeronautical Telecommunications-Part III Communication Systems. International Civil Aviation Organization.

[14] ICAO (2001). Annex 10 to the Convention on International Civil Aviation –Aeronautical Telecommunications-Part IV – Surveillance Radar and Collision Avoidance Systems. International Civil Aviation Organization.

[15] ICAO (2001). Annex 11 to the Convention on International Civil Aviation – Air Traffic Services. International Civil Aviation Organization.

[16] ICAO (2001). Procedures for Air Navigation Services Air Traffic Management (Doc 4444), 14th edition, International Civil Aviation Organization.

[17] ICAO (2005). Annex 2 to the Convention on International Civil Aviation – Rules of the Air. International Civil Aviation Organization.

[18] ICAO (2005). Global Air Traffic Management Operational Concept. Doc 9854 AN/458.

[19] iFly Consortium (2008). Contract for Specific Targeted Research or Innovation Project, Annex I (revised): Technical Work. EC project iFly (TREN/07/ FP6AE/ S07.71574/037180 IFLY), Project for EC-DG-TREN.

[20] iFly Consortium (2008). Deliverable D1.1 "A3 High Level ConOps". EC project iFly (TREN/07/FP6AE/S07.71574/037180 IFLY), Project for EC-DG-TREN.

[21] iFly Consortium (2009). Deliverable D1.3 "A3 ConOps". EC project iFly (TREN/07/FP6AE/S07.71574/037180 IFLY), Project for EC-DG-TREN.

[22] SESAR (2007). D3 - The ATM Target Concept. DLM-0612-001-02-00a, SESAR Consortium for the SESAR Definition Phase Project co-funded by the European Commission and EUROCONTROL.

[23] SESAR (2008). SESAR Master Plan (The European ATM Master Plan), DLM-0710-001-02-00, SESAR Consortium for the SESAR Definition Phase Project co-funded by the European Commission and EUROCONTROL.

8 Acronym List

Acronym	Definition
A^3	Autonomous Aircraft Advanced
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependant Surveillance - Broadcast
AFR	Autonomous Flight Rules
AIS	Aeronautical Information Service
ANSP	Air Navigation Services Provider
AOM	Airspace Organisation & Management
ASAS	Airborne Separation Assistance System
ASEP	Airborne Separation
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATS	Air Traffic Services
CD	Conflict Detection
CD&R	Conflict Detection and Resolution
CDM	Collaborative Decision Making
CDTI	Cockpit Display of Traffic Information
CNS	Communication, Navigation and Surveillance
ConOps	Concept of Operations
CR	Conflict Resolution
CTA	Controlled Time of Arrival
CZ	Comfort Zone
DL	Data Link
FMS	Flight Management System
FOC	Flight Operations Centre
HMI	Human Machine Interface
ICAO	International Civil Aircraft Association
IFPS	Initial Flight Planning System
IFR	Instrumental Flight Rules
LoC	Lines of Change
LoS	Loss of Separation
LTACD	Long Term Area Conflict Detection
LTAZ	Long Term Awareness Zone
MA	Managed Airspace
MET	Meteorological Service
MTAZ	Medium Term Awareness Zone
MTCD&R	Medium Term CD&R
NFU	Non-FOC Airspace User
PANS	Procedures for Air Navigation Services
PAZ	Protected Airspace Zone
SSA	Self Separating Airspace
R/T	Radio Telecommunications
RAA	Restricted Airspace Area
RBT	Reference Business Trajectory
RNP	Required Navigation Performance
RSP	Required Surveillance Performance
RTA	Required Time of Arrival
SBT	Shared Business Trajectory

Acronym	Definition
SES	Single European Sky
SESAR	SES Advanced Research
SFM	Strategic Flow Management
SM	Separation Minima
STAZ	Short Term Awareness Zone
STCD&R	Short Term CD&R
SWIM	System Wide Information Management System
SZ	Safety Zone
TMA	Terminal Manoeuvring Area
TS	Trajectory Synthesizer
UA	Unmanaged Airspace
VFR	Visual Flight Rules

