P04.07.07 Final Operational Service and Environment Definition (OSED)

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Abstract

This Final Operational Service and Environment Definition addresses the Implementation of Dynamic Capacity Management in a High Density Area for Step 1.

Dynamic Capacity Management consists of a series of measures that can be taken to better match capacity to predicted demand and to reduce the complexity of traffic presentation to suit available capacity. Work on the first aspect has focused on the development of a tool to suggest an optimised ACC sector configuration to match forecast demand. Work on the second aspect has concentrated on reducing the complexity of traffic presentation; some aircraft will also receive an improved trajectory that better matches their preference, thereby achieving fuel and environmental benefits.

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Executive Summary

This document sets out the Operational Service and Environment Definition (OSED) for the implementation of Dynamic Capacity Management in High Density Airspace in the context of Step 1 of the SESAR Verification and Validation (V&V) Storyboard.

Originally this project was linked to the Complexity Assessment and Resolution Operational Focus Area within Package 5 (PAC05) of the SESAR V&V Roadmap “Integrated and Collaborative Network Management”. Subsequently it was integrated into OFA05.03.04 “Enhanced ATFCM Processes” [15]. The document follows guidance provided in the SWP4.2 DOD [8] and SWP7.2 DOD [9].

The SESAR concept envisages managing capacity in high density airspace by matching capacity to forecast demand where possible. When no further capacity adjustment is possible, demand may be altered by a series of separate actions or ‘layers’ that cumulatively reduce complexity.

The **Dynamic Capacity Management concept** comprises two aspects. In the first instance, capacity should be adjusted by ATC authorities to best support the predicted demand. A decision-support tool has been developed by Aena that evaluates the most suitable ACC sector configuration during the day of operations; a prototype of this tool has been validated to V3 level in Barcelona ACC [11].

A second aspect is to modify demand. P04.07.07 has developed a ‘**layered’ concept** to support complexity reduction validated in V2 phase [10]. The ‘high density airspace’ chosen as the scenario for this complexity reduction aspect is the UK/Irish airspace that lies to the east of Oceanic airspace. Early morning arrivals to Europe from North America cluster around their optimum trajectory and frequently arrive as a bunch, which can interact with first rotation UK/Irish aircraft, creating traffic of high complexity. The layered planning concepts in P04.07.07 are as follows:

- A NATS-developed Oceanic Domestic Interface Manager (ODIM) that provides the oceanic clearance planner with information to enhance their decision making in order to reduce the complexity of aircraft departing oceanic airspace;
- High Level Direct Routing that aims to take advantage of the improved Medium Term Conflict Detection tools that have been deployed into Swanwick Area Control Centre (ACC), together with improved Flexible Use of Airspace procedures. This will increase the lateral separation of aircraft at an earlier stage into separate over-flight and UK inbound streams.
- An inbound longitudinal streaming concept that uses an extended arrival manager (AMAN) horizon concept being developed within SESAR 5.6.4 [17] to provide longitudinal streaming of UK arrival flows at an earlier stage. Note that the 5.6.4 focus is on reducing workload in the TMA and smoothing the arrival flow. However the solution adopted by 5.6.4 involves transmitting a Target Time to aircraft up to 80 minutes (approximately 500nm) from the airport. This produces a longitudinal streaming effect that also provides a complexity reduction effect in the P04.07.07 target airspace.

Taking into account the level of maturity of each concept the aim of P04.07.07 validation has been as follows:

- **Dynamic Capacity Management Concept**: to validate local procedures and supporting tools in a high density area to evaluate the most suitable ACC sector configuration during the day of operations in terms of capacity matching forecast demand approximately eight hours before the operation;
- **Layered Planning Concept**: to assess the benefits that can be derived by each of these concept ‘layers’. It is expected that the results of this concept ‘layers’ will have relevance for many other areas of Europe where primarily long-haul ‘bunches’ of aircraft would benefit from measures designed to reduce their complexity.

This Final OSED uses as input the results of discussions with Air Navigation Service Providers (ANSPs) and operational network managers in Ireland, Maastricht and the UK in order to provide relevant and timely concepts for of the demand management aspects of Step 1.

1 Introduction

1.1 Purpose of the document

The Operational Service and Environment Definition (OSED) describes the operational concept defined in the Detailed Operational Description (DOD) in the scope of its Operational Focus Area (OFA).

The DOD defines the operational services, their environment, scenarios and use cases and requirements.

The OSED is used as the basis for assessing and establishing operational, safety, performance and Interoperability requirements for the related systems. The Safety and Performance requirements are detailed in the Preliminary Safety and Performance Requirements (SPR) document [13].

This OSED takes into account the 'top down' SWP 04.02 DOD and SWP 07.02 DOD; it also contains additional information which should be consolidated back into the higher level SESAR concepts using a 'bottom up' approach. In addition, the Preliminary OSED and input from Network Management experts from several ANSPs have been used as a top-down reference.

Figure 1 below presents the location of the OSED within the hierarchy of SESAR concept documents, together with the SESAR Work Package or Project responsible for their maintenance.

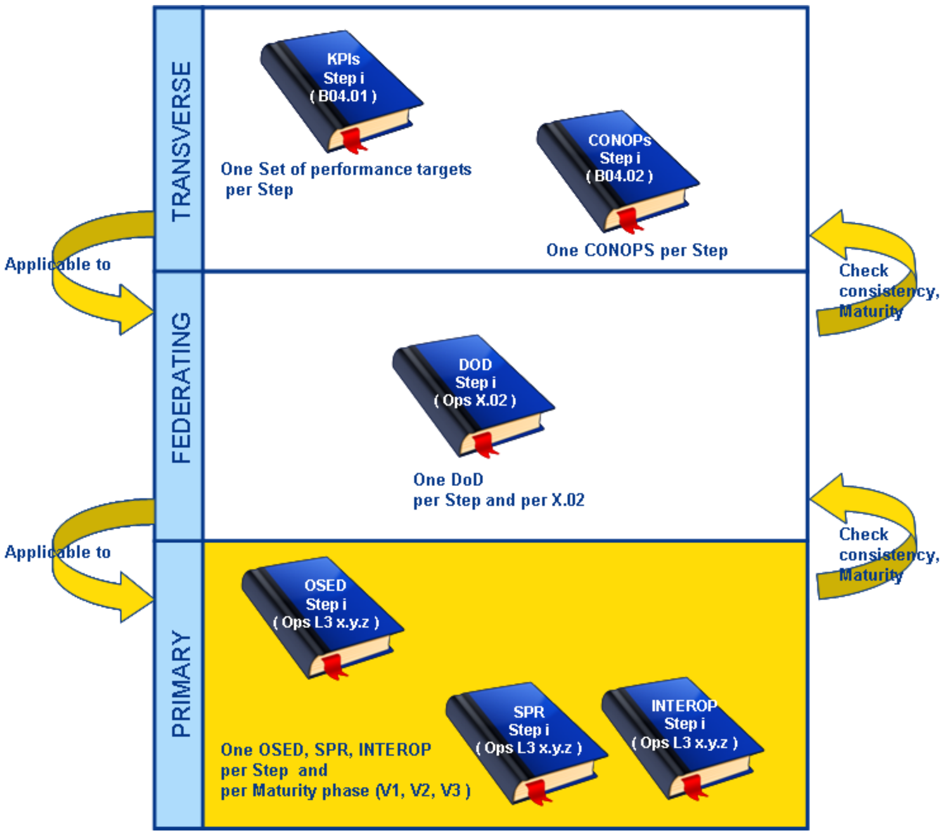


Figure 1 - OSED document with regards to other SESAR deliverables

In Figure 1, the Steps are driven by the OI Steps addressed by the project in the Integrated Roadmap document [16].

1.2 Scope

At the beginning of this project, P04.07.07 was linked to the Complexity Assessment and Resolution Operational Focus Area within Package 5 (PAC05) of the SESAR V&V Roadmap "Integrated and Collaborative Network Management". Subsequently it was moved to OFA05.03.04 "Enhanced ATFCM Processes". Table 1 below identifies the OFA in relation to its Ops sub-package and package.

Operational Package	Operational Sub-Package	Operational Focus Area (OFA)
Integrated and Collaborative Network Management (PAC05)	Complexity management	**OFA05.02.01** Complexity Assessment and Resolution
	Demand and Capacity Balancing en route	**OFA05.03.04** Enhanced ATFCM Processes

Table 1 - Operational Packages and Sub-packages addressed in the OSED

1.3 Intended readership

Intended audience of the document are:

- P04.07.07 Project Members (AENA, NATS, SELEX);
- Project Members of the same OFA (P04.03, P04.07.01, P07.05.03, P07.06.05 and P10.08.01);
- Other projects: P05.06.04;
- Project Members of the technical project P13.02.03;
- Federating Projects: 4.2, 5.2, 6.2 and 7.2 for Consolidation;
- Transversal Projects: WPB for architecture and performance modelling and B.4.2 Maintenance of the Target Concept [5].

1.4 Structure of the document

The project has two concepts which vary by maturity level. Hence, most sections of this document have been divided into the two concepts: **Dynamic Capacity Management** Concept (V3-STEP1) and **Layered Planning** Concept (V2 STEP1). The structure of the document is as follow:

The executive summary provides the information on the purpose and scope of the document as well as an explanation on the methods and approach used.

Section 1 provides the document introduction, its scope, purpose, intended audience, background information as well as the glossary of terms and acronyms.

Section 2 provides detailed description of operational concept elements, its processes and services including the mapping tables for each concept.

Section 3 provides an overview of the operational environment including airspace characteristics and functional capabilities of the ground system for each concept.

Section 4 provides the description of previous and future operating methods and highlights their main differences for each concept.

Section 5 provides an example of the operational scenario for each concept.

Section 6 provides the list of Operational Requirements for each concept.

Section 7 provides the list of applicable and reference documents.

1.5 Background

This Final OSED builds upon the Preliminary OSED ([12]) by adding details regarding the V2/V3 validation reports Tool ([10]/[14]) and adding Operational Requirements for all the concepts described.

1.6 Glossary of terms

Term/Source	Definition
Airspace Configuration **SOURCE:** SWP 7.2	Is a pre-defined and coordinated organisation of ATS routes and/or terminal routes and their associated airspace structures, including airspace reservations/restrictions (ARES), if appropriate, and ATC sectorisation.
Airspace Management **SOURCE:** SWP 7.2 and SWP 4.2	Airspace Management is integrated with Demand and Capacity Balancing activities and aims to define, in an inclusive, synchronised and flexible way, an optimised airspace configuration that is relevant for local, sub-regional and regional level activity to meet users requirements in line with relevant performance metrics. Airspace Management primary objective is to optimise the use of available airspace, in response to the users demands, by dynamic time-sharing and, at times, by the segregation of airspace among various airspace users on the basis of short-term needs. It aims at defining and refining, in a synchronised and a flexible way, the most optimum airspace configuration at local, sub-regional and regional levels in a given airspace volume and within a particular timeframe, to meet users requirements while ensuring the most performance of the European Network and avoiding as much as possible any disruption. Airspace Management in conjunction with AFUA is an enabler to improve civil-military co-operation and to increase capacity for the benefit of all users.
Dynamic Capacity Management **SOURCE:** 04.07.07	Concept proposed by P04.07.07 to adapt the capacity to the traffic load by grouping and de-grouping sectors and managing the staff resources.
Dynamic sectorisation **SOURCE:** SWP 4.2	The geographical and vertical limits of a control sector will be adapted to the traffic flow to optimise the capacity in real-time. Flexible sectorisation does not imply that ATC will be faced with sector configurations that are not known either to them or to the supporting FDP and RDP systems. Sector configurations will be part of the pre-determined scenarios of the ACC and will be simulated and training will be provided prior to usage.
Layered Planning **SOURCE:** 04.07.07	Concept proposed by P04.07.07 to support complexity reduction by a series of separate actions or 'layers' that cumulatively reduce complexity. The actions would be: A NATS-developed Oceanic Domestic Interface Manager (ODIM), High Level Direct Routing and an inbound longitudinal streaming concept.
Network Operations Plan (NOP) **SOURCE:** SWP 7.2	A set of information and actions derived and reached collaboratively both relevant to, and serving as a reference for, the management of the Pan-European network in different timeframes for all ATM stakeholders, which includes, but is not limited to, targets, objectives, how to achieve them, anticipated impact. The NOP has a dynamic and rolling lifecycle starting in the strategic phase and progressively updated up to and including the execution and post-operations phases.

