# Comparison of the SESAR and NextGen Concepts of Operations

NCOIC™ Aviation IPT

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# Contents

# Executive Summary

The purpose of this paper is to summarize, compare and contrast the Network Centric attributes for the two concept documents that will enable the transformation of the European and United States Air Traffic Management Systems from today's legacy paradigm into a trajectory based, performance specified, air traffic operating environment that takes advantage of a robust, automated and integrated digital system.

This review was based on a comparison of the Single European Sky ATM Research Consortium (SESAR) ATM Target Concept (WP 2.2.2/D3, Document Number: DLT-0612-222-01-00) of July 2007, and the US Joint Planning and Development Office (JDPO) documents "Concept of Operations for the Next Generation Air Transport System" Version 2.0 published 13 June 2007 (with emphasis on Chapter 4 Net Centric Infrastructure Services and Chapter 5 Shared Situational Awareness Services). The SESAR ATM Master Plan was released for public review in May 2008 and is expected to be approved in Dec 2008. Both SESAR and NextGen will evolve and adapt to changing needs and this document will be periodically updated to reflect current state of the two concepts.

In general terms the aims of, and concepts discussed within, these documents are consistent. Each describes an integrated Air Traffic Management System wherein automated tools, data network infrastructures, improved surveillance capabilities, weather capabilities, and advanced information services team together to address concerns caused by increased traffic. Each addresses heightened security, safety awareness, and other factors to enable highly efficient, effective, and safe ATM operation. Each concept relies heavily on the development and fielding of an advanced network and data service architecture assets regardless of physical location, and enabling continuous and robust data communications between all assets within the system.

Both SESAR and NextGen Concepts of Operations support a phased approach to this transformation. The SESAR definition phase took place between 2005 and 2008, defining six milestones leading to the specification of the European ATM Master Plan. The development phase began in 2008, and is planned to run until 2016, lead by the SESAR Joint Undertaking (JU), a Public-Private Partnership that includes EUROCONTROL, the European Commission, other States, European industry service providers and airport organizations. The deployment phase is planned to take place between 2015 and 2025, with a design to meet performance targets by 2020.

The plan of activities in the definition phase consisted of six milestones leading to the specification of the European ATM Master Plan. The D3 deliverable is called The ATM Target Concept. Beyond the definition phase, the development work will be headed by the SESAR JU.

Under NextGen, the ATM evolution is seen in three timeframes, including Research & Development activities (2007-2011), aircraft equipage and deployment of capabilities for the mid term (2012-2018) and fully integrated ATM system operating across all air transport domains (2019-2025). The major elements of these phases are compared in this document.

Since both concepts are evolving, this initial comparison will be reviewed periodically and will provide analysis of the differences in the programs with specific recommendations in each forum for NCOIC involvement.

# 1. Basic Operating Concepts

For both concepts, the change to operations includes shared situational awareness for more collaborative decision making and trajectory based operations for safer, more efficient airspace utilization. This requires transforming the procedures and regulations as well as the organizations' fundamental concepts and technologies. Net Centric Operations allow migrating functionality among actors and facilities to improve the efficiency of the system as a whole but requires that basic tenets be changed. In the case of ATM, this means changing the paradigm from extrapolating the aircraft intent based on radar data to the aircraft explicitly sharing it.

**SESAR:**

Supporting the entire ATM system, and essential to its efficient operation, is a netcentric, System Wide Information Management (SWIM) environment that includes the 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. Interoperability between civil and military systems will also be a key enabler to enhance the overall performance of the ATM network. Fundamentally, SESAR operational concepts place the business trajectory at the core of the system, with the aim to execute each flight as close as possible to the intention of the user. This is seen as a move from airspace to trajectory focus while introducing a new approach to airspace design and management. The collaborative planning will continuously be reflected through a common shared Network Operations Plan (NOP). Integrated airport operations will contribute to capacity gains and reduce the environmental impact. New separation modes will allow for increased capacity. Using these new integrated and collaborative features, humans will be central in the future European ATM system as managers and decision-makers.

Key Performance Areas (KPA)

SESAR has set the definition of the initial 2025 performance targets. ATM performance covers a broad spectrum, represented by the eleven ICAO Key Performance Areas (KPA). The KPA targets represent initial values (working assumptions), subject to further analysis and validation. All KPAs are interdependent and will be the basis for impact assessment and consequent trade-off analysis for decision-making.

The 11 KPAs are as follows: Capacity, Cost-Effectiveness, Efficiency, Flexibility, Predictability, Safety, Security, Environmental Sustainability, Access and Equity, Participation, Interoperability. Those that are highlighted, below, are the KPAs that SESAR sees as directly linked to the achievement of the proposed SESAR Vision.

Capacity:

A 3-fold increase in capacity, while reducing delays on the ground and in the air (enroute and airport network), is necessary to be able to handle traffic growth well beyond 2020. The ATM system is to accommodate a forecasted 73% increase in traffic by 2020 from the 2005 baseline, while meeting the targets for safety and quality of service.

Cost-Effectiveness:
2020 Target: Halve the total direct ATM costs. The ATM Performance Framework provides a common basis to ensure the effectiveness of the ATM system through a dynamic relationship between European States, institutions and regulations ("Institutional and Regulatory Framework"), and all aircraft operators, air navigation service providers and airports working in partnership to match the targets ("Business Management Framework").

Safety:
To improve safety levels by ensuring that the numbers of ATM induced accidents and serious or risk bearing incidents decrease. The traffic increase up to 2020 requires an improvement factor of 3, and for the long term a factor of 10 to meet the threefold in traffic.

Environment:
As a first step towards the political objective to enable a 10% reduction in the effects flights have on the environment by emission improvements through the reduction of gate-to-gate excess fuel consumption, minimizing noise emissions and their impacts for each flight to the greatest extent possible, minimizing other adverse atmospheric effects to the greatest extent possible.