9 Appendix 1: Analysis of ATM Legislation and Regulations

9.1 Template for the Analysis of ATM Legislation and Regulations

The Analysis of the ATM regulatory framework aims at the determination of the potential enablers and inconsistencies arising from the implementation of the A^3 ConOps. In this context, each of the regulation relevant to the ATM is assessed in terms of complying with the changes proposed in the A^3 ConOps. This process is facilitated by the development of a summary for each of the ATM regulations relevant with the A^3 ConOps. Each of these summaries is provided in the form presented through the template below. A separate template has been completed for each regulation, including the following types of information: i) document reference, Objectives and scope, stakeholders affected, major issues with emphasis on those relevant with any of the A^3 ConOps elements, and determination of the potential relation of the specific regulation with the corresponding elements of the A^3 ConOps.

Doc:
Objectives and Scope:
Stakeholders Affected:
Major Issues:
Potential Enablers/Barriers for A^3 ConOps:

Figure 9-1. Template for developing an overview of each of the ATM regulations relevant with the

9.2 Completed Templates for the Analysis of ATM Legislation and Regulations

The remainder of this Appendix includes the completed templates for the corresponding ATM regulations.

Doc: Regulation (EC) No 549/2004 laying down the framework for the creation of the Single European Sky (& proposal for a regulation amending EC 549/2004, issued in 2008)
Objectives and Scope: Regulation (EC) No 549/2004 sets the framework for the creation of the Single European Sky. This regulation defines the objectives of the Single European Sky (SES) initiative and establishes the key stakeholders for developing and deploying the SES. It basically identifies the key players for managing the development, application, and monitoring the SES implementing rules. In particular the implementing rules are basically developed and issued by

EUROCONTROL based on related EC mandates. The application of the implementing rules is managed by the National Supervisory Authorities.

Stakeholders Affected: ATM community (ANSPs, Airspace users, Member states, ATM Industry, Airport authorities)

Major Issues:

i) The establishment of the National Supervisory Authority for each Member State which would verify compliance of ANSPs with the relevant SES requirements (as stated in EC 550/2004).
ii) The establishment of Single Sky Committee (SSC) consisted of two representatives by each Member State.
iii) Establishment of an Industry Consultation body, for advising the Commission on technical aspects pertinent to the SES implementation. The Consultation body should consist of the ANSPs, the associations of airspace users, airports, the manufacturing industry and professional staff representative bodies.
iv) SES Implementation rules will be developed (basically) by EUROCONTROL. The EC , after relevant mandates issued by the Commission) and potentially endorsed by the Commission
v) Evaluation of the air navigation performance by analysing information collected from the member states
vi) Supervision, monitoring, and methods of impact assessment of the SES application performed by the Commission. The member States should provide relevant reports about the progress they make on applying the SES relevant measures.
vii) Setting up consultation mechanism for the involvement of the stakeholders in the development of new concepts and technologies in the European ATM Network.

Potential Enablers/Barriers for A^3 ConOps: This regulation is very generic since it only sets the framework for implementing the Single European Sky. The framework proposed in this regulation does not pose any significant obstacle in the introduction of the A^3 ConOps within the ATM. It should be noted however, that based on article 1, military operations and training are not covered by this regulation. However, the A^3 ConOps implies that each military aircraft should be properly equipped and align with Autonomous Flight Rules within the SSA. Potential issues that might arise relate to: i) the intercept missions, and ii) the Head-of-State aircraft.

Doc: Regulation (EC) No 550/2004 on the provision of the air navigation services in the Single European Sky (& proposal for a regulation amending EC 550/2004, issued in 2008)

Objectives and Scope: The objective of this regulation is to set the common requirements for the provision of air navigation services in the Single European Sky framework. In particular this regulation sets a set of common requirements that must be satisfied by ANSPs. A certificate issued by the National Supervisory Authority is given to those ANSPs that fulfil the common requirements. Air navigation services are provided only by certified ANSPs. The certificates issued by one country will be valid to any other member state. In addition this regulation proposes a charging scheme and facilitates the exchange of operational information between the ATM stakeholders regarding the general air traffic.

