TWELFTH AIR NAVIGATION CONFERENCE

Montréal, 19 to 30 November 2012

Agenda Item 1: Strategic issues that address the challenge of integration, interoperability and harmonization of systems in support of the concept of "One Sky" for international civil aviation
1.1: Global Air Navigation Plan (GANP) – performance framework for global planning

EUROPEAN ATM MASTER PLAN

(Presented by the Presidency of the European Union on behalf of the European Union and its Member States[1]; by the other Member States of the European Civil Aviation Conference[2]; and by the Member States of EUROCONTROL)

1. In complement to working paper AN-Conf/12-WP/36, the Appendix to this paper provides the European ATM Master Plan as it has recently been formally updated, by decision of the Administrative Board of the SESAR Joint Undertaking.

2. The European ATM Master Plan can also be found via the ATM Master Plan portal (www.atmmasterplan.eu).

3. The Conference is invited to take note of this information.

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[1] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom. All these 27 States are also Members of ECAC.

[2] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Iceland, Moldova, Monaco, Montenegro, Norway, San Marino, Serbia, Switzerland, The former Yugoslav Republic of Macedonia, Turkey and Ukraine.

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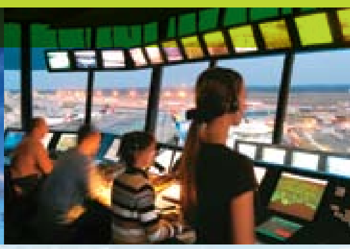
SESAR

THE ROADMAP FOR SUSTAINABLE AIR TRAFFIC MANAGEMENT

European ATM Master Plan

EDITION 2



Updated with SESAR's first developments

OCTOBER 2012

founding members

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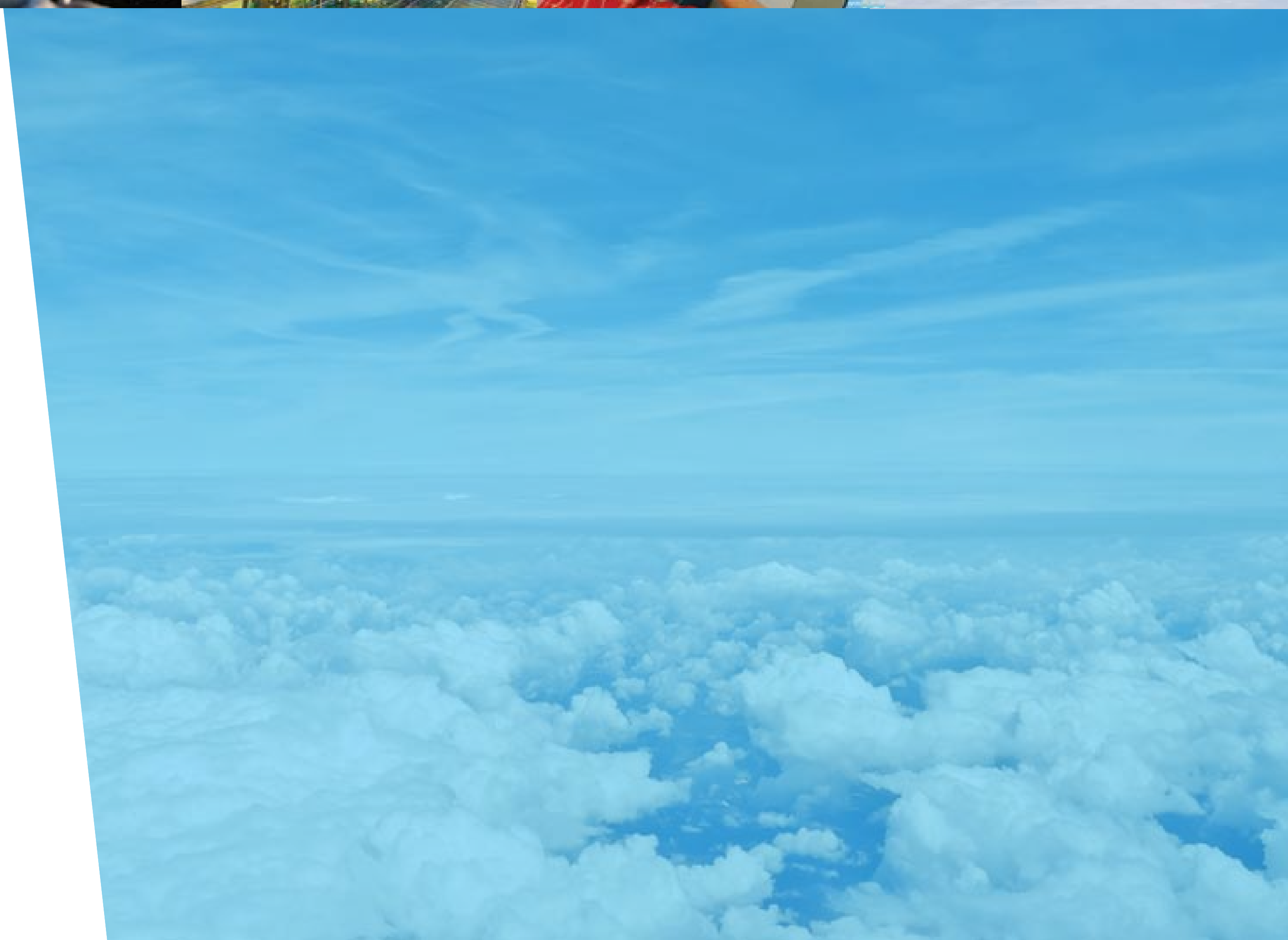
EXECUTIVE SUMMARY



INTRODUCTION:
What is the European ATM Master Plan?

Within the Single European Sky (SES) initiative, the European ATM Master Plan (Master Plan) is the agreed roadmap driving the modernisation of the Air Traffic Management system and connecting SESAR[1] research and development with deployment. It is the key tool for SESAR deployment, providing the basis for timely, coordinated and efficient deployment of new technologies and procedures.

The first edition of the European ATM Master Plan was endorsed on 30 March 2009 and adopted on 12 June 2009 by the SESAR Joint Undertaking (SJU) which is responsible through EU Council Regulation for the maintenance of the Master Plan.

This 2012 edition of the Master Plan embeds major updates which mark a clear distinction compared with the initial document:

- it takes benefit of the first results achieved by the SESAR Programme to prioritise a set of essential changes that either provides significant performance benefits and/or forms a pre-requisite towards the implementation of the target concept;
- it prepares for the SESAR deployment phase, developing stakeholder roadmaps which provide a temporal view (up to 2030) of the ATM Technology Changes required and updating the Business View, providing a basis for timely and synchronised deployments;
- it promotes and ensures interoperability at global level, in particular in the context of ICAO.

PERFORMANCE VIEW:
What are the performance needs and targets?

Air traffic has not evolved in line with the forecast underpinning the 1st edition of the Master Plan.

Although there are still considerable uncertainties regarding the near future, the consensus economic forecasts are for a resumption of near-trend growth in the medium-term and it is on this basis that the Master Plan is developed.

The proposed SES strategic performance objectives presented in this document provide a practical expression of the SES high-level political goals, in terms of measurable Key Performance Indicators (KPIs), and are based on the best current estimation of traffic growth. The SES performance-driven approach focuses on the four Key Performance Areas (KPAs) of environment, cost-efficiency, safety, and capacity/quality of service.

SESAR contributes to meeting these SES strategic performance objectives and drives R&D activities towards the achievement of a set of validation targets.

DEPLOYMENT VIEW:
What is required to be deployed to achieve performance needs and targets?

The transition towards the target Operational Concept follows three complementary Steps. Step 1, Time-based Operations is the focus of the current Master Plan and progresses through Step 2, Trajectory-based Operations to Step 3, Performance-based Operations. Step 1 starts from the Deployment Baseline consisting of operational and technical solutions that have successfully completed the R&D phase and have been implemented or are being implemented.

As shown in the figure, the Master Plan identifies essential operational changes for Step 1 which should establish the foundations for the subsequent steps while responding to the performance needs. These changes are grouped in 6 Key Features that describe the main strategic orientations and are the means to deliver performance to achieve the performance goals. The civil-military dimension is an integral part of these operational changes.

1 As part of the Single European Sky initiative, SESAR (Single European Sky ATM Research) represents its technological dimension. It will help create a “paradigm shift”, supported by state-of-the-art and innovative technology. The SESAR programme will give Europe a high-performance air traffic management infrastructure which will enable the safe and environmentally friendly development of air transport.

How and when will it be deployed?

The operational changes are enabled through improvements to technical systems, procedures, human factors and institutional changes supported by standardisation and regulation.

The human element remains pivotal to the success of SESAR, and in ensuring that SESAR delivers the benefits expected in environment, cost efficiency, safety, and capacity. The SESAR concept of operations will drive changes to the procedures being used by all stakeholders, and in particular will start to modify responsibilities between technology, controllers and flight crew. This needs to be supported by relevant regulatory changes.

The Master Plan includes roadmaps of the identified changes per stakeholder group ensuring that their deployment is planned in a performance-driven and synchronised way (e.g. between ground and air deployments) to maximise the benefits achieved.

BUSINESS VIEW:
What are the costs and the benefits?

The SESAR programme is a key contributor to the achievement of the Single European Transport Area[2] and enables smart economic growth for Europe. SESAR will provide an effective remedy to air transport capacity bottlenecks, fills gaps in the air traffic management system, enables significant reduction of CO_2 emissions, increases safety, and reduces overall costs. SESAR benefits all European stakeholders and extends beyond the air transport industry.

The Business View is a high-level view, which does not replace the need for dedicated stakeholder business cases and cost benefit analyses. Mature solutions, supported by business cases containing a clear quantification of the deployment performance expectations will be the outcome of validation. Pending the validation of the assumed benefits, the approach has been to consider the monetisation of the performance validation targets as a first indication of potential benefits.

Investments required to implement the changes described in the Master Plan for all 3 Steps have been estimated to be between 23 and 32 Bn€ for civil stakeholders for the period 2014-2030. These include investments for the Deployment Baseline, Step 1 and Step 2.

2 White Paper 2011: Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system – EC COM(2011) 144 final

While estimates of the investment required in the shorter term (Deployment Baseline and Step 1) have been recently updated, the costs for Step 2 correspond to estimates provided during the Definition phase. The investment cost for Step 2 will be reviewed once the technologies and functions supporting this step mature. No further cost assessments have been performed by the Military, earlier estimated to reach 7 Bn€. For Scheduled Airlines, taking into account the investments required for Step 1, SESAR is estimated to create a direct net positive impact of at least 5 Bn€ in the 2014-2030 period provided timely and synchronised deployment is achieved. To this value it is necessary to add other benefits such as those from delay avoidance and flight cancellation savings. In addition, the Deployment Baseline and Step 1 will establish the basis on which Steps 2 & 3 will be deployed and thus bring further benefits.

The investment figures should be taken with caution as underlying figures had a very high variance, in particular for Airport Operators and Regional Airlines. They may not be applicable to all sub-categories of stakeholders. In addition, whereas for airborne investments, up-to-date cost estimates from manufacturing industry were available for the ANSP investments this was not the case. There is a need for more detailed analysis of the cost of SESAR to ANSPs and of its integration in ANSP investment cycles. Cost inputs from the manufacturing ground industry will be important for this analysis.

The time lag between the upfront SESAR investments by the different stakeholders and the full realisation of benefits will present a risk to SESAR deployment. The risk is to create a last-mover advantage whereby each stakeholder would wait until all others have proceeded with SESAR investments. This should be addressed through the effective implementation of SESAR deployment governance and incentive mechanisms.

This second edition of the European ATM Master Plan outlines the essential operational changes and technological changes that are required to contribute to achieving the SES performance objectives, preparing the Master Plan to become a key tool for SESAR deployment and providing the basis for timely and coordinated deployment of the efficient technologies and procedures.

The Master Plan provides the best actualised view on the products, technologies and operational procedures, which can be further industrialised and deployed in order to satisfy the needs of the European citizens.

6 Key Features

Essential Operational Changes per Step and Feature

6 Key Features	Deployment Baseline	Step 1 Time based	Step 2 Trajectory based	Step 3 Performance based
Moving from Airspace to 4D Trajectory Management	• Civil/Military Airspace & Aeronautical Data Coordination • A/G Datalink • CPDLC	• Traj Mgt & BMT • System Interop with A/G data sharing • Free Routing	• Full 4D • New A/G datalink • Free Routing TMA exit to TMA entry	
Traffic Synchronisation	• Basic AMAN	• i4D + CTA • Integrated AMAN DMAN & extended AMAN horizon	• Multiple CTOs/CTAs • Mixed mode runway operations	
Network Collaborative Management & Dynamic/ Capacity Balancing	• Basic Network Operations Planning	• Network Operations Planning	• Network Operations Planning using SBTs/RBTs • 4D traj used in ATFCM • UDPP	
SWIM	• Xchange models • IP based network	• Initial SWIM Services	• Full SWIM Services	
Airport Integration & Throughput	• Airport CDM • A-SMGCS L1 & L2	• Surface Management Integrated with arrival & departure • Airport Safety Nets	• Further integration of surface & departure management • A-SMGCS L3 & L4	
Conflict Management & Automation	• Initial Controller Assistance Tools	• Enhanced DST & PBN • Conflict Detection & Resolution	• Advanced Controller Tools to support SBT/RBT • Enhanced trajectory prediction	

TABLE OF CONTENTS

1 INTRODUCTION: WHAT IS THE MASTER PLAN?

The Single European Sky (SES) initiative aims to achieve "*more sustainable and performing aviation*"[3] in Europe. SESAR, the Single European Sky ATM Research programme, aims to develop the new-generation air traffic management system capable of ensuring the safety and efficiency of air transport throughout the ECAC area in the timeframe to 2030. Individual stakeholders will be responsible for deployment supported by a coordinated deployment programme.

SESAR addresses the full range of ATM stakeholders, including civil and military ANS providers, civil and military airport operators as well as civil[4] and military airspace users. As outlined in several high-level conferences, SES objectives cannot be achieved without the contribution of the validated SESAR technological solutions. The SESAR programme is the technological pillar of the Single European Sky initiative.

Within the SES technological pillar, the European ATM Master Plan (henceforth referred to as "the Master Plan") is the agreed roadmap connecting research and development with deployment.

1.1 Focus on R&D Improvements and Initial Deployment View

The Master Plan provides both the Research and Development (R&D) and the Deployment Views for some of those R&D activities that need to be conducted to satisfy the target performance for the future ATM system. Therefore the focus of the Master Plan is primarily on planning these R&D improvements for Steps 1, 2 and 3 and proposing an initial Deployment View for those related to Step 1 as they are more mature (for more details regarding the steps see section 3.1).

3 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions (COM(2008) 389/2 of 25 June 2008) on Single European Sky II

4 Civil airspace users include scheduled aviation, business aviation and general aviation.

The development, deployment and operation of the technical and operational changes required to enhance performance of the ATM system are phased according to a lifecycle approach. Transition to the next phase is subject to a business case driven decision and an assessment of maturity.

The main lifecycle phases are:
- Research and Development;
- Industrialisation;
- Deployment;
- Operations;
- Decommissioning.

The **R&D phase** starts with innovative research, evolves into concept definition and finishes with a set of validated solutions (operational and/or system changes). Innovative R&D, as conducted in SESAR, consists of R&D to support Steps 1, 2 and 3 and long-term R&D to prepare for the next R&D phase. It currently concentrates on two main streams "Managing Complexity Safely" and "Towards Higher Levels of Automation in ATM". Validation implies technical and operational feasibility, meeting performance expectations and a positive business case (overall). At this point it should also be clear where and when the validated solution will be needed to deliver performance benefits.

The timely progress of the changes through these phases is dependent on the progress of R&D, industrialisation and deployment activities and on the involvement of the appropriate stakeholders through consultation and decision making processes in the context of the applicable governance structures.

Following a positive conclusion of the R&D activities, the **Industrialisation phase** can start. Besides the development of operational units, this phase includes many supporting activities such as standardisation activities (see section 4.4.1) and development of procedures and systems (until certification based on availability of regulatory material). The elapsed time for this phase is dependent on several factors including:
- industrial cycles and decision processes;
- the time needed for development and validation of standards;
- the capacity of manufacturing industry.

Depending on the outcome of the business case the deployment decision may also be based on agreed financial (see section 1) and regulatory instruments (see section 4.4.2).

Following confirmation of the operational performance needs and successful completion of the industrialisation phase, the **Deployment phase** can start (see section 3). This can vary from a number of separate local deployments to a fully coordinated Europe-wide deployment. The duration and approach adopted are highly dependent on this. In order to maximise benefits, some operational changes rely on well-synchronised deployments (between stakeholder groups). This needs to have be identified during the R&D phase. Appropriate financial and regulatory instruments, if needed, should be in force in time to ensure synchronised deployment (see sections 5.4 and 4.4.2 respectively).

The **Operations phase** can start once all integration, commissioning and certification tasks have been successfully completed.

1.2 First Edition of the Master Plan: 30 March 2009

The first edition was derived from the "SESAR Master Plan" issued in May 2008 as one of the six main deliverables from the Definition Phase of SESAR in which the major European aviation stakeholders had agreed a common roadmap for the modernisation of the European ATM system. It was endorsed by the Transport Council of the European Union on 30 March 2009. Although the Master Plan is not legally binding, such endorsement by the Council represents a clear political commitment to the SESAR programme and an acknowledgement of its importance.

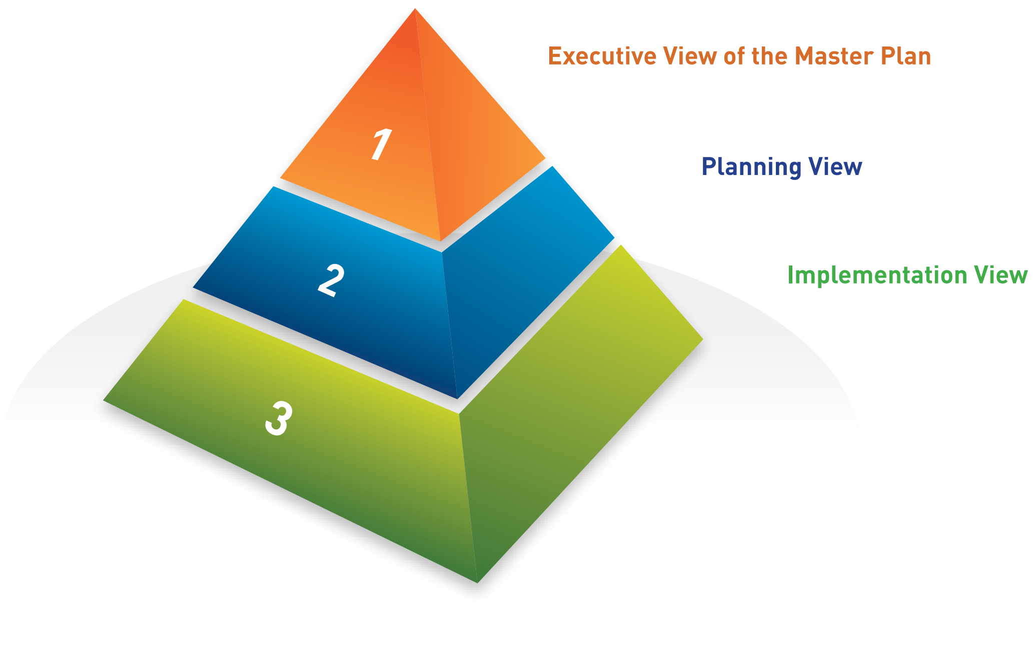
1.3 The Maintenance of the Master Plan

As per EU Council Regulation, the SESAR Joint Undertaking (SJU) is the entity in charge of the maintenance of the Master Plan. On 12 June 2009, the SJU Administrative Board formally adopted the Plan and made it the foundation of the SJU's work programme (Edition 1.0, 2009). A minor update of the Master Plan, mainly focused on the SESAR Deployment Baseline, was approved by the Board a year later, on 12 July 2010 (Edition 1.1, 2010).

1.4 The 3 Levels of the Master Plan

The 3 Levels of Master Plan are shown in Figure 1:

Figure 1 **3 Levels of the European ATM Master Plan**



This document represents the Executive View of the Master Plan (Level 1). The Master Plan comprises an integrated set of information with Level 1 constituting the high-level synthesis and comprising:

- the Stakeholders' Executive Summaries (provided separately);
- the Executive Summary;
- the Performance View;
- the Deployment View including the essential operational and technological changes and high-level deployment roadmaps;
- the Business View;
- a summary of the Standardisation and Regulatory roadmaps;
- the Risk Management plan.

The intended readership for Level 1 is at executive level. Levels 2 and 3 of the Master Plan provide details on operational changes.

Level 2 (Planning View), available in the Master Plan portal, provides the detailed planning information supporting Level 1 and comprises:

- Operational Improvements (OIs):
  - Initial Operating Capability (IOC) dates indicating the date from which benefits can be expected;
- Enablers:
  - synchronisation points (dates) for the coordination of stakeholder deployments e.g. between air and ground deployments;
  - institutional (standardisation and regulation), system, human and procedural enablers;
- Deployment Scenarios.

Level 3 (Implementation View) comprises the European Single Sky ImPlementation (ESSIP) Plan which is composed of commonly agreed implementation actions. These, with the actions resulting from the other SES plans, address the key performance targets in the areas of safety, environment, capacity and cost-efficiency. In addition Level 3 of the Master Plan provides stakeholders with the best possible basis for short-term common implementation planning.

Levels 2 and 3 are targeted for use at expert level.

The Master Plan portal (www.atmmasterplan.eu) provides information at all three Levels in an interactive way. From the visualisation of information at Level 1 a "drill-down" capability allows the related detailed information of the Planning and Implementation views to be examined (Levels 2 and 3 respectively).

1.5 The 2nd Edition of the Master Plan: the First Significant Update

This edition of the Master Plan outlines the essential operational changes and technological changes that are required to contribute to achieving the SES performance objectives, preparing the Master Plan to become a key tool for SESAR deployment and providing the basis for timely, coordinated and efficient deployment of the new technologies and procedures. This edition of the Master Plan is under sole ownership of the SJU in compliance with the EU Council Regulation.

Additional improvements contributing to SES performance targets will be addressed in the Network Strategy Plan[5] and other SES pillar action plans.

1.5.1 Key Drivers of the Master Plan Update

The main drivers leading to the 2nd Edition of the Master plan are:

- to **simplify and prioritise** the Master Plan document, increasing the ATM community's awareness and **focusing its efforts on a manageable set of essential operational changes** that either provides significant performance benefits and/or forms a pre-requisite towards the implementation of the target concept;
- to **prepare for SESAR deployment** phase, developing **clear stakeholder roadmaps** which provide a temporal view of the ATM Technology Changes required and updating the Business View, providing a basis for timely and synchronised deployments;
- to **review and update the risks** regarding the foreseen changes and the associated mitigating actions, strengthening the continuation of the SESAR programme;
- to **promote and ensure interoperability** at global level, in particular with the US ATM Modernisation programme, NextGen, connecting with ICAO's Aviation System Blocks Upgrades (ASBU) concept;
- to **promote synchronisation of ATM R&D and Deployment** Programmes to ensure global interoperability;
- to **update the standardisation and regulatory roadmaps** to indicate what needs to be standardised or regulated and by when in order to have a common European understanding to prepare for the ICAO Twelfth Air Navigation Conference (ANC 12).

5 Regulation (EU) N°677/2011, article 5

1.5.2 Main Limitations of this 2nd Edition of the Master Plan

This edition of the Master Plan constitutes the best possible European view on how the European ATM system will evolve over the next decades. The essential operational changes identified in this edition mainly result from expert judgment. They constitute an initial basis from which to prepare for the deployment phase subject to confirmation by validation results.

The Master Plan is not as such a deployment plan; it is a high-level plan, which defines the needs and means to optimise SESAR benefits and does not provide details on geographic implementation.

The Business View, based on performance needs and their validation targets, complements the Deployment View by providing targeted benefits of deployment and associated costs to stakeholders. It is a high-level view, which does not replace the need for dedicated stakeholder business cases and cost benefit analyses.

1.5.3 Master Plan - Network Strategy Plan Relationship

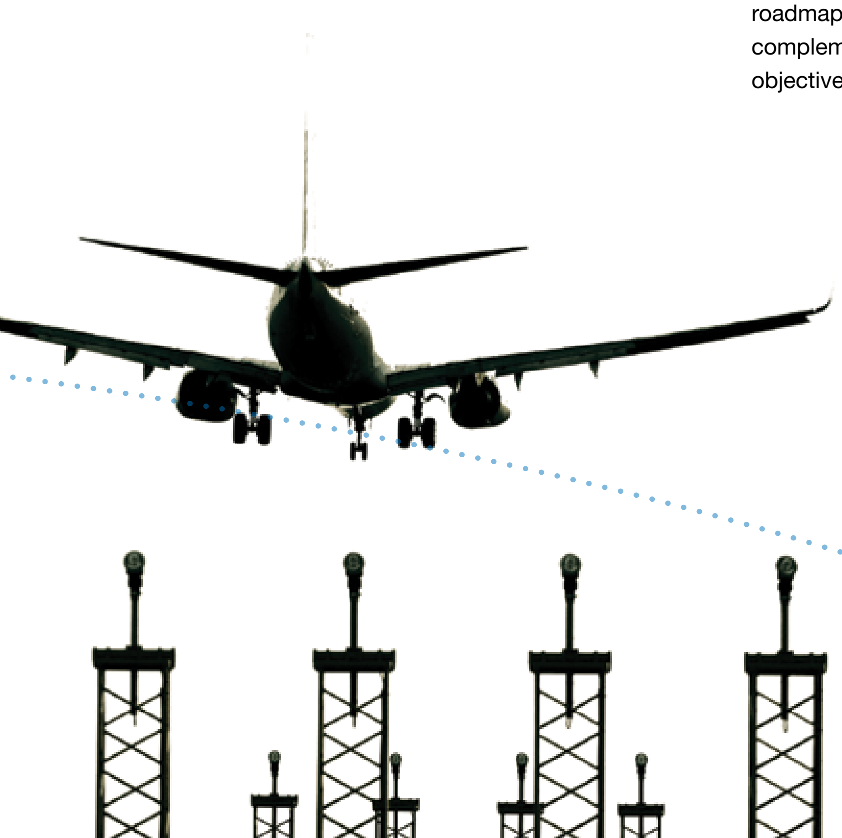
The relationship between the Master Plan and the Network Strategy Plan shall be considered within their specific scope and goals and their corresponding time horizons.

The **Master Plan addresses the high-level operational and technological evolution** of the ATM System, based on agreed performance objectives and deployment scenarios.

The Network Strategy Plan is part of a wider change process driven through the Master Plan. Its goal is to address the ATM Network Performance as defined in the Performance Implementing Rule (IR) for the next reference period(s) focusing on specific objectives, targeting current and known problems and taking benefit of mainly short term solutions and best practices.

Both plans complement each other:

- The Master Plan provides the top-down view. It is the agreed roadmap connecting research and development with deployment scenarios, bringing consistency to the technological evolution.
- The Network Strategy Plan addresses the current operational network performance and the gap to the agreed targets; it uses the technological roadmap as planned in the Master Plan and it complements it by providing additional operational objectives and solutions.



2 PERFORMANCE VIEW: WHAT ARE THE PERFORMANCE NEEDS AND TARGETS?

2.1 Single European Sky High-Level Goals

The SES High Level goals are political targets set by the European Commission with the support of the Single Sky Committee. The scope of the SES High-Level Goals is the full ATM performance outcome resulting from the combined implementation of the SES pillars and instruments as well as industry developments not driven directly by the EU.

In 2005, the Commission stated its political vision and set high-level goals for the SES to be met by 2020 and beyond. It should:

- enable a 3-fold increase in capacity which will also reduce delays both on the ground and in the air;
- improve safety by a factor of 10;
- enable a 10 % reduction in the effects flights have on the environment and;
- provide ATM services to the airspace users at a cost of at least 50% less.

As early as 2008, the definition phase of SESAR concluded that with SESAR's contribution, SES could achieve the following targets by 2020[6]:

- a 73 % increase in capacity from 2004;
- an associated improvement in safety so that the total number of ATM-induced accidents and serious or risk bearing incidents would not increase despite traffic growth;
- a 10 % reduction per flight in environmental impact compared to 2005; and
- a 50 % reduction in cost per flight compared to 2004.

In the 2012 context, the '2005 vision' remains as the high-level, desired political vision for SES and one to which SESAR is a significant but not the only contributor. The other SES pillars will also contribute; for example, the Network Strategy Plan will specify contributions stemming from the Network Management Functions. Then, in line with this vision, the performance scheme and the associated reference periods bring further refinements, defining precise and binding, short-term or medium-term performance targets.

On the occasion of the Council's endorsement of the initial ATM Master Plan, it was agreed that the SESAR contribution to the high-level goals set by the Commission should be continuously reviewed by the SESAR Joint Undertaking and kept up to date through future versions of the ATM Master Plan.

Today, as a direct consequence of this continuous review and based on early results from the development phase, SESAR is now targeting for the Deployment Baseline and Step 1 to enable, as compared to 2005 performance:

- a 27 % increase in airspace capacity;
- an associated improvement in safety so that the total number of ATM-induced accidents and serious or risk bearing incidents does not increase despite traffic growth generated by SESAR (i.e. through air-space and airport-capacity increase);
- a 2.8 % reduction per flight in environmental impact;
- a 6 % reduction in cost per flight.