**NextGen:**
NextGen is focused on ATM System Transformation via trajectory based operations with an emphasis on user needs. .It endeavors to increase efficiencies and decision making to account for growing demand and diversity of airspace participants and eliminate limitations caused by human decision making based on verbal communications. Transformation is enabled through distributed decision making, international harmonization, optimized division of human/automation roles, net-enabled probabilistic weather, integrated into automated decision tools, environmental sustainability, integrated safety management systems, and layered adaptive security.

NextGen establishes principles and definitions of desired end-states in the varying domains associated with these services. This chapter does not discuss specific implementations or standards or methodologies of achieving these end-states or adhering to these principles. Several areas of research and policy are identified for further review and discovery (discussed in Appendix C and D respectively).

## 2. Net Centric Commonalities

**NextGen:**
While the NextGen Concept of Operations uses different language to discuss desired performance improvements, the intent is very similar to the SESAR use of the KPAs. NextGen specifies Transformation Objectives in detail (in the IWP and in the domain

chapters of the COO) for each area of the ATM system, and describes the fundamental goals of NextGen as the following:

- Meet the diverse operational objectives of all airspace users and accommodate a broader range of aircraft capabilities and performance characteristics

- Meet the needs of flight operators and other NextGen stakeholders for access, efficiency, and predictability in executing their operations and missions

- Be fundamentally safe, secure, of sufficient capacity, environmentally acceptable, and affordable for both flight operators and service providers

NextGen also references the general goals of ATM Transformation from the NGATS Integrated Plan (2004). Six national and international goals and 19 objectives for NextGen are described (see Table 1-1 of NextGen). These are:

1. Retain U.S. Leadership in Global Aviation
    a. Retain role as world leader in aviation
    b. Reduce costs of aviation
    c. Enable services tailored to traveler and shipper needs
    d. Encourage performance-based, harmonized global standards for U.S. products and services

2. Ensure Safety
    a. Maintain aviation's record as the safest mode of transportation
    b. Improve level of safety of U.S. air transportation system
    c. Increase level of safety of worldwide air transportation system

3. Ensure our National Defense
    a. Provide for common defense while minimizing civilian constraints
    b. Coordinate a national response to threats
    c. Ensure global access to civilian airspace

4. Expand Capacity
    a. Satisfy future growth in demand and operational diversity
    b. Reduce transit time and increase predictability
    c. Minimize impact of weather and other disruptions

5. Protect the Environment
    a. Reduce noise, emissions, and fuel consumption
    b. Balance aviation's environmental impacts with other societal objectives

6. Secure the Nation
    a. Mitigate new and varied threats
    b. Ensure security efficiently serves demand

c. Tailor strategies to threats, balancing costs and privacy issues
d. Ensure traveler and shipper confidence in system security

In addition to these key performance goals, NextGen sets forth guiding principles for the development and implementation of the enterprise. While not goals, they do establish important achievement markers for industry as the system moves towards the future. The principles are:

- Frequency Bandwidth/Spectrum Capacity Supporting Stakeholder/COI Information Sharing Needs – (i.e. adequate communications capacity and QoS
- Voice by Exception and Improved Where Necessary
- Protocol Resolution – Sufficient/Dynamic addressing, secure end-to-end connectivity
- Data Availability – Push/Pull and Publish/Subscribe capabilities between COIs
- Content Understanding – metadata tagging and federated search
- Technology for Timely Decision Making – Data is relevant for action by COIs
- No Single Point of Failure – an enterprise solution that dynamically allocates resources to continue operations (transport and services)
- Data Interface Oriented – vice a Hardware Interface model, this software and customizable COI interface facilitates ease of improvement and upgrade
- Information Assurance – Appropriate access to information by authorized COIs
- Cross Domain (i.e. Multi-Level Security or Multiple Levels of Security) Exchange/Gateway Capability
- A key element of both SESAR and NextGen is System Wide Information Management (SWIM), which is a focus on how the technologies and systems will enable shared awareness for operations
- The planned technology is very similar – ADS-B, Data Link, Extended Conflict Detection
- Both Systems recognize the primacy of data communications to the cockpit and amongst ground systems ("voice by exception"), while maintaining the requirement for voice for emergency purposes, back up, and for communications with less completely equipped aircraft

- Both systems embrace a network-centric infrastructure with shared services and distributed data environments interacting semi-autonomously to achieve system-wide efficiencies.

## 3. Differences

SESAR and NextGen differ in their implementation frameworks because they are tied to very different European and US industry structures.

NextGen tends to be closely tied to government in a hierarchical framework whereas SESAR appears to be a more collaborative approach, including, but not limited to, ATM ground activities. NextGen, while having a longer timeline to implement, takes a broader approach to transforming the entire air transportation system, including ground activities.

## 4. Flow Management

**SESAR:**
In parallel with all the phases of individual business trajectory planning, a Collaborative Decision Making (CDM) process is in place in which all stakeholders share the necessary information to ensure the long and short-term stability and efficiency of the ATM system and to ensure that the necessary set of ATM services can be delivered on the day of operation.