Stakeholders Affected: ANSPs, Member States.

Major Issues:

- The National Supervisory Authorities are assigned the supervision and monitoring (through inspections) of the regulation (Article 2)
- The inspections for assessing the conformance of the ANSPs with the common requirements for the provision of air navigation service services could be delegated from the national supervisory authorities to designated organizations. (article 3)
- The commission adopts the EUROCONTROL safety regulatory requirements for the provision of ANS (article 4)
- The EC will issue a proposal for licensing controllers (article 5)
- The common requirements for ANS include: technical and operational competence and suitability, systems and processes for safety and quality management, reporting systems, quality of services, financial strength, liability and insurance cover, ownership and organizational structure, human resources, and security. (article 6)
- Certificates to the ANSPs will be issued by the National Supervisory Authorities based on the above common requirements. The certificates will be checked on a regular basis. (article 7)
- Any certified ANSP is allowed to provide part or the entire bundle of ANS to another ANSP (article 7)
- Member states should ensure the provision of ANS to an airspace block to a certified ANSP (article 8)
- The ANSP should make agreements with the relevant member state for allowing of exchange of operational data between all service providers (Article 10)
- Real time exchange of operational data (regarding general air traffic) between all ANSPs, airspace users and airports, according to their needs is established. Access to operational data is granted to any appropriate authority (article 13)
- A charging scheme for ANS is proposed

Potential Enablers/Barriers for A^3 ConOps:

This regulation provides the common requirements for the ANSPs. In A^3 ConOps, the aircraft separation service is delegated to the flight crew. This regulation does not take into account any such ATM development. However, this regulation does not provide any significant obstacle in applying the A^3 ConOps. Moreover, article 10 referring to the exchange of data constitutes an enabler for establishing SWIM and facilitates the implementation Air-Ground, Air-Air Data Link Communications and Surveillance Broadcast.

Doc: Regulation (EC) No 551/2004, on the organization and use of the airspace in the single European sky (the airspace regulation)

Objectives and Scope: The objective of this regulation is to establish common procedures for

airspace organization and use that ensures efficient and safe ATM performance. The long-term target of this regulation is an integrated operating airspace throughout Europe.

Stakeholders Affected: Airspace users, ANSPs

Major Issues:

- Division of the airspace in upper and lower flight information region. The commission will aim at the recognition of this division from the ICAO (articles 2 and 3)
- Establishment of a single aeronautical information publication relating to the European upper flight information region (EUIR) (Article 3)
- The airspace in the EUIR will be classified by the EC and the member states taking into account the long term goal for harmonised airspace classification (Article 4).
- Reconfiguration of the EUIR into functional airspace blocks. Each functional block may include areas under the responsibility of more than one member state. The major criteria for designing the functional airspace blocks relate to the optimum, use of airspace and the flexible transfer of responsibility for air traffic control between air traffic service units (Article 5)
- Common principles and criteria for route and sector design should be developed (article 6)
- Flexible use of airspace (EUROCONTROL) should be adopted by the member states (article 7)
- Implementation rules for air traffic flow management should be developed, covering the following areas: i) flight planning, use of available airspace capacity, and ii) use of routings by general air traffic (e.g. options for diversion from congested areas) (Article 9)

Potential Enablers/Barriers for A^3 ConOps:

This regulation is developed in the light of the current ATM operational concept which involves controlled airspace. However, it provides the following potential enablers for the airspace management component of the A^3 ConOps:

- The introduction of the EUIR where functional airspace blocks are defined constitutes a significant step for the transition from the controlled airspace to the self separating airspace. Based on article 4, the objective of the airspace classification of the EUIR is to facilitate the seamless provision of air navigation services and optimum use of airspace capacity. In this context, the performance-based airspace could be progressively realised though the evolvement of the EUIR.
- The introduction of the flexible use of the airspace constitutes an enabler for the Dynamic Airspace Boundaries proposed in A^3 ConOps between the various areas of the airspace.
- Article 9 on air traffic flow management leaves a window open for the flight planning proposed in the A^3 ConOps and the management of the Reference Business Trajectory (e.g. options for diversion of general air traffic from congested areas).