More details of SESAR's contribution are provided in section 2.4.

6 SESAR Master Plan, April 2008 (D5), §2.1.1.

2.2 From SES Goals to the Performance Scheme and Strategic Performance Objectives

2.2.1 Performance Scheme: a Performance-Driven Approach

With the introduction of the SES Performance Scheme in 2010[7], European ATM now operates a formal and explicit performance-driven approach. The SES Performance Scheme is a key element of the EU Single European Sky initiative, containing probably one of the most significant aviation industry changes in recent times as it heralded the end of the automatic full cost recovery principle that had prevailed for air navigation charges since 1981.

The Performance Scheme, with reference periods of 3-5 years, provides a comprehensive performance-driven approach for operations. However, with long investment lead times common to infrastructure industries, ATM also needs a longer term performance perspective. This is needed to drive today's R&D activity that is developing the SESAR ATM operational concept and technology of the future and to contribute to the long-term context for Performance Scheme target-setting in future reference periods[8].

The SES performance-driven approach focuses on the four Key Performance Areas (KPAs) of environment, cost-efficiency, safety and capacity, reflecting the SES high-level goals and the structure of the first reference period (RP1) of the SES Performance Scheme. They are part of the wider set of 11 ICAO KPAs, which also include efficiency, flexibility, predictability, security, access & equity, interoperability and participation. [9]

2.2.2 The Strategic Performance Objectives: Practical Expression of High-Level Goals

The European Commission high-level goals for SES provide the political vision of the performance-driven approach. They should be complemented by more specific and measurable Key Performance Indicators (KPIs) to capture network performance trends and define success criteria. This need is met by the following strategic performance objectives. They reconcile the SES high-level goals with more practical and measurable KPIs of greater relevance to the definition of R&D activity (SESAR). They are set out in Table 1, based on the best current estimation of traffic growth.

Since the SES high-level goals are general in nature, they need to be interpreted and re expressed. The proposed Strategic Performance Objectives are driven by the SES high-level goals and set in accordance with the performance targets of the performance scheme. Therefore, they provide the more measurable and practical long-term guidance that can serve as the basis for R&D and long-term deployment planning. The proposed Strategic Performance Objectives are of an indicative nature, whereas medium-term and short-term deployment is driven by binding Performance Scheme targets.

7 The main features of the Performance Scheme are defined in Commission Regulation 691/2010 "Performance Regulation". Under this regulation, States are required to submit Performance Plans setting out "binding" national or FAB targets that make an adequate contribution to EU-wide targets. The first reference period (RP1) runs from 2012 to 2014; the second reference period (RP2) is set for 2015 to 2019.

8 This is a general description of the anticipated future interaction between Master Plan and Performance Scheme. The situation for RP1 is slightly different in that the targets are based on current investment plans with very limited contribution from deployment of SESAR enhanced capabilities.

9 11 KPAs and associated expectations were defined by ICAO in the ATM Global Operational Concept (Doc 9854). Furthermore, ICAO Global Performance of the Air Navigation System Manual (Doc 9883) sets out the general principles for a performance based approach which are applied by the SES II Performance Scheme.

Table 1 **Proposed SES Strategic Performance Objectives at European Network Level**[10]

KPA	Key Performance Indicator (KPI)	Strategic Objectives (as compared to 2005)	SESAR Step 1 + Baseline Contribution (as compared to 2005)
Safety	**Improve Safety performance by a factor of 10**		
ECAC annual accidents	No increase in the number of accidents with ATM contribution per annum	No increase – irrespective of traffic growth	No increase – irrespective of traffic increase addressed by SESAR
Safety risk	Safety risk per flight hour	No increase - irrespective of traffic growth	-40%
Capacity	**Enable a 3-fold increase in ATM capacity to be deployed where needed**		
Airspace capacity	En-route capacity	x 3	+27%
Airport capacity	Runway Capacity for best-in-class Airports		+14%
Environment	**Enable a 10% reduction in the effects flights have on the environment**		
Flight Efficiency	Gate-to-gate Overall ANS related CO_2 Emissions Index (2005=100; per flight)	-10%	-2,8%
Cost Efficiency	**Provide ATM services at a unit cost to the airspace users which is at least 50% less**		
Direct ANS Cost per Flight	Total annual en-route and Terminal ANS cost in Europe, €2005/flight	-50%	-6%

The KPIs defined in the above table differ from the KPIs of the Performance Scheme. For reference, the Performance Scheme RP1 EU-wide targets are:

- Environment / Flight efficiency: improve by 0.75 points the horizontal-flight efficiency indicator (as compared to 2009)
- Cost-efficiency: achieve an average en-route Determined Unit Rate[11] of € 53.92 in 2014, as against € 59.97 in 2011 (in euros at 2009 prices)
- Capacity: reduce en-route ATFM delay to 0.5 minutes per flight

Beyond the performance improvement expected from the Deployment Baseline, achieving the 2014 performance targets will require significant improvements driven by other SES initiatives — notably a performance scheme, FABs and cooperative initiatives coordinated through the Network Strategy Plan. SESAR capabilities currently under development are expected to contribute in the medium term.

10 Sources for 2005 and 2010 values: Safety, Environment – PRR2010; Delay – PRR2004 & PRR2010; Cost Efficiency – derived from PRR2004 & draft PRR2011

11 The Determined Unit Rate KPI adopted by the Performance Scheme in RP1 sets a target on En-route ANS cost per Service Unit. The strategic performance objective KPI of cost per flight is wider in scope as it also covers the Terminal navigation costs, for which 'flights' is a more appropriate denominator.

2.3 The Performance Needs: Performance Required in a Particular Environment

Performance needs estimate the performance required in a specific part of the ATM network at a given point in time on the basis of traffic forecasts and business requirements. They are used as the basis for the Deployment View in the Master Plan.

For example, performance at individual Air Traffic Service Unit (ATSU) or airport level is clearly managed in accordance with local needs, e.g. customer priorities and operational opportunities driven by positive local business cases, and in doing so also contributing to the overall proposed SES strategic performance objectives.

Quantitative performance needs are derived for the capacity KPA in order to provide an understanding of the scale of deployment needed across the network. They are used as the performance reference for creating the focused deployment view in section 3. The capacity needs in this context are reference values used to inform long-term planning decisions. Their purpose is to provide a broad requirement against which deployment plans are tested for suitability. However, it has to be recognised that the values derived are not necessarily to be met entirely by deployment of SESAR developed capabilities and that they are subject to change. The deployment view does not constitute deployment decisions – these will be based on updated traffic forecasts and confirmation of performance uplifts expected from the operational changes.

- **Capacity needs** are expressed as busy hour throughputs handled by individual ECAC En-route and TMA ATSUs and airports[12]. These have been divided into four categories of capacity needs for each type of entity. The categorisation assumes that ATSUs and airports in the same category will face similar capacity needs requiring similar operational changes to be rolled out in broadly the same time-frame. This simplification is required in order to enable the capacity needs to form the basis of the deployment view.

The categorisation is as follows:

- Very High Capacity (VHC)
  - for airports and TMAs > 100 movements per busy hour
  - for En-route ACCs > 300 movements per busy hour
- High Capacity (HC)
  - for airports and TMAs between 60 and 100 movements per busy hour
  - for En-route ACCs between 200 and 300 movements per busy hour
- Medium Capacity (MC)
  - for airports and TMAs between 30 and 60 movements per busy hour
  - for En-route ACCs between 50 and 200 movements per busy hour
- Low Capacity (LC)
  - for airports and TMAs < 30 movements per busy hour
  - for En-route ACCs < 50 movements per busy hour

12 131 Airports, 166 TMA Units (either single airport ATSUs or ACCs where more than 1 airport served), 61 En-route ACCs across the ECAC area. Year 2010 traffic is as recorded by Eurocontrol Directorate of Network Management

Any imbalance between the air traffic demand and capacity results in a degradation of the service provided in terms of punctuality, predictability, efficiency, or flexibility. **Quality of Service** is therefore closely linked to capacity and this KPA also indirectly reflects whether there is an effective and efficient use of it. Consequently, it must be noted that the objective related to the increase of capacity is aiming at improving the overall quality of service provided to the Airspace Users. Quality of Service will be urgently addressed and reflected in subsequent editions of the Master Plan when the quantification of punctuality, predictability and flexibility are more mature.

Performance needs for the KPAs of environment, cost-efficiency and safety are expressed in purely qualitative terms. The body of quantitative baseline data needed to create a comprehensive picture of local needs does not exist. The performance needs for these KPAs are therefore expressed as follows:

- **Environment Needs:**
  - The environment need at ECAC level is to reduce the emissions per flight such that the overall emissions per flight allow the proposed SES strategic performance objective to be realised.
  - Each unit or airport needs to reduce the environmental impact per flight in accordance with local priorities and trade-offs whilst contributing to the proposed SES strategic performance objectives.
  - The rate at which the local impact is reduced is dependent on local traffic growth rate and other local circumstances.
  - The categorisation used for capacity is applied to determine applicability and extent of benefits from different operational changes.
- **Cost-efficiency needs:**
  - The cost-efficiency need at ECAC level is to increase Air Traffic Controller (ATCO) productivity and reduce technology costs per flight such that the proposed SES strategic performance objective can be realised.
  - The local productivity and technology cost improvement needs are dependent on local traffic growth and other local priorities and trade-offs.
  - Cost-efficiency needs are therefore not meaningfully categorised or quantified according to the operating environment classification applied for capacity.
- **Safety needs:**
  - The safety need at ECAC level is to reduce the risk per flight hour such that the overall number of accidents per year does not increase, irrespective of traffic growth.
  - At the local operating environment level, the safety need is to reduce the risk per flight hour by an amount that is at least equal to the local rate of traffic growth.
  - It is not meaningful to apply the categorisation of operating environments that is used for capacity as the needs are expressed purely in qualitative and relative terms (i.e. there is no absolute baseline).

2.4 SESAR Contribution to SES Goals

2.4.1 Validation Targets, Basis for R&D Performance

The high-level goals presented in section 2.1 represent the SES vision for the performance of the future ATM System. SESAR, as the technological pillar of SES, is a key contributor to the realisation of these goals, through the development of major new capabilities that are needed in order to service the performance needs.

For the purposes of R&D and deployment planning, the contributions expected from SESAR need to be identified separately. Within the SESAR programme, R&D is therefore driven by Validation Targets, which focus on the development of enhanced capabilities.

The validation targets within the Master Plan represent the plan for deploying validated capabilities where and when needed across the ATM network in order to contribute to the proposed SES strategic performance objectives.

A set of validation targets has been established using as the starting point the SES strategic performance objectives. The aim of these validation targets is to drive capability development and validation activities through a performance-driven approach. The validation targets therefore relate to Concept Step capability enhancements *targeted* by the SESAR development programme. They are not validated performance expectations, nor are they actual performance outcomes in specific timeframes and locations. Performance contributions will only be known after the completion of the appropriate validation activities.

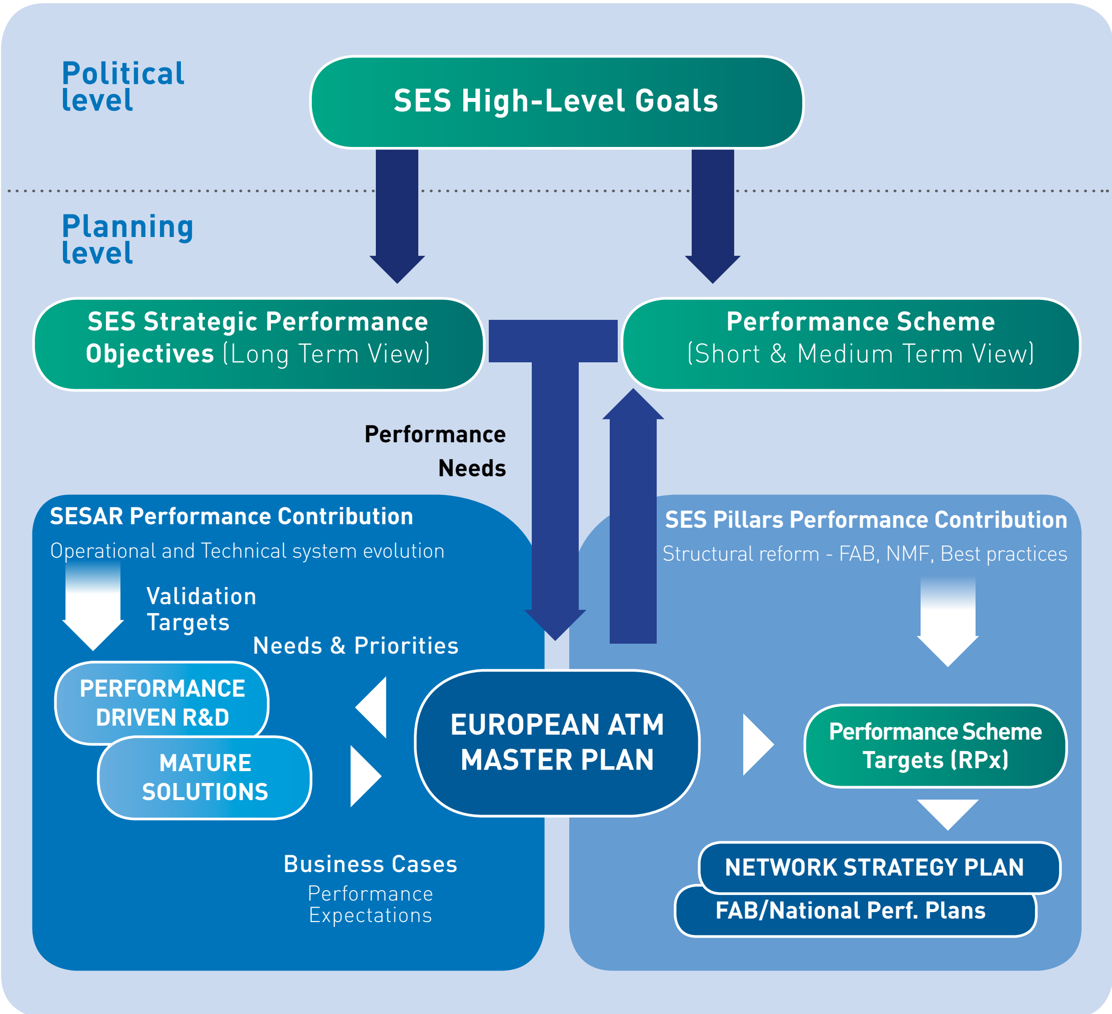
The extent to which capability enhancements being developed by SESAR can contribute to SES goals varies across the KPAs. For some KPAs, the capabilities developed by SESAR are designed to address much of the proposed SES strategic performance objectives and hence SES goals. In other cases – notably cost-efficiency – the expectation is that a significant proportion will come from sources other than SESAR-developed capability enhancements. This is illustrated in section 2.4.2 for each of the four KPAs with quantitative objectives.

Intermediate targets for the three Concept Steps (see section 3.1) have been determined to reflect a progression toward the SES high-level goals. These values are based on expert judgment which has taken into account the amount of change to the operating concept that is anticipated for each Step. As Step 1 represents a more incremental development of the current operation with Steps 2 and 3 bringing about the true "paradigm change", the targeting for Step 1 is more modest. Note that Step 1 targets cover the full scope of Step 1 and include a target contribution from the Deployment Baseline. Step 2 validation targets are expressed in cumulative terms against the 2005 baseline.

For each Concept Step, a portion of the intermediate target is allocated to SESAR. This allocation is based on performance contributions expected from existing initiatives that do not require SESAR R&D (e.g. for fuel efficiency performance in Step 1, the difference between -2.8% and -4% is expected to come from existing initiatives, not requiring SESAR R&D).

In summary, the relationship between these high-level goals and SESAR, as the technological pillar of SES are set out in Figure 2.

Figure 2 **SES, SESAR and Performance Scheme Relationship between Targets and Performance**



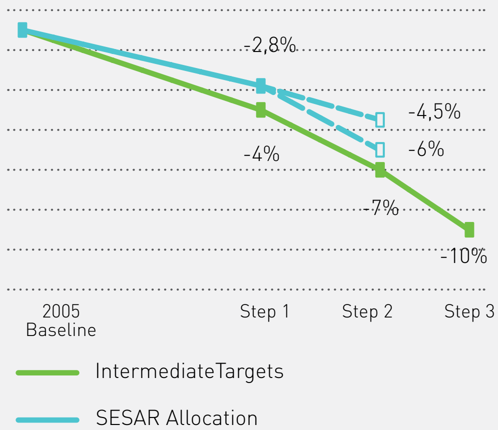
2.4.2 Validation Targets Determined per KPA

Environment / Fuel Efficiency

In line with airspace capacity and cost-efficiency, it is expected that there will be an on-going performance contribution from non-R&D initiatives through the Step 1 and Step 2 developments, e.g. from improvements related to Functional Airspace Blocks (FABs) and Network Management:

- The intermediate allocation to the Step 1 development has been set at -4%, with the ultimate capability enhancement being -10%
- Step 1 has 30% (-1.2% out of -4%) coming from non-R&D and therefore -2.8% coming from SESAR
- The allocation to Step 2 has yet to be finalised, but the likely range is for a target allocation of between -4.5% and -6% vs. the 2005 baseline.

Figure 3 **Fuel Efficiency**



SES High-level Goal: -10%

INTERMEDIATE TARGETS		
Concept Step	Full scope	Allocated to SESAR
Step 1	-4%	-2.8%
Step 2	-7%	tbc
Step 3	-10%	tbd

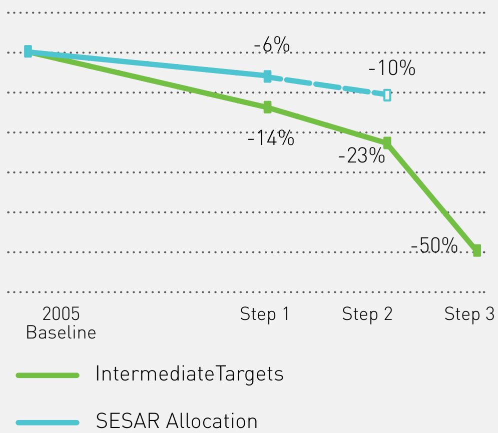
Note: all validation target values are based on improvement vs. baseline (i.e. 2005 baseline)

Cost Efficiency

The allocation of the cost-efficiency target to R&D is based on 45% of the ATM/CNS (Communications, Navigation and Surveillance) cost base being related to the operational concept and technology.

- The intermediate allocation to the Step 1 development has been set at a -14% reduction in the cost per flight – with the ultimate capability enhancement being -50%;
- The SESAR Step 1 allocation is of circa -6%, i.e. 45% of -14%;
- The allocation to Step 2 has yet to be finalised, but on the same basis as the Step 1 allocation, it will be circa -10% vs. the 2005 baseline (i.e. 45% of -23%).

Figure 4 **Cost Efficiency**



SES High-level Goal: -50%

INTERMEDIATE TARGETS		
Concept Step	Full scope	Allocated to SESAR
Step 1	-14%	-6%
Step 2	-23%	tbc
Step 3	-50%	tbd

Note: all validation target values are based on improvement vs. baseline (i.e. 2005 baseline)

Safety

Safety validation targets are allocated on the basis of the EUROCONTROL Accident Incident Model (AIM) which is a comprehensive risk model incorporating a structured breakdown of aviation accident causes, with particular emphasis on ATM contributions.

- The intermediate target allocated to the Step 1 development is for a 40% reduction in accident risk per flight hour – corresponding to the safety need associated with the traffic growth anticipated. This ensures that, as a minimum, capabilities are developed in line with the safety performance needs.
- The full 40% is allocated to SESAR R&D initiatives and the Deployment Baseline.

Figure 5 **Safety**

Proposed SES Strategic Performance Objective: No increase in annual accidents with ATM-contribution

INTERMEDIATE TARGETS

Concept Step	Full scope	Allocated to SESAR
Step 1	40%	40%
Step 2	tbd	tbd
Step 3	tbd	tbd

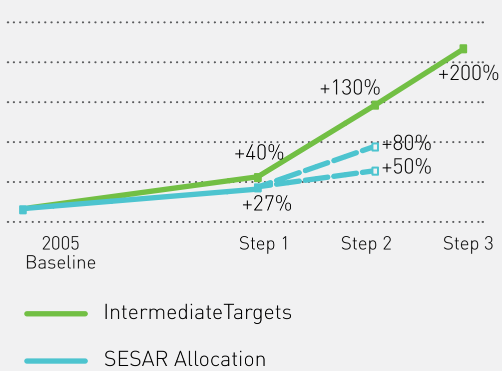
Note: all validation target values are based on improvement vs. baseline (i.e. 2005 baseline)

Airspace Capacity

Airspace capacity here refers to sustainable throughput of a volume of airspace to be achieved through staff productivity enhancements, i.e. without increasing staff. It is a contributor to the overall ATM capacity enhancement goal. It is expected that there will be an on-going performance contribution from non-R&D initiatives in parallel with the Step 1 and Step 2 developments, e.g. from local initiatives and rolling out existing best-practice:

- The intermediate allocation to the Step 1 development has been set at +40% – with the ultimate capability enhancement being for +200% (i.e. 3 times the 2005 value)
- In Step 1 about two thirds of the airspace capacity capability uplift is expected to come from SESAR R&D initiatives with the rest from non-R&D initiatives
- The SESAR Step 1 allocation is therefore for a +27% capacity enhancement (~67% of 40%). As an example, if a "High Capacity" en-route ACC had a busy hour throughput of 250 in 2005, the deployment of SESAR Deployment Baseline and Step 1 capabilities should enable a throughput of about 315 – without additional controller resource.
- The allocation to Step 2 has yet to be finalised, but the validation target is likely to end up in the range +50% to +80% vs. the 2005 baseline.

Figure 6 **Airspace Capacity**



SES High-level Goal: +200%

INTERMEDIATE TARGETS

Concept Step	Full scope	Allocated to SESAR
Step 1	40%	27%
Step 2	130%	tbc
Step 3	200%	tbd

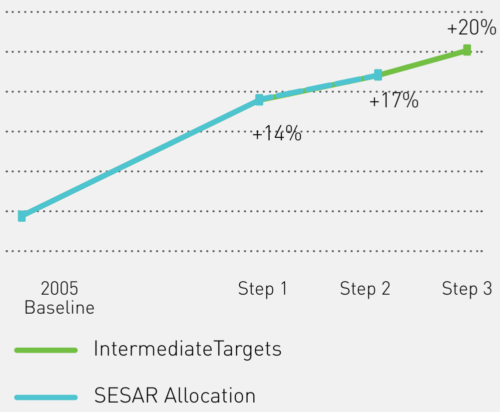
Note: all validation target values are based on improvement vs. baseline (i.e. 2005 baseline)

Airport Capacity

Airport capacity is a contributor to the overall ATM capacity enhancement goal. Airport capacity, in the Master Plan context, refers to runway throughput. Airport capacity in total encompasses more than the runway, but the focus of the ATM contribution is on runway throughput for "best-in-class" airports where busy hour throughput is at a maximum achievable using current operational concept and technology. As such, it is expected that the full contribution to each intermediate target will come from SESAR R&D. The capacity increases required for other airports can be addressed by implementing "best-in-class" procedures progressively to satisfy the increasing demand. The proportioning of what can be achieved by implementing such procedures and what can be achieved with SESAR for the whole network is not addressed here.

- The targeted improvement of +20% is based on the SESAR Definition Phase target for single-runway airports of developing a capability to increase throughput from the 2005 "Best-in-Class" (BIC) of 50 movements per hour to a throughput of 60 per hour.
- The validation target is set against that BIC airport throughput, with improvements assumed to require SESAR R&D. Therefore, the full intermediate targets for Steps 1 and 2 are allocable to SESAR.
- The Step 1 validation target has been set at 14%;
- The validation target for Step 2 has yet to be confirmed.

Figure 7 **Airport Runway Capacity**



SESAR target: +20%

INTERMEDIATE TARGETS

Concept Step	Full scope	Allocated to SESAR
Step 1	14%	14%
Step 2	17%	tbd
Step 3	20%	tbd

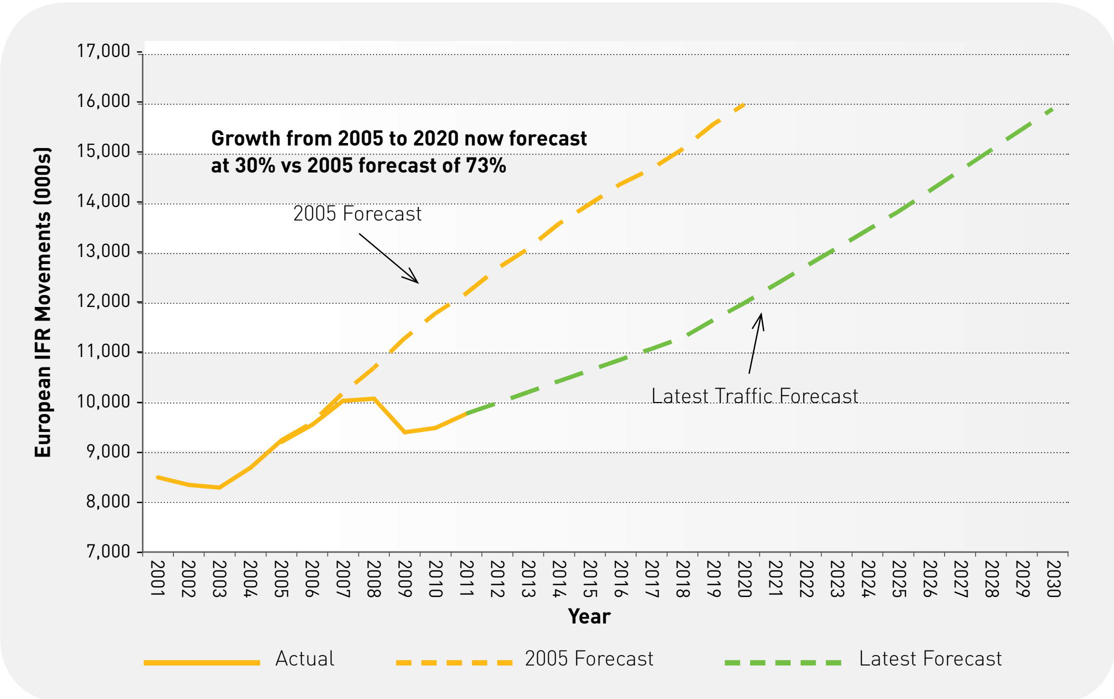
Note: all validation target values are based on improvement vs. baseline (i.e. 2005 baseline)

2.5 Traffic Trends and Impact on SESAR Performance

The original timeframe set out in 2005 for achievement of the SES high-level goals was 2020. The revision introduced by the Single Sky Committee (SSC) in November 2011 has linked the realisation of these goals to a doubling of traffic relative to 2005. This revision has been necessary in light of the unforeseen and historically unparalleled traffic downturn of 2008-2010 along with the expectation of slower future growth than was anticipated in 2005.

Air traffic has not evolved in line with the forecasts underpinning the first edition of the Master Plan. Traffic forecasts at that time had been for average annual compound growth to 2020 of 3.7%, reaching 16M flights from a base of 9.2M in 2005. By 2010, European traffic had been expected to reach circa 12M flights. However, the financial crisis affecting the global economy since 2008 effectively 'lost' 5 years of growth with traffic in 2011 reaching 9.8M, i.e. 6% above the 2005 level. This is illustrated in Figure 8.