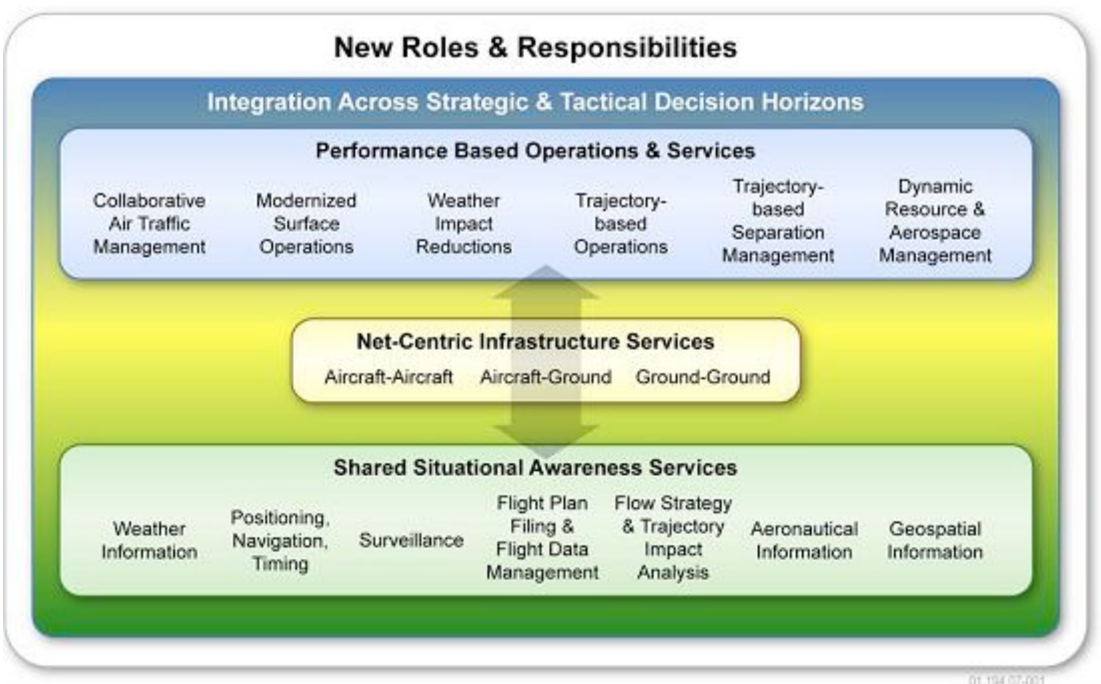
The key tool used to ensure a common view of the network situation will be the NOP. It is a dynamic rolling plan for continuous operations, rather than a series of discrete daily plans which draw on the latest available information being shared in the system. The NOP works with a set of collaborative applications providing access to traffic demand, airspace and airport capacity and constraints, scenarios to assist in managing diverse events and simulation tools for scenario modelling. The aim of the NOP is to facilitate the processes needed to reach agreements on demand and capacity.

The NOP, in its initial phase, enables collaborative Demand and Capacity Balancing (DCB) through an integrated airspace/airport organization and management in accordance with the nature of the traffic being handled. The NOP supports layered planning on local, sub-Regional and Regional level.

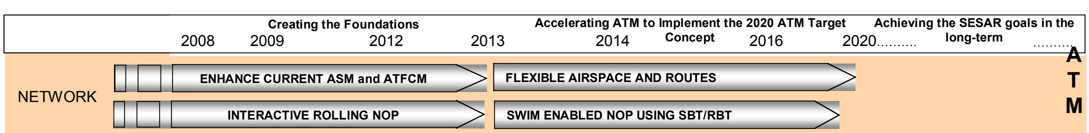
Long-term ATM planning starts with traffic growth forecasts, including user business strategy development, and planned aircraft procurement. The required new assets can be considered as available resources for DCB only when their date of delivery becomes firm. Airspace Users will then declare their intentions through Shared Business Trajectories possibly including the requirement for airspace reservations. Network Management, working collaboratively with all partners will assess the resource situation with regard to potential demand. Network Management will facilitate dialogue and negotiation to resolve demand/capacity imbalances in a collaborative manner. Tools will be used to assess network efficiency.

**NextGen:**
The US version places a great deal of emphasis on the collaborative and/or automated decision making process between the Flight Operations Centers (FOCs)/cockpit and ground Air Traffic Management. The Key Characteristics paragraph of the COO states, "[t]o the maximum extent possible, decisions in NextGen are made at the local level with an awareness of system-wide implications. This includes, to a greater extent than ever before, an increased level of decision-making by the flight crew and FOCs."

Traffic information is available via the network to the ground and onboard displays, thus allowing pilots to collaborate with ground control operators on the best strategy for their preferred trajectory. More importantly, NextGen envisions a set of Infrastructure and Information services that, when provided; enable automated collaborative planning systems to achieve efficiencies for individual airlines and the overall system.
The following graphic is from Chapter 1 of the NextGen COO:



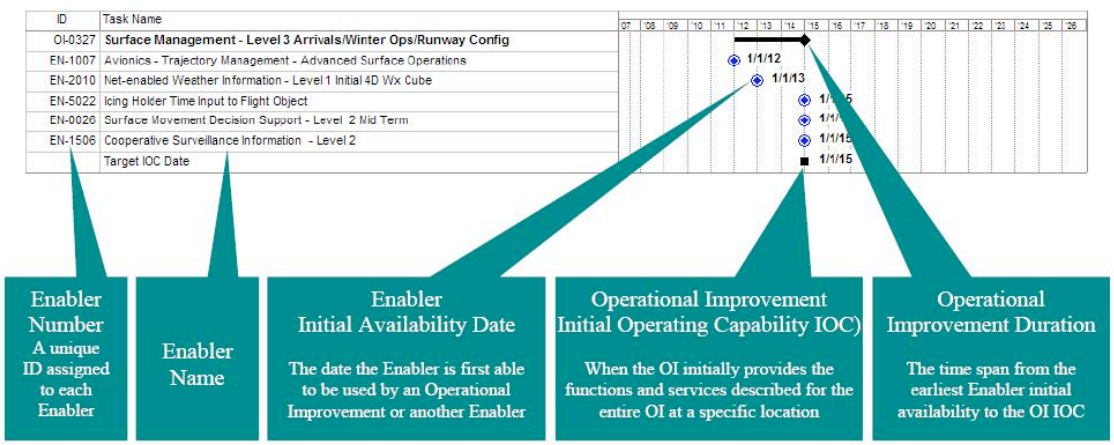

The following graphic is a flow management depiction from the SESAR Master Plan:



The SESAR Operational Concept time horizon is 2020+, while the NextGen time horizon is 2025+.

The NextGen IWP details transition "Operational Improvements (OI), Enablers, Pre-requisite enablers, research and development requirements, necessary policy decisions, and capital investment requirements for each point of transition. While the required transitions and expected improvements are very detailed in capability, the remain consistent in not specifying technologies, solutions, formats, standards, or any other implementation specifics.

In the IWP there are detailed timelines for each element. Below is an example:




## 5. Weather

The primary difference between SESAR and NextGen concerning weather is the manner in which the information is acquired. In NextGen, a centralized government-run weather service is anticipated, and in SESAR the information will be derived from a variety of traditional sources. A more net centric solution would be to allow each carrier to be able to choose whatever information is available from certified sources to provide maximum safety.