Doc: Regulation (EC) No 552/2004, on the interoperability of the European Air traffic Management Network.

Objectives and Scope: The objective of this regulation is to provide the basis for the interoperability of the systems and procedures used in the European Air Traffic Management Network (EATMN). In this context, this regulation aims to harmonize the systems, constituents, and procedures employed in

the ATM through the provision of essential and specific common requirements. A major requirement for the above issue relates to the support for new concepts of operation. Thus, it implicitly aims at expediting the introduction of the new agreed and validated ATM concepts of operations or technologies.

Stakeholders Affected: ATM community

Major Issues: The major issues covered in this regulation are the following:

- determination of the essential requirements for the EATMN systems (article 2 & Annex II
  - seamless operation at all times and all phases of a flight
  - Support for new concepts of operation, including those referring to collaborative decision making, increasing automation and alternative methods of delegation of separation responsibility
  - Safety
  - Civil-military coordination for effective airspace and air traffic flow management
  - Environmental constraints
  - Principles governing the logical architecture of systems
  - Principles governing the construction of systems
- Additional specific requirements could be provided through issuing appropriate implementing rules for interoperability. The implementing rule should include specific requirements for each system or constituent.
- Conformity assessment procedures
- Community specifications (European standards for systems and constituents) could be issued
- A process for the verification of compliance of the ATM systems and procedures with the given implementing rules and the relevant Community specifications through the completion of EC declaration of conformity for use of constituents (by the manufacturer) and EC declaration of verification of system (by ANSPs) (articles 5 & 6)
- Specific requirements for Systems and Procedures for airspace management:
  - Information regarding airspace availability should be provided to all interested parties, taking into account the national security requirements.
- Specific requirements for communication systems and procedures for ground-to-ground, air-to-ground and air-to-air communications
  - The communication systems shall support the implementation of new validated and agreed operational concepts

Potential Enablers/Barriers for A^3 ConOps:

This regulation does not set any obstacles in applying the A^3 ConOps. It actually sets the basis for harmonizing the systems and procedures used in ATM. The A^3 ConOps contributes substantially to the interoperability of the system of the EATMN through the introduction of: i) the SWIM, and ii) the collaborative decision making in flight planning and the trajectory management (Controlled Times of Arrival). Article 3(3) suggests implementing rules for interoperability, including those needed for the introduction of new and validated ConOps. The introduction of any of the systems and procedures included in the A^3 ConOps is in compliance with the essential and specific requirements provided in this regulation. Moreover, any systems needed for A^3 ConOps could be introduced in the ATM through developing a set of relevant implementing rules enhancing those presented in Annex III.

Doc: Commission Regulation (EC) No 2150/2005, laying down common rules for the flexible use of airspace.
Objectives and Scope: This regulation aims to set common rules for the implementation of the concept of flexible use of airspace where the airspace is considered as a continuum where restrictions on use are permitted only temporarily.
Stakeholders Affected:
Major Issues: This regulation deals with the following issues: ▪ Principles that rule the flexible use of airspace: i)coordination between civil-military authorities for airspace management through agreements and procedures, ii) efficient and consistent application of the concept across national borders, iii) airspace restrictions for specific use should be only temporary ▪ The concept of flexible use of airspace will be applied in strategic, pre-tactical and tactical level. At strategic level the member states should define temporary airspace structures and ensure cooperation with neighbouring countries in order to coordinate the cross-border airspace management. At pre-tactical level, each member state should establish an airspace management cell to allocate airspace accordingly. At tactical level the member states should establish procedures and supporting systems in order to provide for real-time airspace management.
Potential Enablers/Barriers for A^3 ConOps: This regulation aims to enhance the cooperation and coordination between member states and between the civil and military authorities in order to facilitate the application of the concept of the flexible use of the airspace. The concept of the flexible use of the airspace considers the airspace as a continuum where airspace structures are temporary. This principle is in line with the A^3 operational concept where the self separating airspace is offered to the airspace users with no permanent restrictions. In this context, this regulation does not constitute a potential barrier for the implementation of the A^3 ConOps.