Figure 8 **Growth from 2005 to 2020 now forecast at 30% vs 2005 forecast of 73%**

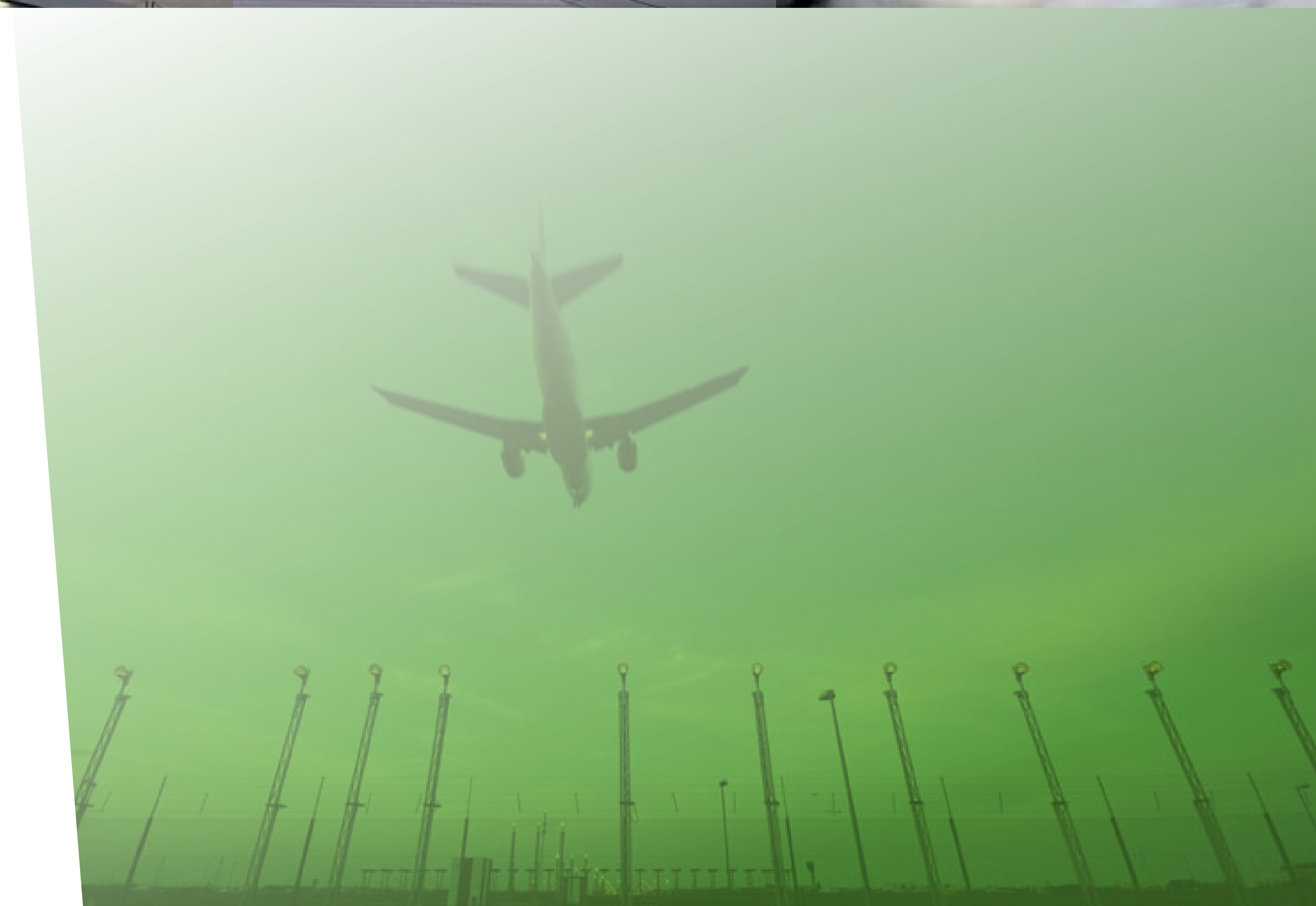


In the context of the Master Plan, it is necessary to define the expected long-term traffic growth to 2030 and beyond, i.e. to the time at which traffic is expected to have doubled when compared to 2005. This forms a key input to determining performance needs for ATM. The latest STATFOR Forecast (based on the long term forecast 2010) models four long-term air transport evolution scenarios forecast up to 2030. Although there are considerable uncertainties regarding the immediate future, the consensus economic forecasts are still predicting a resumption of near-trend growth in the medium term. In the most likely forecast, the average annual growth rate would be 2.6% from 2010 to 2030. This is the forecast that was selected to underpin this edition of the Master Plan. This would imply approximately 15.9M European air traffic movements by 2030, i.e. +73% over 2005. Following this trend, European traffic is expected to double by 2036. Although this could ultimately represent about 8 years of 'lost' traffic growth (vs. the forecasts made in 2005), it is still a significant increase over current volumes.

The Master Plan takes these traffic trends into account to update the priority given to operational changes.

3 DEPLOYMENT VIEW I: WHAT CONTRIBUTES TO PERFORMANCE?



3.1 The 3 SESAR Concept Steps

The 3 SESAR Concept Steps are the phases through which the target concept is realised. These Steps are capability-based and not fixed in time. Each Step brings the ATM system closer to the target concept.

Step 1, "Time-based Operations" is the building block for the implementation of the SESAR Concept and is focused on flight efficiency, predictability and the environment. The goal is a synchronised European ATM system where partners are aware of the business and operational situations and collaborate to optimise the network. In this first Step:

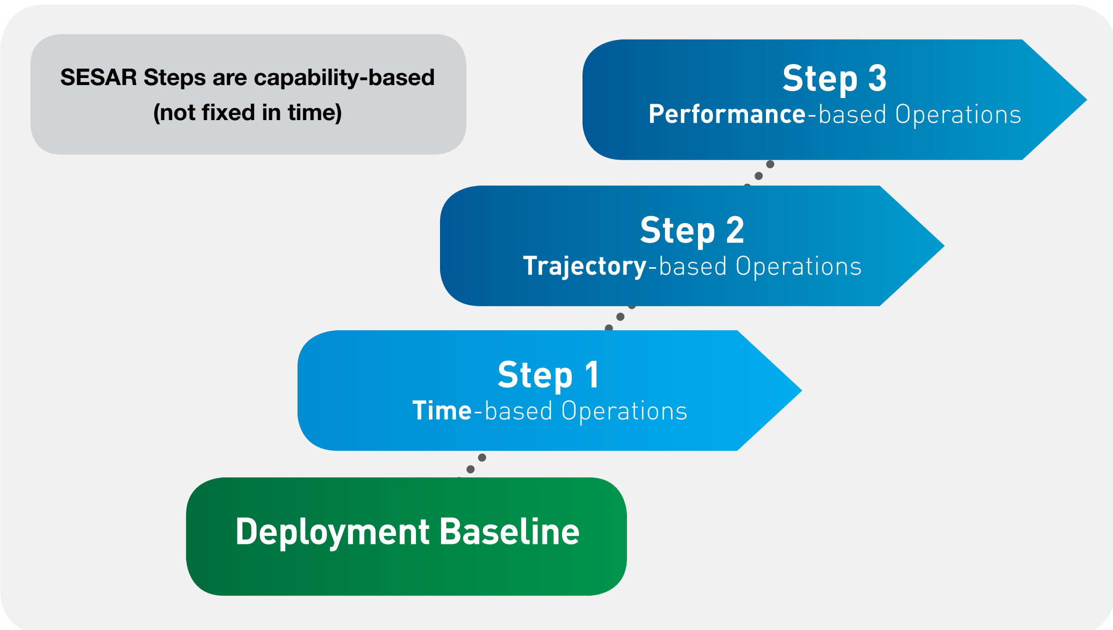
- time prioritisation for arrivals at airports is initiated;
- datalink is widely used;
- initial trajectory-based operations are deployed through the use of airborne trajectories (by the ground systems), and a controlled time of arrival (to sequence traffic and manage queues).

Step 2, "Trajectory-based Operations" is focused on flight efficiency, predictability, environment and capacity, which becomes an important target. The goal is a trajectory-based ATM system where partners optimise "business and mission trajectories" through common 4D trajectory information and users define priorities in the network. "Trajectory-based Operations" initiates 4D-based business/ mission trajectory management using System Wide Information Management (SWIM) and air/ground trajectory exchange to enable tactical planning and conflict-free route segments.

Step 3, "**Performance-based Operations**" will achieve the high performance required to satisfy the SESAR target concept. The goal is the implementation of a European high-performance, integrated, network-centric, collaborative and seamless air/ground ATM system. "Performance-based Operations" is realised through the achievement of SWIM and collaboratively planned network operations with User Driven Prioritisation Processes (UDPP).

Figure 9 shows the 3 SESAR Concept Steps and their relationship to the Deployment Baseline.

Figure 9 **Path to the Target Operational Concept**



3.2 The 6 SESAR Key Features

The realisation of the SESAR target concept follows strategic orientations described by 6 Key Features, which evolve through the 3 SESAR Concept Steps, namely:

- Moving from Airspace to 4D Trajectory Management;
- Traffic Synchronisation;
- Network Collaborative Management and Dynamic/Capacity Balancing;
- SWIM;
- Airport Integration and Throughput;
- Conflict Management and Automation.

Achieving the performance needs requires several actions within various domains (e.g. FAB organisation, technical and operational improvements) ; the contribution of the SESAR solutions is realised by operational changes in specific operating environments in line with the overall SESAR target concept. These operational changes are described in this section within the context of the 6 Key Features.

3.3 The Essential Operational Changes

Operational changes provide performance benefits to one or more of the four types of operating environment, i.e. airport, en-route, TMA and network.

The operational changes are enabled through changes of technical systems, procedures, human factors and institutional changes including standardisation and regulation. Roadmaps of all the ATM Technology Changes per Stakeholder Group are provided in section 4 showing the synchronised view (e.g. between ground and air deployments) needed to ensure that their deployment is planned in a performance-driven and fully coordinated way to maximise the benefits for all stakeholders.

Detailed information is given about the ATM Technology Changes required for each operational change in section 3.6 and Table 3.

An Essential Operational Change is defined as an operational change that either provides significant performance benefits to the performance needs associated with Step 1 (see 2.3 and 2.4) and/or forms a pre-requisite towards the implementation of the target concept. It can be at Local, "Regional" or Network level. A set of Essential Operational Changes has been identified as the core of the Step 1 deployment. Those identified in this edition mainly result from expert judgment. They constitute an initial basis from which to prepare for the deployment phase subject to confirmation by validation results.

A high-level description of the Essential Operational Changes and how they will continue to evolve through Steps 2 and 3 is provided in section 3.5 with details of all the operational changes available in the Master Plan portal (www.atmmasterplan.eu). A qualitative description of key performance benefit expectations from Essential Operational Changes are identified in section 3.5.

The relationship between the 6 Key Features, the Steps and the Essential Operational Changes to deploy Step 1 are shown in Figure 10. A summary of SESAR baseline and Step 1 Essential Operational Changes is provided in Annex A.

Figure 10 **Mapping of Essential Operational Changes to SESAR Key Features**

6 Key Features	Deployment Baseline	Step 1 Time based	Step 2 Trajectory based / Step 3 Performance based
Moving from Airspace to 4D Trajectory Management	• Civil/Military Airspace & Aeronautical Data Coordination • A/G Datalink • CPDLC	• Traj Mgt & BMT • System Interop with A/G data sharing • Free Routing	• Full 4D • New A/G datalink • Free Routing TMA exit to TMA entry
Traffic Synchronisation	• Basic AMAN	• i4D + CTA • Integrated AMAN DMAN & extended AMAN horizon	• Multiple CTOs/CTAs • Mixed mode runway operations
Network Collaborative Management & Dynamic/ Capacity Balancing	• Basic Network Operations Planning	• Network Operations Planning	• Network Operations Planning using SBTs/RBTs • 4D traj used in ATFCM • UDPP
SWIM	• Xchange models • IP based network	• Initial SWIM Services	• Full SWIM Services
Airport Integration & Throughput	• Airport CDM • A-SMGCS L1 & L2	• Surface Management Integrated with arrival & departure • Airport Safety Nets	• Further integration of surface & departure management • A-SMGCS L3 & L4
Conflict Management & Automation	• Initial Controller Assistance Tools	• Enhanced DST & PBN • Conflict Detection & Resolution	• Advanced Controller Tools to support SBT/RBT • Enhanced trajectory prediction

3.4 Focus on Deployment Baseline Essentials

The Deployment Baseline consists of operational changes that have been successfully validated after reaching the end of their R&D phase. The decision for actual deployment is addressed by the individual stakeholder plans.

This edition of the Master Plan includes the Deployment Baseline operational and technological changes necessary for performance and which are pre-requisite to operate and support the Essential Operational Changes of Step 1 (e.g. free routing (direct to), Controller Pilot Data Link Communications (CPDLC)). The description of the Deployment Baseline with respect to the Essential Operational Changes is provided in section 3.5 (for operational aspects) and in section 4.1 (for ATM Technology Changes).

An agreed implementation plan schedules the activities necessary to implement the Master Plan elements with the appropriate level of detail, by listing actions, naming actionees and giving background information such as regulations, related standards, etc. These elements are fed as implementation objectives into the ESSIP which covers the short-term time horizon and which represents level 3 of the Master Plan.

The 6 Deployment Baseline changes listed below are important changes but are not identified as contributing to or a precursor of Step1 Essential Operational Changes but are key contributors to performance:

- Continuous Descent Approach (CDA);
- Continuous Climb Departure (CCD);
- Approach Procedure with Vertical Guidance (APV);
- Performance Based Navigation (PBN) – optimised Required Navigation Performance (RNP) route structures;
- Short Term Conflict Alert (STCA);
- Basic Dynamic Sectorisation

A summary of SESAR baseline and Step 1 Essential Operational Changes is provided in Annex A.

3.5 Focus on Step 1 Essential Operational Changes and Highlights of Steps 2 and 3

Step 1
The full scope of the operational changes in Step 1 is shown in Figure 11 with the operational changes allocated to the Operating Environments where they bring the most benefit. The Essential Operational Changes are highlighted in red.

Each of the Essential Operational Changes contributes to meeting the performance needs identified for one or more Operating Environments. Other operational changes may be needed subject to local needs and business cases.

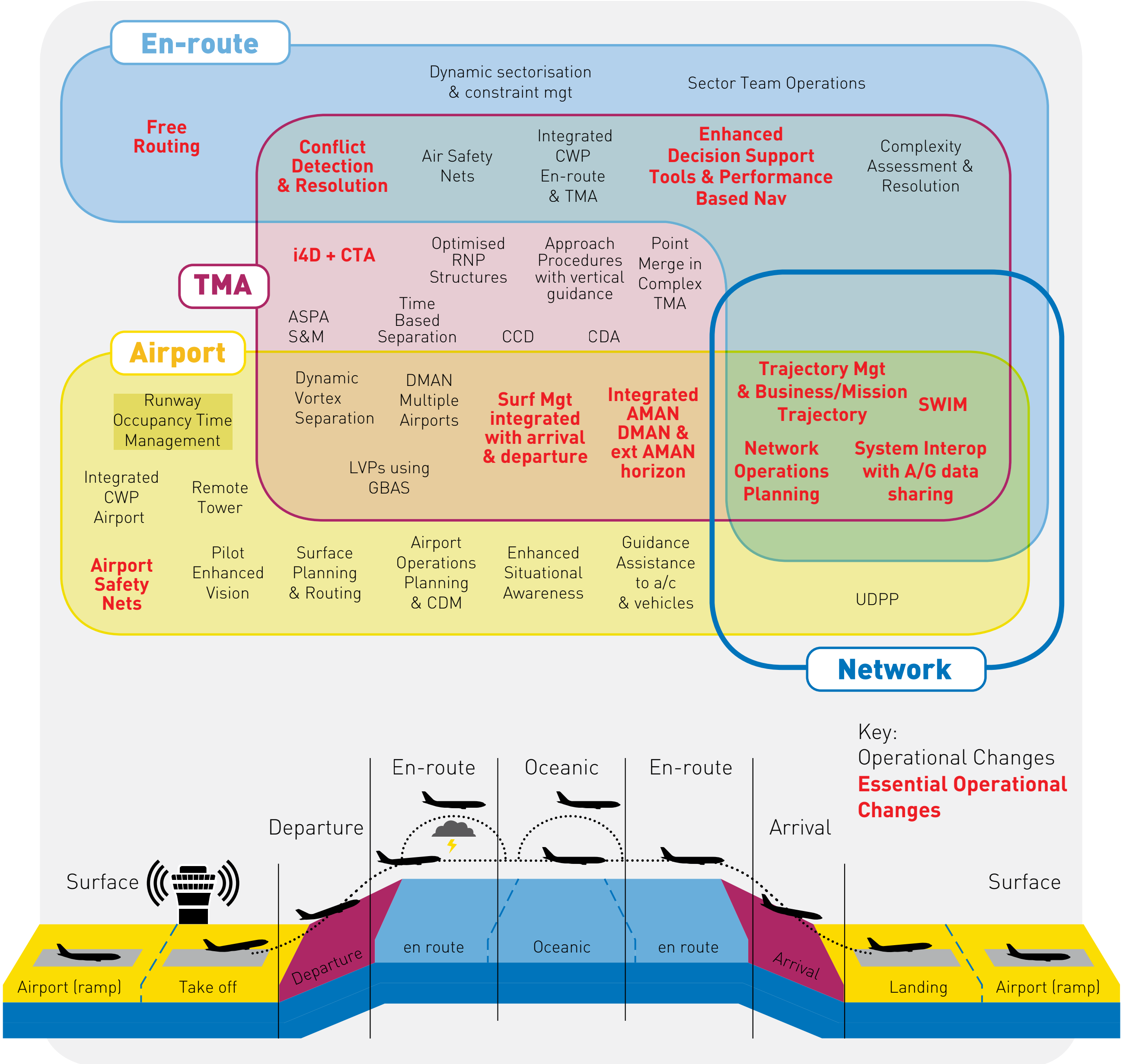
This section provides a description of the Essential Operational Changes in Step 1, their dependency on the Deployment Baseline, a qualitative description of their performance impact, and a description of how they will evolve through Steps 2 and 3.

Steps 2 and 3
Steps 2 and 3 aim at further changing ATM towards more collaborative and performance oriented operations. Step 2 and 3 evolution provides the full capability to plan and fly a specific route profile to accommodate the full users' needs.

In Step 2, the full 4D concept is realised optimising business and mission trajectories through extended sharing of 4D trajectory information between air and ground using System Wide Information Management (SWIM) and supported by new air/ground datalink technologies. Step 2 foresees the capability to implement Multiple Controlled Times of Overfly (CTOs) and Multiple Controlled Times of Arrival (CTAs) to support new terminal airspace designs optimising multiple airport arrival and departure services. Network Operations Planning is based around Shared Business/Mission Trajectories (BMTs) and Reference Business/Mission Trajectories (RBMTs) driven through collaborative process where users define their priorities. 4D trajectory updates are used in the Air Traffic Flow and Capacity Management (ATFCM) process to optimise network usage. Airspace use will be optimised through dynamic demand and capacity management, queue management, flexible military airspace structures, direct routing and dynamic airspace configurations.

To support the use of business/mission trajectories a full set of advanced controller tools using shared BMTs and RBMTs is deployed. These tools exploit

Figure 11 **Operational Changes for Step 1 related to Operating Environment**



the increased amount and quality of information, in particular the reduced uncertainty on trajectory prediction. Separation modes will be enhanced with airborne separation assistance systems providing increased situational awareness for the pilot.

Finally, airport operations will become seamless through the use of automation support tools and full integration of departure, arrival and surface management linked to demand and capacity balancing (DCB) and UDPP. Runway throughput is optimised due to dynamic wake vortex management, the optimisation of the runway occupancy time and weather resilience.

The Step 3 goal is the implementation of a European high-performance, integrated, network-centric, collaborative and seamless air ground ATM system. European airspace will operate as an efficient continuum with two airspace categories where user preferred trajectories are managed with new modes of separation including cooperative air/ground separation. Human roles and responsibilities will be more "management task" oriented than tactical and will be supported by system automation and decision support and monitoring tools. Air and ground safety nets will operate in a compatible manner, adapted to new separation modes. Step 3 represents the achievement of SWIM and collaboratively planned network operations with UDPP.

3.5.1 Trajectory Management & Business Mission Trajectory

Introduction

The foundation for the future ATM Concept is Trajectory-based Operations. A trajectory representing the business intentions of the airspace users and integrating ATM and airport constraints is negotiated - this is the Shared Business Trajectory (SBT) or Shared Mission Trajectory (SMT) (full flight profile) for military users. When the flight is ready for departure it becomes the Reference Business Trajectory (RBT) that a user agrees to fly and the ANSP and airport agrees to facilitate.

The Trajectory Management concept involves the systematic sharing of aircraft trajectories between various participants in the ATM process to ensure that all partners have a common view of a flight and have access to the most up-to-date data available to perform their tasks.

This concept enables the dynamic adjustment of airspace characteristics to meet predicted demand with minimal changes to the business/mission trajectories.

The Trajectory Management Framework (TMF) specifies the standards and structure needed to achieve the safe and efficient creation, amendment and distribution of the Reference Business/Mission Trajectory (RBMT).

Deployment Baseline

There is no major element in the Deployment Baseline addressing this Essential Operational Change. Some systems addressing harmonised civil-military airspace and aeronautical data coordination are being implemented to support the introduction of the business/mission trajectory.

Step 1

For Step 1 the trajectory will not contain all the elements needed to enable implementation of the SBT and the RBT. The trajectory computed on-board will be made available throughout the flight for equipped aircraft, ANSPs will be able to use it to complement the flight data available on the ground.

In Step 1, the BMT will be used for

- Network Operations Plan (NOP) updating and an improved ATFCM function;
- more accurate trajectory prediction and optimisation;
- conformance monitoring;
- Initial 4D operations with refinement of arrival sequencing using a single CTA.

Airspace users will be able to refine the shared BMT through a number of iterations of collaborative flight planning taking into account updated information. Planning will be facilitated through the NOP that provides access to an up-to-date picture of the traffic situation. This collaborative planning process leads to the publication of the RBMT.

The integration of military flights, when these are not emergencies or military exercises, into the rest of the air traffic flow will be possible through a new Operational Air Traffic (OAT) flight planning system which is interoperable with civil systems.

Step 1 Performance

- To improve ATM capacity through more reliable planning based upon the sharing of an accurate flight profile.
- To improve flight efficiency through better anticipation and management of the various ATM system constraints allowing more optimised flight trajectories and profiles.

Steps 2 and 3

In these Steps, the full 4D concept will be realised with the more extended sharing and negotiation of trajectories between air and ground.

During the execution of flights, ATM constraints arising from, for example, ad hoc airspace restrictions or runway closures will imply changes to the RBT. Such changes will be negotiated with airspace users (the flight crew or the aircraft operator if time permits). Similarly, changes to the RBT may be made to take advantage of unexpectedly released airspace, following proper coordination between all stakeholders (ATC, aircraft operator and airport).

3.5.2 System Interoperability with Air/Ground Data Sharing

Introduction

System Interoperability with Air/Ground (A/G) Data Sharing will facilitate ground/ground and air/ground exchanges between the various ATM systems or constituents. These exchanges are possible due to appropriate global standards and associated datalink technologies.

Deployment Baseline

The Deployment Baseline includes the air/ground datalink systems. The datalink systems include the adaptation of communication infrastructure and, in particular, the deployment of VDL Mode 2, upgrades of data processing systems and aircraft equipage to support the required datalink services (e.g. CPDLC En-route).

Step 1

In Step 1, the objective is to share the same view of the air situation. This implies that the trajectory within the ground Flight Data Processing System (FDPS), including the network systems, is as close as possible to the aircraft Flight Management System (FMS) trajectory sent via ADS-C. This improvement is gradually realised as a function of the number of aircraft fitted with such capability.

The air/ground datalink capability is VDL Mode 2/Aeronautical Telecommunication Network (ATN) technology and military datalink interoperability is limited to transport aircraft.

Ground/ground (G/G) basic flight object exchange mechanisms will be implemented between different ATSUs and the Network Manager (NM), providing consistent flight data to be used across the ATM network civil-military ground/ground interoperability will be ensured through Internet Protocols (IP).

Step 1 Performance

- Flight efficiency through the use of accurate and up-to-date flight data at global network level.
- ATM capacity through more accurate trajectory information, more efficient coordination between ATSUs, and a better use of available capacity within the ATM network.

Steps 2 and 3

Typically, revision of the RBT will be more systematically achieved through information exchange between ground and airborne systems.

New A/G datalink technologies will be used (e.g. Future Communications Infrastructure (FCI) using new SATCOM, LDACS, AeroMACS). Military datalink interoperability will impact non-transport type aircraft.

3.5.3 Free Routing

Introduction

Free route operations require a specified airspace within which users may freely plan a route between a defined entry and a defined exit point with the possibility of routing via intermediate (published or unpublished) waypoints, without reference to the ATS route network, subject to airspace availability.

Deployment Baseline

The Deployment Baseline addresses several system improvements related to enhanced en-route airspace structures such as the multiple route options, modular temporary airspace structures and reserved areas, improvements of the route network including cross-border sectorisation and the initial steps towards flexible sectorisation management.

Operations along optimum trajectories are possible in defined airspace volumes at particular times. This is the initial implementation by various States of free route operations in their Flight Information Region (FIR), above a certain flight level (FL), for 24 hours or during limited periods of time.

Step 1

- Airspace users will need to know which airspace is or is not available: route availability will be complemented or replaced by information on the availability of airspace volumes.
- ATC support tools:
  - Advanced conflict detection tools (e.g. Medium Term conflict Detection (MTCD)/Tactical Controller tools (TCT) from 8 to 20 nm), including a what-if function and resolution proposals (e.g. Conflict and Resolution Advisor (CORA) Level 2 and 3) if necessary.
  - Monitoring Aids (e.g. MONA) to improve traffic awareness in particular trajectory conformance tools.
- Datalink communication will be used to support business (or mission) trajectory authorisation and/or revision.
- Automatic coordination between sectors intra centre or between adjacent centres will be eased by use of the Interoperability Protocol (IOP) concept.

In free route airspace there will no longer be discrete crossing points (e.g. at a navigation aid) but a larger number of possible conflict points along each free planned route. The ATC support tools will be necessary to mitigate the effect of less predictability of conflicts, and to maintain safety.

Step 1 Performance

- Flight efficiency by, for example, providing more direct routes (subject to constraints of any segregated airspace), decreasing the flight duration and fuel use by allowing more optimised flight trajectories and profiles.
- Capacity by enhancing the use of available airspace.

Steps 2 and 3

Step 2 & 3 developments will provide the full capability to plan and fly a specific route profile to accommodate the full needs of users (this will no longer simply be a direct route). Increasingly Free Routing will become more widespread from Top of Climb (ToC) to Top of Descent (ToD), based on trajectory prediction tools which will enable the process. The use of Free Routing will be further extended from TMA exit to TMA entry for low-complexity airspace.

3.5.4 i4D + CTA

Introduction

The aircraft capability to comply with a requirement to reach a specific trajectory point at a contracted time (Controlled Time of Arrival, CTA, or Controlled Time Over, CTO) can be exploited both in en-route for metering of flows or in TMA for arrival sequencing. This capability is associated with the aircraft capability to provide by datalink estimates of time (Estimated Time of Arrival (ETA) min/max or Estimated Time Over (ETO) min/max) as computed within the aircraft Flight Management System (i4D).

Deployment Baseline

The Deployment Baseline does not directly address this Essential Operational Change.

Step 1

Within Step 1, the ground ATM system's access to ETA min/max for aircraft fitted with i4D (initial 4D) capability is implemented as a foundation.

The introduction of aircraft capable of meeting a CTA with appropriate accuracy improves the performance and reliability of the Arrival MANager (AMAN) system. This will give better performance in the sequencing and scheduling of the arrival stream as well as higher potential for the aircraft to fly optimised trajectories at speeds and descent rates that save fuel, reduce noise and at the same time provide all stakeholders with higher predictability.

Besides this CTA capability, aircraft are also able to operate with a single CTO allocation for en-route synchronisation or separation purposes.

In Step 1, aircraft can manage only one CTO/CTA. A new CTO/CTA can only be managed after completion of the current CTO.

Step 1 Performance

- Capacity - enhanced runway throughput due to better sequencing of arriving flights; less lateral deviation, reduced holding and reduction of the controller workload.
- Flight efficiency - allocation of a CTA before ToD allows the aircraft to fly a near idle profile and on Performance Based Navigation (PBN) procedures in closed loop operations, i.e. the optimum profile integrating the time constraint and reducing the use of stack holding.

Steps 2 and 3

Multiple Controlled times of Overfly (CTOs) will be permitted and embedded in the RBMT which is coordinated between airborne and ground systems.

3.5.5 Integrated AMAN DMAN and Extended AMAN Horizon

Introduction

The use of extended Arrival MANager (AMAN) horizon consists of coordination between a TMA ATSU and an en-route ATSU to delay or accelerate a given flight in its en-route phase to synchronise its arrival at a TMA entry point.

Integration of AMAN and Departure MANager (DMAN) functions at a given airport is intended to improve resource planning for the turn-around time of a flight by taking into account the local constraints that can impact the arrival or the departure traffic flows therefore improving accuracy of arrival and departure times.

Deployment Baseline

The Deployment Baseline addresses only the basic AMAN and AMAN extended to the en-route airspace. There will also be pivotal implementations of DMAN.

The Basic AMAN tool aims to improve the sequencing and metering of arrival traffic in TMAs and airports. The extended AMAN aims to provide the necessary functionality and information exchanges which support the use of AMAN information in en-route sectors requiring data exchanges generated from AMAN systems and operations in adjacent/subjacent TMAs.

Step 1

- Improved AMAN integrating the use of PBN (P-RNAV (Precision Area Navigation) or RNP-1) together with CDAs. Sequencing support will be based upon on-board trajectory data sharing and CTA for equipped aircraft allowing for a mixed aircraft capability to operate within the same airspace and providing a transition framework to full 4D operations within Steps 2 & 3.
- Further develop the en-route elements of AMAN.
- Couple arrival airport AMAN with DMAN at departing airports with the objective of taking into account arrival constraints to deliver the take-off/push back clearances at departing airports.
- Manage the arrivals at various airports within the same TMA.

Step 1 Performance

- Capacity - optimised usage of terminal airspace and available runway capacity and through dynamic runway rebalancing to better accommodate arrival and departure patterns.
- Flight efficiency - reduction of ground and airborne holding delays, optimised descent profile on predetermined PBN trajectories.

Steps 2 and 3

Further integration of AMAN, DMAN and Surface MANager (SMAN) will be introduced for full traffic optimisation. This will include provision for the controller within the TMA to manage mixed mode runway operations and resolve complex interacting traffic flows.