**SESAR:**
The information will be derived from a variety of (traditional) sources including an Increased reliance on remote sensing systems, aircraft derived data and satellite-based weather information. With enhanced digital communications services, the provision of Metrology (MET) information will encompass ground-based and potentially airborne automation systems and human users.

**NextGen:**

NextGen foresees weather as moving from a stand-alone display to an integrated decision making element. A primary objective of NextGen is the establishment of a single authoritative weather service available to all systems communicating within the network. While little is said about how this service will be run, a great detail is provided on what type of service will be available. The service will draw data from traditional weather reporting systems, aircraft and other sensors in route including UAVs specifically deployed for weather collection, commercial weather services which will augment the system at the basic provision rate and presumably at premium rates as a choice of individual carriers and aircraft and potentially airborne automation systems and human users as well as from weather national service.

# 6. Infrastructure Service Domains

**SESAR:**

SWIM is supported by a set of architectural elements (so-called SWIM architecture) allowing exchange of data and ATM services across the entire European ATM system. SWIM is based on the interconnection of various automation systems. The SWIM architecture aims at providing specific value-added information management services: the SWIM services. They will:

- support flexible and modular sharing of information, as opposed to closely coupled interfaces
- provide transparent access to ATM services likely to be geographically distributed;
- assure the overall consistency.

SWIM services will be required to comply with potentially stringent Quality of Service (QoS) parameters, such as integrity, availability, latency, etc. The full impact of those QoS on the proposed architecture will require significant R&D activities. For instance, not all users will have permission to access all data within a domain because of operational, commercial or security reasons.

SWIM integrates Air-Ground and Ground-Ground data and ATM services exchange. The scope extends to all information that is of potential interest to ATM, including trajectories, surveillance data, aeronautical information of all types, meteorological data etc.

**NextGen:**

NextGen establishes the requirement for the provision of a robust infrastructure on which the entire system will rely. The services provided across the enterprise are:

- **Information Sharing Services**: Enabling operational entities, COIs, services, and applications throughout the NAS to collaborate in a seamless information infrastructure with Air Navigation Service, airport, and flight operations, Shared Situational Awareness, compliance and regulation oversight, and security, safety, environmental, and performance management services.

- **Ground Services**: Providing surveillance, communications, and flight data management to any service provider regardless of its physical location, thus removing geography as a limiting factor for air assets and ground control.

- **Air-Ground Network Services**: Frequency-to-airspace sector mapping is abandoned in favor of a dynamic network environment – the "intelligent network." Data communications are central to Trajectory Based Operations, including the use of 4DTs (pushback and taxi inclusive) for planning and execution on the surface, automated trajectory analysis and separation assurance, and aircraft separation assurance… [with] situational awareness of the 4DTs and short-term intent of surrounding aircraft.

- **ANSP Infrastructure Services**: Summarized with the term "virtual tower." Such services provide the ability to locate ANSP facilities where optimal, without limitation to airspace proximity

- **Aircraft Data Communications Link**: Allowing aircraft and ground assets to connect to the data network for collaborative purposes

- **Infrastructure Management Services –** Insuring QoS

- **Mission Support Services -** provide information assurance, protocols, and standards applicable for the Net-Centric Infrastructure Services (Access, Connectivity, Processing, Posting, and Pulling).

# 7. Information, Data and Information Services

**Information and Data in SESAR and NextGen:**

A difference between the two documents lies in the treatment of information. While both indicate that data and information are key to integration and net centricity, SESAR, being a more decentralized model, calls for the establishment of a Reference Model for data and for data normalization and standardization. NextGen, envisioning a more centralized government-run approach, goes further, describing not only data but the provision of "information services" in a service-oriented and networked environment. Both concepts call for systems to make use of centralized and decentralized services, delivered in a network enabled, SOA environment, with NextGen suggesting a more centralized approach than SESAR. Collaboration on the development and fielding of these services, and agreement on the standardization of data reference models, could provide great efficiencies to both SESAR and NextGen efforts.

SESAR and NextGen both place a great deal of emphasis on the information enabling the processes, interaction, and automated support of the ATM enterprise. While there are differences in terminology and a core difference in how the information elements are described, the content of the information and that content's purpose are very similar. NextGen describes information elements in the terminology of "services" - using a service-oriented architecture context to describe the automated and ubiquitous nature of the key information elements serving the overall system. SESAR describes the information elements in terms of data models associated with different domains (flight, weather, surveillance, etc) and describes a reference model architecture that, when used, makes the data and information available for use by the system participants.

Key to the continued comparison of the two systems will be an in-depth comparison and integration of the data models and the network-centric services. Each system should be able to use the data and information available within the other to execute the integrated, collaborative, and automated analytical and decision making functions necessary to execute this transformational ATM.

**SESAR:**
ATM Information Reference Model

- Within the SWIM, Interoperable ATM information will be precisely defined by a Reference Model

  • Application independent and not constrained by implementation solutions

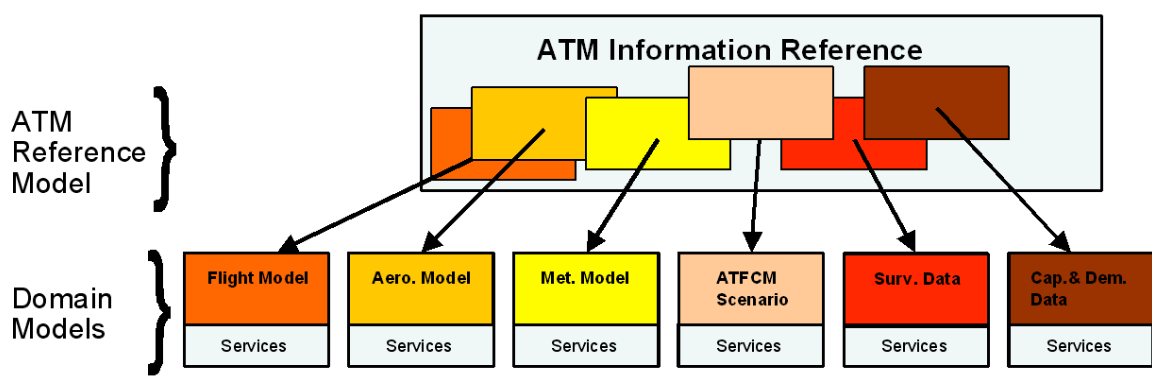
  • Addresses different domains of information as needed by the Users and expressed in business terms

  • Describes cross-domains data in a consistent way

  • Allows fulfilling the SESAR overall information sharing requirement, across ground and air heterogeneous systems.

