

THE CONCEPT OF OPERATIONS FOR THE FUTURE EUROPEAN AIR TRAFFIC MANAGEMENT SYSTEM BEING DEFINED BY SESAR

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1. OVERVIEW

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

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

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

D1: Air Transport Framework – the current situation

D2: Air Transport Framework – the Performance Target

D3: Definition of the future ATM Target Concept

D4: Selection of the “Best” Deployment Scenario

D5: Production of the ATM Master Plan

D6: Work Programme for 2008 -2013

The SESAR Consortium has been selected to carry out the Definition Phase study, which for the first time in European ATM history has brought together the major stakeholders in European aviation to build the ATM

Master Plan. The SESAR Consortium draws upon the expertise of the major organisations within the aviation industry. This includes Airspace Users, Air Navigation Service Providers (ANSPs), Airport Operators and the Supply Industry (European and non-European), plus a number of Associated Partners, including safety regulators, military organisations, staff associations (including pilots, controllers and engineers) and research centres who work together with the significant expertise of EUROCONTROL. This is considered to be a major achievement.

This paper will summarise the scope and the principles of the SESAR Concept of Operations and cover:

1. The SESAR Consortium Agreement on the ATM Target Concept for Implementation by 2020;
2. The key features of the high performing ATM Target Concept in 2020;
3. The ATM ConOps for 2020
4. The ATM System Architecture and Technologies for 2020
5. The Performance Analysis of the ATM Target Concept for 2020;
6. The Cost Benefit Analysis / Cost Assessment;
7. The Means for the Implementation of the ATM Target Concept for 2020;
8. The Next Steps Towards 2020.

1.1. Keywords

Air Traffic Management, Single European Sky legislation, European ATM Master Plan, ATM Target Concept, Concept of Operations, ConOps, Performance Target, SESAR.

2. SESAR CONSORTIUM AGREEMENT ON THE ATM TARGET CONCEPT FOR IMPLEMENTATION BY 2020

In the previous SESAR Deliverable documents D1 ("Air Transport Framework: The Current Situation") and D2 ("The Performance Target"), the SESAR consortium has identified the main challenges of the ATM industry resulting from continuously growing demand in air transport. As the European Air Traffic Management System is operating close to its limits, and to avoid the capacity gap that will otherwise grow, all ATM stakeholder categories have collaborated to produce the ATM Target Concept, its Concept of Operations (ConOps), its Architecture and the supporting Technologies, associated human aspects, the necessary institutional enablers and business aspects.

In D2, the SESAR Consortium defined initial, indicative Performance Objectives and Targets for the European ATM Target System for 2020 and beyond so as to address the current shortcomings identified in D1. In continuation of this performance based approach, the SESAR consortium agreed on the ATM Target Concept enabling the European ATM System with the objective of progressively meeting these performance targets. To accommodate a 3-fold increase in capacity, the ATM Target Concept considers promising further developments that, subject to further R&D, will help achieving the longer-term performance objectives beyond 2020.

Global Interoperability is of major importance for the development of the ATM Target Concept. Compliance with the ICAO Operational Concept Document has been the objective from the outset and will be the basis for convergence with other on-going initiatives (e.g. NextGen in the USA). As the ATM Target Concept is formed around the 4-D Trajectory as the core of the System, a major change is recognised and required to replace the current ICAO Flight Plan with a 4-D Trajectory definition and exchange format.

The ATM Target Concept **is not about one size / one solution fits all**; it offers different concept features which can be tailored to the specific local needs to meet the local performance objectives. It addresses the needs of different Airspace Users (e.g. scheduled airlines, on-demand operators, military, general aviation, et cetera) and various ATM partners ranging from the European core area to oceanic and low traffic density area.

The SESAR Consortium has achieved agreement on the 2020 ATM Target Concept. Work to date suggests that it is sufficiently promising to justify the necessary follow-up work. Further validation and development of the ConOps will take place as part of the SESAR Development Phase.