3.5.6 Network Operations Planning

Introduction

Network Management is ensuring consistency between individual actions and the overall objectives of the ATM Network. The components of Network Management are described in the Network Management Functions Implementing Rule (IR). In the context of the Master Plan, it will evolve around airspace structure enhancements, route network improvements and the co-operative Network Operations Planning, demand and capacity management and network performance management.

The linking of Airport Operating Plan (AOP)/NOP parameters optimises the network and airport management by timely and simultaneously updating AOP and NOP providing Network and Airport Managers with a commonly updated, consistent and accurate Plan.

Deployment Baseline

The Deployment Baseline addresses several system improvements relating to the enhanced en-route airspace management structure and Flexible Use of Airspace (FUA).

The enhanced en-route airspace structure addresses the multiple route options, modular temporary airspace structures and reserved areas, improvements to the route network including cross-border sectorisation and the initial steps towards flexible sectorisation management.

The Baseline also addresses Network Operations Planning via the deployment of three main improvements i.e.:

- Network Operation/Capacity Planning;
- Enhanced ATFCM and DCB process;
- Airport Collaborative Decision Making (A-CDM).

Network Operation/Capacity Planning encompasses seasonal NOP elaboration, interactive rolling NOP and interactive network capacity planning.

The enhanced ATFCM processes mainly encompass the enhanced Airspace Management (ASM)/ATFCM process and ATFCM scenarios.

The Baseline also addresses Network performance assessment.

Step 1

During Step 1 there will be a SWIM-based NOP. The initial Web services (Business to Business (B2B)) made available in the Baseline will be expanded .The initial approach to collaborative planning will be the implementation of an interactive Network Operations Plan which will provide an overview of the ATFCM situation from planning to real-time operations. Local ASM tools are deployed to provide Airspace Management data to the NM.

The linking of AOP/NOP parameters optimises the network and airport management by timely and simultaneous updating of AOP and NOP via SWIM, providing Network and Airport Managers with a commonly updated, consistent and accurate Plan.

Network planning and operations include initial steps of airspace configuration. Through CDM the network resources and infrastructure are configured and managed to optimise network performance. The aim is that every actor (network, ANSPs, airports, airspace users) will realise the NOP through a rolling cooperative process and by sharing operational data.

Network operations will be time-based, making better use of available capacity. Requirements include narrowing the operational gap between ATC and ATFCM as regards planning and execution. Operational procedures will be developed which involve coordination between more than one ACC, Airport Operations and the Network Manager. The principles of Variable Profile Areas (VPAs) will be introduced.

In addition to the Network planning and operations, this Essential Operational Change will address:

- short-term ATFCM measures;
- UDPP tools and procedures;
- enhanced civil-military co-ordination, airspace management systems equipped with the pan-European airspace co-ordination tools and flexible airspace structures;
- the tools that support dynamically shaped sectors and dynamic organisation of terminal airspace, modular temporary airspace structures and reserved areas and the support to dynamic sectorisation and dynamic constraint management.
- dynamic/flexible sectorisation: the ability to be flexible and dynamic in organising the airspace to cope with the traffic pattern will be a key functional enabler to the User Preferred Routing concept (e.g. dynamic modular sectorisation).

Step 1 Performance

- Capacity – Enhancing the use of available airspace through better collaborative planning and collaborative decision-making, sharing of operational data and the introduction of the "Airspace Configurations" concept and tools to better integrate ATCFM/ASM/ATC.
- Flight efficiency – Enhancing predictability through better anticipation and management of ATM constraints, offering optimised trajectories closer to those preferred by the user.
- Cost-efficiency – Operations and provisions of enhanced collaborative network planning approach and management of rare resources to deliver the highest benefits to the network.

Steps 2 and 3

As the network develops Network Operations Planning will be based around shared BMTs and RBMTs driven through a process of Collaborative Flight Planning.

During these Steps collaborative coordination and a systematic approach to selecting airspace configurations will become available. The basis for this collaboration is the NOP.

4D trajectory updates will be used in the ATFCM process to optimise network usage. The aim is to make best use of capacity opportunities and also to support queue management and improve on the accuracy of arrival times.

Military dynamic mobile areas will be implemented in support of dynamic airspace configuration.

3.5.7 SWIM

Introduction

SWIM will introduce a complete change in how information is managed throughout its lifecycle across the whole European ATM system. SWIM consists of standards, infrastructure and governance, enabling the management of ATM information and its exchange between qualified parties via interoperable services.

Information sharing

The rationale for information sharing is to unlock the information and to make it available to a greater number of ATM stakeholders. This will create new opportunities for the stakeholders to optimise their business processes by increasing the overall productivity, quality and safety of the ATM system.

SWIM will provide the technical means to restrict access to the information if necessary for business and security reasons.

Service orientation

SWIM will use services as the mechanism for information exchange and apply methodological, technical and information management standards to their development. The services approach allows the producers of information to be decoupled from the consumers, thus increasing flexibility and agility in responding to business needs.

SWIM enables wider discoverability of pertinent information and available services, thereby making it easier and less costly to share.

Federation

A federative approach means that each stakeholder will be able to maintain their own responsibility in the domains of operations, service provision, technical infrastructure and ownership of information.

This principle, however, provides the possibility for a specific stakeholder to delegate responsibilities to other stakeholders.

Standards

Semantic interoperability will be assured by developing a common information model, allowing all stakeholders to share the same understanding of the information being exchanged. Interoperability will also be guaranteed by developing a common information service model, which standardises the way information is exchanged.

Interoperability of services will be assured by their deployment on the SWIM technical infrastructure which is compliant with appropriate, widely-used, non-ATM specific technological standards in conjunction with a minimal set of ATM-specific complementary standards.

Governance

SWIM information and services will be governed throughout their lifecycle. Governance will ensure controlled evolution and implementation of information models, service models and infrastructure. The governance will also create trust between SWIM participants by ensuring that participants are qualified to participate in the execution of the services.

The implementation of SWIM is not a “big-bang” replacement of the existing ATM environment, but rather an evolutionary process based on a gradual transition towards a service-oriented European ATM system. The adoption of SWIM will be flexible, fostering increased levels of collaboration within business domains and enabling supporting systems to interact in an interoperable and standardised way.

Deployment Baseline

The Deployment Baseline addresses three major improvements related to network information management i.e.:

- the optimisation of aeronautical data exchanges (digital NOTAMs, Aeronautical Information Exchange Model (AIXM));
- migration of the ground/ground ATM network infrastructure from the former technologies (X25) to the more modern ones Internet Protocol (IP) supporting message exchanges;
- the expanded scope of aeronautical information supporting new applications for ATM, avionics or both in a collaborative way.

Step 1

The transition to SWIM will build on developments that have already started pre-SESAR, e.g. the introduction of Network Operations Planning B2B services, the development and validation of flight object standard (ED133), evolution of EAD (European AIS Database) services.

SWIM will facilitate the exchange of flight information between ATC centres.

SWIM will provide easy access to the Network Operation Plan information services and to the existing and new Aeronautical Information Service (AIS) information in a digital form (e.g. terrain and obstacle (eTOD) or aerodrome mapping databases see section 4.4.1.1). SWIM will enable an extensive CDM process to ensure the balance between capacity and demand of the traffic flow, resulting in the Network Operations Plan.

Step 1 Performance

- Cost-efficiency by providing a global integrated data sharing function to replace multiple and fragmented data exchange frameworks. Use of standardised data and protocols will reduce the time required to process a new piece of information, provide higher agility to create new applications, limit bespoke developments by using state-of-the-art industrial products.

Steps 2 and 3

Step 2 and 3 will see the stepwise introduction of SWIM specific governance arrangements, including the establishment of SWIM standards. In parallel there will be an increasing number of SWIM-enabled services deployed in function of the operational changes described previously.

The capabilities of the SWIM Technical infrastructure will evolve and more and more ATM stakeholders will become connected through SWIM.

3.5.8 Surface Management integrated with Arrival & Departure

Introduction

The integration of SMAN contributes to improved airport surface management efficiency with a view to increasing the aerodrome throughput. It will progressively integrate the SMAN tool with the AMAN and DMAN functions. Ultimately, Surface Management deals with the ground part of the Business/Mission Trajectory and is one element to integrate airports into the Network.

Deployment Baseline

The major milestones concerning airport integration with the Network are Airport Collaborative Decision Making (A-CDM) and the initial steps for UDPP implementation (airport slot swapping and consistency of airport slots with flight plans). A-CDM increases the information-sharing between the local ANSP, airport operator, aircraft operators, ground handlers, Network Manager and other airport service providers and improving the cooperation between these partners to enhance the predictability of events and optimising the utilisation of resources.

To maintain ground movement capacity in Low Visibility Conditions (LVC) as close as possible to Normal Visibility Conditions, Advanced Surface Movement Guidance and Control System (A-SMGCS) Level 1 and 2 are in use. The A-SMGCS consists of an airport surface surveillance system that provides ATC with position and identification of aircraft and vehicles, detects potential conflicts on runways and provides the controllers with appropriate alerts.

Step 1

Step 1 will fully integrate the taxiing process into the process chain from arrival to departure and ensure that AMAN and DMAN derived information is well integrated with the SMAN and A-CDM processes in general. Allowing SMAN equipped airports to plan surface traffic based on dynamically updated Variable Taxi Times will increase the predictability of targeted milestones and make latent capacity available. Enhanced guidance to mobiles increases the stability of ground movements.

In addition, the integration of the AOP into the NOP will benefit from more information-sharing between airport operator, ANSP, network manager, airspace users, handling agents, and support services.

Step 1 Performance

- Increased flight efficiency, particularly during adverse weather conditions, ensuring the integration of airport operations and surface management with AMAN and DMAN.
- Increased use of capacity will result from greater stability in the planning of ground movements and departures.

Steps 2 and 3

In these Steps further integration between surface management functions and the departure management functions will be achieved by optimising the queue management process. Additional optimisation criteria for surface management will further increase environmental sustainability.

3.5.9 Airport Safety Nets

Introduction

Increases to runway throughput are being investigated to improve airport capacity. However, surface movement capacity has to be increased without making the risk of runway incursion any greater. A range of measures are needed including conflict detection and warning systems.

Deployment Baseline

The Deployment Baseline includes the Surface Movement Guidance and Control Systems (SMGCS Level 1 and 2). The SMGCS consists of an airport surface surveillance system that provides ATC with the aircraft/vehicle position and identity, detects potential conflicts on runways and intrusions into restricted areas and provides controllers with the appropriate alerts.

Step 1

The ground systems detect potential conflicts/incursions involving mobiles with other mobiles or obstacles on runways, taxiways and in the apron area. Alerts are provided to controllers and vehicle drivers together with potential resolution advisories (depending on the complexity of resolution possibilities).The ground system also alerts the controller in case of unauthorised traffic. Flight crew traffic situational awareness is improved and the aircraft system generates its own traffic alert in the case of traffic proximity on the runway.

Step 1 Performance

- Safety, by providing appropriate tools to avoid runway incursions and to reduce the rate of traffic incident on taxiway and apron.

Steps 2 and 3

Flight crews will receive system assistance to decrease the risk of collision with nearby mobiles or fixed obstacles when moving on the airport surface, based on surveillance system generated alerts when the aircraft is getting close to mobiles/obstacles.

3.5.10 Enhanced Decision Support Tools & Performance Based Navigation

Introduction

The Enhanced Decision Support tools associated with the Performance Based Navigation (PBN) capabilities will offer a greater set of routing possibilities that could reduce potential congestion on trunk routes and at busy crossing points. PBN capability helps to reduce route spacing and aircraft separation.

Deployment Baseline

The Deployment Baseline addresses the use of the Conflict Detection Tools (e.g. MTCD), Monitoring Aids (e.g. MONA) and co-ordination dialogue and transfer messages (SYstem Supported COordination (SYSCO)). MTCD aims to provide the assistance in a form of early and systematic conflict detection, while MONA provides the conformance monitoring warnings in case that the aircraft deviates from the planned trajectory. The SYSCO function provides the assistance to the controllers for seamless co-ordination, transfer and dialogue.

Step 1

After allocation of 2D routes, vertical constraints and longitudinal separations are provided by ATC to complement the 2D route. This will be achieved through surveillance-based separation and/or the dynamic application of constraints. New support tools (including MTCD), procedures and working methods have to be put in place.

2D Precision Trajectory Clearances, based on a pre-defined 2D route, will lead to a RBT revision (new 2D route constraints allocated via datalink) if new constraints arise.

Step 1 Performance

- Capacity, by offering a greater set of routing possibilities allowing the reduction of potential congestion on trunk routes and at busy crossing points. The flexible use of airspace gives more possibilities to separate flights horizontally. PBN helps to reduce route spacing and aircraft separations. This in turn allows a reduction in controller workload by flight.
- Flight efficiency, by enabling trajectories which are closer to user preferred routes.

Steps 2 and 3

3D routes will be used together with CDA and tailored arrivals. The provision of separation based upon these concepts will require more than trajectory prediction on its own. The controller will allocate a separated clearance based on 3D profile constraints. Underlying tools such as the Trajectory Predictor (TP), MTCD and conformance monitoring will be developed as well as candidate Human Machine Interfaces (HMIs) for the presentation of information to the controllers to allow them to choose suitable clearances and to monitor the progress of the aircraft as they fly under those clearances (both for conformance to the expected cleared profile and for the evolution of the traffic situation).

3.5.11 Conflict Detection & Resolution

Introduction

Conflict management support tools will predict conflicts with sufficient accuracy and look-ahead time to allow the controller to manage non-fixed route operations.

Deployment Baseline

The Deployment Baseline includes the introduction of Conflict Detection Tools (e.g. MTCD), Monitoring Aids (e.g. MONA) and SYSCO. MTCD aims to provide assistance in the form of early and systematic conflict detection, while MONA provides the conformance monitoring warnings in case the aircraft deviates from the planned trajectory.

The SYSCO function provides assistance to the controllers for seamless co-ordination, transfer and dialogue.

Step 1

The Step 1 improvement is to implement a set of automated support tools for assisting ATCOs. These tools provide real-time assistance to the tactical controller for monitoring trajectory conformance and provide resolution advisory information based upon predicted conflict detection.

At the same time, this will maintain or even improve the current level of safety, to ensure a safe traffic flow and provide separation between individual aircraft.

The implementation of these tools will improve the coordination between the tactical and planning controllers.

Step 1 Performance

- Safety, by using a tool that effectively monitors the ATM system allowing for early (short-term) detection of conflicts and proposes resolution measures.
- Flight efficiency, by introducing better trajectory prediction to reduce the temporal demand on the controller by assisting in the identification and resolution of conflicts. Capacity will therefore increase as a function of reduced workload per flight.

Steps 2 and 3

To support the use of business/mission trajectories a full set of advanced controller tools using shared BMT and RBMT will be deployed. These tools will exploit the increased amount and quality of information, in particular reduced uncertainty on trajectory prediction, and will also utilise new separation modes.

3.6 Applicability of Essential Operational Changes According to Operating Environment

Since airports and airspaces do not all have the same operational needs, each type of operating environment is allocated one of the following categories:

- Very High Capacity needs (VHCn)
  - for airports and TMAs > 100 movements per busy hour
  - for en-route ACCs > 300 movements per busy hour
- High Capacity needs (HCn)
  - for airports and TMAs between 60 and 100 movements per busy hour
  - for en-route ACCs between 200 and 300 movements per busy hour
- Medium Capacity needs (MCn)
  - for airports and TMAs between 30 and 60 movements per busy hour
  - for en-route ACCs between 50 and 200 movements per busy hour
- Low Capacity needs (LCn)
  - for airports and TMAs < 30 movements per busy hour
  - for en-route ACCs < 50 movements per busy hour

Table 2 **Deployment of Essential Operational Changes**

Essential Operational Changes	Airport				TMA				En-Route				Network
	LCn	MCn	HCn	VHCn	LCn	MCn	HCn	VHCn	LCn	MCn	HCn	VHCn	
Trajectory Management & Business/Mission Trajectory			✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
System Interoperability with A/G Data Sharing	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Free Routing									✔	✔	✔	✔	✔
i4D + CTA						✔	✔	✔		✔	✔	✔	✔
Integrated AMAN DMAN and extended AMAN Horizon						✔	✔	✔		✔	✔	✔	✔
Network Operations Planning	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
SWIM	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Surface Management integrated with Arrival & Departure			✔	✔									✔
Airport Safety Nets	✔	✔	✔	✔									
Enhanced Decision Support Tools & Performance Based Navigation						✔	✔	✔	✔	✔	✔	✔	
Conflict Detection & Resolution							✔	✔			✔	✔	

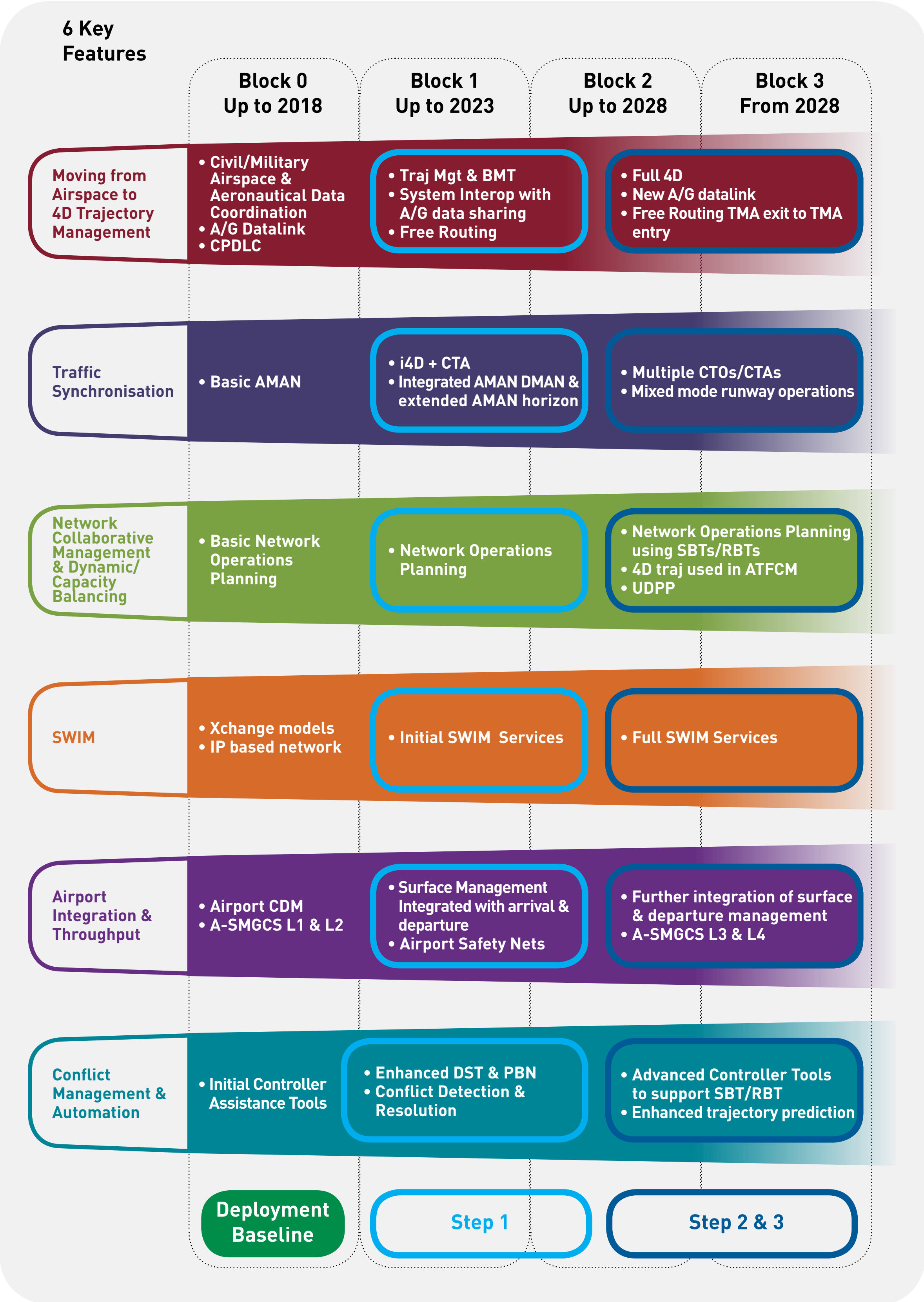
The categorisation assumes that ATSUs and airports in the same category face similar capacity needs requiring similar operational changes to be rolled out in broadly the same time-frame. This simplification enables the capacity needs to form the basis of the focused deployment view. A stakeholder with an Operating Environment corresponding to a specific capacity needs category can identify the Operational Changes to deploy to deliver the performance needed. Table 2 shows where the Essential Operational Changes need to be deployed. For example, the Essential Operational Change "i4D + CTA" applies to the TMA and en-route units with Medium, High and Very High Capacity needs and the Network.
Further to the Deployment View provided by Table 2 the Deployment Scenario for an ATSU or an airport, in response to performance needs, addresses the "roll out" (deployment in time) of all applicable operational changes. This time dimension of the Deployment Scenario is available at Level 2 in the Master Plan portal (www.atmmasterplan.eu).

3.7 Mapping SESAR Changes to the ICAO Framework in order to enable Interoperability

The ICAO framework is set through the Global Air Navigation Plan (Doc 9750), which comprises the "Aviation System Block Upgrades" (ASBU) initiative, developing a set of ATM solutions or upgrades that exploits current equipage, establishes a transition plan and enables global interoperability. ASBUs comprise a suite of modules organised into flexible and scalable building blocks where each module represents a specific, well bounded improvement. The ASBU initiative describes a way to apply the concepts defined in the ICAO Global Air Traffic Management Concept (Doc 9854) with the goal of implementing regional performance improvements.

For the development of the ASBUs, ICAO made use of the material provided by SESAR and NextGen. From a SESAR perspective, mapping ICAO's ASBU initiative is important to achieve global interoperability and synchronisation where and when necessary. To support global interoperability it is necessary that the operational achievements in the Master plan are consistent with the elements in the ASBUs. The mapping between SESAR Essential and Deployment Baseline operational changes and ICAO's ASBU initiative is highlighted in Figure 12. The full mapping of operational changes to ICAO Blocks is provided in Annex B.

Figure 12 **SESAR Essential Operational Changes and ICAO's ASBU**



3.8 Role of the Human

The human element remains pivotal to the success of SESAR, and in ensuring that SESAR delivers the benefits expected in safety, environment, cost efficiency and capacity. It is critical therefore, if the benefits of SESAR are to be delivered, that the concepts being developed within SESAR take account of human strengths and weaknesses in their development.

Controllers and flight crew will face a significant amount of change relating to the Essential Operational Changes.

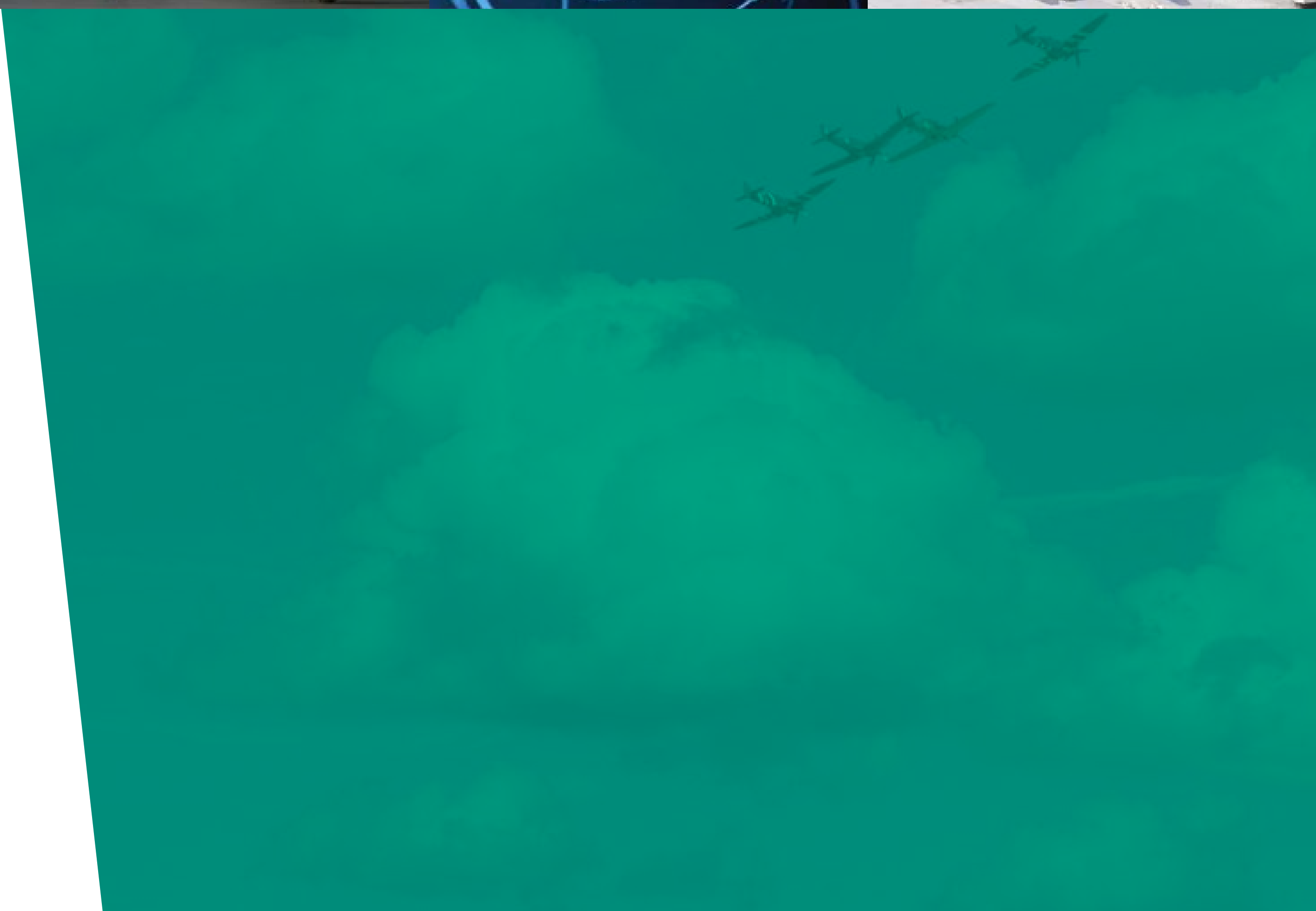
The flight crew will still have to perform all the four main tasks (aviate, navigate, communicate, manage) and there will be no fundamental changes in the role of the flight crew for Step 1 but more and more automated functions are expected to support the Essential Operational Changes.

Controllers will have to face the new trajectory paradigm in Step 1 which will be the first step towards a lower level of tactical intervention. Such an evolution must be reviewed to guarantee that their expertise is maintained and their tasks are appropriately structured in all situations.
The areas of change for ATM staff include:

- initial training, competence and/or adaptation of new/active operational staff;
- new roles and responsibilities and tasks to be defined and implemented;
- social factors, management of the cultural change linked to automation;
- change and transition management.

Recruitment, competence training and selection criteria will be adapted in the light of such an evolution in the role of the human. Standardisation as well as harmonisation among ECAC nations is a key element to assure the same level of human competence in their pivotal role in SESAR implementation.

4 DEPLOYMENT VIEW II: HOW AND WHEN IS DEPLOYMENT NEEDED?



This section contains the stakeholder and infrastructure deployment roadmaps.

4.1 ATM Technology upgrades supporting Step 1 Essential Operational Changes

Each operational change requires that ATM Technology Changes be implemented by one or more stakeholders. Section 4.2 provides roadmaps showing the ATM Technology Changes, including those supporting the Essential Operational Changes, with reference to the dates for the Initial Operating Capability (IOC) for the following groups of stakeholders:

- Airspace User
  - Military
  - General aviation (GA)
  - Business aviation (BA)
  - Scheduled aviation
- ANSP
  - Military
  - Civil
- Airport Operators
  - Military
  - Civil
- Network Manager (NM)

Table 3 identifies, at an aggregated level, the ATM Technology Changes necessary to deliver each of the Essential Operational Changes in Step 1. The aggregation represents a high-level grouping of individual technology changes for each stakeholder.

In addition to the Step 1 ATM Technology Changes, Table 3 shows the Deployment Baseline ATM Technology Changes, also aggregated, which are necessary to support the Essential Operational Changes. This aggregation is used on the stakeholder roadmaps where a temporal view is provided. Table 3 is provided in the Master Plan portal (www.atmmasterplan.eu) where a "drill-down" capability enables the details of the individual ATM Technology Changes in an aggregated group to be obtained.

As well as the ATM Technology Changes institutional changes relating to regulation and standardisation are also required. These are presented in section 4.4. The SESAR concept of operations will drive changes to the procedures being used by all stakeholders, and in particular will start to redistribute responsibilities as defined in current procedures between technology, controllers and flight crew. The role of the human is addressed in section 3.8.

Table 3 **Aggregated ATM Technology Changes to Support Essential Operational Changes**

This table identifies, at an aggregated level, the ATM Technology Changes necessary to deliver each of the Essential Operational Changes in Step 1. The aggregation represents a high-level grouping of individual technology changes for each stakeholder. In addition to the Step 1 ATM Technology Changes, the table shows the Deployment Baseline ATM Technology Changes, also aggregated, which are necessary to support the Essential Operational Changes.