The information to be exchanged needs to be modelled explicitly, to allow a precise and concrete definition to be agreed. This graphic is from SESAR "The ATM Target Concept".

Interoperability Models:



SWIM is first introduced for En route/Approach ATC and Network (NIMS) interactions, and later including interactions with Airports, AOC and the Aircraft. Flight information is accessible through SWIM services around 2013. Airspace, Demand & Capacity data are accessible through SWIM services around 2016.

The SWIM services will be organized around 5 data domains:

- Flight Data (including detailed trajectories)
- Aeronautical Data
- Meteo Data
- Surveillance Data
- Capacity & Demand Data (including Air Traffic Flow and Capacity Management Scenario)

**NextGen:**

In addition to the Network Centric Infrastructure, Chapter 5 of NextGen discusses the centralized provision of Information Services across that infrastructure. This is a central component of the NextGen Transformation – that is, the provision of a set of data and information services (a "service-oriented environment") from which each participant in the ATM system can draw capabilities, whether that is to access data for their own application uses or to actually use another application provided as a service to execute flight operations. The development of these services will be a challenging task, especially given the different data models in use across the industry. Collaboration with SESAR on the reference data models discussed in SESAR may benefit NextGen transformation efforts – just as collaboration on the development of centralized services might benefit SESAR participants.

In addition to the Network Centric Infrastructure, Chapter 5 of NextGen discusses the centralized provision of Information Services across that infrastructure. These are:

- Weather Information Services
- Robust Precision Navigation Services
- Surveillance Services (Cooperative and Non-Cooperative)
- Flight Plan Filing and Flight Data Management Services
- Flow Strategy and Trajectory Impact Analysis Services

- Aeronautical Information Services (AIS)
- Geographical Information System Services (GIS)

The development of services to support flight operations will be a challenging task, especially given the different data models in use across the industry. Collaboration with SESAR on the reference data models discussed in SESAR may benefit NextGen transformation efforts – just as collaboration on the development of centralized services might benefit SESAR participants.

# 8. Aircraft Participation in SWIM

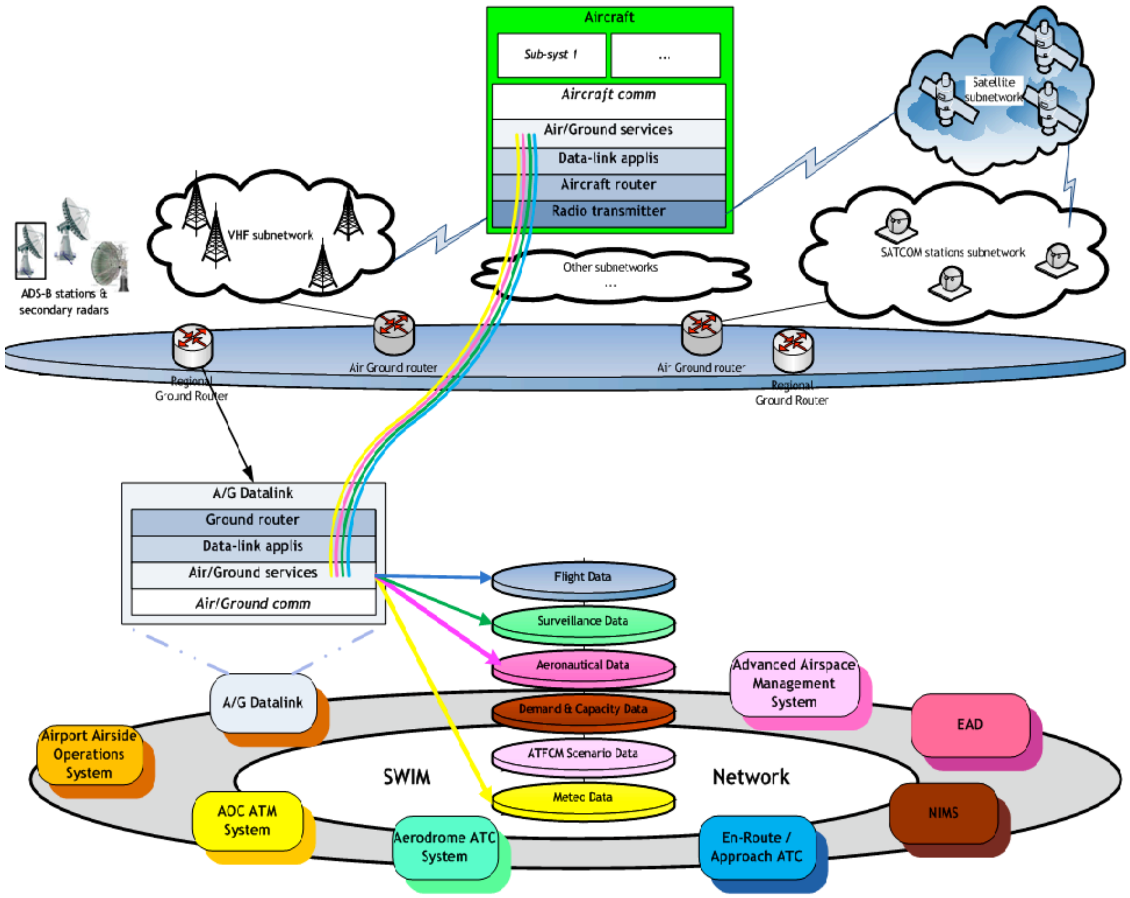
**SESAR:**

The aircraft is an integral part of SWIM.