3. THE KEY FEATURES OF THE HIGH PERFORMING ATM TARGET CONCEPT IN 2020

The stakeholders agree that, in order to strengthen the air transport value chain, the Airspace Users' requirements need to be better accommodated. To this end, each single flight shall be executed as close as possible to the

intention of its owner. This is the main driving principle for the ATM Target Concept, which is centred around the notion of the "business trajectory" (for military "mission trajectory"), representing an Airspace User's intention for a given flight. Air traffic management services necessary to execute this trajectory will ensure that it is carried out safely and cost efficiently within the infrastructural and environmental constraints.

Changes to the business trajectory must be kept to a minimum, altering it only for reasons of separation and/or safety. In the case of unplanned disruptions the overall ATM network goals (relating to capacity, environment and economic performance) will take precedence over individual flight trajectories.

Changes will ideally be performed through a Collaborative Decision Making mechanism consistent with the individual responsibilities of pilots and controllers for separation provision, for safety or for improvement of the air traffic flow.

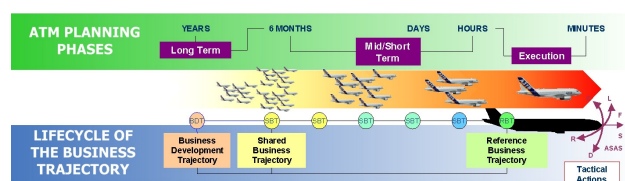


Figure 1: The Business Trajectory lifecycle

Business trajectories will be expressed in all 4 dimensions (position and time) and flown with much higher precision than today. Sharing access to accurately predicted, unique 4D trajectory information will reduce uncertainty and give all stakeholders a common reference, permitting collaboration across all organisational boundaries.

Fundamental to the entire ATM Target Concept is a 'network-centric' operation based on

- a powerful information handling network for sharing data,
- new air-air and air-ground data communications systems, and
- an increased reliance of airborne and ground based automated support tools

4. THE ATM CONOPS FOR 2020

The ATM Concept of Operations for 2020 represents a paradigm shift from an airspace based environment to a trajectory based environment.

4.1. Trajectory Management is introducing a new approach to airspace design and management

Trajectory based operations imply a new approach to airspace design and management to avoid, whenever possible, airspace becoming a constraint on the trajectories. Airspace User preferred routing, without pre-defined routes will be applicable everywhere, other than in some terminal areas and below a designated level in some areas.

The only exception considered is a situation when sufficient capacity can only be provided through the use of structured routes, which at the same time shall decrease holding queues in the air and on the ground. However, such structured routes will only be activated when needed.

Integration of the needs of Military (operators and service providers) alongside civilian stakeholders will ensure the overall efficiency of the ATM network. Military needs regarding access to and flexible use of airspace, including the provision of sufficient airspace volumes to meet operational and training requirements, is safeguarded by the ConOps. No other segregation is considered required by the ATM Target Concept.

Only two categories of airspace will be defined and organised: managed airspace where a separation service will be provided but the role of the separator may in some cases be delegated to the pilot and unmanaged airspace where the separation task lies solely with the pilot.

4.2. Collaborative planning continuously reflected in the Network Operations Plan

Collaborative layered planning undertaken at local, sub-regional and European level will balance capacity and demand taking into account constraints and diverse events. An efficient queue management will allow optimized access to constrained resources (mainly airports). The results of these processes will be permanently reflected in a continuously updated Network Operations Plan ensuring a degree of strategic de-conflicting whilst minimising holding and ground queues. In the event of a capacity shortfall, Airspace Users will be offered the possibility to determine a priority order between themselves for those flights affected by delays and to achieve their business objectives.

4.3. Integrated Airport operations contributing to capacity gains

Airports will become an integral part of the ATM system due to the extension of trajectory management. Increased throughput and reduced environmental impact (through e.g. turn-round management, reduction of the impact of low visibility conditions, et cetera) is envisaged. With improved Airport Resource Planning processes there will be greater coordination between the stakeholders and thereby improved use of available capacity to meet the increased demand.

4.4. New separation modes to allow for increased capacity

New separation modes gradually being implemented over time, supported by controller and airborne tools, will use trajectory control and airborne separation systems to minimize potential conflicts and controllers' interventions.