Term/Source	Definition
	It supports and reflects the result of the collaborative ATM planning process: at each phase, stakeholders collaborate at developing common view of the planned network situation, allowing each of them to take informed decisions considering the network effect and the Network Manager to ensure the overall coordination of individual decisions needed to support network performance.
Nominal/Non-Nominal/Exception Conditions **SOURCE:** SWP 4.2	Nominal conditions relate to flight circumstances which are optimal and fully reflect the SESAR objectives for flying and adhering to an agreed reference trajectory, in accordance with all ATC clearances and constraints. As Step 1 progresses towards Step 2 and onwards to Step 3 the flight conditions should increasingly tend towards the nominal case. Non-nominal conditions relate to circumstances which are to be expected in the Step 1 timeframe because of shortfalls in the various concepts, equipages and procedures. Typically they will involve various ATC measures such as conflict avoidance and complexity reduction. They also include situations where a dialogue or negotiation process is rejected for some reason. Exception conditions relate to circumstances which should not normally occur. For example this includes any failure (air or ground) to reply to an operational request or dialogue. They also include situations where flight behaviour is found to be in significant contradiction to the agreed course of action, with the exception of certain unavoidable circumstances, such as unexpected weather conditions which will be regarded as non-nominal.
PERSEO **SOURCE:** 04.07.07	Web-based local tool where the forecast demand is based on the processing of massive historical data obtained from multiple sources of information or a mix of real traffic data and these historical data. This tool includes an optimization algorithm to provide the most suitable airspace configuration.
Sector **SOURCE:** 04.07.01	A sector is the area of responsibility assigned to a Unit of Control. A sector is composed of one or several elementary sector.
Sector Cluster **SOURCE:** 04.07.07	A sector cluster represents a group of adjoining airspace blocks that are treated as a single ATM airspace. A sector cluster consists of several ATC sectors and multi-sectors.
Sector configuration **SOURCE:** 04.07.01	Airspace configuration in the Centre of Control (ACC)/ Sector Cluster i.e. the relation between the Units of Control and sectors.
Sector configuration schedule **SOURCE:** 04.07.01	List of planned sector configurations with their time of activation.
Target Sector Flow **SOURCE:** 04.07.07	It is a level below that the sector can safely handle to allow for the inefficiencies inherent to the CFMU process and the vagaries of the subsequent control process, providing some headroom /protection of overloads.

1.7 Acronyms and Terminology

Term	Definition
ACARS	Aircraft Communications Addressing and Reporting System
ACC	Area Control Centre
ADS-C	Automatic Dependent Surveillance Contract
ATFCM	Air Traffic Flow and Capacity Measures
AO	Airline Operator
AMAN	Arrival Manager
ANSP	Airspace Navigation Service Provider
CDM	Collaborative Decision Making
CHMI	CFMU Human Machine Interface
CFMU	Central Flow Management Unit
CM	Conformance Monitoring
COOPANS	CO-OPeration between ANS-providers
CPDLC	Controller Pilot Datalink Communications
CTA	Controlled Time of Arrival
DCB	Demand-Capacity Balancing
dDCB	Dynamic DCB
DOD	Detailed Operational Description
ECAC	European Civil Aviation Conference
ENSURE	En-Route Shannon Upper Airspace Re-Design
ETFMS	Enhanced Traffic Flow Management System
EUROCAE	European Organization for Civil Aviation Equipment
FAB	Functional Airspace Block
FDP	Flight Data Processing
FMP	Flow Management Position

Term	Definition
FMS	Flight Management System
FRAM	Free Route Airspace Maastricht
FUA	Flexible Use of Airspace
HLS	High-Level Sectors
IAA	Irish Aviation Authority
iFACTS	Interim Future Area Control Tools Support.
IM	Intent Monitoring
iTEC	Interoperability Through European Collaboration
LAC	London Area Control
LARA	Local and Regional Airspace Management System
LTMA	London TMA
MDA	Military Danger Area
MINSEP	Minimum Separation tool
MNPS	Minimum Navigation Performance Specification
MOPS	Methods of Operating
MTCD	Medium Term Conflict Detection
NAS	National Airspace System
NAT	North Atlantic
NEAP	North European Alliance Partnership
NERS	North Atlantic European Routing Scheme
NIMS	Network Information Management System
NOP	Network Operations Plan
NOTA	Northern Oceanic Transition Area
NTFSR	Night Time Fuel Saving Routes
OACC	Oceanic Area Control Centre
OAT	Operational Air Traffic
ODI	Oceanic/Domestic Interface

Term	Definition
ODIM	Oceanic Domestic Interface Manager
OI	Operational Improvement
OTS	Organised Track Structure
OFA	Operational Focus Area
OSED	Operational Service and Environment Definition
PERSEO	Platform for the Analysis of Network Effects of Sector Configuration
PI	Performance Indicator
P&S	Processes and Services
R Lat SM	Reduced Lateral Separation Minima
RBT	Reference Business Trajectory
RTA	Required Time of Arrival
RVSM	Reduced Vertical Separation Minimum
SAATS	Shanwick Automated Air Traffic System
SBT	Shared Business / Mission Trajectory
ScOACC	Scottish Oceanic Area Control Centre (Prestwick)
SJU	SESAR Joint Undertaking
SOPs	Standard Operating Procedures
SOTA	Shannon Oceanic Transition Area
SPR	Safety and Performance Requirements
SWP	Sub-Work Package
TLPD	Traffic Load Prediction Device
TMA	Terminal Manoeuvring Area
TSF	Target Sector Flow
TTA	Target Time of Arrival
TTG	Time to gain
TTL	Time to Lose
UDPP	User-Driven Prioritisation Process

Term	Definition
UIR	Upper Information Region

2 Summary of Operational Concept from DOD

Airspace capacity is designed to meet projected demand patterns using fixed routes and sectors with controllers validated to these structures to handle the traffic. Different configurations of these structures could be used on the day of operation, but these are also limited to certain pre-defined options and procedures. As a result there is an inherent mismatch between the long lead times it takes to bring new ATM capacity into operation and the shorter time it takes for airlines to open new routes and services.

In order to adapt the demand and capacity in terms of numbers of aircraft and/or complexity, P04.07.07 addresses local airspace configuration measures framed during the medium and short term planning phases. Airspace configurations are related to airspace volumes but also to routes and may combine both of them - e.g. routes to activate depending on sector configuration.

Current airspace issues to be addressed:

- Unused latent capacity which can occur in all Flow Management Positions (FMPs) during peak hour times every day. Currently, the tools to assist the FMPs have improved detection of the overload but do not offer better options to deal with it;
- Transatlantic flights which frequently cluster around an optimum North Atlantic (NAT) track. When such aircraft leave oceanic airspace eastbound, the traffic presentation can be highly complex, requiring high controller workload to resolve the issue. This issue of long haul traffic bunches requiring separating into new flows of over-flying and descending traffic is replicated in many other parts of the European Civil Aviation Conference (ECAC) area;
- Aircraft which are currently unable to fly their most efficient trajectories as they see fit. Aircraft trajectories are constrained in both time and space and are fragmented due to national boundaries.

The solutions proposed in P04.07.07 to address these problems are:

- **Dynamic Capacity Management (Step 1, V3):** This will adapt the airspace capacity to the traffic load by grouping or de-grouping sectors and managing the associated staff resources. Opening additional sectors will use the optimal configuration based on progressive refinement during the medium to short term planning phase and take into account local constraints (e.g. Human resources allocation);
- **Layered Planning (Step 1, V2):**
    - Oceanic Clearance Optimization: This will improve the allocation of oceanic clearances in order to facilitate improved delivery from the NAT organised track system at the UK/Ireland Functional Airspace Block (FAB) domestic interface;
    - High Level Direct Routes (HLDR): This aims to provide the most efficient and effective airspace structure best fitting the requirements of all stakeholders (some form of ‘Free’ or ‘Tailored’ routes) within UK/Ireland FAB Airspace. These measures are framed during the medium to short term planning phase;
    - Inbound Longitudinal Streaming: The early longitudinal streaming of aircraft departing oceanic airspace into arrival streams for individual UK Terminal Manoeuvring Areas (TMAs) will enable the adjusting of an aircraft’s speed during the late cruise phase to reduce domestic complexity. These measures are framed during the medium to short term planning and execution phases.

2.1 Mapping tables

Apart from the required information requested in this section, new additional information related to the maturity level of the P04.07.07 proposed solutions is included.

The maturity phases of a concept are dependent on the operational scenario to be validated and therefore the maturity information relates to the two Scenarios previously described, i.e. the ACC Sector Configuration Scenario (addressed by the DCM concept), and the Layered Planning Scenario.

Table 2 below includes the Operational Improvements (OIs) and the maturity level addressed by P04.07.07 and identifies the relevant Operational Focus Area (OFA).

Relevant OI Steps ref. (coming from the Integrated Roadmap)	Operational Focus Area name / identifier	Story Board Step	Master or Contributing (M or C)	Maturity Level of the OIs depending on the operational scenario	Contribution to the OIs short description
CM-0102-A - Automated Support for Dynamic Sectorisation and Dynamic Constraint Management	Dynamic sectorisation and Constraint management	Step1	C	V3-DCM scenario	This improvement relates to the dynamic management of airspace. The system provides support for decision making based on pre-defined sector sizing and constraint management in order to pre-deconflict traffic and optimise use of controller work force.
DCB-308 Short Term ATFCM Measures Enhancement	Complexity Assessment and Initial Complexity Resolution	Step1	C	V2 – Layered Planning Scenario	The layered planning process contributes to complexity resolution.

Table 2 – List of Relevant OIs within the OFA

Table 3 below identifies the link between the applicable scenarios and use cases of the DOD.

Scenario identification	Use Case Identification	Reference to DOD section where it is described
Operational Scenario Medium/Short Term/ Build the Traffic Demand	UC-NP-09 Forecast Demand based on Historical Data	SWP 07.02 DOD / 4.2.2 Operational Scenario Medium/Short Term
Operational Scenario Medium/Short Term/Build the Traffic Demand	UC-NP-10 Enrich Historical Demand Forecast with incoming Flight intentions	SWP 07.02 DOD / 4.2.2 Operational Scenario Medium/Short Term
Operational Scenario Medium/Short Term/Build the Traffic Demand	UC-NP-11 Assess Predictability and Uncertainty of Demand Forecast	SWP 07.02 DOD / 4.2.2 Operational Scenario Medium/Short Term
Operational Scenario Medium/Short Term/Plan Network Resources and	UC-NP-14 Define and Share Sector	SWP 07.02 DOD / 4.2.2 Operational Scenario Medium/Short Term

Scenario identification	Use Case Identification	Reference to DOD section where it is described
Capacities		

Table 3 – List of Relevant DOD Scenarios and Use Cases

Table 4 below shows the list of relevant DOD environments.

Operational Environment	Class of environment	Reference to DOD section where it is described
En Route airspace	Airspace configurations	N/A

Table 4 – List of Relevant DOD Environments

Table 5 below identifies the link with the applicable Operational Processes and Services defined in the DOD.

DOD Process Title	Process identification	Process short description	Reference to DOD section where it is described
Operational Processes Long, Medium and Short Term	Forecast Traffic Demand based on Historical Data (A10)	Using old flight data from a past period with similar characteristics to that being investigated for forecasting purposes and then overlaying this with some agreed assumptions (traffic growth, upper winds, etc…) to generate a realistic traffic sample upon which some planning decisions can be made.	SWP 07.02 DOD / 5.2.1
Operational Processes Long, Medium and Short Term	Enrich Demand Forecast with incoming SBT/SMT (A30)	An initial demand forecast is added to and progressively replaced by real business and mission trajectory data resulting in an improving forecast dataset.	SWP 07.02 DOD / 5.2.1
Operational Processes Long, Medium and Short Term	Assess Predictability and Uncertainty of Demand Forecast (A50)	Based upon any assumptions made within the process of compiling any forecast demand picture the Network Manager generates a level of reliability that will be afforded to that forecast	SWP 07.02 DOD / 5.2.1
Operational Processes Long, Medium and Short Term	Capture ops environmental data (human resources, contingency plans, technical parameters, weather, performance targets and environmental constraints...) B6	The Local Capacity Management captures data relevant to the local and sub-regional operational environment to get an overall understanding of the short to long term availability of capacity resources in his area of responsibility. This includes data describing human resources (ATCOs, FD assistance etc.) and planning, technical parameters (e.g. scarce resources), contingency plans, performance targets, weather forecasts, environmental constraints etc.	SWP 07.02 DOD / 5.2.1

Table 5 – List of relevant DOD Processes and Services

Table 6 shows the list of DOD-related requirements.

DOD Requirement Identification	DOD requirement title	Reference to DOD section where it is described
REQ-04.02-DOD-0005.0001	The system shall provide support for decision making based on pre-defined sector sizing and constraint	SWP 04.02 DOD / 6.1

DOD Requirement Identification	DOD requirement title	Reference to DOD section where it is described
	management for the dynamic management of airspace.	
REQ-04.02-DOD-0006.0001	Operational procedures shall be developed requiring dynamic coordination between more than one ACC, the AOs and the CFMU in order to close the gap between ATC and ATFCM.	SWP 04.02 DOD / 6.1

Table 6 – List of Relevant DOD Requirements

2.2 Operational Concept Description

P04.07.07 is addressing the issue of dynamic capacity management in high density airspace. In order to achieve this objective, two operational concepts have been developed:

1. Dynamic Capacity Management: This aims to vary capacity to match forecast demand using an ACC sector configuration optimisation tool.
2. Layered planning: This comprises a series of layered planning measures to reduce complexity. These measures involve reducing the complexity of traffic presentation of aircraft departing the North Atlantic (NAT) track structure. This starts with the use of an Oceanic Domestic Interface Manager (ODIM) that aims to take account of aircraft destination when allocating cleared tracks and levels when appropriate and without penalising the aircraft. Subsequently aircraft transiting UK airspace at high level en route to non-UK destinations will be able to take up direct routing through UK airspace, producing a lateral 'fanning out' effect. Aircraft inbound to UK airports, which may also conduct an element of direct routing to a common descent point for their flow, will be longitudinally streamed through use of an extended Arrival Management (AMAN) horizon. This latter concept is being developed through P05.06.04 Tactical TMA and En Route Queue Management. However the focus of 05.06.04 with respect to controller workload and complexity is to produce a predominantly TMA benefit. The focus of this project is to demonstrate how this concept also produces a complexity reduction effect in the target en route airspace. A combination of all these measures should reduce the complexity faced by controllers, thereby enabling further performance improvements in line with overall SESAR goals. It is acknowledged that in SESAR Step 2, such layered planning measures are likely to be made more dynamic and more responsive to user demand. As a Step 1 SESAR project, P04.07.07 is developing the concepts that will lay the path for further refinements.