Doc: Annex 2 to the Convention on International Civil Aviation- Rules of the Air
Objectives and Scope: This document provides the general rules for the use of the airspace. This set of rules aims to addresses the following issues: i) protection of the persons and property from the aircraft activity, ii) avoidance of collisions between aircraft or aircraft and vessels, iii) flight plan content, iv) role of the ATC, and v) VFR and IFR specific rules.
Stakeholders Affected: It affects the airspace users and the ANSPs
Major Issues: Concerning the protection of persons and property: ▪ Aircraft should be flown over congested areas and cities above a given flight level

- No spaying or dropping is allowed
- No towing is allowed
- Aircraft should not be flown in prohibited areas

Concerning the rules for avoiding collisions:

- Right of way rules
- The pilot should be alert to perform collision avoidance manoeuvres issued by ACAS
- Lights displayed by the aircraft: i) anti-collision lights, and ii) navigation lights

Flight Plan issues:

- Situations and conditions under which a flight plan must be submitted
- Content of a flight plan (ID, flight rules and type of flight, equipment, departure aerodrome, estimated block-off time, cruising speed and levels, route, destination and alternate aerodromes, fuel endurance, # of persons on board, emergency/survival equipment)
- Changes to a flight plan should be submitted to ATC as soon as possible

ATC related issues:

- Compulsory reporting points of an aircraft
- Any controlled flight should have a two-way communication with the appropriate ATC unit and watch the appropriate communication channel
- What should the requests for intended flight plan changes include
- How an aircraft should react to unintended flight plan changes (e.g. variation in airspeed, or deviation from track)

The VFR rules indicate that a relevant flight should be performed below FL200, and set the lower altitude boundary under various situations. A flight plan should be submitted if an aircraft operating under VFR is intending to operate under IFR.

Any aircraft operating under IFR should be equipped with instruments needed for flying a specific route. Minimum flight levels are set by the State or they should exceed 300 m (for mountains) /600 m, 8 km ahead. Any non controlled IFR flight should follow the official cruising levels and it should maintain air-ground communication watch on the appropriate communication channel.

Potential Enablers/Barriers for A^3 ConOps:

This Annex specifies a set of general rules for the aircraft operations throughout the entire lifecycle of a flight, within controlled and or not controlled airspace, under IFR or VFR. Obviously, no reference is included regarding the AFR flights within the self separating airspace. Thus the ruled included in this document does not constitute a barrier for the A^3 ConOps. If the A^3 ConOps is introduced in the existing ATM, the Annex 2 should be enhanced in order to address the following issues:

– Rights of way for the AFR flights. The right of way rules already included in the Annex could be used as the basis for the AFR flights. Definitely these rules should be further enhanced in order to deal with the conflicts arising by the various alternative situations in self separating airspace
– Airspace Boundaries of the AFR flights. In this type of rules the AFR flight levels, the cruising levels, and the upper and lower FL of the AFR self separating airspace should be included
– Communication operations (if any) of the flight crew with the ATC should be clarified

- Transition between IFR & AFR and VFR & AFR
- Contents of the flight plan in the light if the RB trajectory built for AFR flights
- How a route should be flown by an AFR aircraft operating within self separating airspace
- Aircraft operations for transition between controlled and performance-based airspace (?)

Doc: European ATM Master Plan

Objectives and Scope: This is the SESAR ATM master plan which has been endorsed by the EC Community as the European ATM Master Plan. The objective of this plan is to provide the steps of the implementation of the SESAR ATM target operational concept. The major features of the SESAR ATM Target concept are the following:

v) the flights will be conducted in a trajectory based form so as to facilitate the optimum routing from the perspective of the airspace users

vi) collaborative planning of all phases of a flight where the overall goal would be the optimum performance of the ATM system

vii) Dynamic airspace management based on the establishment and deployment of the concept of the flexible use of the airspace

viii) New accurate airborne navigation and optimised spacing technologies to maximise airspace and airport capacity

The transition of the current ATM system to the SESAR ATM system is planned into specific implementation steps each one leading to an upgraded ATM service level. The ATM Master plans defines the intended ATM service levels (0-5) and the underlying ATM capability level of the involved stakeholders. The ASAS systems used as a new separation mode (used in a mixed separation modes environment) are included in the highest ATM service level (5). According to the plan, the implementation of this separation mode will start after 2015, while it will be available for operation after 2024.