The introduction of an Air to Ground Data link Ground Management System, which is a SWIM node and offers the aircraft a single point of access on the ground with filtering of the shared information that is needed by the aircraft and the update of onboard databases while the aircraft is still at the gate. Benefits are expected through simplification of connectivity functions and on saving multiple connection infrastructures.

Safety requires a high availability of the A/G Data link Ground Management System as failure of a system at sub-regional level would jeopardize the complete communication with the aircraft in that sub-region.

### The aircraft participation in SWIM

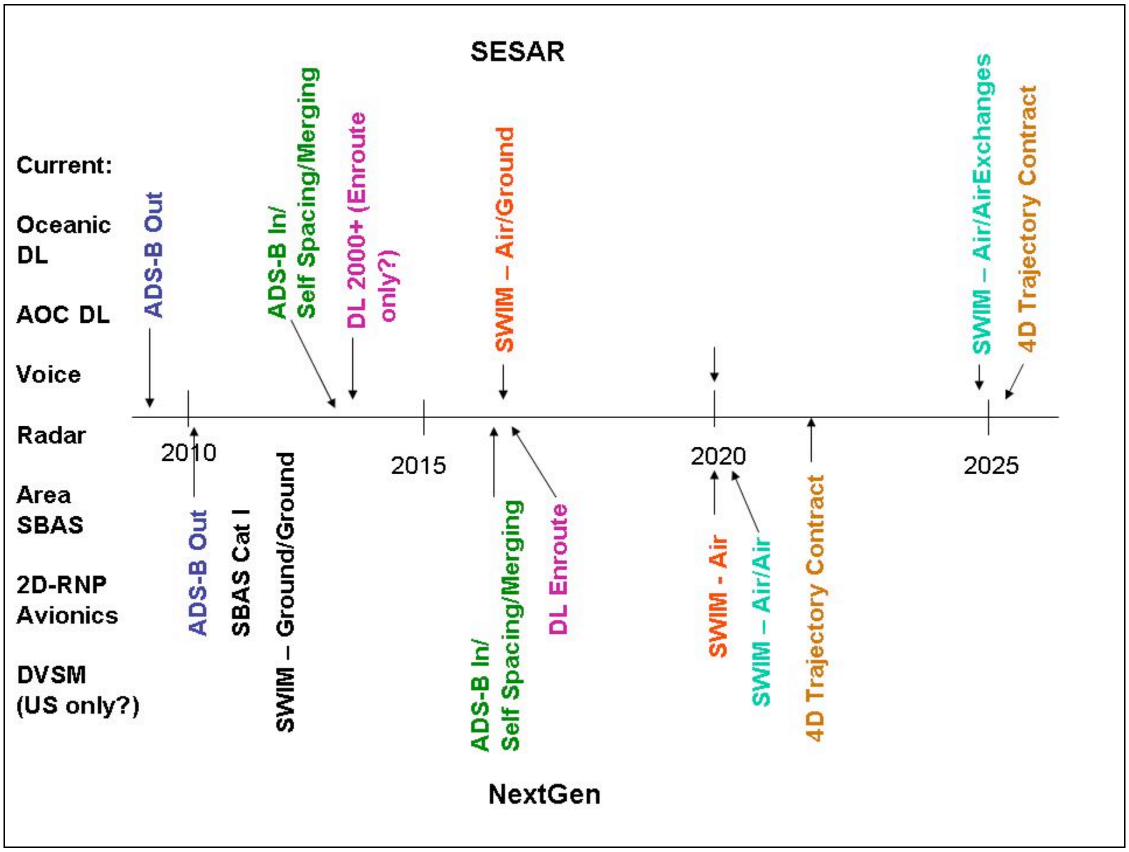



**NextGen:**
SWIM is an integral part of the NextGen concept, with the aircraft serving as a node on the network. SWIM encompasses the ability of aircraft and ground assets to collaboratively participate within an enterprise that is providing automated information cockpit-to-cockpit, cockpit-to-ground, ground-to-cockpit, and ground-to-ground. NextGen envisions a virtual network in which each node represents a part of the system – so all information is "system-wide." Each node participates in the system all the time – and user access and automated tools and services are used to ensure adequate data provision and QoS.

## 9. CNS development and Impacts

Much ground based equipment in Europe will reach end of life by 2018 – this is a major driver. Proposing 4 stages – Stage 1 is ADS-B out – then ATSAW, then self separation (2020 to 2025) and finally the possible need for another link for advanced applications like ASAS (2025). There will be a focus on R&D for possible future applications that might require a better link than 1090 MHz. CASCADE program fits into SESAR process. A Joint Undertaking will take place. NextGen and SESAR are working together on joint R&D and hold regular progress meetings.

Difference in time where various parts will be developed and implemented:




**SESAR:**

In its simplest form, the 2020 CNS baseline can be characterised as follows:

**Communication:**

• Communication technologies that enable improved voice and data exchanges between service actors within the system, such as those necessary to support the SWIM functionality and CDM process, for example:

• Ground-Ground

– A IP based ground-ground communications network supporting all the ATM applications and SWIM services, together with VoIP for ground segments, including VoIP for the ground segment of the air-ground voice link.

• Voice

– 8.33KHz is the standard for voice communications;

– SATCOM voice for oceanic and remote areas.

• Air-Ground Data link

– VDL2/ATN.

• Airport

– A new Airport data-link to support surface communication, using a derivation of the IEEE 802.16.

**Navigation:**
• Navigation technologies that enable precision positioning, timing and guidance of the aircraft to support high performance, efficient 4D trajectory operations in all phases of flight, for example:

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 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.

**Surveillance:**
• Surveillance technologies that enable precision monitoring of all traffic to assure safe and efficient operations, including enhanced Traffic Situational Awareness and ASAS.

• For the airspace, Cooperative surveillance will be the norm, complemented as required by Independent Non Cooperative surveillance to satisfy safety and security requirements. For the Airport both Cooperative and Independent Non-Cooperative surveillance systems will be necessary.