2.2.1 Dynamic Capacity Management (Step 1 V3)

The Dynamic Capacity Management concept proposed by P04.07.07 is to adapt the capacity to the traffic load by grouping and de-grouping sectors and managing the staff resources. The main aspects of this concept are:

- DCM allows the airspace structure to be dynamically adjusted to optimise the efficiency of Air Traffic Management (ATM) services;
- DCM can be applied in high traffic density airspace regions in which an environment (in terms of system capabilities) exists that enables the refinement of airspace sectorisation and traffic planning to be fully dynamic and used to adjust the traffic demand balance.
- DCM seeks to enable an increase in sectorisation efficiency by taking measures in advance that serve to detect, assess and resolve imbalances in traffic as well as to analyse local metrics such as the impact on human resources distribution.
- DCM is part of a layered planning process encompassing all ATM activities. Related SESAR Step 1 projects include: P07.06.03, P07.06.05, and P04.07.01.

In summary, the high level objective of dynamic capacity management is that en route controller complexity shall be reduced though better work/demand distribution within the Area Control Centre (ACC)/ Sector cluster.

2.2.2 Layered Planning Concept (Step 1 V2)

The Layered Planning concept which aims to reduce complexity by a series of separate actions or 'layers' consists of the following:

- Oceanic Domestic Interface Manager
  The aim of Oceanic Clearance Optimisation is to improve allocation of oceanic clearances in order to facilitate improved delivery from the NAT organised track structure to the UK/Ireland FAB domestic interface. It will take into account the forthcoming reduction in oceanic lateral separation (circa 2012) which will enable additional NAT tracks to be established. There is also an opportunity to optimise positioning of aircraft based on their requirements for improved vertical trajectories, and to lessen the impact of relatively unplanned patterns of traffic on domestic sectors. The uncertainties in the arrival times of east-bound NAT traffic are a growing constraint to European domestic 'first wave' traffic.

  An Oceanic Domestic Interface Manager (ODIM) would enable these improvements. It is anticipated that ODIM would also provide similar improvements for the west-bound flow. Therefore, instead of clearing flights based purely on flight plan or request, clearances would be issued according to a plan - constantly validated and updated by ODIM - which would be based upon the best compromise between delivery to domestic airspace, oceanic fuel burn and environmental impact.

  In summary, the high level objective of ODIM is to reduce controller complexity by improving traffic presentation of aircraft leaving oceanic airspace.

- High Level Direct Routing
  This section identifies the high level operating concept within the UK/Ireland Functional Airspace Block (FAB) Airspace for the implementation of some form of direct route airspace bringing simplification or even the removal of traditional Air Traffic Service (ATS) route structures and arranging sectorisation to best fit the requirements of any revised traffic flows and patterns. The aim of the concept will be to provide the most efficient and effective airspace structure best fitting the requirements of all stakeholders, enabling significant environmental and network efficiency benefits alongside anticipated associated capacity and safety benefits. A key feature of the concept allows flight-plannable direct routes between waypoints at the boundaries of the airspace block.

  The concept will provide for increased availability of user preferred routes or trajectories whilst improving on the overall efficiency, safety and capacity within the FAB airspace structure making best use of all available tools. This is particularly important for flights leaving the NAT Organised Track Structure (OTS).

  The concept treats the UK and Irish Flight Information Regions (FIRs) as a single FAB, and will, if possible, co-ordinate with neighbouring Air Navigation Service Providers (ANSPs), not only to minimise the impact this project may have on their operations, but also to develop any opportunities for implementing the concept throughout SESAR.

  In summary, the high level objectives of High Level Direct Routes (HLDR) are that aircraft fuel burn and CO_2 emissions shall be reduced by facilitating direct routes during the cruise phase and that en route controller complexity shall be reduced by dispersing aircraft laterally.

- Inbound Longitudinal Streaming

  This part of the concept aims to reduce complexity of domestic and transatlantic traffic inbound to UK airports as transatlantic arrivals enter UK airspace. The concept introduces the idea of early streaming of aircraft departing oceanic airspace and the UK/Irish FAB into arrival streams for individual UK TMAs.

  Aircraft will be expected to respond to extended AMAN horizon Target Time Over (TTO) constraints using the Flight Management System (FMS) functionality for achieving a Target Time of Arrival (TTA) as soon as they leave oceanic airspace, i.e. to begin to adjust their speed in response to TTA time. P5.6.4 Tactical TMA and En-route Queue Management is responsible for the development of this concept to produce a TMA benefit. This project is responsible for demonstrating the benefit that this concept has in terms of complexity reduction in the target en route airspace.

In summary, the high level objective of Inbound Longitudinal Streaming is that en route controller complexity shall be reduced by dispersing aircraft longitudinally.

2.3 Processes and Services (P&S)

The high-level process and service diagram for traffic complexity is detailed in the 4.2 DOD [[8] and repeated below. Further diagrams are set out in the 4.2 DOD.

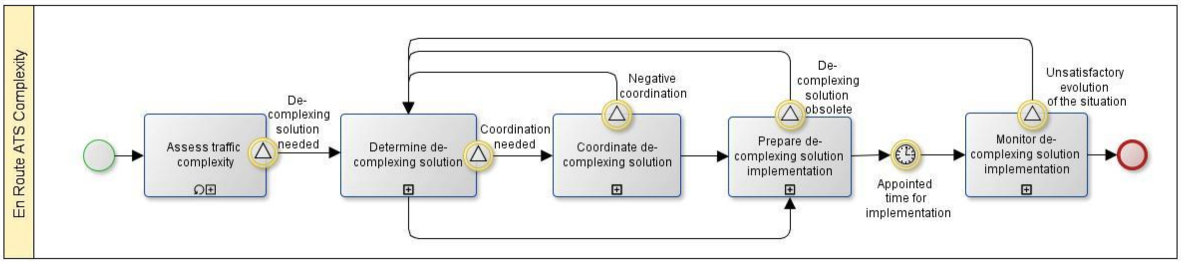


Figure 2 – Traffic Complexity Process Diagram

3 Detailed Operating Method

Airspace capacity is designed to meet projected demand patterns using fixed routes and sectors, with controllers validated to these structures to handle the traffic. Different configurations of these structures could be used on the day of operation, but these are also limited to certain pre-defined options and procedures. As a result there is an inherent mismatch between the long lead times it takes to bring new ATM capacity into operation and the shorter time it takes for airlines to open new routes and services. Thus, demand has always exceeded capacity.

In order to adapt the demand and capacity in terms of numbers of aircraft and/or complexity, P04.07.07 addresses:

- <u>Dynamic Capacity Management Method</u>:

  Unused latent capacity which can occur in all Flow Management Positions (FMPs) during peak hour times every day. Currently, the tools to assist the FMPs have improved detection of the overload but do not offer better options to deal with it;

- <u>Layered Planning Method</u>:

  Transatlantic flights which frequently cluster around an optimum North Atlantic (NAT) track. When such aircraft leave oceanic airspace eastbound, the traffic presentation can be highly complex, requiring high controller workload to resolve the issue. This type of situation is replicated in many other parts of the European Civil Aviation Conference (ECAC) area;

  Aircraft which are currently unable to fly their most efficient trajectories as they see fit. Aircraft trajectories are constrained in both time and space and are fragmented due to national boundaries.

3.1 Dynamic Capacity Management Method (DCM)

3.1.1 Previous Operating Method - DCM

At present a Strategic Phase provides the first step in reducing traffic complexity up to one and a half years in advance of the day of operations. The Strategic Phase is focused on analysing major and significant events as well as anticipated capacity shortfalls for individual ACCs/airports. The result is a set of agreed ATFCM measures/solutions to be considered for implementation (partly or totally) in the medium to short term planning and execution phases. ATFCM solutions can be considered in three parts:

- Optimise capacity: a number of solutions are considered that should result in maximising capacity in line with profile of traffic demand such as sector management, civil/military coordination, reduction in traffic complexity, review monitoring value, balancing arrival/departure capacity and so on;
- Use other available capacity: this encompasses ATFCM solutions that aim to 'shift' traffic demand into areas where capacity is available, such as rerouting, Flight Level (FL) management and advancing traffic;
- Regulate the demand: constraints will be imposed on traffic by means of regulations.

A decision to implement and execute ATFCM measures within the Area of Responsibility of an FMP shall be preceded by coordination between the Central Flow Management Unit (CFMU) and that FMP. In this way, the FMP provides the CFMU with 'local knowledge', including any data or information which could be considered as necessary or useful in the effective and efficient execution of the ATFCM task. The CFMU advises the FMP of any events or information which will or may affect the service provided by its parent ACC(s).

However when aircraft become airborne, the traffic situation frequently evolves in a quite different way from the one planned by the CFMU and there are several reasons for this, including among others:

- Lack of accuracy of the CFMU traffic demand prediction process;
- Poor weather information and accuracy;

- Too coarse control of flights allocated with a departure slot;
- At local level – trajectory revisions due to ATC tactical open loop interventions.

The consequence of this deviation from the CFMU plan is that sectors experience peaks and troughs of demand that are not eliminated by the ATFCM/CFMU process. The less immediate consequence is that to prevent these demand peaks from overloading the sector, the Target Sector Flow (TSF) is set at a level that provides some 'headroom'. Essentially, the TSF is set below the level that the sector can safely handle to allow for the inefficiencies inherent to the CFMU process and the vagaries of the subsequent control process. This means that for much of the time capacity is available but remains unused because the sectors must be protected from overloads.

The goal is that by a better traffic demand predicted locally, the Target Sector Flows (TSFs) can be set at a level that approaches maximum acceptable workload thus closing the gap between theoretical capacity and available capacity.

Such processes must operate on a wide area, at ACC level or at the level of ATC sector families, as the management of the human resource aims at reducing the peaks of traffic by distributing it over a wider number of sectors through early actions supported by an imbalanced traffic prediction process.

3.1.1.1 Issues Associated with Current Procedures - DCM

The main tool used in current procedures is the CFMU Human Machine Interface (CHMI) system, which is used by medium to short term and execution phase decision makers. CHMI data provision includes predicted sector occupancy and sector entries over the next few hours from the current time. However, experience has shown this information to be inaccurate to such an extent that it is used as a guide only. Supervisors/FMP Operators rely upon a mixture of unreliable data and experience to make and adapt short-term tactical plans.

Furthermore, CHMI:

- does not have a sector configuration optimization (in the current CHMI different sector configurations can be selected in advance to have a look at the different sectorisation option, however this process is not automatic and iterative taking into account local restrictions).
- does not take into account the human resources distribution (local restrictions);
- does not make a sector occupancy prediction the day before the period in question. If this were available, it would help with manning requirement planning for the next day (the period in question);
- does not take into account either the historical data and the preceding planning process;
- is based on the Initial Flight Plan, which does not take into account:
  - prevailing or planned tactical flight/flow constraint;
  - typical routing through ACC airspace;
  - other sources of information;
- is subject to CFMU change management.

Additionally, various other non-integrated tools and information and above all operational experience are used, primarily to interpret/enrich/correct the traffic predictions but also to test the feasibility of sector configuration schemes, allowing for better tactical decision making.

Currently predictions are based on sector entries (Hourly Entry Rate) or on occupancy. Occupancy is often a better indicator than Hourly Entry Rate, as the number of aircraft entering a sector per hour is no indication for the distribution of these entries over time (how many aircraft are entering at the same time). The hourly entry rate in sectors close to an airport is not always realistic as this is based on slot distribution and not by logical separation of departures.

Metrics, occupancy and hourly entry rate do not take into account complexity/workload. A combined criterion based on better accuracy of data, local restrictions, several sources of information and a tight capacity sector would enable the user to plan an optimized sector configuration in a strategic phase.

3.1.2 New SESAR Operating Method - DCM

3.1.2.1 Objective

The Dynamic Capacity Management Method is based on a tool (DCM Local Supporting Tool) that allows airspace structure to be dynamically adjusted to optimise the efficiency of the Air Traffic Management (ATM) services in an Area Control Centre. This method seeks to enable an increase in sectorisation efficiency by taking measures in advance that serve to detect, assess and resolve imbalances in traffic as well as to analyse local metrics such as impact on human resources distribution.

3.1.2.2 Scope

Work on the DCM method includes validating the local processes that will allow detecting and assessing traffic imbalances on the day of operation up to two hours before the operation. This assessment will identify the impact of the imbalance at local level by analysing not only current metrics linked to performance areas such as capacity or efficiency but also local metrics such as impact on human resources distribution.

3.1.2.3 Operating Process

The DCM concept aims to enable an increase in sectorisation efficiency by taking measures in advance that serve to detect, assess and resolve traffic imbalances as well as to analyse local metrics such as impact on human resources distribution.

The DCM service addressed by P04.07.07 will validate the local processes that will allow detecting and assessing traffic imbalances on the day of operation until two hours before the operation. This process is currently performed by the FMP by taking into account CHMI indicators. Nevertheless, various other non-integrated tools, external information of CHMI, local short-term ATFCM measures and above all operational experience are used, primarily to interpret/enrich/correct the traffic predictions but also to test the feasibility of sector configuration schemes, allowing for a better tactical decision making.