4.5. System Wide Information Management – integrating all ATM business related data

Underpinning the entire ATM system, and essential to its efficient operation, is a System Wide Information Management (SWIM) environment that includes aircraft as well as all ground facilities. It will support collaborative decision-making processes using efficient end-user applications to exploit the power of shared information.

4.6. Humans will be central in the future European ATM system as managers and decision-makers

In the ATM Target Concept it is recognised that humans (with appropriate skills and competences, duly authorised) will constitute the core of the future European ATM System's operations. However, to accommodate the expected traffic increase, an advanced level of automation support for the humans will be required. The basic principles of an automation strategy have been established and are clearly outlined within the SESAR Definition Phase activities. The nature of human roles and tasks within the future system will necessarily change. This will affect system design, staff selection, training (especially for unusual situations and degraded mode of operations), competence requirements and relevant regulations. Recruitment, training, staffing and competence implications have been evaluated and will be considered when the development phase has progressed sufficiently to support the change of the roles and responsibilities of all the actors within the ATM System up to a successful implementation of the ATM Target Concept.

5. THE ATM SYSTEM ARCHITECTURE AND TECHNOLOGIES FOR 2020

The ATM Target Concept has been designed to support Airspace Users' operations with different levels of ATM capability ranging from those available today up to those anticipated beyond 2020 allowing for a smooth transition. The ATM Target Concept will offer different levels of ATM services but should not use these capabilities to segregate access to airspace or airports.

An **ATM System architecture** supports the 2020 ConOps, servicing aircraft with the flexibility and adaptability to adjust to changing traffic flows, performance requirements and different local conditions while capitalising on the current developments. Solutions have been proposed to implement SWIM (including the management of its security and its safety), which is a corner stone of the future European ATM System. The SWIM environment will shift the ATM architecture paradigm from message exchange to information publishing/using/contributing where the definition of the data and associated services are crucial.

Within the SESAR development phase, the architecture will be developed making use of an Enterprise Architecture methodology and Service Oriented Architecture techniques, ensuring better alignment

between the Information Technology systems and the Air Traffic Management business, as well as a clear distinction between the ATM services that have to be provided, the underlying supporting services and the physical assets that will need to be deployed.

Technology enablers meeting the identified operational and architecture requirements in providing and distributing the information in time and to the right location with the required availability, continuity and integrity have been identified:

- The communication systems will increasingly use digital technology to a full integration of terrestrial and satellite networks towards a data network connecting all ATM subsystems.
- The primary navigation system will be satellite based with a terrestrial fall back solution to mitigate against a potential full blackout of satellite navigation services.
- New surveillance systems e.g. ADS-B will increasingly provide improved 4D-trajectory information (position and time).

6. PERFORMANCE ANALYSIS OF THE ATM TARGET CONCEPT FOR 2020

The performance assessment process in this SESAR Milestone Deliverable D3 has built on the foundation of the Performance Framework and the initial Targets first introduced in D2, and has focused on the ATM Target Concept for 2020.

Based on the preliminary qualitative performance assessment of the various options, there is confidence that the ATM Target Concept, when fully implemented, will meet the initial targets as defined in D2 with the required level of safety.

The conclusion of the qualitative capacity performance assessment is that the ATM Target Concept can achieve airport capacity targets for many airports and low/medium complexity airspace. However, certain major hub airports and some terminal airspace areas at major network nodes are seen as potential bottlenecks and will be severely restricted.

Consequently, additional capacity needs to come from new runways complemented by the greater use of regional and other uncongested airports (including military airports) to satisfy the demand.

The **capacity targets** will be addressed through:

- 4D Trajectory Management,
- new separation modes,
- wide availability of controller support tools,
- collaborative planning and balancing of traffic demand and capacity,
- reduction in trajectory uncertainty and
- improved airport processes.

The major contribution to **safety performance improvement** will mainly come from better planning, increased situational awareness and automated tools detecting all aircraft interactions at a far earlier stage than current methods allow. In order to show evidence of these expected safety benefits, the potential risk contributions need to be identified by continuous appropriate screening

for any safety issues during the development and deployment of the ATM Target Concept and by developing appropriate safety assessment methodologies and procedures.