	Moving from Airspace to 4D Trajectory Management			Traffic Synchronisation		Network Collaborative Management & Dynamic/ Capacity Balancing	SWIM	Airport Integration & Throughput		Conflict Management & Automation	
	Trajectory Management and Business/Mission Trajectory	System Interoperability with Air/Ground data sharing	Free Routing	i4D + CTA	Integrated AMAN DMAN and extended AMAN horizon	Network Operations Planning	SWIM	Surface management Integrated with Arrival & Departure Management	Airport safety nets	Enhanced DST & PBN	Conflict Detection & Resolution
ANSP											
Aeronautical Information data sharing	Deployment Baseline					Step 1	Deployment Baseline, Step 1				
Airspace Management Systems	Deployment Baseline, Step 1										
AMAN				Step 1	Deployment Baseline						
AMAN/SMAN/DMAN Integration					Step 1	Step 1		Step 1			
Datalink Systems and Services	Deployment Baseline, Step 1	Deployment Baseline, Step 1	Step 1	Step 1				Step 1	Step 1	Step 1	
En-route Capacity and Planning tools						Deployment Baseline					
Enhance local ATFCM tool for NOP and Trajectories	Step 1	Step 1	Step 1			Step 1					
Enhanced Conflict Management tool	Step 1	Step 1									Step 1
Enhanced CWP	Step 1	Step 1		Step 1						Step 1	
Enhanced DCB tool	Step 1										
Enhanced FDP	Step 1	Step 1	Step 1	Step 1			Step 1			Deployment Baseline, Step 1	Deployment Baseline
Enhanced Monitoring Aid	Step 1	Step 1		Step 1						Step 1	
Flight Planning and demand data	Deployment Baseline, Step 1	Step 1			Deployment Baseline	Deployment Baseline					
Ground communication and information infrastructure	Deployment Baseline, Step 1	Deployment Baseline, Step 1			Step 1	Step 1	Deployment Baseline, Step 1				
Landing systems for precision approach	Deployment Baseline, Step 1										
Surface management								Step 1	Step 1		
Surface movement systems									Deployment Baseline, Step 1		
Surveillance infrastructure	Deployment Baseline								Deployment Baseline	Deployment Baseline	Deployment Baseline
Airport Operator											
Aeronautical Information data sharing						Step 1	Deployment Baseline, Step 1				
Airport CDM						Deployment Baseline					
AMAN/SMAN/DMAN Integration								Step 1			
Datalink System and Services	Step 1										
Flight Planning and demand data							Deployment Baseline				
Ground communication and information infrastructure	Step 1	Step 1			Step 1	Step 1	Step 1				
Surface management								Step 1	Step 1		
Surface movement systems									Deployment Baseline, Step 1		
Surveillance infrastructure									Deployment Baseline	Deployment Baseline	Deployment Baseline
Airspace User											
ADS-B OUT Capability compliant with DO-260B – ED102A	Deployment Baseline										
Aeronautical Information data sharing (AOC/WOC)	Deployment Baseline						Deployment Baseline, Step 1				
Datalink Systems and Services	Deployment Baseline, Step 1	Deployment Baseline, Step 1	Step 1	Step 1				Step 1		Step 1	
Enhance AOC/WOC systems	Step 1	Step 1				Step 1					
Flight Planning and demand data (AOC/WOC)	Deployment Baseline, Step 1	Step 1				Deployment Baseline					
FMS capability to support i4D operations	Step 1	Step 1		Step 1							
FMS upgrade for Lateral NAV/Approach			Deployment Baseline							Deployment Baseline	
Ground communication and information infrastructure		Deployment Baseline					Deployment Baseline, Step 1				
Onboard D-TAXI management	Step 1	Step 1						Step 1			
Onboard Situational Awareness and alerts on ground									Step 1		
Network Manager											
Aeronautical Information data sharing						Step 1	Deployment Baseline, Step 1				
Airport CDM						Deployment Baseline					
Airspace Management Systems	Deployment Baseline, Step 1		Step 1			Deployment Baseline					
En-route capacity planning tools			Step 1			Deployment Baseline					
Enhanced DCB tool	Step 1		Step 1	Step 1	Step 1	Deployment Baseline, Step 1		Step 1			
Flight Planning and demand data	Deployment Baseline, Step 1	Step 1	Step 1	Step 1	Step 1	Deployment Baseline	Deployment Baseline	Step 1			
Ground communication and information infrastructure	Deployment Baseline, Step 1	Step 1			Step 1	Deployment Baseline, Step 1	Deployment Baseline, Step 1	Step 1			

Key: ■ Deployment Baseline ■ Step 1

4.2 Deployment Roadmaps per Stakeholder

The ATM Technology Changes necessary to deliver the full scope of Step 1 operational changes have been aggregated. The aggregation represents a high-level grouping of individual changes for each stakeholder.

Satisfying the performance needs may require the implementation of these ATM Technology Changes by stakeholders to be synchronised. Synchronisation is a necessary part of deployment planning to ensure that all stakeholders achieve their benefits and avoids issues related to early adoption of, and investment in, a technology that cannot be utilised due to its complementary systems not yet being available. Typically the synchronisation would apply to activities such as air/ground or ground/ground changes and will be indicated on the roadmaps. An illustration of synchronisation between ground and air is given in Figure 13.

The roadmaps (Figure 14 to Figure 20) provide Initial Operating Capabilities (IOC) and, where applicable, IOC synchronisation dates for the individual ATM Technology Changes in the groups. These dates are shown by triangles and marked with a diamond when at least one of the ATM Technology Changes at a given date has a synchronisation date. Green triangles represent the Deployment Baseline (where Baseline technology changes are needed to prepare for Step 1) and the blue triangles Step 1. The numbers in the triangles indicate the number of ATM Technology Changes within an aggregated group with the same IOC/IOC sync date. The triangles in the bordered boxes represent those ATM Technology Changes required for the Essential Operational Changes either in Step 1 or the Deployment Baseline. The roadmaps are to be provided in the Master Plan portal (www.atmmasterplan.eu) where a "drill-down" capability enables the details of the ATM Technology Changes to be obtained.

Figure 14 to Figure 17, show ATM Technology Changes contributing to the full scope of Step 1 operational changes.

Section 4.2.1 contains the Airspace User Roadmap, divided into scheduled, general and business aviation and military airspace users. General aviation is covered by applicability only as no dates are available. The military category is based on military transport aircraft. The applicability column is provided in this roadmap to indicate the category of user the aggregated group of ATM Technology Changes applies to.

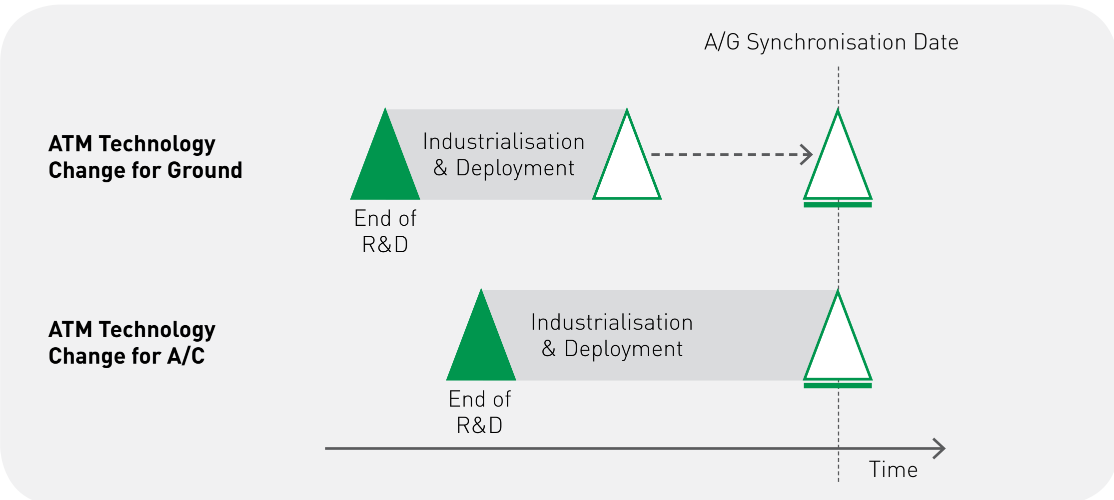
Section 4.2.2 contains the ANSP Roadmap, divided into civil and military ANSPs.

Section 4.2.3 contains the Airport Operator (AO) Roadmap, divided into civil and military AOs.

Section 4.2.4 contains the Network Manager Roadmap.

Section 4.3 contains the Communication, Navigation and Surveillance roadmaps.

Figure 13 **Air/Ground Synchronisation**



4.2.1 Airspace User

Figure 14 shows the ATM Technology Changes groupings contributing to the full scope of Step 1 operational changes. General Aviation is covered by applicability only as no dates are available.

Figure 14 **Airspace User Roadmap**

Aggregated ATM Technology Change Groups	Applicable		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
ABAS Capability	Scheduled	◄										
	GA											
	BA											
	Military				1							
ADS-B OUT Capability compliant with DO-260B – ED102A	Scheduled		1									
	GA											
	BA		1									
	Military											
Airborne safety nets	Scheduled	◄										
	BA	◄										
	Military	◄										
Airborne Traffic Situational Awareness (ATSA) capabilities	Scheduled	◄										
	GA											
	BA					3						
	Military	◄										
ASAS Spacing (ASPA) capabilities	Scheduled						1	1	1	1		
	BA						3					
	Military						1	1	1	1		
Back-up Navigation capability	Scheduled	◄		1								
	GA											
	BA	◄										
	Military	◄										
Datalink Systems & Services	Scheduled	◄					2			2		
	GA											
	BA								4			
	Military						2			2		
Enhanced Synthetic Vision	Scheduled						1					
	BA											
FMS capability to support i4D Operations	Scheduled						1					
	GA											
	BA						1					
	Military						1			1		
FMS upgrade for Lateral NAV/Approach	Scheduled	◄							1	1		
	GA											
	BA	◄								1		
	Military	◄							1	1		
FMS upgrade for Vertical NAV/Approach (SBAS)	Scheduled											
	GA											
	BA	◄										
	Military	◄										
Initial GBAS Cat II/III using GPS L1	Scheduled							1				
	BA						1					
Noise Abatement Departure Procedure (NADP)	Scheduled	◄										
	BA	◄										
	Military	◄										
Onboard D-TAXI management	Scheduled									3		
	GA											
	BA								3			
	Military									3		
Onboard Situational Awareness and alerts on ground	Scheduled			1	1					1		
	GA											
	BA		1			1				1		
	Military		1							1		
Optimised braking	Scheduled							1				
Aeronautical Information Data Sharing	AOC	◄					1					
	WOC	◄				1	1					
Airspace Management Systems	WOC	◄										
Enhance AOC/WOC systems	AOC						2	1	1			
	WOC								1			
Flight Planning and demand data	AOC	◄							1			
	WOC								1			
Ground Communication and Information Infrastructure	AOC	◄						1				
	WOC	◄						1				

Key:

- Deployment Baseline ATM Technology Changes (number indicates number of ATM Technology Changes in the group in the year)
- Step 1 ATM Technology Changes (number indicates number of ATM Technology Changes in the group in the year)
- indicates that at least one ATM Technology Change has a synchronisation date
- Indicates Baseline ATM Technology Changes <u>initially</u> deployed before 2011
- ATM Technology Changes required for the essential Operational Changes either in Step 1 or the Deployment Baseline

Table 4 **Airspace User Step 2 & 3 Technology Changes**

Steps 2 & 3	
A/G Datalink to A/G SWIM Services	Ground Generated speed adjustment managed on-board
ACAS adaptation – new separation modes	High performance A/G datalink
Airborne WV detection	Increase capacity of ADS-B
ASEP Managed Onboard (ITF/F, C&P)	Multi Constellation GNSS
Auto uplink of ground system alerts	Multiple CTOs
Automatic Cruise Climb	On-board prediction of ROT at departure
Automatic prevention of runway incursion	Preferred trajectory to avoid area
Combined Vision for equivalent vision in LVC	PTC 2D/3D managed on-board
Digital A/G voice	Runway friction measured on-board
Dual GNSS & GBAS Cat II & III	WV free approach
Full 4D	

4.2.2 Air Navigation Service Provider

Figure 15 shows the ATM Technology Changes groupings contributing to the full scope of Step 1 operational changes.

Figure 15 **ANSP Roadmap**

Aggregated ATM Technology Change Groups			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Aeronautical Information data sharing	Civil	◄				2	2					
	Military	◄				2	2					
Airport CDM	Civil	◄										
Airspace Management Systems	Civil	◄					1					
	Military	◄					1					
AMAN	Civil	◄					2		1			
AMAN/SMAN/DMAN Integration	Civil						1	2	7 ◆		2	
Complexity Management	Civil			1								
Datalink Systems and Services	Civil	◄				3	7 ◆	1	1	1 ◆		
	Military					1	2 ◆	1				
En-route Capacity Planning Tools	Civil	◄										
Enhance local ATFCM tool for NOP & Trajectories	Civil			1					2 ◆			
	Military			1					2 ◆			
Enhanced Conflict Management tool	Civil						2 ◆	2				
Enhanced CWP	Civil			2 (DB)			2 ◆		1			
Enhanced DCB tool	Civil							1				
	Military							1				
Enhanced FDP	Civil	◄	1				4 ◆	3	1			
	Military							1				
Enhanced Monitoring Aid	Civil						4 ◆		2			
Flight Planning and demand data	Civil		1 (DB)					1	1			
	Military		1 (DB)					1				
Ground Communication and Information Infrastructure	Civil		1 (DB)	1		1		4	3			
	Military		1 (DB)	1				3				
Ground safety nets	Civil	◄										
Landing Systems for precision approach	Civil	◄		1					1			
	Military	◄										
Navigation Infrastructure	Civil	◄										
	Military	◄										
Surface Management	Civil							2		1 ◆		
Surface Movement Systems	Civil	◄								1 ◆		
	Military	◄										
Surveillance infrastructure	Civil		1 (DB)									
	Military		1 (DB)									
Surveillance infrastructure for wake vortex	Civil	◄					1					
	Military	◄										

Key:

- (green) Deployment Baseline ATM Technology Changes (number indicates number of ATM Technology Changes in the group in the year)
- (blue) Step 1 ATM Technology Changes (number indicates number of ATM Technology Changes in the group in the year)
- ◆ indicates that at least one ATM Technology Change has a synchronisation date
- ◄ Indicates Baseline ATM Technology Changes <u>initially</u> deployed before 2011
- (box) ATM Technology Changes required for the essential Operational Changes either in Step 1 or the Deployment Baseline

Table 5 **ANSP Step 2 & 3 Technology Changes**

Steps 2 & 3	
A/G datalink for SWIM	Multi constellation GNSS
AIS enhanced for Dynamic Mobile Areas	Provision of Remote Tower
Enhance Controller workstation to display new info	Safety Net enhancements
Enhanced Airport Demand & Capacity system	Support dynamic flow management
En-Route system to support cruise climb	Support Dynamic Transfer of Sectors between ACCs
FDP & tools to handle 4D trajectories	Support flexible use of airspace
FDP & tools to handle multiple CTOs	Utilise additional SWIM info for tools
High integrity A/G datalink comms service	Utilise enhance real-time info – Met, runway friction, WV
Improve LVP using GNSS / GBAS Cat 2-3	Utilise static WV info for AMAN & DMAN
Improve ROT prediction	

4.2.3 Airport Operator

Figure 16 shows the ATM Technology Changes contributing to the full scope of Step 1 operational changes.

Figure 16 **Airport Operator Roadmap**

Aggregated ATM Technology Change Groups			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Aeronautical Information data sharing	Civil	◄					1					
	Military	◄					1					
Airport CDM	Civil	◄										
Airport environment management tools	Civil	◄										
Airport Lighting system	Civil				1							
	Military				1							
AMAN/SMAN/DMAN integration	Civil								3◆			
Datalink Systems and Services	Civil	◄			2							
	Military							1				
Flight Planning and demand data	Civil	◄										
Ground Communication and Information Infrastructure	Civil				1			2				
	Military			1								
Navigation infrastructure	Civil										1	
Surface Management	Civil							1		1◆		
Surface Movement systems	Civil	◄								1◆		
	Military	◄										
Surveillance infrastructure	Civil	◄										
	Military	◄										
Surveillance infrastructure for wake vortex	Civil						1					

Key:

- (green triangle) Deployment Baseline ATM Technology Changes (number indicates number of ATM Technology Changes in the group in the year)
- (blue triangle) Step 1 ATM Technology Changes (number indicates number of ATM Technology Changes in the group in the year)
- (blue triangle with ◆) indicates that at least one ATM Technology Change has a synchronisation date
- ◄ Indicates Baseline ATM Technology Changes initially deployed before 2011
- (box) ATM Technology Changes required for the essential Operational Changes either in Step 1 or the Deployment Baseline

Table 6 **Airport Operator Step 2 & 3 Technology Changes**

Steps 2 & 3	
Enhanced Airport Demand & Capacity system	VoIP/Digital radio for G/G comms
Support “Non-autonomous Engine-off Taxiing”	

4.2.4 Network Manager

Figure 17 shows the ATM Technology Changes contributing to the full scope of Step 1 operational changes.

Figure 17 **Network Manager Roadmap**

Aggregated ATM Technology Change Groups		**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Aeronautical Information data sharing	◄				2	2					
Airport CDM	◄										
Airspace Management Systems	◄				1	1					
En-route Capacity Planning Tools	◄			1			1				
Enhanced DCB tool	◄	1		1	1	2	2				
Flight Planning and demand data		3					2				
Ground Communication and Information Infrastructure		1					5				

Key:

- Deployment Baseline ATM Technology Changes (number indicates number of ATM Technology Changes in the group in the year)
- Step 1 ATM Technology Changes (number indicates number of ATM Technology Changes in the group in the year)
- indicates that at least one ATM Technology Change has a synchronisation date
- ◄ Indicates Baseline ATM Technology Changes initially deployed before 2011
- ATM Technology Changes required for the essential Operational Changes either in Step 1 or the Deployment Baseline

Table 7 **Network Manager Step 2 & 3 Technology Changes**

Steps 2 & 3	
Adaptation to common ATM info model	Enhance systems for dynamic use of terminal airspace
AIS enhanced for Dynamic Mobile Areas	Ground support for traffic complexity mgt across several sectors
AMS to deal with flexible use of airspace	Support dynamic flow management
Capacity Balancing & Scenario Mgt enhanced	SWIM enabled services for AGDLGMS
Enhance Network DCB	

4.3 Infrastructure Roadmaps

The Communications, Navigation and Surveillance (CNS) ATM Technology Changes needed to deliver the full scope of Step 1 operational changes are provided in three roadmaps in the following sections.

4.3.1 Communications

Figure 18 shows the ATM Technology Changes (not aggregated) contributing to the full scope of Step 1 operational changes.

Figure 18 **Communications Roadmap**

TECHNOLOGY		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
(V)HF											
8.33 kHz Voice communications Air-Ground	◄										
VDL Mode 2 (ATN / ACARS)											
Air-Ground existing datalink (VDL2 and AOA)	◄										
Ground Comms											
Airport wireless communications infrastructure for mobile data							▲				
Military datalink accommodation (ground infrastructure)											
VoIP (Digital voice) for ground telephony and the ground segment of the air-ground voice			▲								
PENS	◄										
AMHS	◄										
Gateway to interconnect the Stakeholder's Networks (ANSP/PENS, Airport, Airspace Users, MIL authorities [Ground IP Network]							▲				
Support MIL-0501 with ground-ground COM interface for interconnection of military systems to PENS							▲				

4.3.2 Navigation

Figure 19 shows the ATM Technology Changes (not aggregated) contributing to the full scope of Step 1 operational changes.

Figure 19 **Navigation Roadmap**

TECHNOLOGY		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CONVENTIONAL											
DME											
DME / DME optimisation	◄										
DME / DME / Inertial			▲								
ILS / MLS											
ILS	◄										
Microwave Landing System (MLS)	◄										
SATELLITE											
Basic GNSS											
Aircraft-based augmentation system (ABAS)	◄										
SBAS											
Space Based Augmentation System (SBAS)	◄										
GBAS											
GBAS Cat 1			▲								
GBAS Cat 2-3 initial, GPS L1 based								▲			
GBAS airport surface										▲	

Key:

- ▲ (green) Deployment Baseline ATM Technology Changes
- ▲ (blue) Step 1 ATM Technology Changes
- ◄ Indicates Baseline ATM Technology Changes <u>initially</u> deployed before 2011

4.3.3 Surveillance

Figure 20 shows the ATM Technology Changes (not aggregated) contributing to the full scope of Step 1 operational changes.

Figure 20 **Surveillance Roadmap**

TECHNOLOGY		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SURFACE											
	SMR ►										
Airport Surface Surveillance through SMR	◄										
	MLAT ►										
Airport Surface Surveillance through MLAT	◄										
GROUND BASED											
	ADS-B ►										
ADS-B Ground receiving station for RAD and APT applications		▲ (green)									
ADS-B Ground receiving station for Non-Radar Airspace (NRA)	◄										
	Wake Vortex Radar ►										
Ground Wake vortex radar						▲ (blue)					
	PSR ►										
Independent Non-cooperative Surveillance (PSR)	◄										
	SSR Mode S ►										
Independent Cooperative Surveillance sensors (SSR)	◄										
	WAM ►										
Wide Area Multilateration System	◄										
AIR											
	ADS-B ►										
Automatic Dependent Surveillance Broadcast 1090 Extended Squitter transmission capability (ADS-B OUT) based on EUROCAE ED 102A/ RTCA DO 260B		▲ (green)									
Coupling TCAS II RAs to the aircraft autoflight systems to enable accurate response to TCAS RAs with display of cues for monitoring the avoidance manoeuvre	◄										
Airport moving map and own aircraft position display in cockpit		▲ (green)									

Key:

▲ (green) Deployment Baseline ATM Technology Changes

▲ (blue) Step 1 ATM Technology Changes

◄ Indicates Baseline ATM Technology Changes <u>initially</u> deployed before 2011

4.4 Standardisation and Regulation

4.4.1 The Standardisation Roadmap

The Standardisation Roadmap presents the standardisation activities that will be needed for the implementation of the operational and technological improvements validated in SESAR for the modernisation of the future ATM system in Europe.

A standardisation body's working group is identified when it has already started the standardisation work or it has already included it in its work programme.

TBD (To Be Defined) indicates that the result of the research and development performed in SESAR will be analysed and the need for standards will be assessed.

The dates of publication are derived from the standardisation organisation's plans or are an estimate of by when the underlying concepts will be mature enough to enable the development of a standard (estimates based on V3 target dates are indicated in *italic* text).

The standardisation roadmap has been organised per Essential Operational Change identified in section 3 and other Step 1 operational changes when standards are not in support of the Essential Operational Changes.

4.4.1.1 Standards for Step 1

The standardisation activities related to Step 1 of the Master Plan are shown in Table 8. These standardisation activities have been identified as critical to support the major short- to medium-term technical and operational improvements from the SESAR programme. It must be noted that at this stage the following list of Standards, necessary for Step 1, cannot be considered as complete. No entry in the Status, Organisations and Documents column indicates that there is, at the time of this report, no document available nor any organisation drafting a document.

Table 8 **Standardisation Roadmap for Step 1**

Standards for Step 1	Publication Date	Status, Organisations and Documents
I4D + CTA (ESSENTIAL)		
ATN Baseline 2, datalink communications	2013	Ongoing WG78/SC214 SPR & INTEROP ICAO Doc9880, PANS-ATM
Initial 4D operations	2013	Ongoing ICAO PANS-ATM
Enhanced Controlled Time of Arrival (CTA)	2014	Ongoing WG85/SC227 ICAO PBN Manual & ED75/ DO236
SYSTEM INTEROPERABILITY WITH AIR/GROUND DATA SHARING (ESSENTIAL)		
ATN Baseline 2, datalink communications	2013	Ongoing WG78/SC214 SPR & INTEROP ICAO Doc9880, PANS-ATM
VDL Mode 2: handover and multi-frequency	2013	Ongoing SC214/WG92, ED92a
Airport Surface Data Communication based on IEEE 802.16, WIMAX	2013	Ongoing WG-82 EUROCAE
Military air-ground datalink	2015	

Standards for Step 1	Publication Date	Status, Organisations and Documents
SYSTEM WIDE INFORMATION MANAGEMENT (ESSENTIAL)		
Electronic terrain and obstacle database (eTOD)	2012	Ongoing ICAO Annex 15
Data Exchange specification for Airport Mapping Database	2012	Ongoing WG-44 ED-99c ED-119b ARINC816 ICAO Annex 15
AIS and MET Data-link Services	2013	Ongoing WG76/SC206 OSED
Guidelines for Electronic AIP	2014	Ongoing ICAO Doc8126
Aeronautical Information Exchange data model (AIXM)	2016	Ongoing ICAO Annex 15
Digital NOTAM at global level	2018	Ongoing EUROCONTROL/FAA ICAO Annex 15
ATC to ATC flight data exchange updated following validation results	2013	Planned ED-133a
Weather information exchange model	2014	Ongoing EUROCONTROL/FAA WXXM
Use of military surveillance data by civil aviation	*2018*	
SURFACE MANAGEMENT INTEGRATED WITH ARRIVAL AND DEPARTURE (ESSENTIAL)		
Airborne Combined Vision System (CVS) supporting taxi, landing and take-off operations	2015	Planned WG79 ED-180 ED179b
AIRPORT SAFETY NETS (ESSENTIAL)		
Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (SURF IA)	2013	Planned DO-323
SURFACE ROUTING AND PLANNING		
ATN Baseline 2, datalink communications (D-TAXI)	2013	Ongoing WG78/SC214 SPR & INTEROP ICAO Doc9880, PANS-ATM
ASPA SEQUENCING AND MERGING		
ATN Baseline 2, datalink communications (ASPA S&M)	2013	Ongoing WG78/SC214 SPR & INTEROP ICAO Doc9880, PANS-ATM
ASAS Spacing Applications	2016	Ongoing WG51/SC186 SPR INTEROP MOPS ICAO Annex 10
GUIDANCE ASSISTANCE TO AIRCRAFT		
Update of Minimum Performance Standard for Airborne Synthetic Vision for landing (SV)	2015	Planned WG79 ED179b
LVP USING GBAS		
Initial GBAS Cat II&III precision approaches based on GPS L1	2014	Planned ICAO Annex 10 ED114, DO253C

4.4.1.2 Standards for Step 2 & 3

The standardisation activities related to Steps 2 and 3 are shown in Table 9. These standardisation activities have been identified as longer term activities to be further defined with more precision as regards the standardisation content and dates (Step 2 or 3).

Table 9 **Standardisation Roadmap for Steps 2 & 3**

Standards for Step 2 & 3	Publication Date	Status, Organisations and Documents
INTEGRATED AMAN DMAN AND EXTENDED AMAN HORIZON		
Arrival management integrating traffic information from en-route and from departing airports nearby.	*2015*	
TRAJECTORY MANAGEMENT AND BUSINESS MISSION TRAJECTORY		
Integration of mission trajectory functionalities in future ATC systems	2020	
Full 4D Trajectory	*2020*	
SYSTEM INTEROPERABILITY WITH AIR/GROUND DATA SHARING		
Satellite based communications	2018	Planned ICAO
Datalink Services for full 4D trajectory	*2020*	SPR & INTEROP
FREE ROUTING		
User Preferred routings and User driven prioritisation process	*2020*	
NETWORK OPERATIONS PLANNING		
Airspace status information exchange	*2015*	
Network operations based on shared 4D Trajectories	*2018*	Ongoing ICAO ATMRPP (FF-ICE), FIXM & ATMCP
SYSTEM WIDE INFORMATION MANAGEMENT		
Governance (data access, integrity, supervision, registry, impact of service orientation on current interfaces, etc)	*2018*	
ATM Information Reference Model (AIRM)	*2016*	
Information Services Reference Model (ISRM)	*2016*	
New MET services (e.g. customized sea, land, mountain, 4D Data Cube)	*2020*	WG76/SC206
Interoperability of military systems with SWIM	*2017*	
SURFACE MANAGEMENT INTEGRATED WITH ARRIVAL AND DEPARTURE		
A-SMGCS including SMAN	2015	
Surface Route Planning	2018	
Airport Surface Operations satellite based positioning	2020	WG-41

Standards for Step 2 & 3	Publication Date	Status, Organisations and Documents
AIRPORT SAFETY NETS		
Runway status lights	2015	Ongoing ICAO Visual aids
ENHANCED DECISION SUPPORT TOOLS & PERFORMANCE BASED NAVIGATION		
Trajectories data exchange	*2018*	ICAO FF-ICE, FIXM
CONFLICT DETECTION AND RESOLUTION		
Use of 4D trajectory for conflict detection	*2020*	
COMMUNICATION		
Use of SATCOM A/G datalink	2014	Ongoing ICAO DOC 9925
Protection against interference for L-Band	2015	
Terrestrial cellular L-Band Technology (LDACS 1or2)	2018	ICAO ACP-WG and EUROCONTROL-FAA MoC
Software Defined Radio for ATM	*2020*	
NAVIGATION		
New Galileo/GPS/SBAS combined receivers	2014	Ongoing WG 62 MASPS and MOPS
Performance based navigation for enhanced VNAV & CTA/CTO	2020	ICAO PBN Manual
SBAS L1/L5 Signal Specification	2015	Ongoing WG-62 ED134
New Galileo services for aviation communication and navigation	2017	Ongoing EUROCAE/RTCA for ICAO Annex 10
GPS L5	2015	Long-term Implementation ICAO Annex 10
Requirements on military aircraft for vertical performance based navigation	2013	
SURVEILLANCE		
Sharing of infrastructure and data between ADS-B and Wide Area Multilateration WAM ground networks.	2013	Planned WG-51
Multi-static Primary Surveillance radars	*2020*	
AIR SAFETY NETS		
Evolution of air based safety nets	*2017*	WG75/SC147, WG-51/SC196, ICAO ASP,
AIRBORNE SPACING / SEPARATION		
ASAS Separation Applications	2020	ICAO Annex 10, SPR & INTEROP
New ADS-B Out standard to support ASAS Self Separation	*2022*	
DYNAMIC VORTEX SEPARATION		
Airborne wake vortex detection (Doppler-X, Lidar)	*2018*	
Airborne wake vortex prediction	*2018*	
Airborne Wake vortex data exchange	*2018*	
TERMINAL AIRSPACE OPERATIONS		
Full GBAS Cat II&III precision approaches based on multi constellation/multi frequency	2020	Planned ICAO Annex 10 ED114, DO253C

4.4.2 The Regulatory Roadmap

The regulatory roadmap aims to present the regulatory activities foreseen in support of the modernisation efforts for the future ATM system. It consists of the identification of both mandatory and voluntary material.