Aena had developed a tool that provides the functionalities described above. PERSEO is a decision-support tool that forecasts the expected performance of the ATM system from several months before the day of operation to “D-1 day”. Forecasts are based on the processing of a large volume of historical data obtained from multiple sources of information. An optimization algorithm has been developed to provide the necessary output for decision-making. One of the 04.07.07 Tool’s functionalities localized in a pre-operational stage is the process for the selection of the optimum sector configurations along the day of operation in order to optimize the number and distribution of human resources.

According to the objective and scope to be addressed by P04.07.07, dynamic capacity management is focused on implementing and improving the optimisation capacity process in the strategic phase. With PERSEO, the person responsible for operations (OPS Supervisor – Flow Manager) could:

- Select an optimum sector configuration and its distribution of human resources. Starting from sector families defined at the ATC Centre and applying the optimization algorithm, the tool provides the necessary output for the decision maker.
- Recalculate the sector configuration in accordance with local human restrictions, reduction of sector’s capacity and so on.
- Plan the first shift the day before, when existing CHMI data is not reliable or realistic taking into account the expertise/ references of others similar analysis.
- Compare several data resources, during the previous mentioned tasks (e.g. Select sector) , where the forecast demand is based on:
    - the processing of large volumes of historical data obtained from multiple sources of information or;
    - a mix of real traffic data and historical data;
    - uniquely real traffic data.

In order to address and validate this concept, two prototypes based on PERSEO will be implemented on the ATC System (hereafter both prototypes are named "DCM Local Supporting Tool"). The final design should take into consideration the high-level principles identified in the dynamic capacity management process, such as:

- Planning is a continuous process with progressive refinement of the results when more accurate data is available. This implies that processes along the planning phases may be based on similar optimization algorithms that have already been developed. Differences in the results will be a consequence of the quality of the available data. For instance, the local "D-months" algorithm that provides the optimum sector configurations on the day of operation and the subsequent number and distribution of human resources may be similar or even the same as the local "D-hours" algorithm. Differences in the output will be due to the quality of the traffic samples.
- The System will be capable of capturing multiple sources of information. Consequently, large volumes of data will be stored and processed. This will provide the final user with a more reliable output in the timeframe of the consultation;
- The output from the preceding planning process is available for the following one, and for the new involved actors within the context of their responsibility. This will allow decision-making with a wide view of the changes in the planning and the reasons for those changes. As an example, the sub-regional manager has access to the previous output used by the management staff to take decisions about the number and distribution of human resources;
- Different HMIs and functionalities will be designed depending on the needs and the decisions to be taken by the final users. From the perspective of the air navigation service provision, there will be potentially the following HMIs:
    - HMI for the regional management staff to monitor the network from D-months to D-hours;
    - HMI for the sub-regional and local management staff to detect, assess and resolve the local imbalances from D-months to D-hours. Different instantiations will be available depending on the local needs of the service providers;
    - HMI for the regional manager to monitor the network from D-hours to D;
    - HMI for the sub-regional or local manager to detect, assess and resolve the local imbalances from D-hours to D. This HMI will integrate the functionalities from D-hours to D-2 hours with the functionalities in the timeframe between D-2 hours and D. As an example, the complexity metrics will be provided in a time horizon between D-2 hours and D. This information will be integrated in a wider timeframe – from D-hours to D -. The reason is that today the decisions related to the resolution of local imbalances in a shift (usually, D-8 hours to D) are taken by one single role, the OPS supervisor. This integrated HMI will allow the supervisor monitoring the whole shift.

3.1.2.4 Summary of Benefits

The next proposal for the Step 1 development is based on the functionalities of DCM Local Supporting Tool but extending them into the gap from D-hours to D-2 hours. This development will:

- Provide the OPS supervisor / FMP Manager with local constraints (e.g maximum number of sectors to be deploy , reduce a sector capacity in a short period, local re routing due to the operation, ect) and opportunities in order to identify the impact of the imbalances at local level. Dependencies with the developments related to the implementation of the STAM concept at network level will be identified;
- Permit an early assessment of the human factors aspects related to the integrated HMI for the OPS supervisor / FMP Manager;
- Assess the quality of the data in the day of operation. The benefits of sector configurations and human resources planning based on historical data or on traffic in the day of operation will be analysed.

The adaptation of the P4.07.07 Tool's functionalities in the day of operation will be done by reproducing the algorithm just validated in the ATC System. Developments related to the integration of the network view – STAM – with local functionalities could be implemented.

3.1.3 Differences Between New and Previous Operating Methods - DCM

Table 7 summarizes the main differences between current and SESAR methods.

Operational method element used	Current	SESAR 2013 +
ATFM Planning	Based on Sector hourly entry rates or in best case on sector occupancy (provided by CHMI). No local restrictions are considered.	The system shall calculate the predicted demand for each operative sector in all the operational sector configurations available. Some (if not all) demand indicator shall be calculated in terms of occupancy.
Sector configuration management	Predefined, linked to demanding procedures and coordination arrangements	Dynamic based on seamless implementation of pre-defined schedules
Roles	Ops supervisor – FMP Manager.	Ops supervisor – Flow and Complexity Manager
Accuracy of prediction	Based on standard FPL information and messaging of CFMU.	Demand provided by CHMI, based on ATC Centre System information and historical data.

Table 7 – Differences between New and Previous Operating Methods - DCM

3.2 Layered Planning Method (LP)

3.2.1 Previous Operating Method - LP

Currently when an Eastbound transatlantic flight using the Organised Track Structure (OTS) requests an oceanic clearance this clearance is usually granted. The main criteria for deciding whether or not an oceanic clearance should be granted is whether or not this flight would conflict with any other flights already cleared on the OTS. Other flights that have not yet requested an Oceanic Clearance are not usually taken into account when deciding whether to grant an Oceanic Clearance.

The eastbound oceanic traffic flows, from North America to Europe, converge into a relatively narrow front – most Eastbound OTS tracks end within UK or Irish Domestic Airspace. Also, most flights land in a relatively small geographic area – London, Paris, Amsterdam or Frankfurt. Finally, the flights tend to be concentrated into a short timeframe, with most reaching their arrival airfield soon after 06:00 UK Local Time.

Due to the diurnal traffic pattern on the North Atlantic (NAT) and the traffic pattern of domestic flights, overloading of key domestic sectors can occur. This results in delays to domestic flights, but rarely to NAT flights, and occurs when arriving eastbound NAT traffic interacts with the first cycle of (typically) North-South domestic/continental short haul traffic.

Overloading of sectors is caused by high traffic flow rates and a high traffic complexity level. Not only does the NAT traffic arrive in a high concentration, it is also often highly complex and not arranged in a pattern convenient to its destination (e.g., Frankfurt inbound traffic on tracks to the South of London Terminal Manoeuvring Area (TMA) inbound traffic), requiring that this arrangement be reversed to allow transit through the London Flight Information Region (FIR) and onward to the destination. On those days when the OTS is towards the north, overloading generally occurs in the Lakes Sector Group, which are the first UK sectors to receive such traffic. On those days when the OTS is towards the south, overloading generally occurs in the West End Sector Group.

3.2.1.1 Issues Associated with Current Procedures

As the oceanic clearances are granted on a first come, first served model, this could lead to sub-optimal use of the OTS tracks. For example, if a flight requested a certain track/flight level/time combination on the OTS, then this will probably be granted if it does not conflict with other confirmed flights on the OTS. However, there may be another flight that would be a better use of this track/flight level/time combination which requests its clearance later. Without planning, this would lead to the second flight having to use a different track/flight level/time combination.

The main causes of complexity in domestic airspace as a result of oceanic traffic are as follows:

- When too many flights exit the OTS into the same sector at around the same time;
- When flights on the same OTS track are heading for different airfields and need to cross busy 'streams' in domestic airspace;
- When over-flying aircraft are on lower flight levels than aircraft landing in the UK for flights exiting the same OTS track at around the same time.

As the oceanic clearances are not planned, this complexity is not managed.

The planned introduction of reduced lateral separation minima (R Lat SM) on the NAT will further exacerbate the congestion problem. R Lat SM could also potentially double traffic concentrations if the extra capacity were to be fully utilised.

3.2.2 New SESAR Operating Method - Oceanic Domestic Interface Manager (ODIM)

The Oceanic Domestic Interface Manager (ODIM) aims to support enhancements to safety, flight efficiency, cost effectiveness and capacity to 2020 by enabling controllers at Gander OACC to plan traffic on the OTS in a way that does not penalise participating aircraft but which reduces traffic complexity once aircraft leave oceanic airspace.

It is envisaged that the finished optimisation tool will provide 'proposed clearances' for the transatlantic flights for when they enter oceanic airspace. This will propose the OTS track, entry and exit times, speed and flight level for the flight. The tool will also provide an approximation of the fuel burn difference in kilograms that these changes would result in for each flight. To provide these proposed clearances, the tool will need to have up-to-date information about the flight plans of the flights using the OTS, as well as information about any oceanic clearances that have already been issued to ensure that the tool does not propose changes to anything that has already been finalised.

REQ-04.07.07-OSED-ODIM.0004. The tool shall plan routes, clearances and level distributions in order to minimise the need to descend aircraft past overflying aircraft and consequently the need for tactical deconfliction.

REQ-04.07.07-OSED-ODIM.0006. ODIM shall calculate the fuel burn difference in kilograms that ODIM proposal clearances would result in for each flight.

3.2.2.1 Optimisation Objectives

When the optimisation tool runs, it attempts to reduce the complexity that occurs in domestic airspace as a result of the traffic exiting the OTS. The complexity has been defined in four categories and the tool will allow the user to input weightings to control how much each category affects the overall optimisation. These four complexity categories are described below:

- Altitude Distribution Category. The altitude distribution of aircraft at the oceanic domestic interface (ODI) is more complex when aircraft destined for UK airports are higher than transiting aircraft destined for airports beyond the UK. This situation requires the controller to descend the UK inbound aircraft past the transiting aircraft. Conversely, the altitude distribution of aircraft at the ODI boundary is less complex when the over-flying aircraft are above those destined for the UK. The altitude distribution of aircraft at the ODI boundary contributes to UK domestic sector complexity (and therefore the overall complexity for the day) because the moves which must be performed on the oceanic aircraft happen in UK domestic sector airspace.

  REQ-04.07.07-OSED-ODIM.0015. ODIM shall take aircraft level in relation to its destination into account when optimising oceanic clearances

- Number of Aircraft – Absolute Rate category. A measure of complexity, related to the number of aircraft arriving in a sector for a time-slice, is how close to full capacity that sector is. This is the absolute rate of the number of aircraft. The absolute rate of the number of aircraft arriving in a sector can be measured for a time-slice as follows. The day is split into time-slices of a configurable length, which initially will be set to 30 minutes. The number of flights arriving in a sector in each time-slice is compared to the maximum number of flights which are allowed to arrive in a sector (due to longitudinal separation constraints). The maximum number of flights need only be calculated once as the time-slices are all the same length. When the actual number of flights is close to the maximum, the complexity is high. When the actual number of flights is low in comparison to the maximum, the complexity is low.

  REQ-04.07.07-OSED-ODIM.0020. ODIM shall take number of aircraft absolute rate into account when optimising oceanic clearances

- Number of aircraft – Relative Rate Category. A second measure of complexity, related to the number of aircraft arriving in a sector for a time-slice, is how evenly distributed the aircraft are. This is the relative rate of the number of aircraft. A high number of aircraft entering and occupying a sector at a given time increases complexity. Given that there is a fixed number of aircraft which fly across the Atlantic on a given day (i.e., the optimisation process cannot stop a number of these aircraft from flying) and that the number of aircraft switching between sectors (by switching between tracks) is very low, a high number of aircraft entering and occupying a sector at a given time is influenced most by the aircraft being bunched together (i.e., when the time between aircraft arriving at the ODI is smallest). Therefore, when the flights for the day are evenly distributed with respect to the time at which they cross the ODI, the complexity is reduced.

  REQ-04.07.07-OSED-ODIM.0025. ODIM shall take number of aircraft relative rate into account when optimising oceanic clearances

- Routes to Destination Category. Domestic sector complexity is high when there are a large number of aircraft which must cross busy streams of aircraft in order to get to their destination. There are known preferred routes for eastbound oceanic traffic destined for a number of airports (12), which may be obtained from the North Atlantic European Routing Scheme (NERS) data. A stream of aircraft are the aircraft flying from the OTS to one of the 12 NERS destinations and is considered to be busy when there is at least a minimum number of aircraft travelling in the stream in a time-slice. Domestic sector complexity is lower when the eastbound oceanic traffic destined for the NERS destinations flies via these known preferred routes.

  REQ-04.07.07-OSED-ODIM.0030. ODIM shall take the number of routes to destination into account when optimising oceanic clearances

3.2.2.2 Expected inputs and outputs of the developed system

It is expected that the optimisation tool will accept input data from the Enhanced Traffic Flow Management System (ETFMS), from SAATS (Shanwick Automated Air Traffic System) and from the available Flight Plans (FPL) and would produce proposed clearances for the flights. The prototype displays this information on a standalone electronic strip display. The future HMI has not yet been determined but clearances could potentially be passed back to the SAATS system to help the controller when they are considering a clearance request (the expectation is that both the clearance request and the proposed clearance will be displayed on screen in SAATS for the controller when they make their decisions). This is displayed in Figure 3 below. This will have to be used at Gander to alleviate the problems in UK domestic airspace.