Stakeholders Affected: ATM community

Major Issues:

Potential Enablers/Barriers for A^3 ConOps: The European ATM Master Plan does not provide any definite barriers for the implementation of the A^3 ConOps. However, its implementation as an ATM concept is not assumed as part of the ATM Master plan ranging from 2009 up to 2025. Parts of the concept (SWIM, collaborative decision making, trajectory based operations, and ASAS separation) are considered and planned to be incorporated in the ATM system from 2025 onwards.

Doc: Annex 11 to the Convention on International Civil Aviation "Air Traffic Services"

Objectives and Scope: The objective of this annex is to define the Air Traffic Services and provide the role of the ATC units.

Stakeholders Affected: Air Traffic Service Providers, Airspace Users

Major Issues: In particular, this Annex addresses the following major issues:

- The air traffic services are divided to air traffic control, flight information services, and alerting services. According to the annex, the air traffic control services consist of the area control services, approach control services (associated to departure & arrival), and aerodrome control services. The goal of the air traffic control services is to prevent collisions and expedite and ensure the orderly flow of air traffic. The flight information services include only the provision to the flight crew of information (and whenever possible advise, not clearance) in order to operate a safe flight. The alerting service aims only to notify the appropriate organization for providing search and rescue aids to aircraft.
- Classification of the airspaces with respect to the types of ATS provided. Classes A to G are provided where class A implies that the corresponding airspace is permitted only to IFR flights, controlled by ATC and G implies that the corresponding airspace is permitted to IFR or VFR flights receiving only flight information services upon request. The intermediate classes imply a slow degradation of the control services for the IFR and VFR flights.
- The air traffic services shall make to the operators any information (regarding the aircraft) or messages (regarding the aircraft) that may support them to carry out their tasks.
- Major operations of the air traffic control units: i) get information regarding the intended movement of aircraft (including any intended deviation from it) and get current information regarding the progress of each flight, ii) determine the aircraft positions based on the relevant information collected, iii) prevent collisions and expedite flow of air traffic by issuing clearances (including separation), iv) coordinate clearances with other flights
- Types of aircraft separation methods performed: vertical, horizontal, composite.
- The ATS air-to-ground communication involves radiotelephony and/or data link.
- Information required by the ATS: i) meteorological, ii) aerodrome conditions and operational status of the associated facilities, iii) operational status of navigation aids, iv) unmanned balloons positions, and v) volcanic activity and radioactive materials and toxic chemical clouds.

Potential Enablers/Barriers for A^3 ConOps: The scope of the regulations provided in this annex relates to the operations performed by the air traffic services providers. A major assumption in the A^3 ConOps is that the tasks of conflict prevention and separation assurance (currently performed by the air traffic controllers) will be performed by the flight crew. Moreover, the management of the flight trajectory will be also performed by the flight crew. Note that the management of the controlled flights in order to expedite the orderly flow of air traffic is currently performed by the air traffic controllers. Thus, it is implicitly assumed that in the A^3 airspace, there are no air traffic control services. In addition, the A^3 ConOps does not make any exemption for the flight information services or the alerting services. In this context, the current regulations do not constitute a potential barrier in implementing the A^3 ConOps. Moreover, under the assumption that the A^3 airspace will be considered as a specific type of class of airspace, this Annex could be enhanced with the operations of ATS within the self separating airspace.