4.4.2.1 Mandatory Material

Two candidates for potential regulation are identified in the roadmap in support of the Step 1 Essential Operational Changes. Both will be subject to an early Regulatory Impact Assessment Process (eRIA) in 2012 to confirm the need for regulation and to serve as a basis for an analysis of the interdependencies between the regulations, sequencing and synchronisation of activities and deliverables in terms of development of implementing rules and community specifications:

- Revision of EC29/2009 laying down requirements on datalink services (DLS IR), to support Initial 4D applications and other datalink services related to SESAR Step 1 deployments (DLS II);
- Establishment of provisions defining the rules, roles and responsibilities for each of the Stakeholders involved in the SWIM process, also called the SWIM Framework. The implementation of SWIM will require Information management Functions and governance to be defined taking into account the functional criticality of the information. Data ownership, data provision and data usage rules will need to be redefined and possibly harmonised. Issues such as liability, charging and copyright principles should be proactively managed. This will be done in parallel with the ongoing work concerning the SWIM concept of operations and governance. It will consider the benefits of new standards complementary to regulation.

One regulatory activity has been started and is on-going:

- Performance Based Navigation (PBN) – The EC have issued a mandate for this regulation to EUROCONTROL who are presently executing the required work in close coordination with the European Aviation Safety Agency (EASA). This will define minimum navigation requirements and introduce a new package of functionalities in en-route and terminal airspace, and also in final approach. Depending on the selection of the corresponding scenario, final implementation of PBN IR could cover NAV requirements for i4D + CTA.

Figure 21 presents these on a timeline against Essential Operational Changes.

4.4.2.2 Early Regulatory Impact Assessment

Each candidate activity will be subject to validation within an eRIA which will, *inter ali*a, determine its maturity and identify early impacts and suitability for inclusion in the roadmap.

The eRIA will also determine if a regulatory approach is required ensuring that any regulation is:

- only provided in cases where action is needed,
- transparent,
- accountable,
- proportionate,
- consistent, and
- targeted.

The need for regulatory support to deployment will be assessed on the basis of relevant deployment scenarios, Cost Benefit Analysis (CBA) and financial incentives. The assessment could lead to an adjustment of the operational improvement either to avoid the need for regulatory support or limit the applicability of the regulatory actions.

4.4.2.3 Voluntary Material

Voluntary material such as SES Community Specifications and EASA Certification Specifications, Acceptable Means of Compliance (AMC) and Guidance Material (GM) are also considered for inclusion in the regulatory roadmap, where they can be identified as possible means of compliance with the mandatory material.

The EASA Basic Regulation places an obligation on all service providers in the field of ATM/ANS (AIS, DAT, ATS, CNS, MET, ATFM, ASM and ASD).

In the long-term EASA aims to develop appropriate GM and AMC which will be proportionate to the type of organisations and the services they perform.

In this edition of the roadmap, an initial list of certification material that will be necessary to support Step 1 aircraft functions has also been identified (EASA certification specifications related to airworthiness).

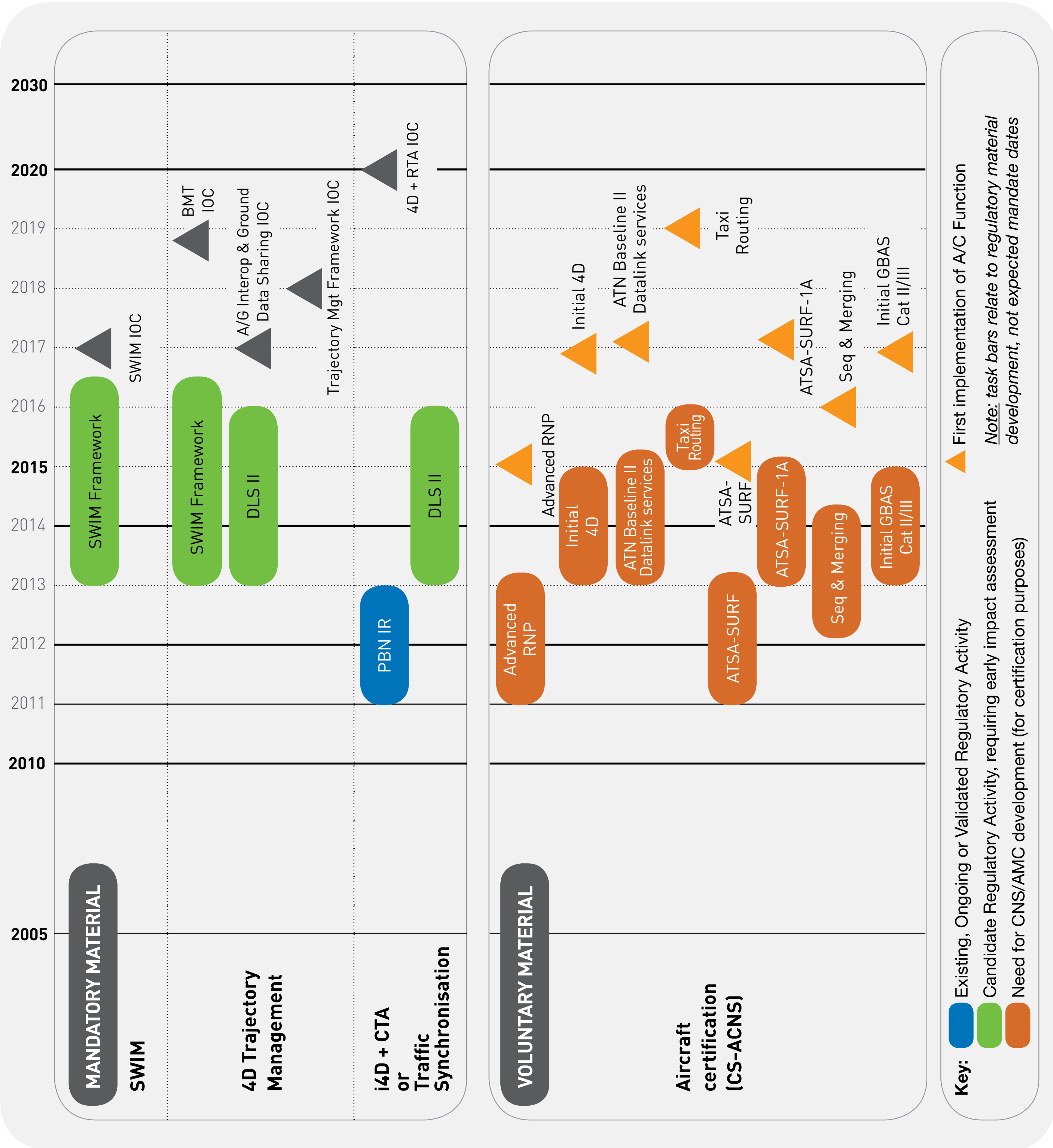
The proposed “packaging” of certification material (e.g. one specific AMC per aircraft function) is only indicative and may differ from the final packaging that will be chosen by EASA (e.g. CS-ACNS) or any competent certification authority (i.e. military aircraft case). The targeted availability date for such material has been derived from the corresponding ATM Technology Change’s IOC date, applying a two years notice period.

Industry standards (Table 8 and Table 9) should provide a sound basis for EASA rulemaking activities, thus optimising Certification Specifications and AMC development effort, for the timely certification and deployment of SESAR ATM solution sets.

Certification of aircraft whose type is not addressed by EASA (i.e. military aircraft) might follow certification processes supported by different material (AMC and GM) approved by the competent certification Authority.

Figure 21 presents an initial list of certification material that will be necessary to support Step 1 Aircraft Functions.

Figure 21 **Regulatory Roadmap**



4.4.2.4 Study Areas for Regulation

It must be noted that, like any plan, the Regulatory Roadmap will be updated regularly to take into account the results of the investigation conducted in the SESAR Programme in response to potential regulatory needs emerging from the research and development and consolidated in deployment scenarios.

For example, the following areas of investigation have been identified:
- Trajectory management and exchanges (study into the status of 4D Trajectory Management) and the need for possible regulatory action in Europe, beyond the ones already identified (DLS II, PBN IR) including new coordination mechanisms between ATSU and the Network Management Function (NMF);
- Traffic synchronisation;
- Integrated Airport management;
- Conflict Management and Automation;
- Transversal Areas, including Human Performance, Safety, Security and Environmental aspects.

It should also be noted that existing EU Regulation 677/2011 laying down detailed rules for the implementation of air traffic management network functions (NM IR) may provide a suitable regulatory framework to enable the Network Management Essential Operational Changes.

Trajectory Management and Exchanges

The definition of scope, content and use of 4D trajectories in the framework of Initial 4D still needs to be further developed at R&D level.

However, regulatory support will likely be needed, and could be divided into four groups:
- Trajectory exchange;
- Air/Ground datalink;
- Air/Air datalink and;
- Ground/Ground data exchange.

The A/G datalink element could be supported by a revision of EC29/2009 laying down requirements on datalink services (identified as DLS II in Figure 21).

The G/G data exchange element should be considered together with the SWIM Framework.

Traffic synchronisation

There is need to review the status of AMAN/DMAN and a need for possible regulatory action in Europe.

Conflict Management and Automation

There is a need to study the development of material to enable synchronised deployment of PTC-2D. Regulation could be required to enable synchronised deployment of the following enablers (non-exhaustive list):
- Flight Data Processing System (FDPS) update to support PTC-2D;
- A/G datalink update to support exchanges required for PTC-2D;
- ATC & cockpit procedures for PTC-2D operations.

The A/G datalink element could be supported by a revision of EC29/2009 laying down requirements on datalink services (identified as DLS II in Figure 21).

5 THE BUSINESS VIEW: WHAT ARE THE COSTS AND BENEFITS?

The Business View is based on performance needs and is derived from the validation targets. It complements the Deployment View by providing targeted benefits of deployment and associated costs. It is a high-level view, which does not replace in any way the need for dedicated stakeholder business cases and cost benefit analyses at the level of individual investment opportunities.

Mature solutions, supported by business cases containing a clear quantification of the deployment performance expectations for a set of deployment scenarios will be the product of the validation activities.

An appreciation of required investment is also provided for all stakeholders. This section comprises a quantification of 2 scenarios for the deployment of the SESAR Deployment Baseline and Step 1. These scenarios are monetised for Scheduled Airlines only at this stage.

5.1 Benefits of SESAR Step 1 and Deployment Baseline

SESAR is expected to bring benefits in a variety of areas: reduction in fuel consumption through better flight profiles and fewer delays, a decrease in ANS cost per flight, an increase in capacity at airports and in the airspace to meet traffic demand. The increase in capacity will also limit ATFM delays and reduce flight cancellations due to capacity shortages.

SESAR is also expected to improve predictability of operations by reducing the variability of flight duration (block-to-block). The benefits of improved quality of service have not been quantified at this stage but will be further assessed as part of SESAR activities. Figure 22 shows the path from validation targets to benefits that can be monetised.

Considering the current limited availability of validation results, the best possible approach to quantifying the benefits is to use the validation targets. Hence, the benefits of SESAR have been monetised by interpolating the validation targets for the period. This monetisation is dependent on the traffic growth and allocation in time across stakeholder groups. Therefore changes in traffic growth, R&D results and deployment scenarios will impact the value of the benefits.

Figure 22 **The path from validation targets to benefits**

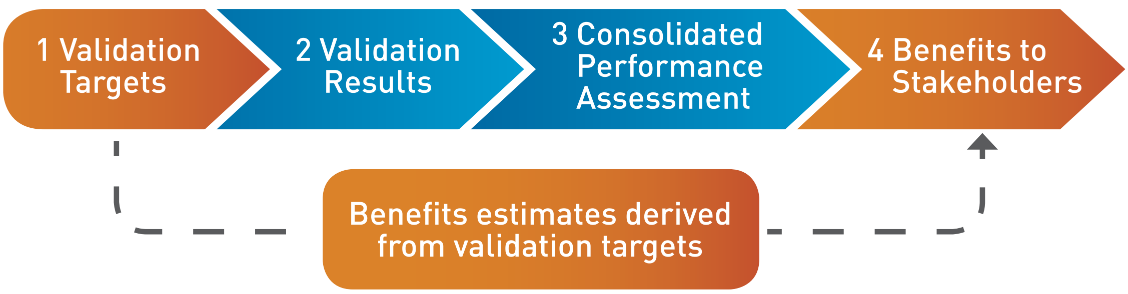


Table 10 shows the benefit estimates that can be derived from the validation targets. In section 5.3 a high-level CBA for scheduled airlines is presented using the Step 1 and Deployment Baseline targets for fuel efficiency (-2.8% fuel burn per flight) and cost efficiency (-6.1% in ANS cost per flight).[13]

Table 10 **Targeted benefits per KPA**

Key Performance Area	Validation Targets	Benefit
Environment/ Fuel Efficiency	-2.8% of fuel burn per flight	Fuel Cost Savings for Scheduled Airlines CO_2 Savings - Emissions Trading Scheme – reduced costs for Scheduled Airlines
ANS Cost Efficiency	-6.1% of ANS cost per flight	Reduction in ANS Charges per flight to Scheduled Airlines
Airspace Capacity	+27% of airspace throughput	Delay Cost Savings to Scheduled Airlines
Airport Capacity	+14% of runway throughput	Unaccommodated Demand - Value of additional flights at Airports to Scheduled Airlines Airport Capacity - Value of additional flights to Airports Flight Cancellation Cost Savings to Scheduled Airlines due to Low Visibility Improvements Avoidance of Reduced Profits for Airports from Flight Cancellations due to Low Visibility Conditions

5.2 Costs of SESAR Deployment Baseline and Step 1

This section presents the cost assessment that has been conducted and is available for the following stakeholder groups:

- Airspace Users : Scheduled Airlines, Business Aviation (BA), General Aviation (GA),
- ANSP & Network Manager,
- Airport Operators,
- Military (the data requires further validation which has not been performed at this stage[14])

13 A quantification of all benefits in Table 10 and their impact on the different stakeholder groups is provided in the “Business Case Report in Support of the Master Plan”

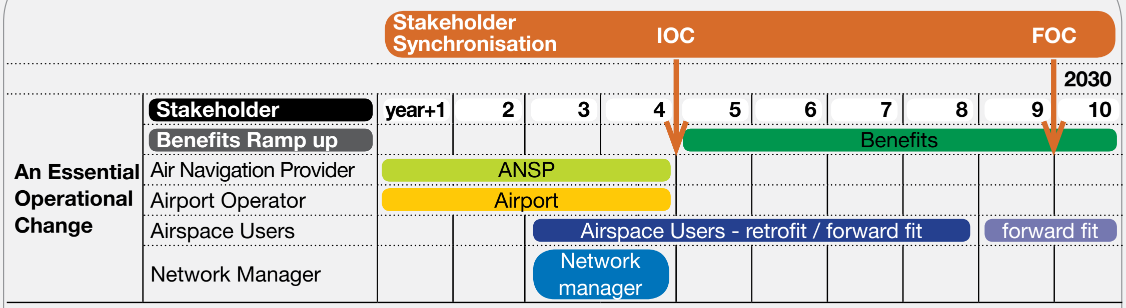
14 The Military are significantly reviewing their avionics roadmap and other requirements for SESAR. As a result, the costs estimated during the Definition Phase will need to be reviewed and validated. These validated data are not yet available.

5.2.1 Main Assumptions for Cost Assessment

To ensure the synchronisation of the deployment between the stakeholders and to maximise the return on investment for each contributor, a number of assumptions were made for the deployment of the Step 1 Operational Changes which are presented in this section.

It is important to understand that there is not one single period of deployment per stakeholder group for the whole of Step 1 but one period of deployment per Operational Change and per stakeholder group.

Figure 23 **Stakeholder Synchronisation**



1) The implementation periods for the different stakeholder groups have been extrapolated from the benefits ramp up period, that is the period from the Initial Operating Capability to the Full Operating Capability of the Operational Change.

2) Airspace Users retrofit period was assumed to take 6 years for Operational Changes that provide network benefits and 4 years for local Operational Changes. Note that the forward fit period extends until 2030 and the equipage rate was fixed to 80% of the total European fleet in 2030.

3) ANSPs and Airports will deploy one or two years before Airspace Users airborne equipage. The objective is to secure Airlines investments by ensuring that there will be no gap between ground and air investments.

4) Network Manager investments are achieved at the same time as the ANSP investments but require a shorter period of implementation (2 years).

5.2.2 Deployment Cost per Stakeholder Group

Two high-level deployment scenarios were considered for the assessment of the cost of Step 1 and Deployment Baseline:

1. **Basic Package**: (Essential scenario). All ATM Technology Changes necessary to support the Essential Operational Changes in Step 1 are deployed in a synchronised way.
   - It includes the cost of the Deployment Baseline (DB).
   - Other Step 1 changes are not considered.

2. **Target Package**: (Full Scope scenario) The full scope of ATM Technology Changes necessary to support all the operational changes for Step 1 are deployed in a synchronised way.
   - It also includes the cost of the Deployment Baseline (DB) operational and technological changes necessary for performance and to support Essential Operational Changes for Step 1.
   - All costs associated with Step 1 operational changes are taken into account.

For both packages, time period covered and assumptions used are as follows:

- Deployment costs have been computed for the period 2014 and 2030;
- The ground investments are expected to be fully implemented by 2024 corresponding to 60% of the total airborne cost;
- Airborne equipage at that time will exceed 50% of the total European fleet for both scenarios;
- Costs provided represent the delta compared to nominal investments.

The cost for each stakeholder group includes capital costs, one-off costs such as training, and changes in operating costs. It excludes R&D costs as these are assumed to have been already incurred in the SJU work program.[15]

15 More details about the assumptions and method are provided in the "Business Case Report in Support of the Master Plan"

Table 11 provides the detailed assessment of the two packages. Investment costs for scheduled airlines, airports and ANSPs are given in low-high ranges of values reflecting the uncertainty and variability in costs. The variability and uncertainty result from factors such as the nature of the ground architecture and systems in place, type of aircraft and avionics, characteristics of the operating environment and the uncertainty in the technological changes required.

Table 11 **SESAR Step 1 and Deployment Baseline costs**

SESAR Step 1 and Deployment Baseline				**Basic Package**	**Target Package**
AIRSPACE USERS	Retrofit	Scheduled	Single Aisle	504-867 M€	1 725-2 736 M€
			Long Range	271-465 M€	927-1 471 M€
			Regional	287-695 M€	584-1 421 M€
			Scheduled Total	***1 062-2 027 M€***	***3236 – 5 628 M€***
		BA		1 100 M€	2 524 M€
			BA Total	***1 100 M€***	***2 524 M€***
		GA	IFR	183 M€	256 M€
			VFR	116 M€	246 M€
			GA Total	***299 M€***	***502 M€***
		Military		*Not Assessed*	*Not Assessed*
			Military Total		
	Forward fit	Scheduled	Single Aisle	666-771 M€	1 627-1 853 M€
			Long Range	357-413 M€	870-993 M€
			Regional	224-886 M€	506-1 492 M€
			Scheduled Total	***1 247-2 070 M€***	***3 003-4 338 M€***
		BA		1 603 M€	3 768M€
			BA Total	***1 603 M€***	***3 768 M€***
		GA	IFR	155 M€	224 M€
			VFR	66 M€	163 M€
			GA Total	***221 M€***	***387 M€***
		Military		*Not Assessed*	*Not Assessed*
			Military Total		
	Total (Retrofit + Forward fit)	Scheduled	Single Aisle	1 170-1 638 M€	3 352-4 589 M€
			Long Range	628-878 M€	1 797-2 464 M€
			Regional	511-1 581 M€	1090-2 913 M€
			Scheduled Total	***2 309- 4 097*** *M€*	***6 239-9 966*** *M€*
		BA		2 703 M€	6 292 M€
			BA Total	***2 703 M€***	***6 292 M€***
		GA	IFR	338 M€	480 M€
			VFR	182 M€	409 M€
			GA Total	***520 M€***	***889 M€***
		Military		*Not Assessed*	*Not Assessed*
			Military Total		
	Airspace Users Overall Total			***5 532-7 320M€***	***13 420-17 147 M€***
ANSP & NETWORK MANAGER	Civil including Network Manager			2 140-4 200 M€	3 562-6 500 M€
	Military			*Not Assessed*	*Not Assessed*
	ANSP & Network Manager Total			***2 140-4 200M€***	***3 562-6 500 M€***
AIRPORT OPERATOR	Civil			837-2 534 M€	3 070-5 289 M€
	Military			*Not Assessed*	*Not Assessed*
	Airport Operator Total			***837-2 534 M€***	***3 070-5 289 M€***
			OVERALL TOTAL	***8 590-14 054 M€***	***20 052-28 936 M€***

5.2.2.1 Deployment Cost Assumptions: Airspace Users

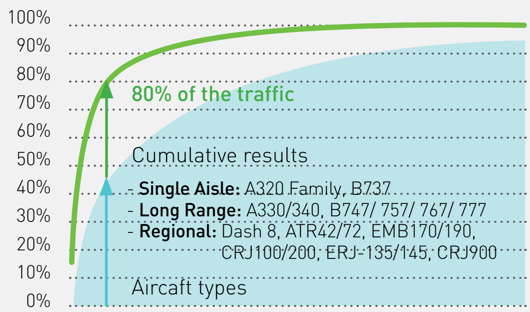
Airspace Users Fleet Evolution

The fleet is clustered depending on the age of the aircraft as it impacts the retrofit cost. The global estimated target fleet equipage rate for Step 1 is set to 80% for 2030.

With a view to optimising the investments to be made by the airlines, an analysis of the fleet to be considered has been made prior to the costs estimation. This analysis shows that **80% of the total number of flights is flown by 45% of the fleet operating in European airspace**, as illustrated in Figure 24 (this diagram gives an illustration of the European air traffic in 2010 compared to the fleet operating in European airspace).

The fleet composition and its forecasted evolution are shown in Table 12[16]:

Figure 24 **Airspace Users Fleet Evolution**



Fleet & Traffic assumptions:
Each aircraft type flying in Europe performs a number of flights per year:
The blue series shows, in %, how much each aircraft type counts within the European controlled fleet
The green series shows, in %, how many flights are performed by each aircraft type within the European air traffic in 2010

Table 12 **Fleet composition and evolution**

		Fleet composition & evolution					
		Scheduled Airlines			Business Aviation	General Aviation	
		Single Aisle	Long Range	Regional		IFR	VFR
Fleet composition & evolution	**2011**	5 291	2 838	975	3 350	4 966	64 894
	2020	6 784	3 638	1 250	5 249	6 480	68 882
	2030	8 942	4 795	1 648	7 359	8 708	77 609

16 Fleet evolution has been extrapolated from 2011 total number of flights per type of aircraft based on data provided by PRISME Fleet database, CFMU Flight plans and EASA database for General Aviation. These numbers are based on aircraft registered in Europe.

For a small number of operational changes a lower equipage rate of 70% in 2030 was chosen for GA, as not all GA IFR aircraft are expected to be equipped since some solely operate into low density TMAs and at low level.

The annual delivery of new aircraft is based on the assumption that 71% of the total number of aircraft in 2030 will be less than 20 years old for scheduled airlines. For GA the average retirement age is estimated at 30 years, from NSA registration data, leading to an average retirement rate of 3.4%. For GA VFR the retirement rate is 2%

The annual fleet growth rate was 2.8% for Scheduled Airlines, 2.9% for General Aviation IFR aircraft, 1.2% for General Aviation VFR.

For Business Aviation the following was assumed:
- Constant growth of the fleet (+211 aircraft/per year) from 2011 to 2030.
- Total retirement rate -13% over 20 Years (Bombardier assumption)
- Retirement rate per year = -0.65%
- No retirement for aircraft less than 20 years old

For scheduled airlines, the reference costs are based on the A320 family and the A330/340. For regional aircraft, the reference costs are based on the ATR-72/ATR-42 family.

Scheduled Airlines

The number of aircraft to be retrofitted depends on the target equipage rate and on the number of aircraft forward fitted. The retrofit first concerns the most recent aircraft (built between 2012 and 2015) unless older aircraft need to be retrofitted to achieve the target equipage rate; in this latter case, the retrofit starts with older aircraft (aircraft built between 2002 and 2011) to maximise the payback period.

There is wide variance in the costs of equipage for Regional Airlines. To capture this, the cost assessment has been consolidated in a range between High and Low by considering regional aircraft configurations with different avionics architecture and propulsion mechanism (regional turboprop and regional jet).

The cost of equipage for Regional aircraft is substantially greater than for Single-Aisle and Long-haul aircraft. This is due to the variability of the regional fleet and the significantly smaller fleet volumes for regional aircraft.[17]

Business Aviation

The European Business Aviation (BA) fleet is extremely varied as it includes aircraft from a large number of manufacturers carrying both integrated and non-integrated cockpits which, especially for the latter, have evolved in many different ways with different technologies in accordance with the needs of the operator and the required missions. The vast majority of the European BA fleet is customised to operate different missions in different ATM environments using the same aircraft. BA aircraft need to be equipped with the technology to operate one day in a large hub environment in complex airspace, in a regional/secondary airport in a less complex airspace the next day and in a GA environment including all its different modalities such as gliders, parachuting and other air-sports, on another day.

General Aviation

GA IFR aircraft are assumed to comply with necessary ATM Technology Changes as with any other AU model. The longer life of many GA aircraft will drive retrofit costs, even given the calculated 50% retrofit equipage by 2024 to meet the 2030 equipage rate target.

17 More detailed assumptions can be found in the "Business Case Report in Support of the Master Plan"

5.2.2.2 Deployment Cost Assumptions: ANSP and Network Manager

A low and a high value have been estimated for the SESAR deployment costs of Step 1 and the Deployment Baseline for ANSPs and the Network Manager using two different approaches.

For the low value, the costs have been derived from previous data used in the Definition Phase, with the following changes:

- The R&D costs were deducted as they're already incurred in the SESAR work-program.
- Human Performance costs such as training were added.
- A factor of 15% was applied to the costs to account for gaps in data, the means of allocation not being robust and the age of the cost estimates used.

For the high value, a top-down cost assessment performed by ANSPs concluded that the total SESAR related capital investment for ANSPs (not including the Network Manager) in the period 2014 to 2024 would amount to 4200 M€ for the Basic Package and 6500 M€ for the Target Package.[18]

18 A sensitivity analysis has been carried out in the "Business Case Report in Support of the Master Plan" showing the impact of increases of 50% and 100% in the ANSP investment costs on the Business View.

5.2.2.3 Deployment Cost Assumptions: Airport Operator

The costs of Step 1 and Deployment Baseline to Airport Operators have been estimated using a range of costs between low and high to take account of differences in airport size and the technology changes required to support the operational changes. Cost ranges were calculated based on levels of complexity provided by the ground industry. For each technology a complexity range was provided, this range considered the variability of the different airport categories, the uncertainty derived from the systems baseline at each airport and specific features of the airport.

Levels of complexity of ATM Technology Changes were aggregated to obtain a level of complexity per operational change in relation to each package (Target and Basic) to be implemented. for each sub-operating environment (VHC, HC,MC, LC). Finally each level of complexity was translated into a cost range by airport experts.

The values are based on a set of 131 airports.

5.2.2.4 Deployment Cost Assumptions: Military Users

Military costs have not been reviewed since the Definition Phase due to the unavailability of new validated data. However, the list of Essential Operational Changes in Step 1 shows that main system changes will impact the ground infrastructure supporting airspace and Mission trajectory management functions.

5.3 High-level Cost Benefit Analysis for Scheduled Airlines

A high-level cost benefit analysis was performed for Scheduled Airlines using two deployment scenarios described in the following sections.

5.3.1 Deployment Synchronised Scenario Description

Table 13 provides a description of two scenarios: Synchronised and De-synchronised. These two scenarios are further illustrated in this section in terms of preliminary results for scheduled airlines.

The validation targets presented in section 2 of the Master Plan for SESAR Step 1 and the Deployment Baseline were used. The roadmaps in section 4.1 were also used as the basis as the main assumption for the synchronised scenario, for Scheduled Airlines only, at this stage.