REQ-04.07.07-OSED-ODIM.0035. ODIM shall display proposed clearances on a standalone display

REQ-04.07.07-OSED-ODIM.0040. ODIM shall send proposed clearances in a form capable of being integrated into SAATS/GAATS

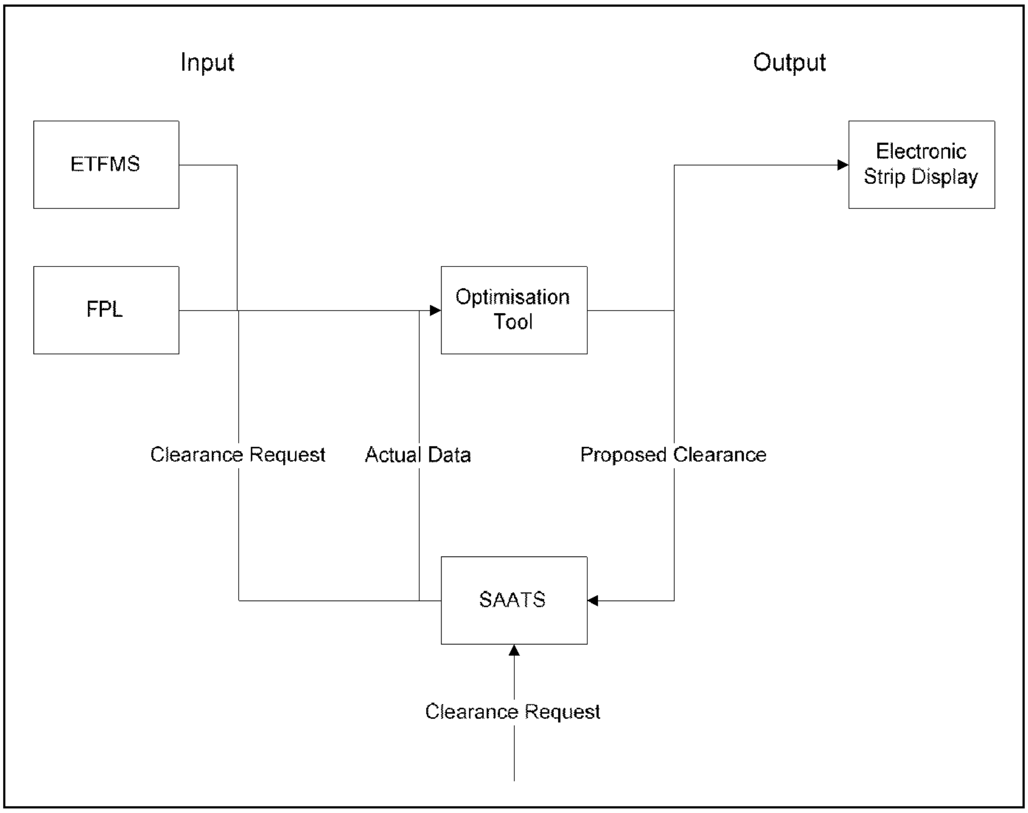


Figure 3 – Potential Inputs to and Outputs from the Optimisation Tool

3.2.2.3 Running ODIM

There are two alternative options to run the optimisation tool:

- The optimisation could be applied across the whole day's flights going in the same direction. The system would keep an up to date list of all of the flights and all of the proposed clearances so that when a clearance request was received, the system could provide its best proposed clearance instantly. The optimisation would run across the whole day's flights at regular intervals so that as changes were made to flight plans and oceanic clearances, the proposed clearances would be updated to take the new information into account;
- The optimisation could be applied to an individual flight when a clearance request is received. This would assess all of the potential changes that could be made to the flight and the flights around it that have not yet received oceanic clearances and then decide the best proposed clearance at this point. This would mean that the optimisation would be run on demand once for every flight and would encompass less of the overall solution on each run. It may take longer for the controller to receive the proposed clearance and there would have to be a mechanism (e.g., queuing) for when the system receives multiple clearance requests at the same time, but the optimisation may be simpler to solve.

REQ-04.07.07-OSED-ODIM.0044. The mechanism for managing multiple Clearance Requests shall not delay the issue of Proposed Clearances.

The first option gives the more accurate measure of complexity when it is run as it takes the full day's flights into account, rather than looking at individual flights. However, the second option bases the proposed clearance for the individual flight on the most up-to-date flight plans at the point when the optimisation was run. The first option is preferable due to its accuracy, as long as the optimisation tool completes quickly enough to minimise the effect of flight plan changes.

REQ-04.07.07-OSED-ODIM.0045. The ODIM optimisation process shall balance performance against accuracy and currency of flight plan information.

3.2.2.4 Summary of Benefits

The benefits are as follows:

- No longer first come, first served. As the proposed clearances will be generated taking all of the flights from the day into account, it means that the order in which clearance requests are received will not affect the optimal use of the OTS tracks. This should lead to better use of the OTS tracks.
- Causes of Complexity. The main causes of complexity in domestic airspace as a result of oceanic traffic are listed in a previous section. These complexities will be taken into account by the optimisation tool when the proposed clearances for the day are being calculated. This means that the complexity in domestic airspace is planned, will be known and can be reduced.
- Effect of Reduced Lateral Separation and Open Skies. Once the oceanic traffic on the OTS is planned and the resulting complexity in domestic airspace is known, it will be easier to study the effects of increased traffic or traffic that is arriving in a different pattern. This will make it easier to manage both of these changes to ensure that domestic airspace complexity is not heavily increased.

3.2.3 New SESAR Operating Method - High-Level Direct Routing (HLDR)

The High Level Direct Routing (HLDR) concept aims to provide improvements to the overall ATM of the UK/Ireland FAB airspace structure.

3.2.3.1 Definition

A full understanding of the type of airspace to be developed is fundamental to the understanding of the concept. The ultimate aim of the concept would be the provision for Airline Operators (AOs) to utilise user preferred trajectories i.e. completely free flight from any entry point to any exit point. This ultimate free flight without the required associated support tools and systems can provide more complications than solutions with the truly random nature of the flight (unusual traffic patterns and flows and impact on adjacent airspace).

What this concept will aim to facilitate is the most efficient and effective airspace that current systems, tools and procedures can provide, transferring reliance on the fixed route network to allowing, to the greatest extent possible, user preferred trajectories.

REQ-04.07.07-OSED-HLDR.0005. The HLDR design shall enable users to fly their preferred trajectories to the greatest extent possible

3.2.3.2 Scope

The whole of the UK/Ireland airspace is within the scope of the concept. Initial discussions on the development of a revised airspace within the UK UIR airspace structure highlighted a proposed Divisional Flight Level (DFL) of FL365 above which some form of ‘tailored’ airspace structure could be implemented. The IAA ENSURE project [20] implemented a revised airspace structure throughout the Shannon UIR, SOTA and NOTA i.e. above FL245. Maastricht is in the process of a phased implementation of their FRAM programme (Free Route Airspace Maastricht) throughout the whole of their airspace asset again with a DFL of FL245. EUROCONTROL also supports free route airspace developments to be implemented as widely as possible and aims for these developments to be harmonised throughout the Upper Airspace where possible (above FL245). The project will look to the feasibility of developing concepts as low as practicable, and not be constrained by previous investigations.

REQ-04.07.07-OSED-HLDR.0010. The HLDR concept will be applied above an agreed Divisional Flight Level.

3.2.3.3 Stakeholders

Stakeholder engagement will be a vital part of the concept development as all parties considerations must be taken into consideration in order to provide the most appropriate design for development.

3.2.3.3.1 Military

One of the major constraints to the development of any 'free' or 'direct' route airspace is the commitment for providing appropriate airspace for national military agreements. There are several large long-established military training areas that have a direct impact on the route structure within the UK, and negotiating better access and availability of these airspaces could significantly increase the benefits of this concept.

The current ATS route structure and military training area requirements (depicted in Figure 4 below) may no longer be in the most appropriate position or be the ideal size and shape for current Operational Air Traffic (OAT) requirements and General Air Traffic (GAT) traffic flows. It will be a vital part of the development to investigate all opportunities to formulate better provision of Flexible Use of Airspace (FUA) taking into consideration current military and civil requirements. Any cross-border concepts would need to consider impact on military access and national security issues.

REQ-04.07.07-OSED-HLDR.0015. The HLDR concept shall take account of military needs.

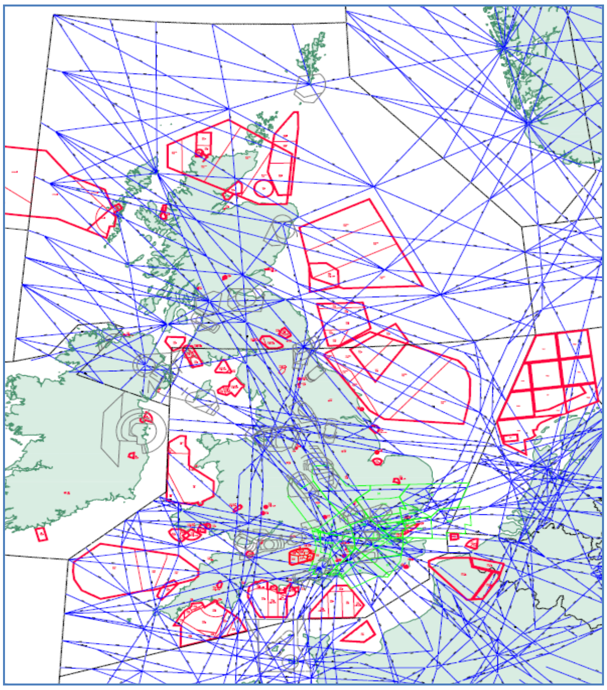


Figure 4 – Map of Current UK route Structure and Danger Areas

Concepts to be addressed could include changing the shape of current military airspace while maintaining the overall military airspace asset and the creation of 'floating' military airspace that could be tactically moved (by up to an agreed distance to limit fuel impact) to best fit the traffic flows of the day. Both these concepts should not be constrained by current UK/Ireland FIR boundaries.

Also, procedures will need to be developed and agreed as to the handling of OAT traffic within any defined free route type airspace. These may involve discussions on all traffic being deemed as being en route unless within an active DA (danger area) and handled by the same agency.

The EUROCONTROL 'LARA' airspace management tool (Local and Regional Airspace Management System [21]) should be an enabler for the initial provision of improved FUA concepts. Further benefit could be achieved from gaining a better understanding of civil/military requirements leading to improved FUA (Flexible Use of Airspace) procedures.

3.2.3.3.2 Aircraft Operators (AOs)

Engagement with aircraft operators from an early stage will enable the concept to include AO requirements and to address potential constraints they may impose on the concept.

Engagement with the AOs will identify at an early stage potential FMS issues. Already highlighted from other free route airspace developments are problems caused to the FMS by the removal of waypoints for determining speed/level fixes for transition.

It is also important to understand financial implications within the design as there is always an important trade-off for AOs with regard to the environment versus cost as a direct route may involve greater distances in more expensive airspace thus creating financial constraints for its use.

The concept will also consider potential equipment fit requirements for the AO's within the new design, as this may produce constraints for maximising the potential benefits.

REQ-04.07.07-OSED-HLDR.0020. The HLDR concept shall take account of airline operator routing needs.

3.2.3.3.3 Other ANSPs

As stated above, the UK and Ireland have created a single FAB (Functional Airspace Block) and the concept will treat this as one airspace asset with a 'transparent' border between the regions.

The concept assumes the use of the same MOPs (Methods of Operating Procedures) and SOPs (Standard Operating Procedures) for both the UK and Irish operations and these will align with the requirements of adjacent ANSPS. The rationale being that there is little or no constraint on developing procedures between internal sectors and it should be the same for sectors that that connect at international interfaces.

The concept ensures that the IAA ENSURE project [20] and the Maastricht FRAM project (Free Route Airspace Maastricht [22]) will be harmonised and aligned to other possible projects, including developments in surrounding ANSPs and FABs such as NEAP (North European Alliance Partnership) and Brest for example on well utilised route structures.

The concept will include designs and procedures stretching from the Oceanic boundary at 15W to at least the eastern boundary of the FAB airspace and also work with neighbouring ANSPs to explore the potential for cross border concepts.

REQ-04.07.07-OSED-HLDR.0025. The HLDR concept shall take account of the interface with neighbouring ANSPs.

3.2.3.4 Airspace and Route Structure

The concept will look at the potential for complete 'free route' airspace but is aware of the many issues that surround this concept such as the fact that complete free route airspace has the potentially detrimental effect on capacity. The concept will seek to utilise any 'lessons learned' from the development of the Irish ENSURE project and the Maastricht FRAM development. The issues that have been identified are as follows:

- The ENSURE project has removed the traditional ATS route structure throughout the Shannon UIR, SOTA and NOTA and introduced in its place a series of flight plannable direct routes from/to specific entry and exit points. Rather than being Free Route this can be described as being Route Free.
- The Maastricht model due for phased implementation from spring 2011 onwards retains the current ATS route structure but also introduces a wide number of direct routes from/to Entry and Exit points on their UIR boundary. The premise being that this offers complete user preferred options as some operators will still utilise traditional ATS routes.
- It is highly likely that some form of re-sectorisation will be required within the FAB airspace.
- An initial aim of the concept will be to maintain or not unduly affect operational resource costs, and this will be much harder to achieve if creating new extra high level sectors unless there is an associated reduction in sector numbers in the underlying airspace.

REQ-04.07.07-OSED-HLDR.0030. The HLDR concept shall not generate increased operational resource cost.

