JPDO Paper

A Comparative Assessment of the NextGen and SESAR Operational Concepts

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This analysis highlights similarities and differences in the operational concepts developed in the United States and Europe. While both concepts have significant similarities, there are some noteworthy differences. The intent of this analysis is not to endorse one alternative over the other, but rather to seek areas of alignment and areas where additional coordination may be necessary.

This task is being overseen by the JPDO's Global Harmonization Working Group, with the goals of seeking global harmonization and identifying "best practices" wherever possible. This activity is expected to stimulate further analysis by individual working groups seeking specific detail to ensure access to the global airspace and enable the highest value benefits at the minimum cost.

Background information is provided to explain why different political motivations or levels of contribution may hinder alignment of the concepts.

The complete paper is also available on www.jpdo.gov.

A Comparative Assessment of the NextGen and SESAR Operational Concepts

Introduction

The United States and Europe share a common challenge – they operate highly-complex, dense airspaces in support of their national economies. While similar in challenge, they are quite different in structure, management, and control. Both share a system built on a safety referenced infrastructure. Where the U.S. has developed a single system that spans the entire continent, Europe is a patchwork of service providers, systems and airspaces defined by the boundaries of sovereign states.

Both systems are built on strong legacy infrastructures that must migrate to a new operational paradigm. As the operational concepts were developed, both regions recognized the need to distribute the decision-making process, address safety risks and augment the role of the human with improved integrated automation. These changes will support new capacity-enhancing operational concepts and enable the unencumbered growth of the air transportation system.

Both concepts are built on a similar foundation – one of a performance-based airspace that supports aircraft of varying capabilities whose operations are enhanced by a sharing of common, timely information.

Process Employed

This analysis of the two operational concepts is a high-level "philosophical" assessment of the two concepts seeking to describe where the concepts are aligned and where they differ. Part of this assessment is designed to determine if the differences are significant or if they represent regional and/or political positions, neither of which is necessarily mutually exclusive.

This analysis is also designed to define any gaps that may exist, based on a review of the documents. One of the methods considered was to attempt to correlate the proposed Operational Improvements (OIs) described by each concept.

In the future we anticipate there will be a more detailed assessment, performed in the different domains such as Safety, Security, Weather, Aircraft Concepts, Air Navigation Systems, etc. This effort will use the conclusions offered in this document as a proposed work plan for more in-depth analysis.

Airspace Change Vision

Both the U.S. and Europe share a common vision for change. Each anticipates a long-term need to accommodate three-times the growth in system capacity, and both concepts are developed with this in mind.[1] SESAR states a target metric of an order of magnitude improvement in safety. In the U.S. National Airspace System long-term safety metrics have generally been set in terms of reducing accident rates and/or fatalities per miles flown. The Federal Aviation Administration (FAA) has stated similar goals for the Next Generation Air Transportation System however NextGen has not yet been specifically linked to such goals. NextGen anticipates that with the significant increase in the number of operations, a commensurate improvement in safety will be required.

Environmental considerations are driving the SESAR concepts toward reduction of local noise and pollution, and in particular to address aviation's increasing contribution to global warming. In NextGen a key objective is the development of a strategy to achieve environmental protection in the areas of community noise, local air quality, global climate change, and water quality, while reducing energy use and allowing for sustained aviation growth. NextGen uses the Environmental Management Framework to manage and mitigate environmental constraints to capacity.

And finally, SESAR targets efficiency gains that will halve the cost of air traffic services to users.[2] NextGen does not project a specific cost metric or goal, but rather seeks to use greater awareness and access to data to enable operations in a freer market of services and choices which results in greater efficiencies and cost savings for the government and users.

The Operational Concepts – Background

Both Europe and the United States have been evaluating their respective airspace performance for the past few decades. Europe described an initial evolutionary approach with their Air Traffic Management (ATM) Strategy for 2000 plus by closely coordinating between stakeholders and EUROCONTROL. However, even that approach recognized the fragmented requirements of the sovereign participants. Further, significant investments in research did not bear the degree of change necessary to enable an airspace capable of supporting significant improvements in capacity, flexibility, and safety. These changes were reflected in a family of OIs that identified necessary changes in the infrastructure related to the various phases of flight.

Europe's Single European Sky (SES) legislation was passed in 2004 to support progress towards harmonization of European ATM across its member states. It is addressing the problem at all levels including airspace fragmentation, system interoperability, and institutional issues.

[1] With the addition of new member states to the European Union, Europe is actually experiencing more dynamic growth in some regions.
[2] Europe operates on the basis of full cost recovery of air traffic services via user fees.

SESAR is the ATM modernization program that combines technological, economic and regulatory aspects. It will be underpinned by the SES legislation to ensure timely and coordinated implementation by the different stakeholders, for both airborne and ground systems.

The first phase of SESAR, the Definition Phase, is co-funded by EUROCONTROL and the European Commission. It comprises a two-year study executed by a wide-ranging industry consortium, supplemented by EUROCONTROL's expertise. In 2008, it will deliver a European ATM Master Plan covering the period up to 2020, together with a program of work for the following SESAR phase, the six-year Development Phase.

The United States, like Europe, began planning for OIs in the 1990's. A major step in this planning was made by the RTCA Task Force 3 which delivered "Final Report of RTCA Task Force 3 Free Flight Implementation" in 1995. That task force began collaboration between the FAA and the aviation community that continues today. It resulted in a joint concept of operations and cooperation on implementation.

As a result of the events of September 11, the U.S. realized that it needed to expand the framework of the concept of operations to include aspects of aviation security. The Aerospace Commission report highlighted the urgency to move forward with change and brought a realization that a multi-agency structure was necessary to accommodate all of the operational, security, environmental, and safety initiatives which drove the definition of a future concept. This formed the mandate for the design and deployment of a system to meet the nation's air transportation needs in 2025. This mandate was established in the "Vision-100" legislation (Public Law 108-176) signed into law in December 2003. This legislation also established the JPDO to carry out this mission.

To mature this concept, OIs, enabling technologies, and trade studies/research were described. Work continues to be performed to understand how best to allocate the improvements to the airborne and ground systems and which domains hold the most promise for a system that will provide significant operational improvement at an affordable cost.