– PSR will provide Independent Non-Cooperative surveillance;

– Since aircraft will have the necessary mode S and ADS-B equipage, the choice of Cooperative surveillance technology (Mode S, ADS-B, MLAT) remains flexible, with the service provider determining the best solution for their particular operating environment, based on cost and performance;

– SMR will provide the Independent Non-Cooperative airport surveillance

• ADS-B-In/Out is provided by 1090 ES

• With a mandate of 1090 ES-ADS-B-Out, TIS-B will not be needed in the transition to support ASAS applications

• Satellite based ADS-C for oceanic and remote areas.

**CNS beyond 2020**

**Communication**
• Data link becomes the primary means of communications. Voice remains as a back-up;
• Common inter-networking transport mechanism to support the various data-links, managing an end to end Quality of Service;

• Post 2020 implementation of new communications components, comprising terrestrial (wide or narrowband) and space based components in complement of VDL2/ATN to support the new most demanding data-link services.

**Navigation**
The availability of other constellations enables increased accuracy and availability. Multi constellation receivers are able to exploit available constellations/satellites (e.g. China, Russia), if the benefits outweigh the added complexity compared to a basic GPS + Galileo combination. Ground based augmentation (GBAS) for Cat II/III approach and landing with backup provided by ILS/MLS, and specific GBAS features may be necessary to meet high performance guidance requirements for airport surface navigation

**Surveillance**
• PSR is replaced by cheaper forms of Independent Non-Cooperative surveillance;
• The 1090 ES system supporting ADS-B-In/Out is improved and/or complemented with an additional high performance data link.

**SESAR:**
CNS is formulated for 2020 that builds on 8, 33 kilohertz, VDL2/ATN for communication. Navigation builds on satellites for position determination Surveillance system has four fundamental principles that build on primary radar, SSR model S, Wide area Multilateration, ADS-B (builds on 1090 MHz) and monitoring in the aeroplane.

ADS-B equipment has been extensively and successfully tested in operational environments, and is an example of a developed SESAR and NextGen technological component.

NextGen addresses transformation as a function of changes to the operational concepts and capabilities between the current state (2006) and 2025. There are interim transformation steps for various sub-domains, but no timelines are discussed for those interim steps to total transformation. (For example, Weather Transformation is discussed in detail between 2006 and 2025. There are also four “functions” of transformation without timelines ranging from Function 1 – the ability of all aircraft to receive digital weather products and process them in the cockpit through Function 4 – achieved when the centralized weather service is able to interact with automated decision tools to inform TBO. ) General transformation objectives are summarized below:

**NextGen:**

| ***Info Service*** | ***2006 State*** | ***Transformation to 2025*** |
|---|---|---|
| Weather Information Services | Weather info requires meteorological interpretation, is drawn from multiple uncoordinated sources, and is unavailable to many users | Easily understandable, Net-centric, and common weather information is made available to all approved users from a centralized government source that fuses multiple sources together. The system is tailorable based on user need and draws from a wide variety of observation systems (commercial, platform, UAS, and gov't) |
| Robust PNT Services | Air routes are mostly defined by fixed ground-based navigational aids and expensive space based assets. | Air routes are independent of the location of ground-based navigation aids. RNAV is used everywhere; RNP is used where required to achieve system objectives. System is adjustable to changing levels of demand.<br><br>Virtual system increases availability of instrument approach procedures with lower weather minimums at smaller airports |
| Surveillance Services | Dependance on air surveillance radars | Passive radar, cooperative (data-link-based) surveillance systems tied to Fused surveillance data services and deployable area-specific systems |
| Flight Planning Services | Limited ability to receive projections on conditions that affect aircraft flight plans – no interactivity | Provides all operators with extensive and interactive flight planning and feedback on anticipated conditions affecting flight. |
| Flight Object Services | Multiple calculations of flight information (e.g. TOA) are specific to application or location, dispersed through many owners, and lead to inconsistent information about a flight. | Flight information provides consistent trajectory information that can be provided to all authorized users as a service on every flight. Services multiple applications and locations, including across international boundaries. Information about a flight is contained in one logical unit, and proprietary or security sensitive information is protected. |
| Flow Strategy and Trajectory Impact Analysis Services | Reliance on oral and textual communication of strategies and | High reliance on data communications and graphical presentations – increased data access and improved decision support. Common tools provide increased consistency to wider range of users. |

| | | |
|---|---|---|
| | concerns. Limited decision support. | Analysis addresses uncertainties in the underlying data and predictions, allowing operators to appropriately manage risks |
| Aeronautical Information Services | Much of the AIS provided by hard copy or voice | Digital globally harmonized and accurate aeronautical information is uploaded, received, and exchanged in a timely manner providing real-time information regarding airspace regardless of location. |
| GIS | Limited use in current structure | Digital and dynamic airspace boundary adjustments, trajectory-based operations, and interactive flight planning provided with updated information about the physical locations of assets available to a wide variety of users in real-time |

# 10. Anticipated Risks

**SESAR:**

- SWIM (including the A/G Data link Ground Management System) **may not meet the required quality of service** (which is still to be defined), e.g. with respect to integrity, consistency.

- **Stakeholders may fail to achieve the required certification of their systems** since they will need to carry out a safety analysis of a system that is connected to other stakeholders' systems via SWIM.

- Many problem remain particularly with **data quality** and **interoperability**.

- A key limitation has been the **absence of a globally accepted aeronautical information exchange format**, but this is now being addressed by AIXM V5.0

**NextGen:**

Automated tools, communications and enterprise management, and improved information flow will naturally provide for increases in efficiencies and effectiveness regarding the ATM System. The overall concept is not, however, without risks. NextGen COO addresses these risks within the appendixes describing additional policy and research needs. Some of the major ones are listed below:

- NextGen assumes a fully available (very high QoS) and robust enterprise network supporting ground, surface, and air assets through all stages of every flight operation. If this network is not reliable, **if communications paths and data integrity are not adequately assured**, then the **automated decision making will not happen** and the **efficiencies will not be achieved**.

- Moreover, should the system rely heavily on TBO and Flow Management in dense environments and then suffer an outage or data compromise, serious **safety or security implications may arise**.