- The concept will seek to deliver a sectorisation that is flexible and adaptable to the required traffic flows and this again will not be constrained by the current UK/Ireland UIR boundary as concepts can be developed in line with current principles for delegated airspace provision. The flexibility and delegation could be targeted to specific times of the day or predicated on the major traffic flows (i.e. Eastbound/Westbound or to target the Oceanic track structure of the day).

  REQ-04.07.07-OSED-HLDR.0035. The HLDR concept shall be flexible enough to provide ATC capacity to meet major demand flows.

- The flexibility of the sectorisation could also be with regard to the DFL of the 'free route' concept, with the lowering and rising of the levels of airspace available for the desired concept, depending on traffic numbers (i.e. more availability in quiet hours).

  REQ-04.07.07-OSED-HLDR.0040. The HLDR concept shall be flexible with regards to variable DFL.

- The current route structure within the UK is constrained by the funnelling of traffic flows through various pinch points within the ATM system. The concept will develop a route structure (or traffic flows) that avoids, as far as is practicable, the funnelling of traffic and will seek to separate route structures (i.e. over-flights vs. TMA traffic).

  REQ-04.07.07-OSED-HLDR.0045 The HLDR concept shall avoid funnelling traffic flows as much as possible by enabling traffic dispersal.

- The removal of the traditional ATS route structure may also create issues for certain tools and systems. For example iFACTS (interim Future Area Control Tools Support) implementation within London Area Control (LAC) Swanwick provides medium term conflict detection (MTCD) and conformance monitoring functions to the controllers based on trajectory information. There is the potential for issues with aircraft that are in 'free route' airspace (user flies a trajectory based on a series of waypoints defined by their latitude and longitude) although iFACTS and the National Airspace System (NAS) can be adapted to handle 'route free' (trajectory based on a series of direct routes between waypoints offering the closest match to the user-preferred trajectory).

  REQ-04.07.07-OSED-HLDR.0050. The HLDR concept shall be compatible with envisaged ANSP tools and systems.

- There may also be issues with free route airspace and the capabilities of Traffic Load Prediction Devices (TLPD) and also within CFMU (Central Flow Management Unit) capabilities.

  REQ-04.07.07-OSED-HLDR.0055 The HLDR concept shall not adversely affect the accuracy of network management demand tools including TLPD and CFMU.

- Procedures will be developed for the movement of aircraft between 'free route' type airspace and the traditional ATS route structure below.

  REQ-04.07.07-OSED-HLDR.0060 The HLDR concept shall take into account the transition of aircraft between high level sectors and underlying airspace structures

- The airspace will optimise flight level allocation and will not be constrained by traditional use of eastbound and westbound only levels.

  REQ-04.07.07-OSED-HLDR.0065 The HLDR concept shall optimise level allocation and not be constrained by uni-directional flight levels.

- The concept will investigate the impact of the creation of large point to point route structures with regard to anticipated tracks and great circle routes.

- The concept will deliver procedures for the opening and closing of restricted airspace structures in accordance with agreements with relevant stakeholders.

- The concept will mitigate against issues created by the removal of any ATS route structure. These include procedures for routings around restricted airspace, adjacent ANSP FDP (Flight Data Processing) requirements, FMS issues and contingency.

3.2.3.5 Tools, Systems & Programmes

The airspace design delivered by this concept will take account of and make best use of the controller toolset available at the time of implementation and also toolsets expected to be delivered over the lifecycle of the investment.

3.2.3.5.1 Flight Data Processing (FDP)

The project will deliver a concept that is able to align with the varying data processing systems within the FAB and also neighbouring ANSPs. The Irish use the COOPANS system (CO-OPeration between ANS-providers) whilst NATS retains the NAS system until implementation of the iTEC (interoperability Through European Collaboration) system at a date to be determined. The final design, whether 'free route' or 'route free', will be compatible with all the operating platforms with particular emphasis on the FDP system being able to deliver accurate information in a timely fashion to the correct sector groups.

The Maastricht FRAM development has already highlighted the requirement of some neighbouring ANSPs to have next waypoint information (within 'free route' airspace) as a requirement for their FDP systems. In fact the current NATS NAS processing system has the requirement to use the next waypoint information in neighbouring airspace for processing flights across an FIR boundary.

It has also been identified that CFMU currently has issues with dealing with adjacent free route airspace structures. As such it may be a requirement that to enable the greatest benefits the concept may have to consider the UK/Ireland HLS airspace and Maastricht FRAM airspace as one defined airspace block, for this context.

3.2.3.5.2 iFACTS

Swanwick implemented the iFACTS (interim Future Area Control Tools Systems) tool set in winter 2011. The iFACTS tool set provides the controller with an advanced set of controller tools in order to reduce workload. The system utilises current position of aircraft, the flight plan and complex algorithms to predict the likely position of all traffic in a defined sector. These positions are compared for up to 18 minutes in the future and potential conflict and deviations from predicted track are highlighted to the controller. Due to this medium term conflict detection capability (MTCD) iFACTS is seen as an enabler for the development of 'free route' airspace concepts with the increased amount of random confliction points compared with today's rigid ATS route structure. The only limiting factor at this stage will be the relatively short exposure to iFACTS in real time for the controllers assisting with the current High Level sectors design process.

3.2.3.5.3 COOPANS

A significant controller tool support development in the COOPANS system for Shannon is the MINSEP (minimum separation) tool for each controller working position as well significant developments in Medium Term Conflict Detection (MTCD). The developments in MTCD allows for far more accurate flight plan conflict probing during the en-route phase of flight.

3.2.3.5.4 EUROCONTROL

EUROCONTROL have developed a Free Route Concept of Operation to ensure coherent development and implementation of free route operations within various States and FABS.
This project will support and comply with the recommendations therein. General criteria include compatibility with existing operations, sustainable through further development and capable of expansion/connectivity to/with adjacent airspace, while providing guidance on various aspects of free route airspace to ensure compatibility with other development programmes.

3.2.3.6 Benefits

A number of benefits have been identified arising from implementation of the High Level Sectors concept. They are described below.

3.2.3.6.1 Increased capacity in the current airspace

This concept will deliver a measurable increase in network capacity. This could be achieved by the creation of new and/or revised sectorisation. Creating new sectors will remove workload from underlying sectorisation thereby creating capacity within these sectors. Revisions to current sectorisation to better balance workload and to better fit the revised traffic flows and patterns will also create extra capacity.

3.2.3.6.2 Increased Safety Benefits

New or revised sectorisation to best fit traffic flows and patterns reduces safety risk by the reduction in co-ordinations required.

These revised and potentially larger sectors will make best use of controller support tools, utilising MTCD to assess separations within free route airspace reducing the potential for 'misjudgements' and its inherent latent risk.

Formalising, and making the tactical direct routings routinely given by controllers during quieter periods flight-plannable leads to a reduction in co-ordinations, and the FDP information presented to controllers is more accurate, reducing the potential for human error in planning separations.

3.2.3.6.3 Reduced Track Mileage

The creating of 'free route' or 'route free' type airspace brings obvious and significant reductions in track mileage flown by the aircraft operators. As guidance, analysis of the Night Time Fuel Savings Routes (NTFSR) project, which introduced a number of flight-plannable direct routings from oceanic landfall positions within the Shannon UIR to various exit points on the eastern UK UIR boundary, identified that for a typical 'busy' week, 470 flights benefited from overall track mileage savings of 4000nm.

3.2.3.6.4 Improvements to the Environment through reduced CO2 emissions

From the reduced track mileage flown there is an associated reduction in CO_2 emissions. As a guideline, from the same analysis as above on the NTFSR project, the same 470 flights flying on the flight-plannable direct routings produced total CO_2 savings of 182000kg for a typical week.

3.2.3.6.5 Reduced Operating Costs

If aircraft are to benefit from flying fewer miles on flight-plannable routes then there is an associated benefit to operating cost by the reduction in fuel burn. As above the analysis on the NTFSR project produced fuel savings in the region of 57800kg/week.

Further analysis identified a typical flight-plannable track mileage saving of 9.7NM per route, which equated to potential fuel cost saving in the region of €39m. The High Level Sectors concept will be an expansion of the direct route concepts identified by the NTFSR programme and as such, total cost savings are anticipated to be much higher.

3.2.3.6.6 Potential Reduction in Controller Cost

Revisions to the current sectorisation within the UK UIR have the potential to reduce overall controller costs. This can be achieved by redesigning the sectorisation to better reflect the revised traffic flows brought about by the introduction of some form of 'free route' airspace. The current rigid sectorisation and controller validations within the UK means that there are potential inefficiencies in controller resourcing especially as peak periods of traffic flows are affected by varying track structures over the ocean. These track structures are dynamic in nature and therefore the same number of controllers is resourced for any given sector on any given date in advance of knowing the traffic loading for the day. Therefore, improved dynamic band-boxing capabilities and flexible sectorisation (i.e. portions of airspace delegated to different sectors according to traffic flows/times of day, etc.) have potential to produce benefits in controller costs by improved efficiencies in manpower management.

3.2.3.6.7 Extensions to the Concept

It is highly likely that final design options from this concept will be enablers for further expansion of the 'free route' airspace concept to cover greater amounts of airspace both horizontally and vertically. Implementation of further controller support tools (such as FACTS and datalink capabilities), improvements to FDP capabilities and also SESAR developing concepts are all anticipated to provide functionality that will allow improvements to the final proposals within this project.

As neighbouring ANSPs formulate their own 'free route' airspace concepts the potential for expansion of direct routings over ever increasing distances will no doubt affect future iterations of the design proposed by this project.

3.2.4 New SESAR Operating Method - Inbound Longitudinal Streaming

Aircraft inbound to major UK airports will be expected to respond to an extended AMAN horizon Target Time of Arrival (TTA) as soon as they leave oceanic airspace, i.e. to begin to adjust their speed in response to a TTA time. This concept is being developed by P05.06.04. However, the 5.6.4 project seeks to produce a benefit within the TMA, whereas this project seeks to use the same concept to measure the benefit on the target en route airspace. Operational requirements relating to this aspect have been developed by 5.6.4 and are not therefore repeated in this document.

3.2.4.1 A Framework for the Concept Elements

Figure 5 below presents a unifying framework for the concept elements. It shows two points where AMAN constraints may be applied: The Long Range portion is suitable for flow metering, with a relatively wide arrival window, and the 'standard' portion is intended to focus more on aircraft sequencing with a more precise arrival target. The rationale for defining two target constraints is to allow for uncertainty regarding the accuracy of predicted demand; an outer horizon allows aircraft to adjust their trajectories to achieve an approximate time, suitable for flow metering. An inner horizon is more precise, using updated demand information and where all relevant inbound aircraft are airborne.

Local operators may set different values for the various horizons to suit local needs. In the case of P04.07.07, the Long Range Eligibility Horizon would be approximately 80 minutes, equivalent to around 550 NM, and the Initial Metering Horizon would be approximately 75 minutes, equivalent to around 500 NM from London.

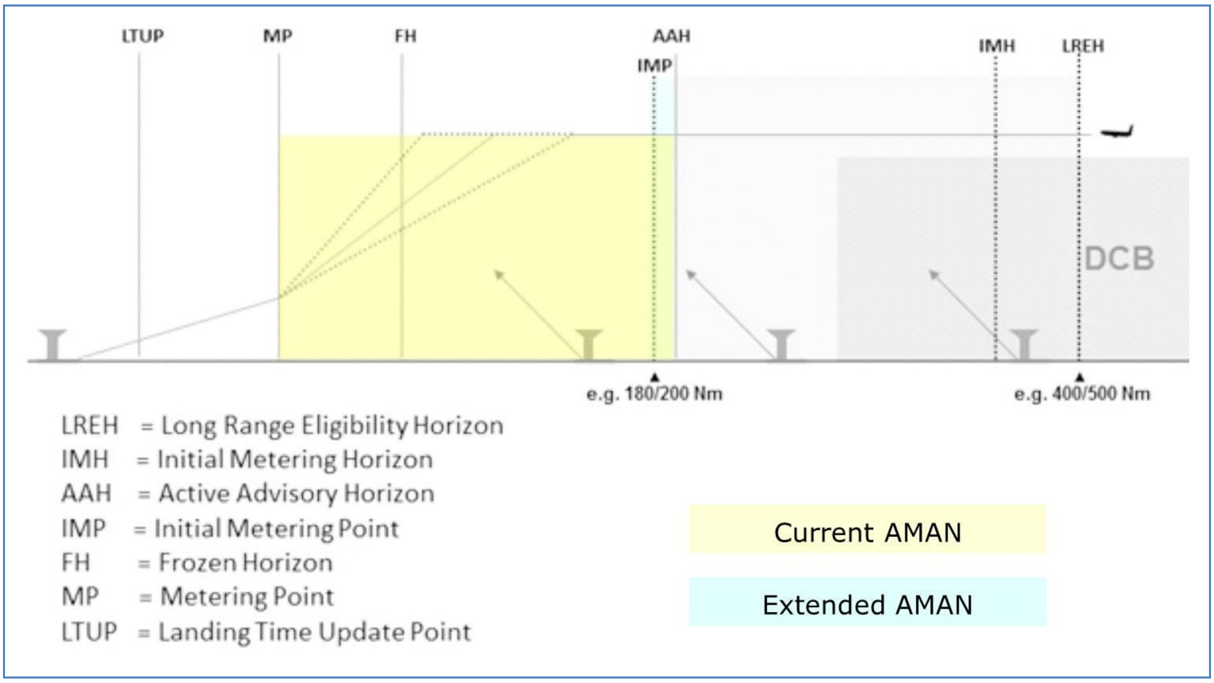


Figure 5 – Long Range AMAN Extended Horizon Concept Diagram

3.2.4.2 Procedures at the Arrival Airport

P05.06.04 will address the problem of calculating Target Times of Arrival (TTAs). The preliminary arrival sequence will use trajectory prediction (Ground TP) to calculate an Estimated Time of Arrival (ETA). Arrival management at the destination airport will then calculate a TTA as close as possible to the ETA that satisfies arrival management requirements. This constraint is set on the appropriate sequencing fix. The AMAN process at the arrival airport will expect the TTA to be respected with an accuracy of e.g. +/-2mins.