Both the FAA and EUROCONTROL realized that the evolution of the two systems had similar drivers and challenges. The FAA/EUROCONTROL Memorandum of Cooperation developed a series of action plans to coordinate on a series of activities including on concept development and comparison. The early work performed under this cooperative agreement led to alignment on terminology and approaches. These efforts were brought together in the International Civil Aviation Organization (ICAO) Global Concept which has influenced both NextGen and SESAR, and other global concepts.

More recently, U.S. industry representatives participated in the SESAR Definition Phase to ensure that work advanced by the JPDO Integrated Product Teams and Working Groups found its way into the SESAR plans. Similarly, those same members from the U.S. industry brought back concepts and ideas from participating in the various SESAR Work Packages and ensured that similar concepts were included in the NextGen Concept of Operations (ConOps). Since both the NextGen and SESAR concepts have extended their predecessor concepts in scope and detail,

this continued interaction has been important to limit unintentional divergence in definition and intent.

The following represents a high-level overview of the operational concepts to improve understanding.

NextGen Concept of Operations

There are presently two key mature guiding documents for NextGen. The Concept of Operations Version 2.0 (June 2007) and Enterprise Architecture (EA) Version 2.0 (June 2007). An additional foundational document, Integrated Work Plan (IWP) Version 1.0 is slated for public release in September 2008.

The ConOps was created to give a common vision of how NextGen will operate in 2025 and beyond. Two previous documents defined the problem and set the goals that NextGen will meet: the NGATS Integrated Plan (2004) and the NGATS Vision Briefing (2005). The latter document sets forth the following goals and objectives for NextGen: Retain U.S. Leadership in Global Aviation; Expand Capacity; Ensure Safety; Protect the Environment; Ensure Our National Defense; and Secure the Nation. The intent of the NextGen ConOps is to describe a system that meets these national goals. As such, NextGen is transformational by design. The significant NextGen characteristics are:

- User Focus: Greater flexibility and better information to users. Capacity is increased through infrastructure investments, shifting resources to meet demand, the development and implementation of new procedures, better airspace utilization, and minimizing weather constraints.

- Distributed Decision-making: Information rich environment and better information exchange allows an increased level of decision-making by flight crews and Flight Operations Centers.

- Integrated Safety Management System: Safety ensured through the use of a formal, top-down, business like approach to manage safety risk.

- International Harmonization: Collaborative development and implementation of best practices in standards and procedures and advocating for the highest operational standards for aircraft operators and air navigation service providers worldwide.

- Taking Advantage of Human and Automation Capabilities: Processes and systems that capitalize on the strengths of humans and automation through research and analysis.

- Weather Operations: Integration of weather information to support NextGen human and automation decision-making processes. Integrated weather information along

with the use of probabilistic forecasts to address weather uncertainty and improved forecast accuracy. In turn, this will minimize the effects of weather on NextGen operations resulting in less constrained airspace and greater capacity.

- Environmental Management Framework: New aircraft and ATM technology, procedures and policies to minimize aviation impacts on community noise, local air quality, global climate change, and water quality, while reducing energy use. Environmental effects on the ground and in the air are reduced by improvements in aircraft design, performance, and operations.

- Robustness and Resiliency: A high availability system that can withstand and rapidly recover from a diverse set of failures and disruptions by maintaining a balance of reliability, redundancy, and procedural back-ups.

- Scalability: An overall system design that can handle wide ranges and modes of operations, and adapt to both predictable and unpredictable changes in demand to meet short or long-term changes in traffic demands.

- Layered, adaptive security: A risk-managed security system that depends on multiple technologies, policies, or procedures that are adaptively scaled and arranged to defeat a given threat. The security system will have the adaptability to scale its systems and procedures to the risk level of a threat in a given situation, rather than being bound to an inflexible "one size fits all" approach.

The second NextGen guiding document is the EA. The document provides a structure for developing, evaluating, and communicating the various components necessary for the transformation of the U.S. air transportation system. It provides the organizing logic for stakeholders to align and evaluate their processes against NextGen components in a standardized, consistent framework. The EA can also be used as a valuable analysis tool yielding a variety of benefits and outcomes.

In the near future, NextGen will be guided by a third key document, the IWP. The document provides the details to transition to NextGen as defined and described by the ConOps and EA. The IWP describes the major activities, dependencies, and resources needed to achieve NextGen. It synchronizes partner agency's and department's decisions and implementation plans and provides them a collaborative planning and management mechanism. The IWP also serves a critical function in allowing JPDO to review progress and to ensure critical policies and elements are researched, developed, and implemented effectively and efficiently.

The FAA has the responsibility for the implementation of the vision and plan established by the JPDO's multi-agency Working Groups. The implementation plan is described in the Operational Evolution Partnership (OEP). The OEP, in collaboration with industry, validates, prioritizes, and coordinates the rollout of the new functionality to enable the future airspace.

The ATM Target Concept

The ATM Target Concept (SESAR Consortium Deliverable 3, 4 September 2007) follows a service-oriented approach based on a partnership among stakeholders. 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 will 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 centered around the characteristic of the business trajectory (for military "mission trajectory") representing an airspace user's intention with respect to 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 or in case the airspace users' and ATM network goals (relating to capacity, environment, and economic performance) are best met through maintaining capacity and throughput rather than optimization of an individual flight. In the case of unplanned disruptions, the overall ATM network goals will take precedence over individual flight trajectories.

Changes will ideally be performed through a Collaborative Decision Making mechanism but without interfering with the pilots' and controllers' tactical decision processes required for separation provision, for safety or for improvement of the air traffic flow. Business trajectories will be expressed in all four 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 organizational boundaries. Fundamental to the entire ATM Target Concept is a 'net-centric' operation based on:

- A powerful information handling network for sharing data;
- New air-air, ground-ground and air-ground data communications systems; and
- An increased reliance of airborne and ground-based automated support tools.

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

- <u>Trajectory Management is introducing a new approach to airspace design and management</u> – 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 where sufficient capacity can only be provided through the use of structured routes, which at the same time will 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 the 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 NextGen ConOps. No other segregation is required by the ATM Target Concept. Only two categories of airspace will be defined and organized: 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.

- 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 while minimizing holding and ground queues. In the event of a capacity shortfall, airspace users with flights affected by delays will be allowed to determine a priority order between themselves to achieve their business objectives.

- 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 turnaround management, reduction of the impact of low visibility conditions, etc.) is envisioned. 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.