At this stage and for the purpose of this high-level Business Assessment, no deployment scenarios where analysed for other stakeholders such as ANSPs, Airports, Military, General and Business Aviation. These will be further developed in future activities of the SESAR Programme.

All benefits referred to hereafter assume a full-scope SESAR deployment (see "Target Package" referred to in section 5.2.2).

Table 13 **Description and Prerequisites of the two scenarios**

Scenario	Description	
Synchronised	SESAR Deployment Baseline and Step 1 fully implemented in 2027 (Target Package) • by 2024 all ground costs of ANSPs and Airports will have been disbursed without any negative repercussions on airspace user charges and that more than 60% of the airborne cost will have been expended. • The global estimated target fleet equipage rate for Step 1 is set to 80% for the 2030 projected fleet (100% for the DB) • 100% of aircraft operating in European airspace are Deployment Baseline equipped by 2018 • 50% of new aircraft delivered operating in European airspace are Deployment Baseline and Step 1 equipped in 2018 and 2019, thereafter 100% • 50% of aircraft operating in European airspace are Step 1 equipped by 2024, 80% from 2027 • 90% of the Deployment Baseline and Step 1 benefits are reached in 2024 and 100% from 2027	Prerequisites: • R&D activities deliver in line with Validation target and in time to meet IOC dates • Timely industrialisation and procurement to meet IOC dates • Effective governance and incentive mechanisms implemented to support transition from R&D to deployment
De-synchronised	SESAR Deployment Baseline and Step 1 fully implemented in 2040 (Target Package) • 100% of aircraft operating in European airspace are Deployment Baseline equipped by 2024 • 80% of aircraft operating in European airspace are Step 1 equipped by 2040 • 100% of the Deployment Baseline and Step 1 benefits are captured from 2040	Possible root causes: • R&D results not in line with Validation Targets •Unsynchronised industrialisation and procurement activities not allowing to meeting the targeted IOC date • Ineffective governance and incentive mechanisms implemented

5.3.2 Illustrative preliminary results for Scheduled Airlines

Figure 25 **Yearly Benefits in M€ Deployment Baseline + Step 1 (2014-2030)**

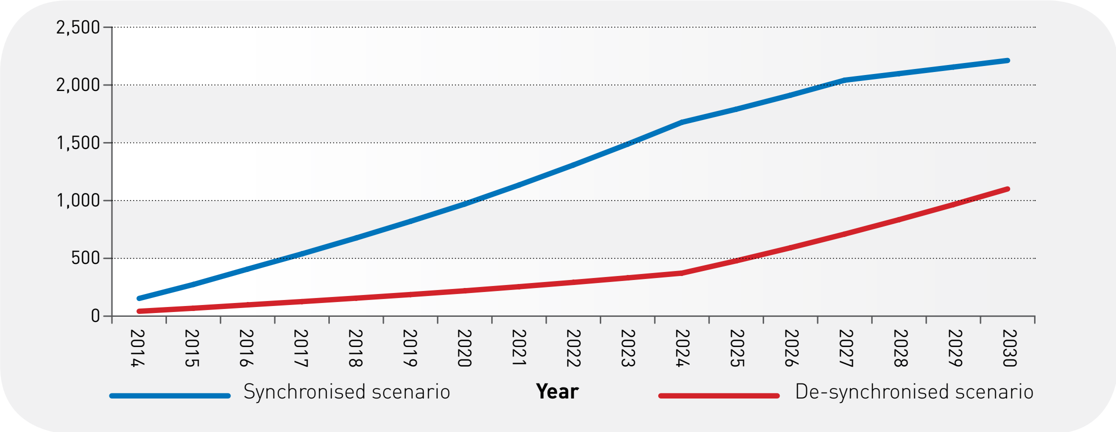
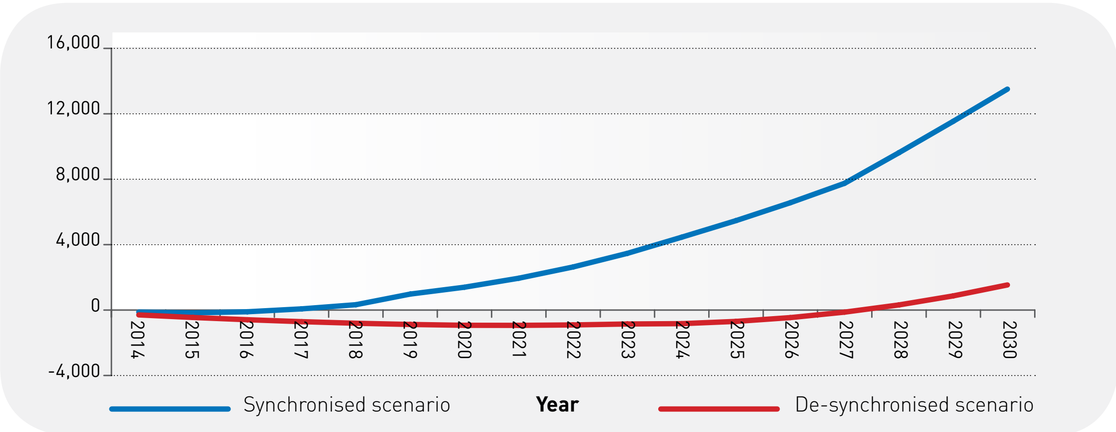


Figure 26 **Net Cumulative Benefits in M€ Deployment Baseline + Step 1 (2014-2030)**



Note: The blue line represents the Synchronised scenario and the red line the De-synchronised.

The preliminary high-level analysis performed shows that the accumulated net cash-flow is positive for Scheduled Airlines from 2017 (within 3 years of 2014) in the Synchronised Scenario compared with 2028 (within 14 years of 2014) in the De-synchronised Scenario using the highest cost from Table 11.

The significant gains in terms of average yearly net cash flow between the two scenarios is driven primarily by a more rapid benefits ramp-up period (13 years faster in the Synchronised scenario) and represents approximately 900 M€ per year in net benefits for Scheduled Airlines over the period 2014-2030.

It is worth noting that the figures presently only account for fuel and ANS charges savings. The fuel cost calculations are conservative since they use a flat fuel cost of 0.78 EUR/KG over the period and exclude at this stage a gradual fuel cost increase scenario. Additional benefits such as time and quality of services related savings have also not been accounted for at this stage. For ANS charges it was estimated that the expected increased CAPEX (capital expenditure) would be offset by reduced OPEX (operational expenditure) and other possible sources of financing. This is expected to result in an overall net reduction of ANS charges for Airlines.

The analysis re-emphasises the importance of ensuring a timely and synchronised deployment to build a compelling overall business case for SESAR. Synchronisation of deployment is a key condition to acceptable return on investment for stakeholders.

Table 14 **Synthesis of Cost Benefit Analysis for Target Package**

Bn€ (2014-2030)	**Synchronised Scenario**	**De-synchronised Scenario**
Cumulative cost	-8.1	-5.3
Cumulative benefit	21.7	6.8
Net cumulative benefit	13.5	1.6
NPV 2014-2030	5.2	0.0

5.4 Required Investments and Financing

5.4.1 Required Investments in the Period 2014 to 2030

This section provides indicative values of the total investment required between 2014 and 2030. These values are shown for the two high-level packages: the Basic Package, where only the ATM Technology Changes necessary to support the Essential Operational Changes in Step 1 are deployed and the Target Package where the full scope of ATM Technology Changes necessary to support all the operational changes are included (See Table 15).

Estimates also include the Deployment Baseline operational and technology changes necessary for performance and to support the Essential Operational Changes of Step 1. The cost to Military stakeholders is not included in these values.

While estimates of the investment required in the shorter term (Step 1 and Deployment Baseline) have been recently updated (see section 5.2), the costs for Step 2 correspond to estimates provided during the Definition Phase[19]. These costs have not yet been updated to include the cost of technology changes that were supporting Step 1 but are now supporting Step 2. In addition, Essential Operational Changes for Step 2 have not yet been identified. The cost of Step 2 will be reviewed once the technologies and functions supporting this step mature.

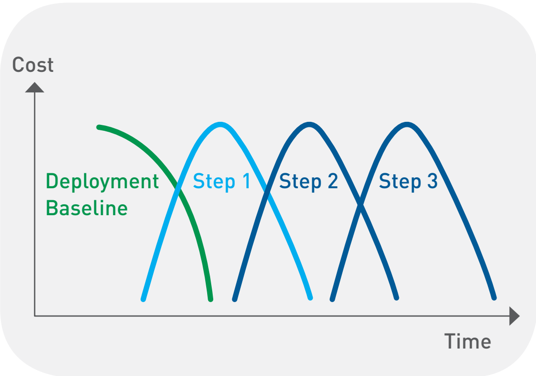
Table 15 **SESAR Investment Overview in 2014-2030**

		Step 1 and Deployment Baseline	**Step 2**	**Total**
Basic Package	2014-2024	6.4 – 11.3 Bn€	1.2 Bn€	7.6 – 12.5 Bn€
	2025-2030	2.1 – 2.8 Bn€	1.9 Bn€	4.0 – 4.7 Bn€
	TOTAL	***8.5 – 14.1 Bn€***	***3.1 Bn€***[20]	***11.6 – 17.2 Bn€***
Target Package	2014-2024	15.0 – 22.4 Bn€	1.2 Bn€	16.2- 23.6 Bn€
	2025-2030	5.1 – 6.5 Bn€	1.9 Bn€	7.0 – 8.4 Bn€
	TOTAL	***20.1 – 28.9 Bn€***	***3.1 Bn€***	***23.2 – 32.0 Bn€***

19 The cost estimate for Step 2, 6.2 Bn€ overall, comes from the Definition Phase. It only includes the cost to Scheduled Airlines, Business Aviation and ANSPs. The cost to General Aviation, Airports and the Military was not included. It corresponds to the Target Package as Essential Operational Changes for Step 2 have not yet been identified.

20 Cost of Step 2 corresponds to the Target Package as Essential Operational Changes for Step 2 have not yet been identified.

Figure 27 **Illustrative cost diagram**



To calculate the required investment the following assumptions were made. In the period 2014 to 2024 all ground investments are made as well as 60% of the cost to airspace users. Furthermore 20% of the overall cost for Step 2 is also allocated to this period. Then between 2025 and 2030 the remaining 38.5% of the investment of airspace users in Step 1 is assumed to take place, as well as a further 30% of investment in Step 2.

The assessment of the cost of Step 1 and the Deployment Baseline as well as the breakdown per stakeholder are presented in section 5.2.

The periods of overlap initially between Deployment Baseline, Step 1 and Step 2 investments and later on between investments in Steps 2 and 3 are shown in section 3.

5.4.2 Financing

History has shown that it often takes a long time to implement improvements to the ATM system, and that there are often long delays until a deployment is complete.

The main risk of SESAR deployment results from the partial disconnection between investments and the realisation of benefits. Not only is it the case that a timing lag is likely to occur between upfront investment costs and the gradual generation of subsequent benefits, but also that such benefits might only be realised when several stakeholders deploy in a reciprocal, synchronised and timely manner.

Stakeholders have expressed concerns regarding the extent to which they are reliant on the performance of other stakeholders, over whom they have no control, in order to obtain the expected SESAR benefits. The risk is to create a last-mover advantage whereby each stakeholder would wait until all others have proceeded with SESAR investments. This should be addressed through the effective implementation of SESAR deployment governance and incentive mechanisms.

In order for individual stakeholders to overcome these concerns, they will need greater certainty of the deployment costs and sequencing, of the synergies and ATM performance benefits and of the timing of when the benefits will be realised (i.e. when sufficient elements of the system are operational to enable benefits to flow). Furthermore, they will require access to financial and operational incentives that provide the necessary inducements to encourage timely and synchronised deployment.

An optimised financial solution must therefore be developed, which will result in a coordinated combination of public and private funds. In order to ensure timely implementation, it is estimated that SESAR deployment would require at least 3 Bn€ in EU funds[21] in the next financial perspective of the European Union starting in 2014. EU funding should facilitate the synchronisation and coordination between stakeholders and be focused on Essential Operational Changes identified in the Master Plan. An important part of the public funds is estimated to be required during the period 2014-2024 where investments to implement SESAR Deployment Baseline and Step 1 will overlap.

21 "Communication from the Commission – Governance and incentive mechanisms for the deployment of the Single European Sky's technological pillar: SESAR", 22 December 2011

Current EU financial instruments, such as the Connecting Europe Facility within the framework of the Trans-European Networks Policy, could be used to provide public funding. Additional sources of financing could also include loans and guarantees from the European Investment Bank, the SES Charging regulation and the Emissions Trading Scheme.

It is recognised that for some stakeholders, the issue is not asynchronous costs and benefits, but a lack of benefits to offset identified costs. In this case, many of the costs are imposed to ensure the interoperability of the overall network, contributing to the overall benefits but without significant returns at an individual level. The financing and funding solutions to this issue will need to be considered at a European and national level.

5.5 The Business View Conclusions

The Business View illustrates the economic impact of operational and technological changes, based on both the deployment scenario comprising the Essential Operational Changes for Step 1 and that comprising the full-scope changes for Step 1 (Target Package). Deployment Baseline operational and technology changes necessary for performance and to support Essential Operational Changes for Step 1 are also included.

Focusing on Essential Operational Changes for Step 1 and the Deployment Baseline limits investment costs whilst ensuring deployment of changes that are either key to performance or are strategic to future Concept Steps. The assessment of the cost of operational changes in Step 1 and Deployment Baseline shows that cost would be between 8.5 and 14.1 Bn€ and would be less than half of the cost of implementing a full scope SESAR foreseen in that period.

Cost and Return on Investment (ROI) across stakeholders are likely to differ. For example, ROI is likely to be higher for airlines that rely on single aisle aircraft than for airlines that use regional aircraft. Considering the number of flights performed by single aisle and regional aircraft, this result is likely to be even more valid when considering average cost per flight.

The high-level cost benefit analysis performed for Scheduled Airlines for Step 1 and Deployment Baseline indicates that, if validation targets are achieved, benefits to the ATM community in high priority areas such as in fuel efficiency, financial cost-efficiency and airport capacity are substantial in the Synchronised deployment scenario reaching over 13 Bn€ in benefits in the period 2014-2030. To this value it is necessary to add other benefits such as those from delay avoidance and flight cancellation savings. These benefits are sensitive to traffic growth and ANSP investment costs. The distribution of benefits and costs across the different stakeholder groups (Scheduled Airlines, Business Aviation, General Aviation, Airports, ANSPs, Military) and individual stakeholders will differ depending on their business model. In addition Step 1 and Deployment Baseline will establish the basis on which Steps 2 & 3 will be deployed and thus bring further benefits.

However, these figures should be taken with caution; considering that they are relying on a certain number of assumptions which may not be applicable to all categories or sub-categories of stakeholders. Furthermore, some underlying figures, from manufacturing industry in particular, had a very high variance. Finally, the cost estimates consider that SESAR will be uniformly deployed throughout Europe, which is likely not to be the case. To further refine the individual business cases for groups or sub-groups of stakeholders, detailed discussions need to take place with each of them, in particular in the framework of the SESAR deployment phase.

The time lag between the upfront SESAR investments by the different stakeholders and the full realisation of benefits will present a risk to SESAR deployment. The variability in the ROI across the different stakeholder groups and individual stakeholders will also impact the timely uptake of investments and the realisation of benefits.

To encourage early deployment, financial and operational incentives are necessary. A deployment timing lag is likely to occur between upfront investment costs and the gradual generation of subsequent benefits which might only be realised when several stakeholders deploy in a reciprocal, synchronised manner. Synchronisation of deployment across stakeholders maximises and speeds up benefit delivery.

The risk is to create a last-mover advantage whereby each stakeholder would wait until all others have proceeded with SESAR investments. This should be addressed through the effective implementation of SESAR deployment governance and incentive mechanisms.

An optimised financial solution must therefore be developed, which will result in a coordinated combination of public and private funds. In order to ensure timely implementation, it is estimated that SESAR deployment would require at least 3 Bn€ in EU funds[22]. EU funding should facilitate the synchronisation and coordination between stakeholders and be focused on Essential Operational Changes identified in the Master Plan. An important part of the public funds is estimated to be required during the period 2014-2024 where investments to implement SESAR Baseline and Step 1 will overlap.

22 "Communication from the Commission – Governance and incentive mechanisms for the deployment of the Single European Sky's technological pillar: SESAR", 22 December 2011

6 RISK MANAGEMENT

6.1 Risk is Systematically Captured, Analysed and Mitigated

The Master Plan risk management addresses uncertainty associated with the delivery of the Essential Operational Changes that are required to contribute to achieving the performance objectives. A Master Plan risk may be defined as an undesired event or series of events which reduce confidence in the Master Plan and, on occurring, may represent a potential obstacle towards delivering the timely, coordinated and efficient deployment of the new technologies and procedures in line with the Target Concept.

The Master Plan risk management reviewed and updated the risks highlighted in the previous version using the risk management framework implemented by the SJU. Risks were identified according to their relation to the achievement of the performance objectives defined in the Master Plan. Risks which have a significant impact on implementation of the Programme or its subsequent deployment have also been analysed. While the risk analysis covered in a comprehensive way all potential areas, this risk management chapter focuses on the risks with the highest priority. More detailed information on the less critical risks is managed within the SJU Risk Management Framework. An example of a risk not shown here is "The safety objective is not reached". The reason for its lower criticality is linked to the safety objective receiving the highest attention and adequate risk mitigation action being in place.

All recorded risks have been tackled or are still treated through mitigation action plans recorded within the SJU Risk Management Framework. Each mitigation action identifies dedicated ownership and a target date in order on one hand to reduce the likelihood of the event materialising and on the other hand to reduce the possible impact, thus increasing confidence in the Master Plan and encouraging decision-making. Section 6.2 shows the actors on mitigation together with some of the main actions. The more detailed action plans are captured in the risk management process.

Risk management is necessarily an activity that needs regular attention, including updates and monitoring of the status of the on-going mitigation actions. A regular review of all risks and mitigation actions is conducted through the SJU Risk Management process.

6.2 High-Priority Risks identified

<table>
<tr><th>Risk</th><th>Objectives affected by the risk</th><th>⌖ Consequences / Impact</th><th>⇒ Mitigation by: / action:</th></tr>
<tr><td>1
The capacity objective is not reached</td><td>The capacity goal is defined as:
➲ Enable a 3-fold increase in ATM capacity to be deployed where needed by the time traffic demand will have doubled
➲ By then, enable reduction of total ATFM delay minutes per flight from 1.9 (2005) to 1.0</td><td rowspan="3">⌖ Rework required resulting in delays in development and increased development costs
⌖ Compromise on capacity performance objective
⌖ Compromise on cost efficiency performance objective
⌖ Compromise on environmental performance objective
⌖ Delay of the deployment of the Programme
⌖ Reduction of the benefits associated with SESAR deployment
⌖ Potential delay of the deployment or need to revise the environmental objective
⌖ The nature of the deployment will be dependent on the degree to which the environmental objective has been reached</td><td rowspan="3">By: EC, SJU, Network Manager
Action:
⇒ Ensure alignment of SESAR Programme with other SES pillars and EC initiatives. Define performance contribution expected from SESAR Programme and other SES pillars and EC initiatives. Address performance contribution expected from Network Strategy Plan and from National/ FAB performance plans.
⇒ Strengthen cooperation SJU-PRB/PRU to ensure appropriate preparation of RP2. Provide an estimated contribution of SESAR to RP2. Extend this collaboration to the preparation of RP3.
⇒ Monitor contribution of projects as a result of validation exercises.</td></tr>
<tr><td>2
The cost efficiency objective is not reached</td><td>The cost efficiency goal is defined as :
➲ Provide ATM services at a unit cost to the airspace users which is at least 50% less when traffic demand will have doubled
➲ Total annual en-route and terminal ANS cost in Europe, €400/flight when traffic demand will have doubled</td></tr>
<tr><td>3
The environmental objective is not reached</td><td>The environmental goal is defined as:
➲ Enable a 10% reduction in the effects flights have on the environment when traffic will have doubled
➲ Gate-to-Gate ANS flight inefficiency index 90 when traffic will have doubled (2005=100; per flight)
➲ ANS-related en-route horizontal route extension 1.5% when traffic will have doubled (2005=4.1%)</td></tr>
<tr><td>4
Interoperability and global harmonisation are not ensured</td><td>Ensure that the synchronised application of standards and common principles, together with common technical and operational solutions for aircraft and ATM systems, will enable a measurable improvement of the ATM performance.
This objective may be affected by the following causes:
➲ Failure of the cooperation mechanisms in place to ensure this goal (with FAA, with ICAO, with other global actors)
➲ Not taking properly into consideration the interests of civil and military airspace users.</td><td>⌖ Rework required resulting in delays in development and increased development costs
⌖ Compromise on interoperability performance goal
⌖ Delayed deployment of the Programme
⌖ Reduction of the magnitude of the deployment of the Programme</td><td>By: EC, SJU
Action:
⇒ Work towards interoperability in the framework of ICAO working arrangements, specifically in preparation of ANC 2012.
⇒ Develop and maintain a global avionics roadmap.</td></tr>
<tr><td>5
Investment to support deployment beyond Deployment Baseline is not secured</td><td>The SESAR Programme is performance driven and must lead to implementation.</td><td>⌖ Insufficient commitment, financial resources and investment for the deployment phase
⌖ Delay / de-synchronisation of deployment
⌖ Performance objectives are not met
⌖ Severe negative impact on the EU economy, employment, mobility and environment</td><td>By: EC, SJU
Action:
⇒ Prepare for the deployment of first SESAR R&D results (business cases, linked performance improvements).
⇒ Ensure that financial and operational incentive mechanisms are defined and implemented to facilitate the deployment of SESAR
⇒ Ensure consistency between the stakeholders' roadmaps in the ATM Master Plan and stakeholders' investment plans.</td></tr>
</table>

Risk	Objectives affected by the risk	⌖ Consequences / Impact	⇒ Mitigation by: / action:
6 Delays in the implementation of the Deployment Baseline	The Deployment Baseline provides the initial baseline for future deployment of first SESAR R&D results	⌖ Insufficient commitment for the deployment phase ⌖ Delay / de-synchronisation of deployment plans related to first SESAR results ⌖ Performance objectives are not met ⌖ Negative impact on the EU economy, employment, mobility and environment	By: EC, SJU and All stakeholders Action: ⇒ Establish an Interim Deployment Steering Group (IDSG) to monitor implementation of the Deployment Baseline and report any deviation from the ATM Master Plan for further action to the appropriate forum (e.g. SSC, SJU AB, NMB). ⇒ Implement SESAR Deployment Baseline according to stakeholder roadmaps ⇒ Identify, stabilise and ensure implementation of baseline elements that are a prerequisite for SESAR deployment and/or essential for contributing to SES performance objectives.
7 Governance structure is not capable of ensuring successful deployment	The future deployment governance structure will be capable of ensuring a strong link between development and deployment of the SESAR Programme. Deployment of the SESAR Programme will be in alignment with Master Plan expectations.	⌖ Lack of accountability between the various actors. ⌖ Delay / de-synchronisation of deployment ⌖ Performance objectives are not met ⌖ Severe negative impact on the EU economy, employment, mobility and environment	By: EC Action: ⇒ Establish lessons learnt feedback from the IDSG to elaborate further the deployment governance mechanism. ⇒ Develop all guidance material necessary to establish the deployment governance structure through common projects. ⇒ Run the actual process of establishment, leading to the establishment of the deployment governance structure. Ensure early setup of the Deployment Manager as in EC COM (2011) 923. ⇒ Define and implement appropriate deployment governance mechanism to ensure an effective execution of the Deployment Programme consistently with the ATM Master Plan and the Network Strategy Plan.
8 Regulatory and standardisation needs are unable to support the deployment phase	Identification of the necessary standardisation and regulatory activities to support the implementation of the ATM Master Plan. Regulatory arrangements and standard implementation support the deployment of the Programme.	⌖ Delay / de-synchronisation of deployment ⌖ Potential for regulatory fragmentation leading to increased costs for the Programme ⌖ Compromise to the delivery of enhanced performance due to the reliance on “workarounds” to secure regulatory approval ⌖ Results of development phase are not deployable ⌖ Inappropriate regulation, regulation not in line with ICAO requirements or end-user expectations	By: EC, SJU, EASA Action: ⇒ Ensure the necessary involvement of SSC aiming the buy-in on the Regulatory Roadmap ⇒ Strengthen current engagement of the standardisation bodies in the development phase to prepare for deployment ⇒ Fully leverage the current mechanism to capture, in particular for ATM Master Plan essential operational changes , the regulatory and standardisation needs out of the R&D activities ⇒ Strengthen current engagement of the regulatory authorities in the development phase to prepare for deployment.

Risk	Objectives affected by the risk	⌖ Consequences / Impact	⇒ Mitigation by: / action:
9 The SWIM concept is not broadly adopted	SWIM is a key enabler for the future ATM system. Moreover, it is expected that SWIM will be the basis of the development of Concept Storyboard Steps 2 and 3 components.	⌖ The further evolution of CDM between ATM partners is not exploiting benefits that SWIM can bring thus limiting the capacity and operational efficiency improvements that can be derived from the NOP and trajectory management ⌖ Aeronautical information with extended scope is not available to ground and airborne systems ⌖ The whole basis of the SESAR Concept of Operations and business case would be jeopardised	By: SJU Action: ⇒ Ensure common understanding and a better integration between SWIM Projects and the rest of the Programme. ⇒ Ensure that SWIM related requirements for information services are expressed by all operational projects. ⇒ Ensure availability of a prototype SWIM infrastructure supporting the broadest possible use in R&D and validation activities of operational and system projects.
10 The definition and follow-up of the main milestones and business criteria do not enable the Programme to be steered effectively	The Programme must set clear guidance to the projects in terms of milestones to achieve target dates, level of maturity, performance targets and business expectations to reach (top-down approach). The content of the milestones and targets set by the Programme must be clear to allow for: ➲ possible alignment of the R&D Projects in the scope of the releases, ➲ possible measure of the contribution of projects to the performance & business targets.	⌖ Project deliverables will not deliver solutions that allow for completion of the milestones and business expectations of the Programme.	By: SJU Action: ⇒ Implement the gap analysis process related to the releases ⇒ Strengthen top-down approach for driving the Release 3 definition phase. The approach will rely on a better consideration of the integrated roadmap. This integrated roadmap should provide a link between OIs and Enablers per project, and performance targets
11 The technical management approach does not enable the Programme to ensure the overall coherence of the future ATM system	In this respect, the SESAR Work Programme objectives are to ensure: ➲ consistency of the future ATM system architecture and requirements in accordance with the three steps of the SESAR Concept Storyboard; ➲ consistency & coherence within & between Operational Work Packages (WP), SWIM WP, System WP and Transversal WP; ➲ Overall validation and consistency of the SESAR Programme.	⌖ Consistency and synchronisation between the projects cannot be guaranteed	By: SJU Action: ⇒ Assign Programme priorities based on critical path analysis for the main SESAR components ⇒ Ensure compliance of projects with quality criteria related to content definition and validation and proper content integration processes through the effective use of transversal activities ⇒ Ensure that transversal activities deliverables are fit for purpose and strongly coupled with programme priorities ⇒ Further improve system engineering reviews, including progressively strengthening entry and exit criteria for the SESAR Release definition and closure and assign performance targets to Release validation activities.

Risk	Objectives affected by the risk	⌖ Consequences / Impact	⇒ Mitigation by: / action:
12 Discontinuation of R&D activities in support to deployment.	The ATM Master Plan should ensure the integrity and consistency of the entire R&D and validation process, from inception to industrialisation, where deployment-oriented R&D constitutes the backbone. This should be a continuous, dynamic and collaborative process aiming to achieve the SES performance requirements.	⌖ An interruption in the planning and monitoring of this process, at any stage, will substantially compromise the successful and coherent modernisation of European ATM. ⌖ Lack of clarity on the continuation of the R&D activities beyond 2016, in scope and means, and on the "ownership of the ATM Master plan would seriously undermine the capacity of ATM to meet the performance requirements with a negative impact on the industrialisation processes and consequently on synchronisation of deployment. In particular, the SESAR JU is established up to 2016 and an inadequate anticipation of the future R&D needs would detract from the major momentum that has been established to coordinate and concentrate R&D deployment oriented activities.	By: EC, SJU Action: ⇒ Carry out the necessary evaluation and consultations on the continuation of the EU PPP approach for planning and coordinating future ATM R&D and validation activities and for the execution and maintenance of the ATM Master Plan. ⇒ SJU to provide support to the EC in order to ensure that the needs to address technological innovation to support evolving performance requirements and necessary funding are assessed in a timely manner, and sufficiently in advance of the short-term deadlines. ⇒ Ensure the adequate documentation of all relevant R&D output and the identification and storage of all results, necessary to ensure continuity of ATM Research and Development and deployment planning activities supporting the execution of the ATM Master Plan.
13 Failure to manage Human Performance (Human Factors, Competency and Change Management) issues in the development and implementation of the ATM Target Concept	➲ Human Factors not integrated in concepts, development and validation (with operational staff), including applying minimal standards and unrealistic assumptions (especially human workload and automation) ➲ Lack of appropriate Competency (Training and Assessment) regulatory, certification, training and assessment framework ➲ Lack of verified and competent Human Resources to support operations in a new technological environment (timely and in sufficient numbers) ➲ Absence of appropriate Social and Change Management processes and Social Dialogue structures at European, national and local levels. ➲ Lack of an integrated and consistent approach (consistency between regulatory and working bodies).	⌖ Without addressing these risks the future European ATM System will not fully achieve its objectives ⌖ Risk of additional safety hazards	By: SJU and All stakeholders Action: ⇒ Ensure that operational staffs are included in development and validation activities. ⇒ Issue regular recommendations and activity plans for Human Performance in the area of R&D, regulation, standards, and management at industry level. ⇒ Monitor all SESAR oriented R&D and validation phases regarding Human Performance standards, methods and requirements. ⇒ Examine staffing implications of all deployment activities for all groups of operational aviation staff and publish results and related recommendations. ⇒ Ensure appropriate coordination between all stakeholders concerned to ensure consistency between initiatives related to Human Factors, Competency and Social Dialogue.