Security aspects of the ATM Target Concept, e.g. the extensive use of IT Infrastructure, have been analysed in respect of self-protection and collaborative security support. In order to achieve the expected security benefits, the potential risk contributions need to be identified by continuous appropriate screening for any security issues and addressed during the development and deployment of the ATM Target Concept by developing appropriate security techniques and procedures.

Matching the societal expectation of a 10% CO₂ emission reduction per flight is considered as challenging. However, the ATM Target Concept will **minimize the environmental impact** that can be attributed to ATM in terms of noise, local air quality, additional fuel burn and the related CO₂ emissions by optimizing the flight trajectories and lessening gaseous and particulate emissions on the surface by eliminating holding and ground queues.

7. COST BENEFIT ANALYSIS / COST ASSESSMENT – A MAIN CONSIDERATION WITHIN SESAR

A preliminary **cost assessment** has been performed which provides initial indications of the magnitude of the total costs associated with the R&D, implementation and operation of the ATM Target Concept for all stakeholders. It should be noted that this cost assessment has been based on a number of assumptions which will be further refined in the SESAR Milestone Deliverable D4 as well as during the SESAR Development Phase.

The SESAR Target Concept is likely to be affordable and economically viable to all stakeholders only under the following conditions: (on the benefits side) if the cost-effectiveness target is met and capacity and quality of service targets are met to their greatest extent, (on the cost side) if global interoperability (e.g. with NextGen) is achieved allowing significantly reduced forward fit costs. However, the results of D3 are not conclusive with regard to the questions of affordability and economic viability. A low benefit to cost ratio is currently expected, therefore the investment in the ATM Target Concept should be seen as long-term and strategic in nature which would justify the need for public funding for implementation. Especially for General Aviation, the rate between costs and benefits is critical and requires further consideration. Also the distribution of costs and benefits for the military will need further study.

A major critical factor for the successful implementation of the SESAR ATM Master plan is the full alignment of the implementation plans of all partners. For the benefits of all stakeholders the set-up of special purpose financing structures to finance the investments necessary for the implementation of the SESAR ATM Master plan is recommended.

The initial ATM Target Concept assessment results show that the direct cost of providing gate-to- gate ATM services, in an unconstrained traffic increase scenario,

could reduce from €800 to an average of €450 (up to €600 for highly complex airspace) per flight when fully implemented. In order to fully achieve the initial cost-effectiveness target (€400 per flight) additional measures, external to the scope of the SESAR programme but within the framework of the Single European Sky (e.g. de-fragmentation of service provision), will be needed.

8. MEANS FOR THE IMPLEMENTATION OF THE ATM TARGET CONCEPT BY 2020

A main principle under which the 2020 ATM industry will conduct business is the ATM Performance Partnership (ATMPP). To be successful, the ATMPP must achieve genuine participation and buy-in from ALL stakeholder groups¹. It must provide added value by producing coordinated and consistent positions to a level not achieved so far. Within the ATMPP, business decisions will be coordinated. Regulatory decisions, which must be enforceable (e.g. changes to mandatory aircraft equipage) will remain within the Institutional and Regulatory Framework, although it is anticipated that the improved discussion process enabled by the ATMPP, including full discussion with regulatory representatives, will permit preparation and development in a timelier manner. The ATMPP will coordinate stakeholder views as inputs to existing organisations.

At a pragmatic level, **there should be no outright legal showstoppers** at European Level to the ATM Target Concept. Variation between national laws in some areas may complicate specific issues but not to the point where harmonisation is essential. To enable further capacity gains beyond 2020, promising concepts such as the full implementation of self-separation will require major changes in European and global legislation to ensure the necessary technical and operational harmonisation.