- 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.

- 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.

- Humans will be central in the future European ATM system as managers and decision makers – The ATM Target Concept recognizes that humans (with appropriate skills and competences, duly authorized) 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 SESAR 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.

The SESAR ATM Target Concept capacity targets will be supported by an integrated set of capabilities. These include:

- 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
- Improved airport processes

Conclusions and Recommendations

The vision and "philosophical" perspectives of both concepts are closely aligned. This is to be expected based on the existence of formal cooperative arrangements between the U.S. and Europe. Further, the participation of a wide variety of stakeholders in both the JPDO and SESAR initiatives allowed for significant information sharing and the identification of best practices to be incorporated.

The fact that both concepts were developed by similar participants to the ICAO Global ATM Concept and that both are founded on a realization that success must include a globally harmonized solution also drives alignment.

However, an analysis based solely on the operational concepts would likely miss specific implementation-oriented differences. Work continues in both regions to validate the concepts through research, trade studies, and scenario-based analysis. It is important to carefully track these activities as they add more detail to the respective concepts, in order to guard against significant divergence. Additionally, there are cultural, societal, political, and infrastructural differences that must be considered.

Probably the most easily recognized difference in the two concepts is the breadth of scope. The NextGen ConOps includes a full "curb-to-curb" approach that includes passenger and intermodal security considerations. These build on the traditional "block-to-block" concepts that are centered on the airspace operations (including environmental considerations). The SESAR ATM Target Concept remains focused on the more traditional airspace elements and recognizes the need to include airport operations for a complete gate-to-gate process description.

Another area of difference, although not as dramatic, is how weather is considered in the two concepts. In the U.S. National Airspace System, summer convective weather causes a majority of system-wide delays and therefore has been included as a core element of the proposed concept. Weather is recognized in the SESAR ATM Target Concept, but there does not appear to be the same level of focus on infrastructure, prediction, modeling, and planning as appears to be included in the NextGen concept.

This Information Paper is only the first step in a continuous process to analyze the different domains. It is recommended that the appropriate JPDO Working Groups will perform detailed assessments on the following proposed issues:

- Determine whether there are significant differences in the developing understanding of Trajectory-Based Operations in the two operational concepts.

- Further clarify the roles and responsibilities of the aircraft, air navigation service provider, and automation throughout the operational transition.

- Harmonize NextGen and SESAR Avionics Road Map with RTCA, EUROCAE and other standards bodies and reflected in the ICAO Global Plan

- Identify and harmonize definitions, measures, and objectives for environmental aspects of air transportation,

- Recognizing the value of SWIM, it is important to establish a harmonized information architecture

- With safety as a foundational requirement, there is a need to establish harmonized safety management systems

- Define and harmonize goals and objectives of performance management.

The JPDO will work with the appropriate Working Groups, JPDO Divisions, and partner agencies to further explore the above recommendations with the goal of seeking global harmonization.

Appendix A: Study Team Participants

Participant	Organization – JPDO Working Group/Division
Richard Heinrich (Lead)	Rockwell Collins – Global Harmonization Working Group/Aircraft Concepts Working Group
Colin Meckiff	FAA/EUROCONTROL – Global Harmonization Working Group
Jay Merkle	JPDO - Enterprise Architecture and Engineering Division
Diana Liang	FAA
Bill Nix	Sensis – Global Harmonization Working Group
Elizabeth Ray	FAA/JPDO – Air Navigation Service Working Group
Steve Bradford	FAA/JPDO – Air Navigation Service Working Group
Julie Draper	FAA Office of Environment and Energy
Sandy Liu	FAA – Environmental Working Group
Rick Shay	NASA – Safety Working Group
Carey Fagan	FAA – Global Harmonization Working Group Co-Chair
Angela Harris	FAA – Global Harmonization Working Group

Appendix B: References

Concept of Operations for the Next Generation Air Transportation System; Version 2.0; Prepared by: U.S. Joint Planning and Development Office (JPDO); 13 June 2007

Document D3 - The ATM Target Concept; DLM-0612-001-02-00; Prepared by: The SESAR Consortium; 4 September, 2007

NextGen / SESAR Concepts Comparison; Working Draft; Prepared by MITRE; December 2007

Enterprise Architecture for the Next Generation Air Transportation System; Enterprise Architecture V2.0; June 2007

The Integrated Work Plan for the Next Generation Air Transportation System; Integrated Work Plan; V0.2

NextGen / SESAR Concepts Comparison; MITRE for JPDO/Enterprise Architecture and Engineering Division; Working Draft – December 2007