7 LIST OF ABBREVIATIONS

2D: 2 dimensional
3D: 3 dimensional
4D: 4 dimensional
A/G: Air/Ground
ABAS: Aircraft Based Augmentation System
ACARS Aircraft Communications and Reporting System
ACAS: Airborne Collision Avoidance System
ACC: Area Control Centre
ACNS: Airborne Communications, Navigation and Surveillance
A-CDM: Airport-CDM
ADS: Automatic Dependent Surveillance
ADS-B: Automatic Dependent Surveillance - Broadcast
ADS-C: ADS-Contract
AeroMACS: Aeronautical Mobile Airport Communications System
AFIS: Aerodrome Flight Information Service
AFUA: Advanced Flexible Use of Airspace
AGDLGMS: Air/Ground Datalink Ground Management System
AIM: Accident Incident Model, Aeronautical Information Management
AIP: Aeronautical Information Publication
AIRM: ATM Information Reference Model
AIS: Aeronautical Information Service
AIXM: Aeronautical Information Exchange data Model
AMAN: Arrival MANager
AMC: Acceptable Means of Compliance
AMHS: ATS Message Handling System
AMS: Airspace Management System
ANS: Air Navigation Services
ANSP: Air Navigation Service Provider
AO: Airport Operator
AOA: ACARS Over AVLC
AOC: Airline Operations Centre
AOP: Airport Operating Plan
APT: Airport
APV: Approach Procedure with Vertical Guidance
ASAS: Airborne Separation Assistance/Assurance System
ASBU: Aviation System Block Upgrades
ASD: Aircraft Situation Display
ASEP: Airborne Separation
ASM: Airspace Management
A-SMGCS: Advanced Surface Movement Guidance and Control System
ASPA: ASAS Spacing
ASPA-S&M: ASPA – Sequencing & Merging
ATC: Air Traffic Control
ATCO: Air Traffic Controller
ATFCM: Air Traffic Flow and Capacity Management
ATFM: Air Traffic Flow Management
ATM: Air Traffic Management
ATMCP: ATM Operational Concept Panel
ATMRPP: ATM Requirements and Performance Panel
ATN: Aeronautical Telecommunications Network
ATS: Air Traffic Services
ATSA: Air Traffic Situational Awareness
ATSA-ITP: Air Traffic Situational Awareness – In Trail Procedure
ATSA-SURF: Air Traffic Situational Awareness on the Airport Surface
ATSU: Air Traffic Service Unit
AVLC: Aviation VHF Link Control
B2B: Business-to-Business
BA: Business Aviation
BIC: Best-in-Class
BMT: Business/Mission Trajectory
C&P: Crossing & Passing
CAPEX: Capital Expenditure
CBA: Cost Benefit Analysis
CCD: Continuous Climb Departures
CDA: Continuous Descent Approach
CDM: Collaborative Decision Making
CDO: Continuous Descent Operations
CNS: Communications, Navigation and Surveillance
CORA: COnflict and Resolution Advisor
CPDLC: Controller Pilot DataLink Communications
CS: Certification Specifications (EASA) or Community Specification
CTA: Controlled Time of Arrival
CTO: Controlled Time Over/Over fly
CWP: Controller Working Position
CVS: Combined Vision system
DAT: Datalink
DCB: Demand & Capacity Balancing
DLS: Datalink Services
DMAN: Departure MANager
DME: Distance Measuring Equipment
DST: Decision Support Tools
D-TAXI: Datalink Taxi Support
EAD: European AIS Database
EASA: European Aviation Safety Agency
EC: European Commission
ECAC: European Civil Aviation Conference
eRIA: early Regulatory Impact Assessment
ESSIP: European Single Sky ImPlementation
ETA: Estimated Time of Arrival
ETO: Estimated Time Over
eTOD: Electronic Terrain and obstacle database
EU: European Union
EUROCAE: European Organisation for Civil Aviation Equipment
FAA: Federal Aviation Administration
FAB: Functional Airspace Block
FCI: Future Communications Infrastructure
FDP: Flight Data Processing
FDPS: Flight Data Processing System
FF-ICE: Flight and Flow Information of a Collaborative Environment

FIR: Flight Information Region
FIXM: Flight Information eXchange Model
FL: Flight Level
FMS: Flight Management System
FUA: Flexible Use of Airspace
G/G: Ground/Ground
GA: General Aviation
GBAS: Ground Based Augmentation System
GM: Guidance Material
GNSS: Global Navigation Satellite System
GPS: Global Positioning System
HC: High Capacity
HCn: High Capacity needs
HF: High Frequency
HMI: Human Machine Interface
i4D: initial 4D
ICAO: International Civil Aviation Organisation
IEEE: Institute of Electrical and Electronics Engineers
IFR: Instrument Flight Rules
ILS: Instrument Landing System
IOC: Initial Operating Capability
IOP: Interoperability Protocol
IP: Internet Protocol
IR: Implementing Rule
ISRM: Information Services Reference Model
ITF: In-Trail-Follow
KPA: Key Performance Area
KPI: Key Performance Indicator
LC: Low Capacity
LCn: Low Capacity needs
LDACS: L-band Datalink Aeronautical Communication System
LVC: Low Visibility Conditions
LVP: Low Visibility Procedures
MASPS: Minimum Aviation System Performance Standards
MC: Medium Capacity
MCn: Medium Capacity needs
MET: Meteorology/Meteorological information
MLAT: Multilateration
MLS: Microwave Landing System
MONA: MONitoring Aids
MOPS: Minimum Operational Performance Specifications
MTCD: Medium Term Conflict Detection
N/A: Not Applicable
NM: Network Manager
NMF: Network Management Function
NOP: Network Operations Plan
NOTAM: Notice to Airmen
NRA: Non-Radar Airspace
OAT: Operational Air Traffic
ODP: Optimised Descent Profile
OI: Operational Improvement
OPEX: Operational Expenditure
OSED: Operational Services and Environment Description
PANS: Procedures for Air Navigation Services
PBN: Performance Based Navigation
PENS: Pan-European Network Service
P-RNAV: Precision Area Navigation
PSR: Primary Surveillance Radar
PTC: Precision Trajectory Clearances
R&D: Research & Development
RA: Resolution Advisory
RAD: Radar
RBMT: Reference Business/Mission Trajectory
RBT: Reference Business Trajectory
RNP: Required Navigation Performance
ROI: Return on Investment
ROT: Runway Occupancy Time
RP: Reference Period
RPA: Remotely Piloted Aircraft
RTCA: Radio Technical Commission for Aeronautics
SATCOM: SATellite COMmunications
SBAS: Satellite Based Augmentation System
SBT: Shared Business Trajectory
SES: Single European Sky
SESAR: Single European Sky Research programme
SJU: SESAR Joint Undertaking
SMAN: Surface MANager
SMGCS: Surface Movement Guidance and Control System
SMR: Surface Movement Radar
SMT: Shared Mission Trajectory
SPR: Service Provision Regulation
SSC: Single Sky Committee
SSEP: Self Separation
SSR: Secondary Surveillance Radar
STATFOR: EUROCONTROL Statistics and Forecast Service
STCA: Short Term Conflict Alert
SURF IA: Surface Indications and Alerts
SV: Synthetic Vision
SVS: Synthetic Vision System
SWIM: System Wide Information Management
SYSCO: SYstem Supported Coordination
TCAS: Traffic Collision Avoidance System
TCT: Tactical Controller Tools
TMA: Terminal Manoeuvring Area
TMF: Trajectory Management Framework
ToC: Top of Climb
ToD: Top of Descent
TP: Trajectory Predictor
UDPP: User Driven Prioritisation Process
VDL: VHF Datalink
VFR: Visual Flight Rules
VHC: Very High Capacity
VHCn: Very High Capacity needs
VHF: Very High Frequency
VNAV: Vertical NAVigation
VoIP: Voice over Internet Protocol
VPA: Variable Profile Area
WAM: Wide Area Multilateration
WIMAX: Worldwide Interoperability for Microwave Access
WOC: Wing Operation Centre
WV: Wake Vortex
WXXM: Weather data eXchange Model
X25: Standard Protocol for Telecommunications

8 ANNEXES

8.1 Annex A: Summary of SESAR Baseline and Step 1 Essential Operational Changes

Key features	Essential Operational Changes	
	Baseline only or Baseline in support of Step 1	**Step 1**
Moving from airspace to 4D trajectory management	**Baseline only (section 3.4):** • Approach Procedure with Vertical Guidance (APV) **Baseline in support of Step 1 (section 3.3):** • Civil/Military Airspace & aeronautical data coordination • A/G datalink • CPDLC	• Trajectory management and business/mission trajectory (section 3.5.1) • System interoperability with A/G data sharing (section 3.5.2) • Free routing (section 3.5.3)
Traffic synchronisation	**Baseline in support of Step 1 (section 3.3):** • Basic AMAN	• i4D+CTA (section 3.5.4) • Integrated AMAN, DMAN & extended AMAN horizon (section 3.5.5)
Network Collaborative management and Dynamic/Capacity Balancing	**Baseline only (section 3.4):** • Basic dynamic sectorisation **Baseline in support of Step 1 (section 3.3):** • Basic network operations planning	• Network operations planning (section 3.5.6)
SWIM	**Baseline in support of Step 1 (section 3.3):** • exchange models • IP based network	• Initial SWIM services (section 3.5.7)
Airport Integration and Throughput	**Baseline only (section 3.4):** • Continuous Climb Departure (CCD) • Continuous Descent Approach (CDA) **Baseline in support of Step 1 (section 3.3):** • Airport CDM • A-SMGCS levels 1 & 2	• Surface management integrated with arrival and departure (section 3.5.8) • Airport safety nets (section 3.5.9)
Conflict Management and Automation	**Baseline only (section 3.4):** • Performance Based Navigation (PBN) – optimised Required Navigation Performance (RNP) route structures • Short Term Conflict Alert (STCA) **Baseline in support of Step 1 (section 3.3):** • Initial controller assistance tools	• Enhanced decision support tool and performance based navigation (section 3.5.10) • Conflict detection and resolution (section 3.5.11)

8.2 Annex B: Mapping SESAR Operational Changes - ICAO Aviation System Block Upgrades

The mapping between SESAR Operational Changes and ICAO's ABSU initiative is highlighted in the following figures. In ICAO Block 0 the links to the Deployment Baseline are highlighted in green and in Block 1 the SESAR Operational Changes to the Essential Operational Changes are highlighted in blue.

Figure 28 **ICAO Block 0 / SESAR operational changes**

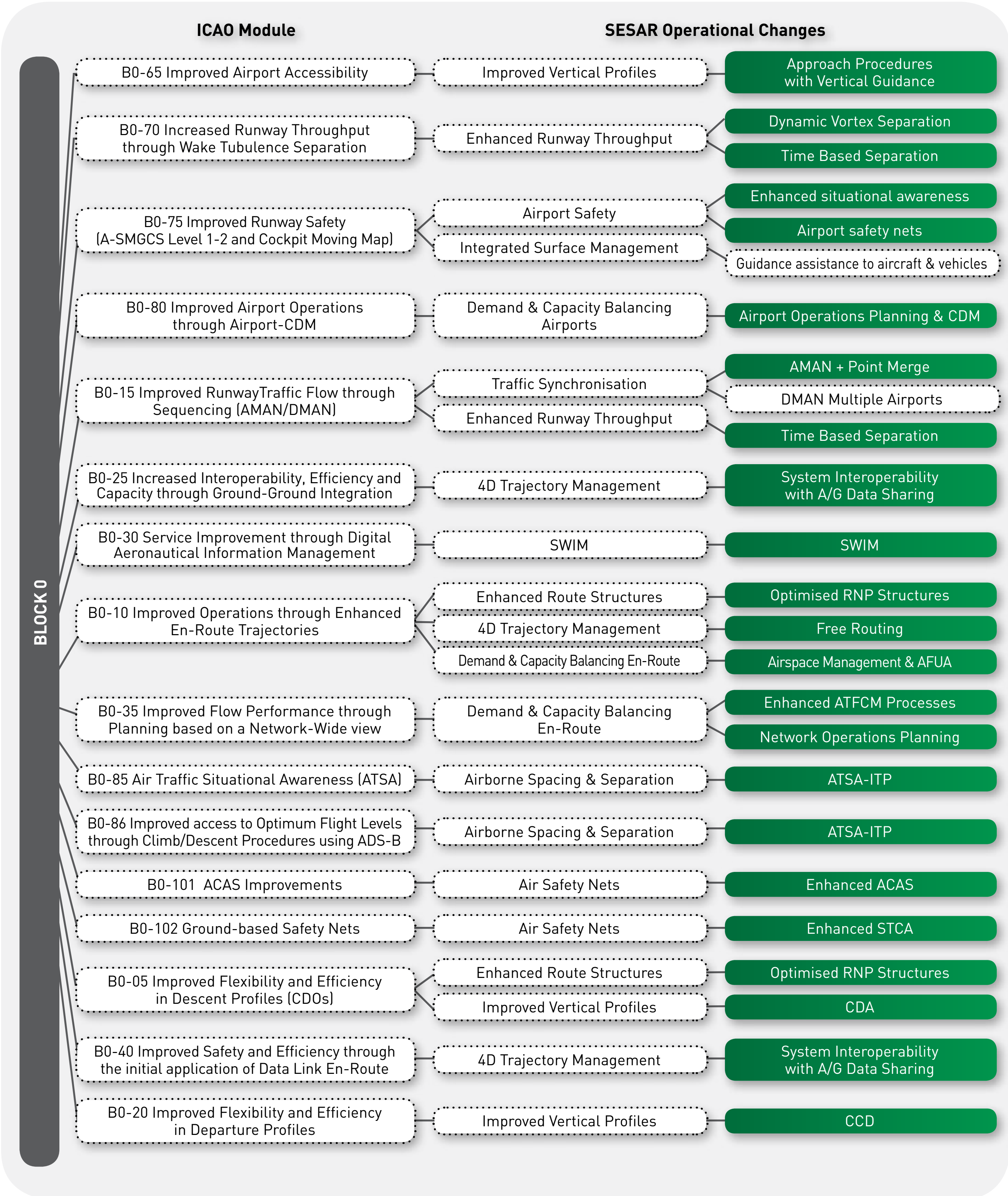


Figure 29 **ICAO Block 1 / SESAR operational changes**

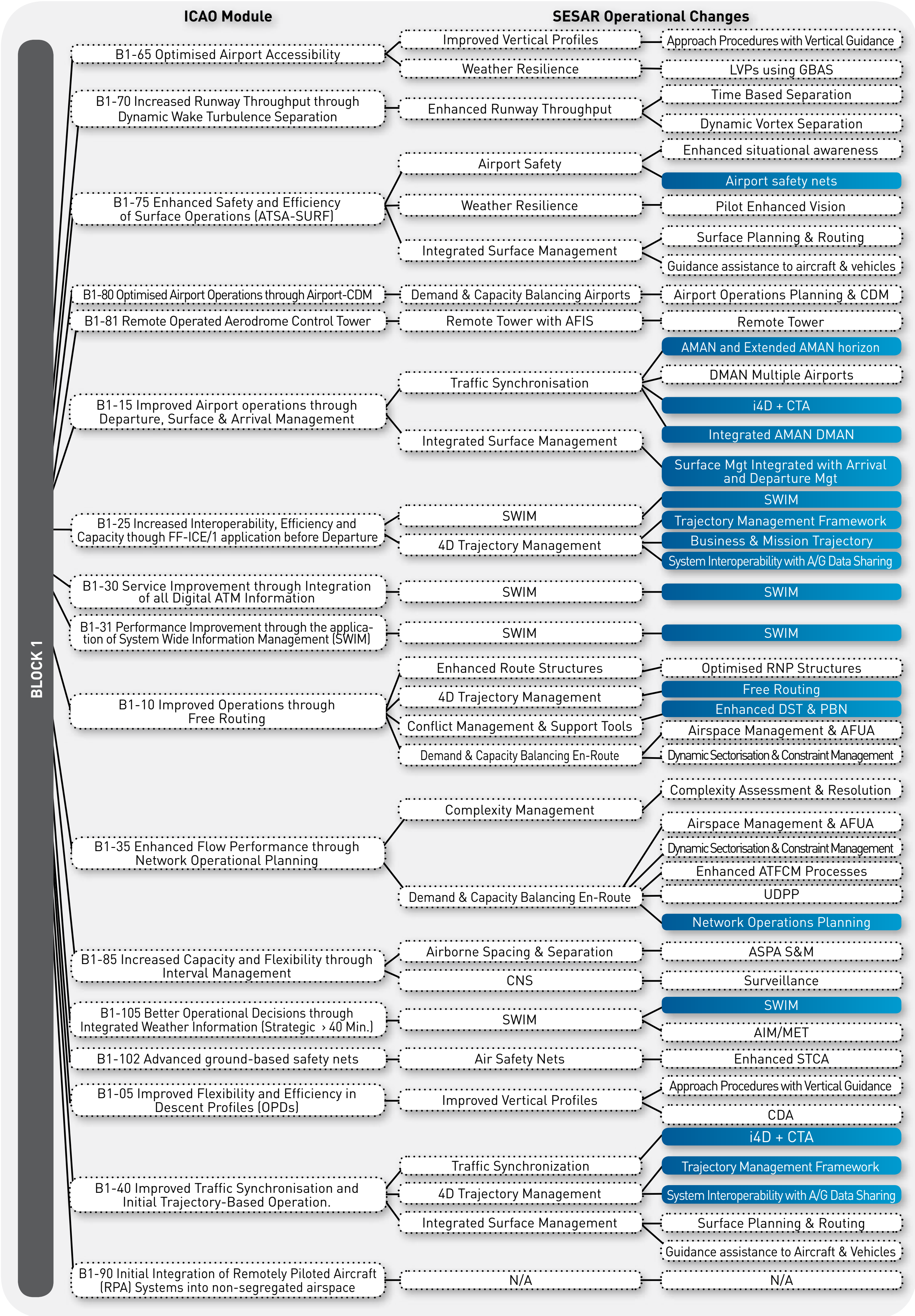


Figure 30 **ICAO Block 2 / SESAR operational changes**

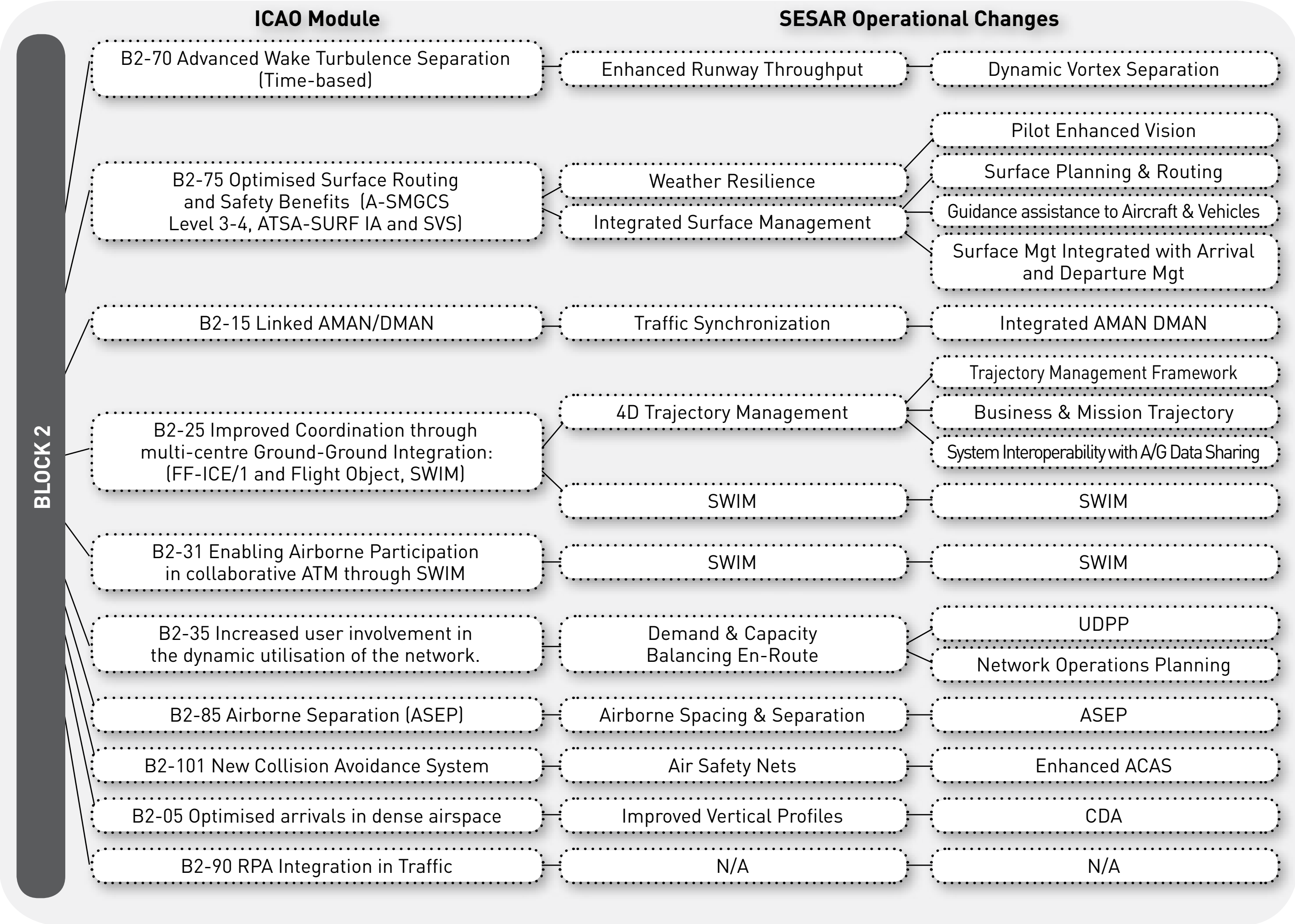
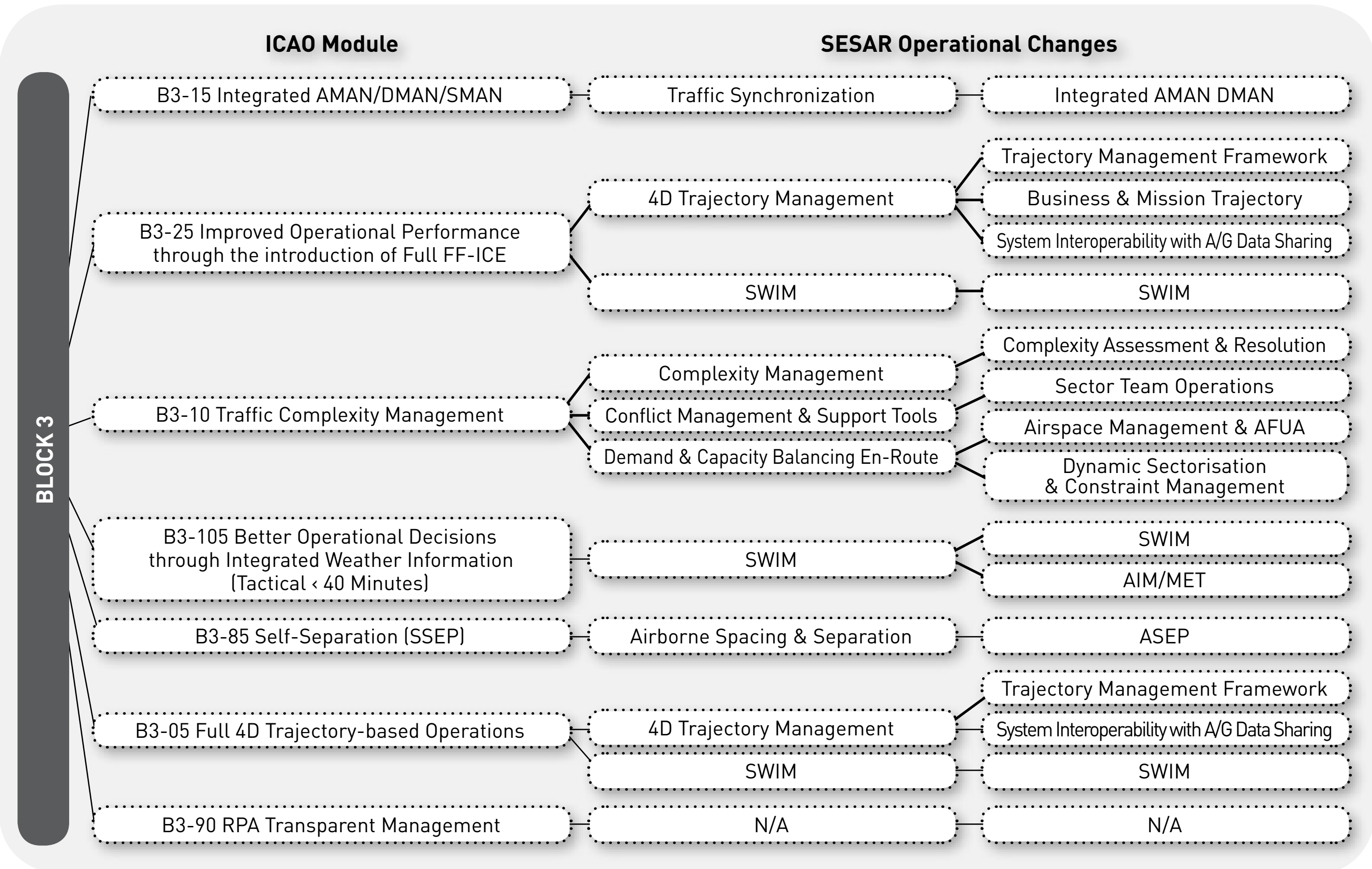


Figure 31 **ICAO Block 3 / SESAR operational changes**



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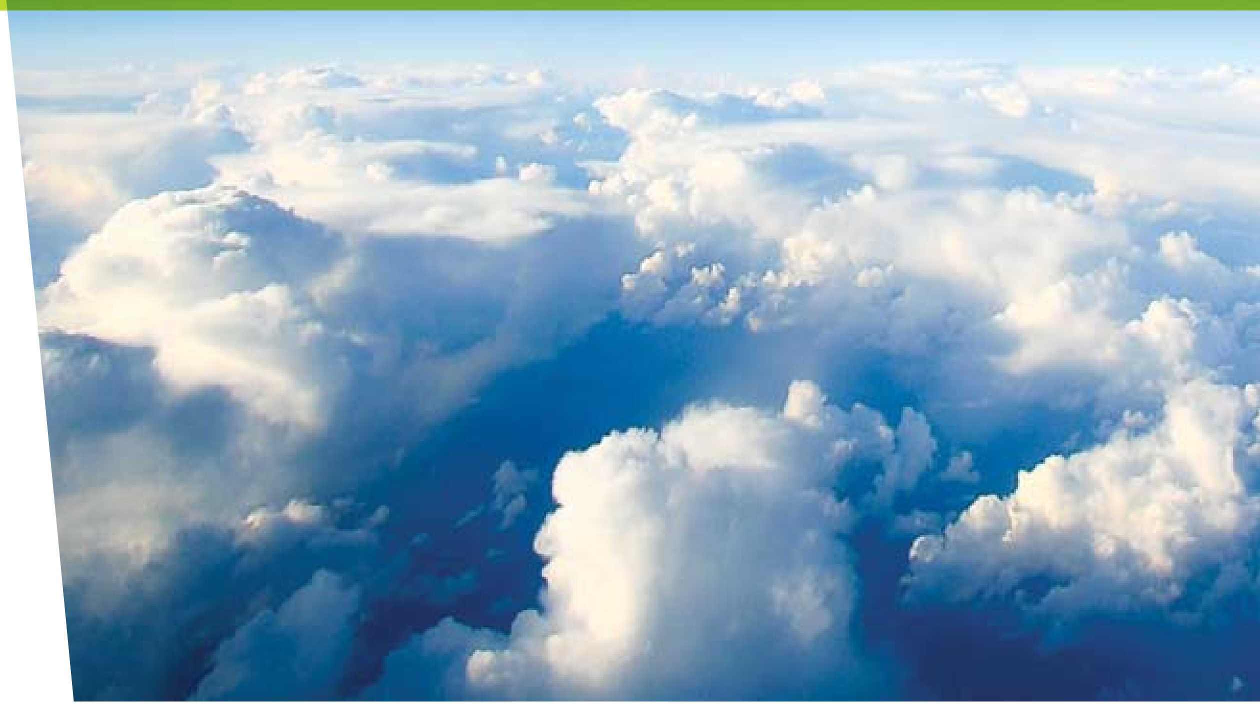

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