3.2.4.3 Responsibility for Achieving the AMAN Sequence

Validation work conducted within 5.6.4 has shown that there are some occasions when controllers prefer to pass the TTA to aircraft and aircrew become responsible for meeting it. This tends to be the case when aircraft are not in close proximity to other aircraft. When inbound aircraft are part of a bunch of aircraft, controllers are focused on separation management issues but can pass suitable separation instructions that take account or partial account of the calculated TTAs.

3.2.4.4 Communicating AMAN Advisories to the Responsible Actor

When AMAN has generated advisories which allow the landing sequence to be achieved, it must convey them to the actor who will implement them, in this concept that is the flight crew. Two possibilities are anticipated, although others may exist:

- Controller-Pilot Datalink (CPDLC) free-format messages. CPDLC messages may only be passed between the current controller and the aircraft. If this option is used then AMAN must be able to route its message to the sector which contains the aircraft. The ability to communicate by CPDLC has been mandated by the European Commission to cover new aircraft operating above FL285 after 2011, all ground systems after 2013, and retrofits to all aircraft operating above FL285 after 2015 (with some exemptions up to 2017). There are specific message formats conveying CTA information defined by EUROCAE Working Group 78 and they will be supported in the prototypes for SJU Step 1 validations (project P09.01 for airborne equipment and P10.7.1 for ground-based equipment). However, they are not covered by the existing mandate and the number of equipped aircraft is not clear.
- Voice. If AMAN information is passed to the current controller, then a target time can be passed to the flight crew by voice.

3.2.4.5 En Route Complexity and Traffic Streaming

The AMAN TTL/TTG (Time to Lose/Time to Gain) requirements may sometimes interfere with a well-organised stream of traffic. Small differences in speed may result in catch-ups between aircraft. An extreme case is that AMAN requests for a sequence change which involves one aircraft overtaking another to improve the wake vortex sequence. This will require many miles stretching over several sectors. Even when no overtaking is involved specific speeds will be required, and these may result in traffic bunching or make it more difficult to resolve conflicts. New flight levels may be requested for some aircraft, which may also increase complexity.

Several methods are available to mitigate the risk that traffic complexity will lead to AMAN advisories not being implemented:

- Medium Term Conflict Detection (MTCD) tools and What-If trajectory tools, which are being specified in SESAR Sub-Work Package 4.7, should assist controllers with the timely identification of potential conflicts and complexity and with effective resolution.
- Offset routes could offer a structure for handling traffic with different speeds.
- The way in which an AMAN generates and maintains its sequence may take traffic complexity into account thereby reducing its additional effect on complexity. This is important for the trans-Atlantic concept.

However, it is not realistic to expect that it will always be possible for pilots to adhere to the AMAN plan.

3.2.4.6 Constraints

This section of the OSED describes a streaming system that can be achieved without new aircraft equipment and with ground systems which are similar to those available today. The most complex changes needed are probably the need for changes to procedures for tactical controllers, and multiparty agreements involving all airports and ANSPs inside the AMAN Horizon. Development may be constrained by these complexities, which include:

- Feasibility of pre-sequencing/metering in En Route due to possible interaction of traffic synchronisation with higher priority separation tasks in high density/complexity extending to En route airspace;
- Feasibility of significant delay absorption through speed reduction, due to airlines using lower cost indices / slower operating speed, or aircraft flying at high cruise altitudes.
- Extending the time horizon brings advantages in that aircraft have a greater distance over which they may absorb delay. However, it also brings an issue to be solved in that it increases the number of aircraft departing from airports within the horizon. These aircraft are likely to cause some instability of AMAN-identified delay as their departure time may vary from that anticipated due to airport constraints.

4 Detailed Operational Environment

4.1 Detailed Operational Environment - Dynamic Capacity Management

This section describes the expected operational environment for the trajectory management services defined in SESAR STEP 1, with respect to the phased validation of the concepts in the operational environment, currently limited to the airspace of a single Area Control Centre.

4.1.1 Operational Characteristics - DCM

The main characteristic brought by the DCM Local Supporting Tool is the optimal distribution and use of human resources through dynamic application of optimal sector configurations. This balance of demand and capacity will be based on appropriate data (real-time ATC System data, CHMI, historical data or mixed data) and an optimization algorithm that has already been validated locally.

4.1.1.1 Airspace Characteristics - DCM

The DCM Local Supporting Tool is applicable to regions of high traffic loads in which classical sectorisation and flow control measures are insufficient to support the capacity demand.

Airspace organisation planning and management are based on the current Implementing Rule (IR).

Military aspects are based on current IR related to Flexible Use of Airspace (FUA).

4.1.1.2 Ground Technical Capabilities - DCM

Ground technical capabilities are expressed in terms of their ATM Capability Level. Note that these descriptions do not fully detail all the capabilities associated with each ATM Capability Level, but instead provide those characteristics which are relevant to this document.

This section summarizes the capabilities of the ground system that are expected to be available to support en-route operations within the timeframe of SESAR Step 1.

4.1.1.3 Tools - DCM

The DCM Tool will forecast the expected performance of the ATM system from several months before the day of operation to “D-1 day”. Forecasts are based on the processing of large amounts of historical data obtained from multiple sources of information. An optimization algorithm has been developed to provide the necessary output for decision-making.

The DCM Tool will enable a continuous planning process with progressive refinement of the results when more accurate data is available. It will provide the optimum sector configuration on the day of operation and the subsequent number and distribution of human resources.

The DCM Tool will be able to capture multiple sources of information. Consequently, large amounts of data will be stored and processed. This will provide the final user with more reliable output in the timeframe of the consultation. The output from the preceding planning process will be available for the following one, and for the new involved actors within the context of their responsibility. This will allow taking decisions with a wide view of the changes in the planning and the reasons for those changes.

4.1.1.4 Arrival management extended to En-route - DCM

AMAN into En-route concept enables the modification of the trajectories of flights (based on arrival management constraints) while still in the Area of Responsibility of en-route sectors.

4.1.1.5 Conflict detection tools for planning purpose – DCM

Conflict detection tools for planning purpose will be not required.

4.1.1.6 On-line data interchange (OLDI) - DCM

On-line Data Interchange (OLDI) messages mandatory for implementation by 2012, in accordance with Commission Regulations EC N 1032/2006 and 30/2009 [23].

4.1.1.7 Air / ground data link - DCM

European Commission Regulations No 29/2009 laying down requirements on data-link services for the Single European Sky (SES) [24].

4.1.1.8 Human Machine Interface (HMI) -DCM

Different HMIs and functionalities will be designed depending on the needs and decisions to be taken by the final users. From the perspective of the air navigation service provision, there will be potentially the following HMIs:

- HMI for the regional management staff to monitor the network from D-months to D-hours;
- HMI for the sub-regional and local management staff to detect, assess and resolve the local imbalances from D-months to D-hours. Different instantiations will be available depending on the local needs of the service providers;
- HMI for the regional manager to monitor the network from D-hours to D;
- HMI for the sub-regional or local manager to detect, assess and resolve the local imbalances from D-hours to D. This HMI will integrate the functionalities from D-hours to D-2 hours with the functionalities in the timeframe between D-2 hours and D.
- En-route controller interface will not be modified.

4.2 Roles and Responsibilities –DCM

The SESAR concept envisages new air traffic controllers' roles and responsibilities. The Dynamic Capacity Management concept has been developed to support the person responsible for determining the sectorisation in operation.

In this way, OPS supervisor, Local Traffic Manager or new roles like Complexity Manager could be taking on those tasks.

4.3 Constraints - DCM

The main constraints for the effective operation of the DCM Local Supporting Tool could be:

- Lack of accuracy / incoherence among the inputs Flight Data Processing data to be used for dynamic capacity management prediction.
- Local Human Factors constrains prevent to apply an optimum sectorisation. Or the initial family of sectors defined in the ATC Centre is inadequate.
- Additional co-ordination procedures required by introducing of additional layer of planning without adequate automated support in STEP 1.

4.4 Detailed Operational Environment – Layered planning

4.4.1 Operational Characteristics

4.4.1.1 Airspace Characteristics

The responsibility for air traffic control services within the NAT Region is delegated by the International Civil Aviation Organisation (ICAO) to six states: the United Kingdom, Iceland, Canada, Norway, USA and Portugal. The NAT Region is Class A airspace (at and above FL55); in which Instrument Flight Rules (IFR) apply at all times.

The NAT airspace is divided into six FIRs or Control Areas for the implementation of the Communications Navigation Surveillance/Air Traffic Management (CNS/ATM) systems. The NAT Region comprises the following FIRs/Control Areas:

- Bodø Oceanic;
- Gander Oceanic;
- New York Oceanic;
- Reykjavik;
- Santa Maria;
- Shanwick.

Traffic is controlled by Oceanic centres at Reykjavik, Bodø, Gander, New York, Santa Maria, and Prestwick. ATC for the Shanwick FIR is provided by NATS at its Prestwick ACC (ScOACC). Figure 6 below illustrates the NAT Airspace:

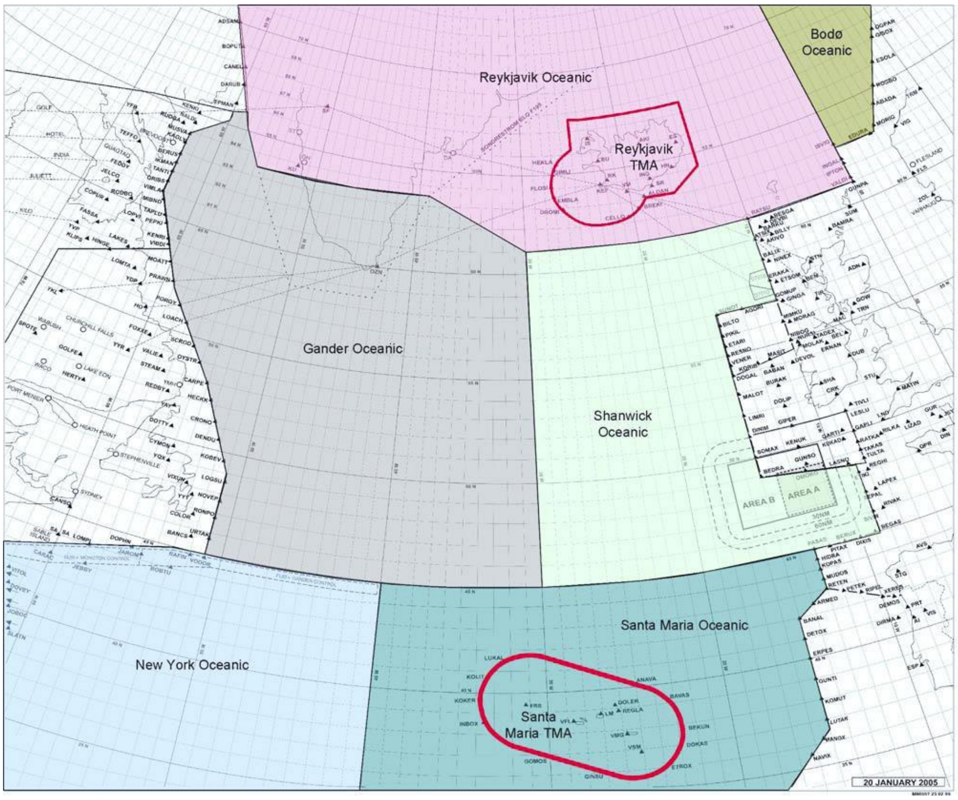


Figure 6 - NAT Airspace

4.4.1.2 Organised Track Structure (OTS)

Although a number of fixed trans-Atlantic tracks exist, the bulk of traffic operates on tracks which vary from day to day dependent on meteorological conditions. The variability of the wind patterns would make a fixed track system unnecessarily penalising in terms of flight time and consequent fuel usage. Nevertheless, the volume of traffic along the core routes is such that a complete absence of any designated tracks (i.e., a free flow system) would result in major flow restrictions given the need to maintain procedural separation standards in airspace largely without radar surveillance.

As a result, an OTS is set up on a diurnal basis for each of the Westbound and Eastbound flows. Each core OTS is comprised of a set, typically 4 to 7, of parallel or nearly parallel tracks, positioned to make the best use of the prevailing winds to benefit the traffic flying between Europe and North America. The designation of an OTS facilitates a high throughput of traffic by ensuring that aircraft on adjacent tracks are separated for the entire oceanic crossing - at the expense of some restriction in the operator's choice of track. In effect, where an operator's preferred track lies within the geographical limits of the OTS, the operator is obliged to choose an OTS track or fly above or below the system. Where the preferred track lies clear of the OTS, the operator is free to fly it by nominating a random track. Trans-Atlantic tracks, therefore, fall into three categories: OTS, Random or Fixed.

4.4.1.3 Reduced Lateral Separation Minimum (R Lat SM)

Tracks in the OTS are separated laterally by 1 degree of latitude (60NM). NATS currently plans to introduce a Reduced Lateral Separation Minimum (R Lat SM) of ½ degree (30NM) in the 2010 to 2012 timeframe.