Appendix C: Notional Comparison of a Subset of Operational Improvements

NextGen OI	NextGen description	NextGen IOC	SESAR OI	SESAR description	SESAR deployment start/end
OI-0309	Limited Continuous Descent Approaches	2008	L02-08 AOM-0701	Continuous Descent Approach	2007/2013
OI-0311	Enhance Arrival/Departure Routing and Access	2009	L02-07 AOM-0602	Enhanced Terminal Route Design using P-RNAV	2010/2014
OI-0313	Virtual Towers - Level 1 Sequencing, Separation and Spacing	2016	L02-09 SDM-0201	Remotely Provided Aerodrome Control Service	2020/2025
OI-0315	Virtual Towers - Level 2 Sequencing/Separation/Spacing/Surface Mgt.	2018		As above - only one SESAR OI	
OI-0316	Enhanced Visual Separation for Successive Approaches	2012	L08-03 AUO-0402	*Possibly:* ATSAW during Flight Operations	2010/2017
OI-0317	All Weather Airport Access	2020			
OI-0318	Arrival Time-Based Metering - Controller Advisories	2008	L10-05 AO-0302	Time Based Separation for Arrivals	2012/2015
OI-0319	Time-Based Metering into En-Route Streams	2008			
OI-0323	Wake-Based Departure Operations for Parallel Runways	2012	L10-05 AO-0303	Fixed Reduced Separations based on Wake Vortex Prediction	2012/2019(?)
OI-0324	Wake-Based Spacing - Level 1 Static Subsequent Arrival/Departures	2013			
OI-0325	Arrival Time-Based Metering via ANSP/Aircraft Collaboration	2013			
OI-0326	Airborne Merging and Spacing - Single Runway	2013	L08-04 TS-0105	ASAS Sequencing and Merging for Traffic Synchronization in TMA	2013/2017
OI-0328	Wake-Based Spacing - Level 2 Dynamic Drift Only	2015	L10-05 AO-0301	Crosswind Reduced Separations for Departures and Arrivals	2009/2013
OI-0329	Airborne Merging and Spacing with CDA	2015			
OI-0330	Time-Based and Metered Routes with CDA	2016	L02-08 AOM-0702	Advanced Continuous Descent Approach	2013/2017
OI-0331	Integrated Arrival/Departure and Surface Traffic Management	2016	L10-02 AO-0207	Surface Management Integrated with Departure and Arrival Management	2013/2017
OI-0333	Airborne Merging and Spacing for Multiple Runways	2016		See OI-0326. No distinction in SESAR between single and multiple runways.	
OI-0334	Independent Parallel or Converging Approaches in IMC	2017			
OI-0335	Dependent Multiple Approaches in IMC	2017	L10-04 AO-0403	Optimized Dependent Parallel Operations	2012/2015
OI-0336	Wake-Based Spacing - Level 3 Dynamic Drift and Decay	2018	L10-05 AO-0301	Crosswind Reduced Separations for Departures and Arrivals	2009/2013
OI-0338	Efficient Metroplex Merging and Spacing	2018	L07-01 TS-0303	Arrival Management into Multiple Airports??	2015/2020
OI-0339	Integrated Arrival/Departure and Surface Traffic Management for Metroplex	2018	L07-03 TS-0304	Integrated Arrival/Departure Management in the Context of Interfering Airports	2015/2020
OI-0341	Limited Simultaneous Runway Occupancy	2020			
OI-0381	Near All-Weather Airport Access	2017	L10-06 AO-0502	Improved operations in Low Visibility Conditions Through Enhanced ATC Procedures	2009/2015

Appendix D: MITRE Concepts Comparison performed for JPDO

ICAO Essence	NextGen ConOps Essence	SESAR Essence	CARATS Essence	Conclusion/Comments
Improved ATM planning tools o Mission planning is performed by airspace users as a collaborative exercise with airspace organization and management, aerodrome operations, and demand and capacity balancing, as appropriate.	**Improved ATM planning tools:** o FOC automation supported flight planning Planning and decision support tools are available in all areas of NextGen from planning to post analysis. Flight crews are responsible for the control of an individual aircraft while it is moving on the surface or airborne. Under delegated operations, crews are responsible for separation. May comprise a single pilot or multiple individuals (e.g., two pilots). For UAS systems, may operate the aircraft remotely; for "autonomous" UAS (programmed with an overall mission), may be an automata. UAS operations are some of the most demanding operations in NextGen. UAS operations include scheduled and on-demand flights for a variety of civil, military, and state missions. Because of the range of operational uses, UAS operators may require access to all NextGen airspace. UASs are expected to fly in trajectory-	**Improved ATM planning tools:** o AOC plays an active role in all phases of the planning processes. o Accommodates Un-Manned Aerial /Aircraft Systems (UAS/UAV) Business/Mission Trajectory The Concept places the Business Trajectory at the core of the system with the aim to execute each flight as close as possible to the intention of its owner: • Air traffic management services will ensure that it is carried out safely and cost efficiently within the infrastructural and environmental constraints; • Changes to the Business Trajectory are kept to a minimum, through a Collaborative Decision Making (CDM) mechanism, except in time critical situations; • Business Trajectories are expressed in all 4 dimensions (position and time) and flown with much higher precision than today.	**Improved ATM planning tools** o Flight planning is performed by airspace users as a collaborative exercise with airspace management, aerodrome operations, and demand and capacity balancing, as appropriate.	In SESAR the UAS/UAV can be fully automatic systems or systems connected to a ground pilot. When a ground pilot exists, the systems supporting it will be connected to the SWIM infrastructure. The technical UAS architecture will be such that irrespective of the actual path its connection to SWIM is transparent to the European ATM System. o SESAR discusses UAS planning function; others do not other than in NextGen UAS operations participate in trajectory management (assumes some planning)- otherwise essentially equal.

	based airspace. The UAS operators are capable of conducting the procedures required for the airspace and must achieve the same target level of safety against collisions as manned aircraft. Because UASs may also operate in airspace in which cooperative surveillance may not be required, they have the responsibility for sensing and avoiding other aircraft. This may include responsibility for separating from aircraft that do not have cooperative surveillance in some airspace.			
4D trajectory management o Traffic synchronization will make use of integrated and automated assistance to surface, departure, arrival and en-route management to ensure an optimum traffic flow. o Traffic synchronization will be applicable and tailored to all airspace and aerodromes where the optimized ordering and sequencing of traffic are critical to accommodate demand.	**4D Gate-to-Gate trajectory management** o Automation supported negotiations Capability to permit extensive negotiation between air and ground of 4DT NextGen stakeholders maximize their ability to achieve their goals and business objectives by actively participating in the C-ATM process. This involves not only information exchange and negotiation with respect to flight trajectories but also involvement in the process of allocating ATM resources.	**4D trajectory management** o Through a collaborative traffic flow management process, the Business Trajectory stabilizes into an RBT which the airspace user agrees to fly and the ANSP agrees to facilitate o High complexity terminal operations will feature pre-deconflicted 3D Departure Routes (until en-route levels) and 3D Arrival Routes (from en-route levels) o 4D Contracts will be segmented with an effective period of 20 minutes. Moving from airspace to trajectory focus while introducing a new approach to airspace design and management: • Airspace Users fly preferred routing without pre-defined routes;	**4D trajectory management** o Traffic synchronization will make use of integrated and automated assistance to surface, departure, arrival and en-route management to ensure an optimum traffic flow. o Traffic synchronization will be applicable and tailored to all airspace and aerodromes where the optimized ordering and sequencing of traffic are critical to accommodate demand.	o NextGen makes extensive use of automated negotiations o SESAR limits 4D contracts to RBT 20 min segments o SESAR considers 4D trajectory en route to en route, which includes gate turnaround times as part of the business or mission trajectory. SESAR also discusses 2D, 3D and 4D for various operations. SESAR Network Management will facilitate dialogue and negotiation to resolve demand/capacity imbalances in a collaborative manner. Tools will be used to assess network efficiency. Capacity can be adjusted. o CARATS focuses more on the