• New capabilities and **technologies may over-burden the cockpit operation.**

• New **policies and standards** may be needed **to ensure data** and **information security**.

• Transformation to **"virtual towers" and satellite-based IAPs** may present **new difficulties** in very low visibility conditions.

• There are changing **rules, policies, security protections, responsibilities, and authorities for Safety Assurance and Safety Data Information sharing.**

• Stakeholders must **ensure data integrity across such a wide range of information services**, weather, navigation, route planning, etc.)

**Both:**

• Need to **ensure that architectural differences do not impact**, for example, how the aircraft is included in the network.

• **The investment side of things is a major challenge**; stakeholders will need to be convinced that the benefits outweigh the costs.

• **Achieving and providing safety for SESAR/NextGen** is an enormously tough challenge.

# 11. Contradictions and Major Concept Differences

- NextGen assumes a fully available (very high QoS) and robust enterprise network supporting ground, surface, and air assets through all stages of every flight operation. If this network is not reliable and if communications paths and data integrity are not adequately assured, then the automated decision making will not happen and the efficiencies will not be achieved.

- The SESAR Operational Concept time horizon is 2020+: NextGen time horizon is 2025+

- The SESAR Concept essentially has a strict ATM focus: NextGen also deals with other elements that may impact ATM either directly or indirectly (for example Homeland Security)

- The SESAR Concept adopts a largely Gate-to-Gate view with a window on the turn-round process that provides an Enroute-to-Enroute view through shared situational awareness of the status of the process. NextGen adopts a Curb-to-Curb view that encompasses all aspects of airport terminal and passenger operations

- The SESAR Concept deals with certain issues, for example Safety and the Environment, through some high level statements and at the KPA level and the detail is the responsibility of other Work Packages: NextGen deals with these issues in detail within the Concept.
- Europe seems to be ahead of the U.S. in data communication, and the U.S. is ahead in defining ADS-B Out.
- Both systems emphasis the increased use of underutilized airports, however there are minor differences. For example, NextGen includes an Airports Preservation Program to "increase community support and protect against encroachment of incompatible land use", while SESAR states that capacity goals can be met in airspace but that airports are limiting factor.
- SESAR and NextGen differ in the way that Europe comprises several member states that must agree and US is one nation from the start.
- SESAR and NextGen differ in their implementation frameworks because they are tied to very different European and US industry structures.
- The primary difference between SESAR and NextGen concerning weather is the way to acquire the information. In NextGen it seems to be a centralized government-run weather service and SESAR considers the Weather information provision services as outside its scope of work (even it requires that it can use a variety of sources).
- NextGen concepts are developed in anticipation of a widely expanding air traffic environment, but also in anticipation of greater technological capabilities for aircraft, ground control systems, surveillance, networks, and automated decision support systems. The overall vision is widely applicable to all operations related to air travel in the US Airspace - from commercial route and passenger planning through ATM and ground support operations.

# 12. Conclusion

SESAR and the US NextGen both have the same basic aim – more efficient use of airspace and better air safety – the implementation frameworks for each are radically different, with the European approach based on a single, multi-stakeholder consortium, and the US model requiring close internal coordination between various government-led programmes to ensure interoperability of components delivered by a variety of consortia.

SESAR tends to focus primarily on Air Traffic Management, but has a nearer term for completion. NCOIC highly recommends that the sharing of approaches and lessons learned from each program be made a priority in the other program in order to improve efficiency and avoid stove piping and potential incompatibilities across the Atlantic.

Both organizations are embracing basic network centric concepts. The manner in which each is choosing to implement these is taking a different form.

The common vision is to integrate and implement new technologies to improve air traffic management (ATM) performance – a 'new paradigm'. SESAR and NextGen combine increased automation with new procedures to achieve safety, economic, capacity, environmental, and security benefits. The systems do not have to be identical, but must have aligned requirements for equipment standards and technical interoperability.

SESAR:

- SWIM is a main feature of the SESAR ConOps
- Information technologies are already available to support SWIM (Datalink may need further Development)
- Institutional barriers (property of data) will need to be mitigated through regulation (if not good will) before SWIM is possible
- SWIM SUIT will prove the concept using legacy systems using wrapper techniques
- By year 2020 new systems will be developed to be directly connectable to the SWIM infrastructure, interoperability will be the result.
- Each aircraft should be equipped so that it can achieve adequate end-to-end QoS by being able to receive the required data.
- Investment is a major challenge; stakeholders will need to be convinced that the benefits outweigh the costs.
- The SESAR Operational Concept time horizon is 2020+: NextGen time horizon is 2025+. As a result, all airlines with European routes will be required to harmonize with Eurocontrol solutions early, as each entity seeks long term interoperability solutions
- Europe is now leading the world in controller pilot data link communications (CPDLC), with 15 airlines already using the service via the first operational implementation at Maastricht Upper Area Control Centre. But that lead is likely to be short-lived, thanks to the revival of US CPDLC plans through the FAA's budget allocation for a new Datacom system and the expected issuing of a notice of proposed rule making on aircraft equipage in 2010.

- A key element of both SESAR and NextGen is System Wide Information Management (SWIM), which is a focus on how the technologies and systems will enable shared awareness for operations. Some on-going initiatives such as ICOG, D-AIM, and SWIM-SUIT will enable legacy systems to operate in the SWIM environment.

- The planned technology is very similar – ADS-B, Data Link, Extended Conflict Detection. ADS-B equipment has been extensively and successfully tested in operational environments, and is an example of a developed SESAR and NextGen technological component. The United States is further along on the surveillance part, known as Automatic Dependent Surveillance - Broadcast (ADS-B) Out, while Europe's SESAR is further advanced on datalink communications. Both Europe and the U.S. clearly are moving toward the same goal, although the pace and emphasis during the transition to next-generation traffic management still must be worked out.

- Both systems embrace a network-centric infrastructure with shared services and distributed data environments interacting semi-autonomously to achieve system-wide efficiencies.

- Critical to consider global interoperability and harmonisation.

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