Doc: *EC Regulation No 1033/2006, laying down the requirements on procedures for flight plans in the pre-flight phase for the single European Sky*

Objectives and Scope: The objective of this regulation is to provide the requirements for the submission, processing and distribution of the initial flight plan, during the pre-flight phase of a flight. The initial flight plan for a flight is submitted to, processed, and distributed by the Integrated Initial Flight Plan Processing System (IFPS). The objective of the flight plan processing is to assess the consistency of the flight plan submitted by the relevant authority (operator or agent). The establishment of the IFPS and its operation is under the responsibility of each member state which lays down requirements for flight plans in the Pre-Flight Phase for the single European sky. Regulation No 1033/2006 was developed in order to refine and complement specific requirement 3.1.1 (Seamless operation of the Flight data processing systems) of Regulation No 552/2004 on the provision of measures for ensuring the interoperability of the European Air Traffic Management Network (EATMN).

Stakeholders Affected: Airspace users, Airline operators, ATC units

Major Issues:

- Given an initial flight plan, the IFPS checks it for compliance with format and data conventions, completeness and accuracy, takes action to make it acceptable by the air traffic services, and communicates to the operator any changes or acceptance of the flight plan
- Each member state is responsible for ensuring that the IFSP communicates the accepted flight plan to all affected ATS units.
- The ATC units should make available through IFSP any necessary changes (which could affect the safe conduct of a flight) to a flight plan. Any other changes should be made in coordination with the relevant operator

Potential Enablers/Barriers for A^3 ConOps:

This regulation aims to set up a framework for the specification of a complete and accurate initial flight plan, at the pre-flight phase of flight, based on the establishment of the IFPS. This regulation may have effect on the collaborative decision making process for setting up the shared business trajectory submitted to the SWIM (according to the A^3 ConOps). In this context, this regulation may constitute a preliminary framework for applying the planning phase of the shared business trajectory. Note that in the A^3 ConOps, the flight plan will also include the 4D trajectory. In other words the IFPS could evolve in the A^3 ConOps as the collaborative decision making process for setting up the share business trajectories.

Doc: *Regulation EC 730/2006 on airspace classification and access for flights operated under visual flight rules above flight level 195 (Entry into force 01/07/2007)*

Objectives and Scope: The objective of this regulation is to establish a harmonised airspace classification (Class C) above flight level 195 for all member states.

Stakeholders Affected: ATM community
Major Issues: – Airspace above flight level 195 is characterised as class C airspace, i.e. IFR and VFR flights are permitted, IFR flights are separated from IFR and VFR (through ATC) and VFR flights are separated from IFR (through ATC). VFR flights are self separated from other VFR flights, based on traffic information received by the Air Traffic Service.
Potential Enablers/Barriers for A^3 ConOps: This regulation contributes to the harmonization across the member states of the airspace where mixed traffic (VFR and IFR) is permitted. Moreover, it allows, above FL 195, the VFR flights to separate from the other VFR flights. Although, at its current form this regulation does not enable the introduction of a performance-based A^3 airspace, it could be modified/ enhanced in the future in order to include the AFR flights as well.

Doc: *Commission Regulation (EC) No 29/2009 laying down requirements on data link services for the single European sky*.
Objectives and Scope: The objective of this regulation is to force the use of Controller Pilot Data Link Communication for any IFR flight within the airspace above FL285. The regulation sets out a set of common requirements for the data link services provided by the ATC based on the relevant EUROCAE and ICAO data links systems requirements.
Stakeholders Affected: ATC, Airspace users
Major Issues: – Any IFR flight operating above FL 285 should be able to establish data link communication with the appropriate ATC unit – The ATC units should be able to establish data link communication with any IFR flight above FL285 under their responsibility – Each member state should ensure that the ATC units are able to establish data link communication with the flights under their responsibility, covering the common requirements included in the annex III & IV of the regulation.
Potential Enablers/Barriers for A^3 ConOps: The data link communication constitutes a major issue in applying the air-ground data exchange between the flight crew and the ground support (SWIM) proposed in the A^3 ConOps. Thus the present regulation constitutes a major enabler for implementing the communication of the aircraft with the SWIM in order to exchange flight related information such as, updated flight trajectory, restricted airspace structures (e.g. hazard areas, prohibited areas), ground surveillance data.