o The ability to tactically and collaboratively modify sequences to optimize aerodrome operations, including gate management and/or airspace user operations; o Delegation of maintenance of spacing to the flight deck to increase traffic throughput while reducing ground system workload;	Tools are in place in NextGen to allow virtually any operator to participate in the C-ATM process. Information exchange is more clearly targeted to the appropriate decision makers, reducing workload and unnecessary actions by those not affected. Machine-to-machine negotiation replaces labor-intensive, voice, or text-based processes.	• Structured routes will only be activated where and when needed to enable the required capacity (e.g. congested TMAs); • The needs of the military are safeguarded; • It is considered that segregation is not required; • Only two categories of airspace are defined and organized: managed airspace where separation service is provided by ANSPs (it can be delegated to the pilot) and unmanaged airspace where the pilot carries out the separation task.		supporting CNS infrastructure. The SESAR process will rely on the exchange of data on 4D trajectories (the three spatial dimensions plus time). Once a 4D trajectory is agreed to, the aircraft will have to execute it as planned and keep changes to a minimum, or end up being given less desirable routings. The NextGen ATC system in the U.S. will also rely on the use of 4D trajectories, but there has been no mention of a similar "business trajectory" approach. The European "business trajectory" approach will start with strategic planning months or possibly years before operations begin and continue through flight planning on the day of flight. While some of this occurs today in a process called collaborative decision making, the objective of the new effort is to minimize the need for real-time tactical intervention by controllers once the aircraft is airborne. This approach is no different that that described in NextGen and various other FAA concepts. Ownership of the trajectory SESAR - User owned NextGen – Implicit, not explicit the agreement is owned by the

				a/c ANSP – single “owner” (human, auto)
Improved separation management o Hazards that an aircraft will be separated from are: other aircraft, terrain, weather, wake turbulence, incompatible airspace activity and, when an aircraft is on the ground, surface vehicles and other obstructions on the apron and maneuvering area o Delegation of separation can be: (a) full self-separation; (b) distributed separation; or (c) cooperative separation	**Improved separation management** o Delegated separation including merging, spacing, and self separation o Automation of separation management and short term trajectory negotiation Separation provision, both airborne or by ANSP, relies heavily on automation support, allowing reduced and performance-based separation standards for different airspace categories. • 4DTs of many aircraft following similar routes may be aligned to nearly eliminate conflicts. • Trajectory changes required for separation assurance are communicated digitally. Separation Management (SM) is performed automatically by ground automation. If conflicts are detected, the ground automation issues revised 4DTs to the flight operator.	**Improved separation management** o Through the management of 2D, 3D, 4D trajectories, flows of traffic will be organized and there will be a degree of pre-deconfliction o Selectively delegates suitable separation tasks to aircrew	**Improved separation management** o TBD	Essentially equal with some differing terminology. Although NextGen does speak of some full and seemingly autonomous separation requirements controlled by automation.

Dynamic reduced separation and spacing requirements o Wake vortex avoidance	**Reduced separation and spacing requirements** o En route, terminal airspace o Closely space parallel runway operations o Equivalent visual operations o Wake vortex avoidance NextGen discusses adaptive flexible spacing and sequencing of aircraft on the ground and in the air. NextGen ties reduced separation to really more efficient use of existing separation standards using tools to reduce human inconsistencies.	**Reduced separation and spacing requirements** o Final Approach Spacing: Accurate and more consistent spacing on final approach will be achieved by time based separation o Reduced Departure Spacing o The separation minima will allow such routes to be designed and approved as 'separated' for each other Wake vortex spacing Parallel runway spacing	**Dynamic reduced separation and spacing requirements** oTBD	ICAO limits any discussion of dynamic separation to wake vortex avoidance. NextGen and SESAR are consistent in concept. NextGen and SESAR do not discuss spacing in terms of Dynamic.

Improved airspace management o Dynamic and flexible airspace boundaries, based on demand o Optimized airspace configuration o Accommodate dynamic flight trajectories and optimal system solutions o Uniform airspace organization and management principals that are easily learned and understood o Accommodate all users with mixes usage/mixed equipage operation o Subject to service limitations o All airspace is managed o Segregated airspace o Dynamic airspace reservations o Some structured routes when required	**Improved airspace management** o Dynamic airspace boundaries, including SUAs o Flexible service delivery points to balance controller workload o Non-managed airspace with VFR procedures o Flow corridors with self separation within them o Staffed virtual towers Airspace allocation is flexible over different time horizons and geographic boundaries to meet demand. Airspace restrictions for aircraft capability are applied only when needed (e.g., for capacity, safety). • Changes to airspace configuration are provided dynamically to flight crews so that maximum flexibility is possible. • Delivery of services is flexible and not constrained by geographic location of personnel and infrastructure. NextGen ensures the continued capability and integration of military as well as other user airspace requirements. Includes Aeronautical Information Management and SWIM.	**Improved airspace management** o Designed according to their level of complexity (High/Low/Medium) and based on NOP initial demand data (including traffic forecast). The Aeronautical Route Network and CDRs are designed based on area navigation technologies and the ground-based transmitter infrastructure is only used as a backup. The Airspace Design sub-system contributes to the airspace data in the NOP by providing an initial airspace structure, the elements of which will be further refined and activated by airspace management processes. o Below the specified level conventional route structures and airspace organization will continue to segregate managed and unmanaged traffic. o Airspace is made available in a more dynamic manner on the basis of the close cooperation between civil and military authorities o Flexible and real-time allocation of military training areas (MTA) according to military mission profiles and routing Below a centralized level of provision, only a single level of individual stakeholder provision is currently identified. Whilst some sub-regional roles and responsibilities are recognized and	**Improved airspace management** o Optimized airspace configuration o Accommodate dynamic flight trajectories and optimal system solutions o Accommodate all users with mixes usage/mixed equipage operation o Subject to service limitations o All airspace is managed o Segregated airspace o RNAV/RNP Routings where needed	o ICAO, SESAR and CARATS do not address staffed virtual towers but discuss the facilities in more general terms. SESAR and ICAO also do not address to any clarity flexible delivery of services and constraints such as geographic location and personnel and infrastructure in general; they are considered State functions. o SESAR places much emphasis on military airspace management thus the Mission Trajectory concept. o NextGen integrates the military as well as airspace into the system as dynamic, flexible and accommodates special military requirements.