Future developments of the ATM Target Concept should include clarification of the new roles and responsibilities in order that the legal implications and liability issues, as well as the **ATM safety responsibilities** and new interfaces between stakeholders may be assessed. It is recognised, that adequate change and transition management supports and contributes to aviation safety. The ATM Target Concept will require significant changes to technology, both on the ground and in the air, and this will need to be developed within a **clear safety regulatory framework** where safety responsibilities are unambiguously defined. A close civil-military interaction and the involvement of appropriate military expertise within this safety regulatory authority will be an essential requirement. Recommendations have been established to address these safety concerns during the SESAR development phase. Moreover, there is potentially a significant amount of European and worldwide regulations which will be subject to **change in the area of training and verification of competence for operational and technical staff**.

For the environment regulations, the institutional arrangements should provide a pan-European

environmental sustainability coordination mechanism/process to establish an inward facing pan-ATM guidance, performance monitoring and assessment role; together with a formal external liaison and advisory role with relevant industry, policy, legislative and regulatory bodies. In this respect, airports are encouraged and offered guidance to produce a strategic business plan, of appropriate scope for their scale, and, which is fully integrated with local land-use planning allowing planned growth (onus on planning authorities). In support of this, there should be adequate supervision of ATM relevant planning restrictions at national and international level (through EU working arrangements) to ensure that the implementation of the SESAR program is not compromised.

8.1. Transition towards the implementation of ATM Target Concept has already started

In order to demonstrate the feasibility of the transition, an outline of the ATM Concept for 2013 has been developed by the SESAR consortium linking the current ATM system and its on-going initiatives to the ATM Target Concept. The definition has been based on a pragmatic consideration of what the air transport industry (including the Military) can deliver. The Mid-term ATM Target Concept for 2013 is characterised by the following:

- As part of the progression towards business trajectory management, flight plans will be improved with more detailed information and airline preferences to support collaborative processes with Airports, ATFCM and Air Traffic Control, in order to **optimise the trajectories**.
- The **management of the airspace** will be more dynamic and flexible and the information on the airspace organisation and management will be more accurate and predictable.
- **Airports** will be part of the European ATM System improving the planning information. Improved runway throughput will be achieved through technological and procedural improvements, also in low visibility conditions. Advanced safety nets will substantially reduce runway incursions. Better synchronisation of surface movements and improved arrival/departure procedures will reduce queuing and the induced environmental impact.
- Increased and balanced automation (e.g. through air/ground data link, advanced planning tools) will result in a higher sector throughput (mainly for en-route ATM) and thus in significant capacity improvements.
- The route structure will still be maintained throughout European airspace although flown through precision navigation technologies.

The Mid-term ATM Target Concept for 2013 is based on the implementation of on-going initiatives such as DMEAN, LINK 2000+, FUA and many others. **Their implementation has already started** delivering benefits in support of the performance objectives for 2013.

¹ Civil Airspace Users (both Commercial and General), Military, ANSPs, Airports, Supply Industry and Social Partners.

9. SESAR – NEXT STEPS TOWARDS 2020

The 2020 ATM Target Concept is a result of the SESAR Definition Phase. It gives the first level of details necessary to support the decisions to build the SESAR Master Plan for the 2020 European ATM system. It will be further analysed and detailed during the last steps of the Definition Phase, and then during the SESAR development phase.

For optimal coordination of the SESAR development phase, the EC and EUROCONTROL have founded the SESAR Joint Undertaking (SJU), which starts its operations in 2007. In partnership with ATM industry members, the SJU will coordinate the necessary R&D activities between 2008 and 2013 to implement the SESAR ATM Master Plan (SESAR Deliverable D5) of which the ATM Target Concept will be a fundamental part.

The next SESAR Deliverable D4 will be based on the agreed ATM Target Concept for 2020 and it will define the respective implementation packages for 2008-2020 in terms of timing and transition from today's ATM system.

The ATM Target Concept – on the pathway to enhanced ATM performance!

10. WHO IS THE SESAR CONSORTIUM?

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

The SESAR Associated Partners are: ATC EUC, Boeing, CAA UK, ECA, ELFAA, ETF, EURAMID, IFATCA, IFATSEA, Honeywell, Rockwell-Collins, Dassault (representing EBAA).

Research Centres: AENA, DFS, DLR, DSNA, INECO, ISDEFE, NLR, SICTA, SOFREAVIA.