		encompass the geographic areas of responsibility of several ANSPs, no specific level or location is identified for their supporting technical systems. The current assumption is that they will be co-located at one of the related ANSP en-route ATC facilities for each sub-region. The functions that are supported by technical systems, which will need to be provided to enable the local provision/co-ordination of specific air traffic services– but not necessarily at the same location – are: • Airspace Organization and Management; • Network Management; • Queue Management; • Aeronautical Information Management. o SESAR places important emphasis on military airspace management		
Improve flow management o The ATM system will accommodate diverse types of airspace user missions o The ATM system will accommodate diverse types of vehicle characteristics and	**Improved flow management** o Emphasis on strategic flow management to minimize the need for tactical separation maneuvers but also considers the end-to-end flow management including surface and airport personnel and cargo flows as part of the total Air transport system.	**Improve flow management** o Time-based spacing or separation may be used to achieve the required runway throughput and this may be done using ATC or aircraft separation assistance capabilities. o Multiple planning tools to assist ATM in optimizing the sequence. o SESAR discusses flows in terms	**Improve flow management** o Optimized spacing and sequencing; o Optimized 4D trajectories; o Optimized user requested trajectories;	o ICAO, NextGen and CARATS all emphasize "optimization" of flows SESAR discusses the vision as the optimized management of the ATM Network encompassing all aspects of ATM, including airspace design, and upon which all stakeholders will focus their roles, responsibilities and

capabilities o Optimized spacing and sequencing; o Optimized 4D trajectories; o Optimized user requested trajectories;	Tools include capabilities for Probabilistic decision making o Integrated impact assessment tools o Collaborative optimization of flows and airspace configuration o Accommodate UAS, trans-atmospheric operations and domestic supersonic operations There is better decision support and integrated strategic and traffic flow management (TFM). Flight planners have an increased role in collaborating with the ANSP on capacity and flow management strategies, Within the ANSP workforce, the emphasis in NextGen is on strategic flow management and collaboration with airspace users. Flow contingency managers monitor and assess capacity requirements for flows of traffic. With DSTs, they determine optimum flow and airspace configurations in collaboration with capacity managers and through collaboration with flight operators and other stakeholders. Separation managers and trajectory managers interact to determine optimum system solutions and implement decisions strategically.	of: (a) flight profiles; (b) sequencing; (c) airport network; (d) airspace and routes; (e) descent profiles; (f) sector configurations; (g) optimal engine combustion; (h) use of runway structures; (I) surface traffic flows; (j) take-off times; (k) conflict free routes; (l) wake vortex avoidance; (m) departure sequence; (n) balance of arrivals and departures (o) terminal and en route traffic		activities.

Improved surface management o Improved landside operations o Integrated with en route and terminal operations o Reduced runway occupancy time o Improved all weather maneuvering capability o Precise surface guidance to and from a runway in all conditions	**Improved surface management** o Integration of surface, ramp, and terminal airspace traffic management and control tools o Improved runway incursion prevention and previsions o Automated distribution of braking action reports, negotiated taxi exit instructions, pre-departure and pre-landing taxi instructions Airspace around airports serving trajectory-based traffic is ANSP-managed, with the TM and SM functions supported by advanced automation. Integrated arrival/departure area and airport surface management ensure that arrival flows match projected airport capacity for improved overall throughput and efficient flight trajectories. For both trajectory-based and classic traffic, surface operations in the NextGen timeframe at medium- and large-demand airports are integrated with other ATM functions, including departures, arrivals, and collaborative traffic management. Cooperative ground surveillance at most airports, including state vector information (e.g., aircraft	**Improved surface management** o The integration of the airfield surface in the 4D trajectory of aircraft allows airports to be developed as ground “sectors” within the concept. o Arrival, departure and surface management tools will evolve to become components of an integrated airport information architecture o Acts on the efficiency of flights and optimizing the usage of the bounded capacity of airspace and airport surface;	**Improved surface management** o TBD	SESAR considers surface as another sector and part of the Business trajectory and considers aircraft turn around times as part of the trajectory Business trajectory: it imposes the move from partial trajectories - produced and used independently - to a shared trajectory including the surface part. In addition, the trajectory is managed and shared during both the planning and the execution phase.

	speed/direction), with more effective runway incursion prevention automation Integrated surveillance of ground traffic, along with airport layout and taxi routes, with cockpit warning of runway incursions. Updated pushback information provides improved surface and departure management. Surveillance of surface movement provides basis for more accurate departure time and taxi delay estimates. Availability of improved departure time estimates significantly improves capability of FCM and TM. Flight-specific traffic management initiatives are handled via automation and data communications. Elimination of one-in-one-out restrictions at most airports for equipped aircraft. Use of aircraft avionics for ground movement (moving maps, CDTI, warning systems, etc.)			
Improved airport and aircraft sensors and equipment o On board met sensors	**Improved airport and aircraft sensors and equipment** o Ground support equipment with sensors and logic to avoid hitting aircraft, powered by alternative and/or low-emission fuels o Improved airport sensors	**Improved airport and aircraft sensors and equipment** o CDTI technology provide aircrew with mapping and guidance as well as separation capabilities o Wake-vortex detection and transport technology The airport is part of the ATM	**Improved airport and aircraft sensors and equipment** o no mention	NextGen is much broader re sensors and equipment requirements than either ICAO or SESAR. However SESAR does have a complete emphasis on avionics costing and timing and considers the Airport as part of the total system..

	(weather, pavement conditions, wildlife, bird activity) o Improved aircraft sensors (de-icing) and automated aircraft braking systems o Wake vortex and weather sensors The airport is part of the total air transportation system Sensors are incorporated into the runway environment for the active detection and dissipation measurement of wake vortices, which will enable reduced aircraft separation during conditions when wake turbulence is not a hazard. Advanced weather sensors are also deployed to airports, including sensors that provide a detailed picture of the atmosphere along the airport approach and departure paths in order to detect the varying conditions that may affect flight operations and wake vortices.	system.		
Automated Virtual Towers	**Automated Virtual Towers** o Automated virtual towers that provide automated sequencing and basic airport information Automated virtual towers (AVTs) or better where economically feasible For lower-demand airports, staffed or automated virtual towers may be implemented, enabling tower services	Environmental factors and considerations are heavily stressed	**Automated Virtual Towers**	Only JPDO considers automated virtual towers

	equivalent to those provided by traditional towers to be provided at more airports than is affordable today and/or for extended hours of service.			
New Airports	**New Airports** o New air portals for UAS, VTOL, space planes and other new flight vehicles In NextGen, new airports are built, including both major airports for scheduled air carrier service and non major airport facilities that will serve the GA community. In busy metropolitan areas, some nonmajor airports grow into facilities to support significant scheduled air carrier service.	**New Airports**	**New Airports**	Only JPDO/NextGen seriously considers new airports. SESAR considers equipped and non-equipped airports as part of their costing structure and the use of reliever or secondary airports as NextGen.
Airport improvements o Non-ATM activities such as inter alia, customs, security, baggage handling and fuel supply will be optimized through the collaborative exchange of information	**Airport improvements** o Information sharing o Ability to rapidly reconfigure the airport terminals, airports, and airspace Airport system planning includes activities to determine the role of each airport within a system, estimate aviation demand, determine infrastructure needs, and provide for environmental management.	**Airport improvements** o Increasing airport capacity through runway throughput improvements and by network optimization to assure best use of available capacity. Additional capacity needs to come from new runways complemented by the greater use of regional and other uncontested airports (including military airports) to satisfy the demand.	**Airport improvements** CARAT scope does not presently include airport improvements	ICAO, SESAR and NextGen are essentially equal. Automation and information sharing through NEO or SWIM is discussed in all the concepts to varying degrees. SWIM implementation scenarios and architecture are currently different in SESAR.

Improved airport planning	**Improved airport planning** o Long term airport planning tools Financial, ANSP, SSP, environmental reviews, and regional coordination is integrated into the planning process to reduce oversights, improve capabilities, and enhance efficiency. • Integrated, comprehensive, annual updates identify gaps and initiate solutions. • Post-implementation evaluation of new actions is carried out in coordination with environmental management systems (EMSs). Metropolitan planning organizations and an integrated planning process foster agency coordination in order to address jurisdictional constraints. • Incentives promote intermodal and ground transportation connections within regions as needed to facilitate expanded use of nonmajor airports. Policy, financing, and regulatory mechanisms provide for both public and private ownership and management of airports. • As appropriate, increased use of joint-use military/civilian airports provides for improved civil access to the NAS. Also,	**Improved airport planning** Two high-level operational processes are identified, aligned with the ATM planning process: • Airport Resource Planning; • Airport Resource and Capacity Plan Management. Airport operations support co-operation between all stakeholders at appropriate decision-making stages whilst ensuring a seamless process over the entire planning spectrum, starting many years ahead down to the real-time. Besides these high-level operational processes, there is also a medium to long-term development process which focuses on future demand and capacity planning for airport expansion. This includes issues ranging from airport infrastructure and environmental aspects to landside capacity and regional planning. The focus of airports is equally divided between both the potential aircraft movement rate and also passenger throughput. SESAR acknowledges that the airport planning cycle is generally longer than that of the airport users.	**Improved airport planning** Not discussed in current literature	ICAO and CARATS do not discuss airport planning in the context of NextGen and SESAR.

	capacity is expanded through the identification and conversion to civil aviation use of former military air bases that are part of the Base Realignment and Closure (BRAC) process. • Finance system has dedicated funding sources with government support for critical nonmajor airports. • Airports within a region are operated in an integrated and complementary manner The impact of aviation on the surrounding environment is a critical study element in the development of airport infrastructure. As air traffic grows, airports need to operate in a more environmentally sustainable and energy-efficient manner to prevent environmental degradation. Sustainability and environmental management measures will be incorporated into proposed facilities, programs, and procedures.			
Improved airport utilization o Runway geometry will permit runway entry and exit at any location along its length, minimizing runway occupancy time and	**Improved airport utilization** o Improved landside access o Improved access to secondary airport terminals o Multi-modal networks to link airports with population and business centers o Increased use of joint use	**Improved airport utilization** o Airports must be integrated with other modes of transport o New aircraft and ground capabilities for airport surface operations enable the maintenance of throughput in all weather conditions	**Improved airport utilization** o TBD, currently not addressed	ICAO and CARATS do not discuss joint use, regional airports, even though both are in use in JAPAN. SESAR and NextGen are essentially the same.

reducing holding areas. o There will be a dependency on landside operations where improvements will be needed to optimize aerodrome capacity.	airports, regional airports, non-major airports, and additional runways at busiest airports Airports must be integrated with other modes of transport o New aircraft and ground capabilities for airport surface operations enable the maintenance of throughput in all weather conditions o Development of underused airports or combined use of nearby military airports is promoted o Grouping airports and their surrounding airspace permits a consolidated explanation of queue management concepts in relation to both inbound and outbound flows to constrained runways. o Increased runway throughput via (a) reducing dependency on Wake Vortex separation; (b) minimizing Runway Occupancy Times (ROT) o Optimizing runway configuration / mode of operation o Increase runway utilization during Low Visibility Conditions (LVC) o Improved surface automation	o Development of underused airports or combined use of nearby military airports is promoted o Grouping airports and their surrounding airspace permits a consolidated explanation of queue management concepts in relation to both inbound and outbound flows to constrained runways. o Increased runway throughput via (a) reducing dependency on Wake Vortex separation; (b) minimizing Runway Occupancy Times (ROT) o Optimizing runway configuration / mode of operation o Increase runway utilization during Low Visibility Conditions (LVC) Improved surface automation		

Improve aviation policy, financial, and regulatory mechanisms o Regulatory authorities will need to implement the regulatory framework within the legal powers given to them and to monitor the safety status of the ATM system.	**Improve aviation policy, financial, and regulatory mechanisms** o Service tiers based upon aircraft performance capabilities o Government mandates allowed Policy and regulatory reforms are key transformational elements of NextGen Financing is only discussed in terms of airports Cost and how to do that is discussed extensively.	**Improve aviation policy, financial, and regulatory mechanisms** o Procedures will be harmonized across Europe and interoperability of the functions will be achieved The "SESAR option", which combines operational improvements based on the new ATM ConOps and the related technology uplift with the institutional improvements. The financing analysis of the ATM Target Concept costs was performed with the following assumptions: • The capital investment level for the implementation of the SESAR program (capital employed) will be aligned with the already planned investment level of each stakeholder; • In order not to hinder implementation and to avoid pre-financing costs impacting the ATM unit cost, the capital investment (and perhaps some portions of operations costs) will be financed via debts and refinanced (paid back) at a later stage when efficiency gains out of the system cover financing costs; • The financing costs imply additional cost-effectiveness efforts.	**Improve aviation policy, financial, and regulatory mechanisms** o TBD	ICAO as a regulatory body does not directly address policy nor financing SESAR addresses policy but does not elaborate as NextGen CARATS has not addressed this in the Concept to date but the issues on policy and rulemaking are actively worked.

Improved Infrastructure o Information management provides accredited, quality-assured and timely information used to support ATM operations. Information management will also monitor and control the quality of the shared information and provide information-sharing mechanisms that support the ATM community o The provision of meteorological information will be an integrated function of the ATM system. The information will be tailored to meet ATM requirements in terms of content, format and timeliness	**Improved infrastructure** o Network enabled information access and infrastructure, SWIM o Broad area precision navigation o Improved cooperative and non-cooperative surveillance o PNT services o Geospatial information services SSA Flexible infrastructure to changing demands	**Improved Infrastructure** o Precise meteorological information will play a major role in the contribution to the future operational concept of ATM o System Wide Information Management (SWIM - Information is not sent, it is made available) and Collaborative Decision Making (CDM) o Advanced navigational capabilities including a satellite based infrastructure to complement the ground infrastructure o Conventional ATC surveillance methods can also be applicable in a range of situations requiring the application of relative separation o Improved weather and aircraft performance modeling o ASAS, CDTI o New landing systems and new surface movement systems o The Airborne Weather Data Collection and Exchange concept is for the effective utilization of weather data captured by on-board systems and available for transmission via data link Primary aircraft positioning means will be satellite based for all flight phases; • Positioning is expected to rely on a minimum of two dual frequency satellite constellations (Galileo, GPS L1/L5 and potentially other constellations, assuming	**Improved Infrastructure** o The provision of meteorological information will be an integrated function of the ATM system. The information will be tailored to meet ATM requirements in terms of content, format and timeliness	ICAO only discusses information infrastructure. For NextGen and SESAR, the evolution of the navigation technologies will be dominated by the transition from a predominantly ground-based to a satellite-based infrastructure based on the navigation performance requirements.

		interoperability) and augmentation as required: Aircraft based augmentation (ABAS) such as INS and multiple GNSS processing receiver; Satellite based augmentation (SBAS) such as EGNOS and WAAS. • Terrestrial Navigation infrastructure based on DME/DME is maintained to provide a backup for en route and TMA; • Enhanced on-board trajectory management systems and ATS Flight processing systems to support the trajectory Concept.		

Improved environmental management o Environmental issues such as noise, gaseous emissions and visual intrusions will be considered in the design, development and operation of aerodromes	**Improved environmental management** o Aviation system environmental management systems with improved analytical tools o Environment friendly flight profiles o Environment friendly airport environments o Environment friendly aircraft o Environmental incentives	**Improved environmental management** o Aircraft fly their individual optimum profiles to the maximum extent possible, o Enhanced airport capacity and sustainable throughput substantially reduces airborne holding and ground queuing leading to reductions on an average aircraft basis. The non CO2 environmental performance focus areas are offered here together with the key elements that will support their achievement. • 100% compliance with environmental regulations: Supported by collaborative environmental management, community dialogue, SWIM including environmental rules and performance information, transparent assessment; • Avoid counter-effective or optimize proposed environmental regulations: (as above); • Adopt a sustainability scope: Supported by all elements that help to safely, efficiently and securely serve demand, providing European sustainability benefits21; • Reduce global and local atmospheric impacts Supported by all improvements for efficiency: -<3,000ft for air quality, upper	**Improved environmental management** o Environmental issues such as noise, gaseous emissions and visual intrusions will be considered in the design, development and operation of aerodromes	Essentially equal NextGen sees CDA as part of flexible operations rather than high density operations SESAR includes continuous climb departures

		atmosphere for NOx and potentially route flexibility to avoid contrail-cirrus critical air masses; • Reduce noise impact. Supported by OCEs that allow improved trajectory accuracy and more enhanced CNS plus punctuality (curfews) and profile optimization. All the above are supported through Collaborative Environmental Management.		
Improved safety planning and management o Search and rescue organizations will need timely and accurate search and rescue information on aircraft in distress and accidents because such information plays an important role in the quality of the search function.	**Improved safety planning and management** o National Aviation Safety Strategic Plan o Safety Improvement Culture o Safety Risk Management o Safety Information Integration o Enhanced Safety Assurance	**Improved safety planning and management** o SESAR discusses a Safety Management System for participants The safety management processes including safety reporting, the sharing of safety data and lessons learned, safety benchmarking and the creation and maintenance of a just culture are the central to SESAR and are completely recognized within the concept o Safety is supported by the ground	**Improved safety planning and management** o TBD	ICAO doesn't talk about improved safety planning per se; others do not specifically talk about investigations or search and rescue. Essentially NextGen and SESAR are equal. However note that the ICAO CONOPS was produced long before ICAO Doc 9859 which addresses SMS for all ATM domains and users.

o Aviation accident/incident investigation authorities will need to exploit recordings of flight trajectory data and ATM actions.		based monitoring applications and the equivalent airborne functions.		
Improved security planning, equipment, and procedures o Air defense systems and military control systems will need timely and accurate information on flights and ATM system intents. They will be involved in airspace reservations and notification of air activities and in enforcing measures related to security. o Law enforcement (including customs and police authorities) will need flight identification and flight trajectory data, as well as information about traffic at aerodromes.	**Improved security planning, equipment, and procedures** o Integrated risk management o Secure People o Secure Airports o Secure Checked Baggage o Secure Cargo/Mail o Secure Airspace o Secure Aircraft	**Improved security planning, equipment, and procedures** System wide security management function (e.g. access control, network management) will be integrated.	**Improved security planning, equipment, and procedures** o TBD	o JPDO/NextGen has much more in-depth coverage of security than any of the other concepts. This is mainly due to the sovereignty of the European nations and how they must develop their security concepts and subsequent implementation. However, ICAO really sets the stage in this area and SESAR CONOPS addresses in general the same areas as NextGen. o SESAR and CARATS do not discuss passenger and cargo security