4.4.1.4 Irish ENSURE Airspace

In December 2009 the Irish Aviation Authority (IAA) implemented the ENSURE (En-Route Upper Airspace Re-design) project throughout the Shannon UIR (Upper Information Region), SOTA (Shannon Oceanic Transition Area) and NOTA (Northern Oceanic Transition Area). This project involved the removal of the traditional ATS route structure allowing airline operators to flight plan direct routings from entry to exit points on the UIR boundary. A major re-sectorisation programme was introduced at the same time to provide a multitude of band-boxed sector configurations that are flexible to adapt to differing traffic flows and patterns. Figure 7 illustrates the reduction of complexity in Irish airspace enabling airlines to flight plan direct routes across Shannon's airspace resulting in time and cost savings.

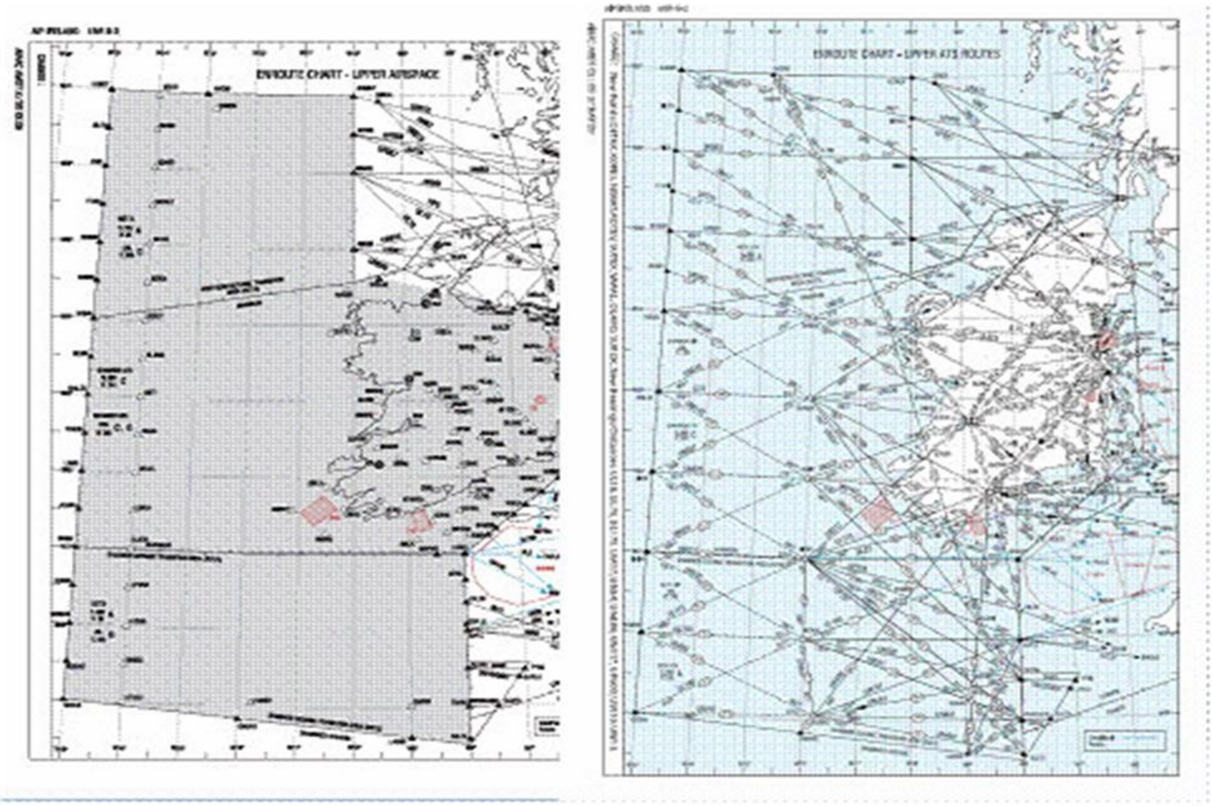


Figure 7 – New and Previous Shannon ATS Route Structure

Close co-operation between NATS and the IAA has already identified the possibilities for establishing a network of flight-plannable, long distance, direct routings to take advantage of quiet periods (night time operations between midnight and 06.00 local) when routings through restricted areas are normally permitted (depicted in Figure 8 below). These have been progressed through the NATS/IAA Night Time Fuel Saving Routes (NTFSR) project, which has involved a phased implementation with continual discussion taking place with various stakeholders for the identification for further additions to the route structure.

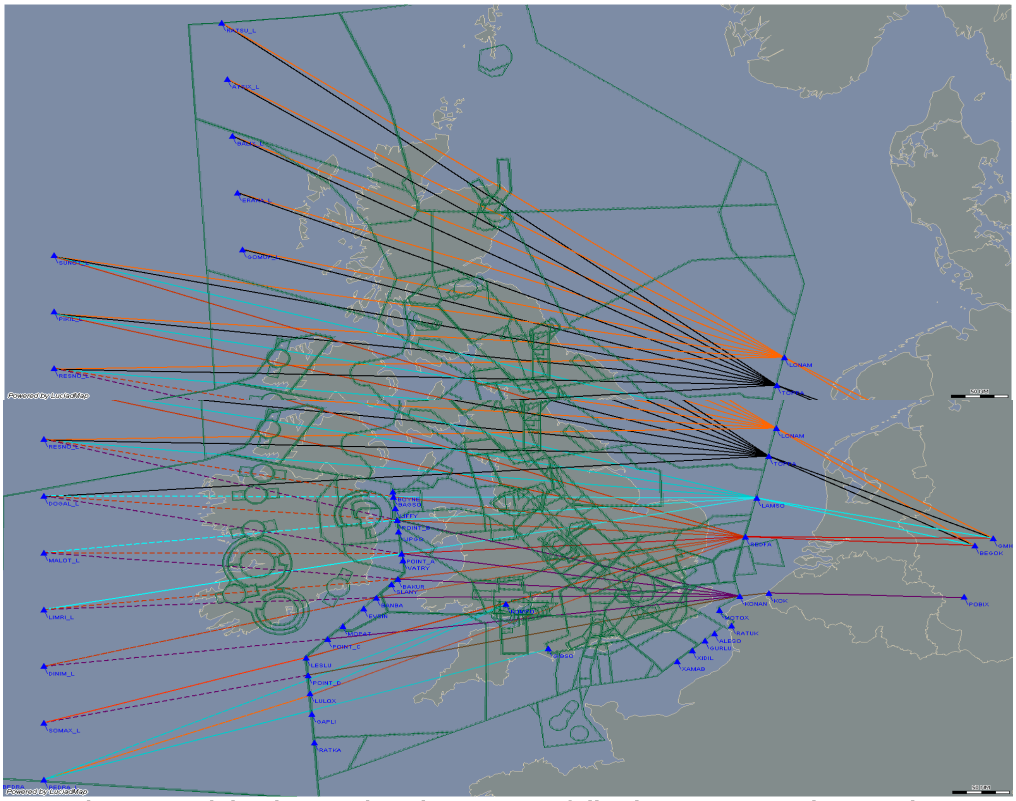


Figure 8 – Night Time Fuel Savings Routes following Stage 2 Implementation

4.4.2 Traffic Characteristics

The traffic is dominated by two major axes, which are the axis linking Europe and the Middle East to North America and the axis linking Europe to the Caribbean and South America. A substantial proportion of NAT traffic, namely that operating between cities in Europe and those in North America, operates on the first axis. The major traffic flow between Europe and North America takes place in two distinct traffic flows during each 24-hour period. This is due to passenger preference, time zone differences and the imposition of night-time noise curfews at the major airports. The majority of the westbound flow leaves European airports in the late morning to early afternoon and arrives at North Eastern American coastal airports typically some 2 hours later (local time). The majority of the eastbound flow leaves North American airports in mid/late evening and arrives in Europe early to mid-morning local time. Consequently, the diurnal distribution of this traffic has a distinctive tidal pattern characterised by two peaks passing 30°W, the eastbound centred on 0400 Universal Co-ordinated Time (UTC) and the westbound centred on 1500 UTC. Figure 9 illustrates this diurnal traffic pattern.

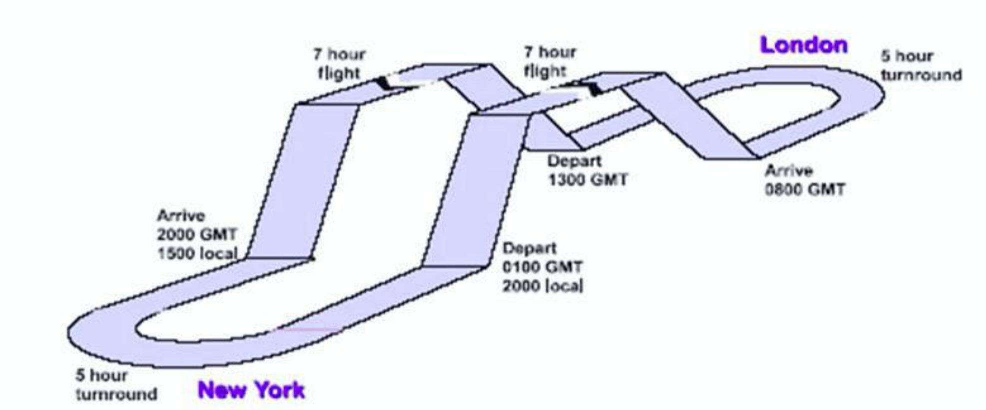


Figure 9 – Diurnal Traffic Pattern on the NAT

4.5 Roles and Responsibilities

No changes to existing roles or responsibilities are required by the deployment of the layered planning concepts described in this concept.

4.6 Technical Characteristics

This section identifies the technical characteristics or constraints applying to the Operational Service/Process environment.

This information is necessary in order to be used to determine the system performance (see next section) in the technical development path.

4.7 Performance Characteristics

This section provides performance information to be used as an input to develop technical performance requirements (developed in the corresponding Safety and Performance Document SPR [13] in the environment supporting the operational concept.

5 Detailed Operational Scenarios / Use Cases

5.1 Operational Scenario - Dynamic Capacity Management - Short Term

The description of the operational scenario "Medium/short Term", defined in the 07.02 Step 1 DOD, has too wide a scope for this project and therefore P04.07.07 has produced the following operational scenario.

Operational Scenario Description

This scenario describes the operation in a high-density En-route environment in which aircraft in cruise-flight are integrated with aircraft climbing and descending into and out of one or more TMAs. Although the operational scenario could be a medium or low density area, it is considered to be a representative scenario since this ACC/Sector Cluster handles the highest number of movements (150 movements per hour) within the Area of Interest. The airspace will be both FIR and UIR and some sectors will cover the entire vertical range whereas others will cover only a range of levels within the overall FIR/UIR extent.

The scenario will assume full radar coverage, although, in reality, there may be extremities of some sectors that are outside radar cover (due to the distance from a radar head) or below radar cover as a result of high terrain.

The scenario will assume a predefined airspace configuration for the Area of Interest (ACC/Sector Cluster) where Sector Configuration planning is planned.

Operational Description

The Network Operations Plan (NOP) includes all flights, as described by their Reference Business Trajectory, planned to enter the Area of Responsibility of the Area Control Centre within 2 hours from the now-time. In creating the RBT from the Shared Business Trajectory (SBT), consideration is given to the constraints on the day of operation of airspace and ATC resources. At the strategic planning level (Medium and Short-term planning phase), resource availability has been exhausted and all the known ATC and airspace resources and their operational or technical limitations have been taken into account in the day's NOP.

Consequently, at the ACC/Sector Cluster level, no new resources can be made easily available to alleviate congestion problems. However, temporary adjustments to the ATC sectors' airspace allocation can be made to alleviate excessive ATC sector workload/demand. RBTs can also be reallocated to specific controllers regardless of possibly restrictive Sector Configuration.

Sector Configuration schedule for the day of operation is published by all ANSPs via the NOP (Sector Configuration Activation Plan). It details the expected ATC sector opening scheme along the day. By predicting the future traffic demand, this plan (closing or opening of ATC sectors and special use airspace) may be adjusted to satisfy the following goals:

- no ATC sector (or an airspace block) is overloaded;
- ATCO workloads are balanced;
- ATC sector density (number of aircraft within an airspace volume) may be reduced.
- Local Human Resource constraints and sector capacity (e.g. weather) constraints are taken into account.

Airspace adjustments within an Area of Responsibility (ACC/Sector Cluster) are called Sectorisation Plans or Sectorisation Schedules.

The ground system functionalities required to support dynamic sector configuration in a multi-sector environment include:

- A Sector Configuration Tool that will suggest an optimum sector configuration according to the Human Resources expected per shift. This suggestion will include the optimum distribution of human resources;

- Automated tool support that will allow a Manager to construct, assess, amend and implement alternative sectorisation or traffic allocation plans.

Demand Balance

The RBT is not fixed and the aircraft operator and ATC may revise the plans via the trajectory management process. Although it would be convenient to assume the existence of just one unique flight trajectory represented by the RBT, in fact, the aircraft Flight Management System (FMS) trajectory may at times be different from the ground trajectory. The collection of all the RBTs collate into an overall traffic plan, the NOP.

The Tactical Controller (TC) operates by monitoring the evolving and predicted traffic, identifying problems (concerning queue or conflict management) and issuing instructions to aircraft to revise their trajectory. The instructions are issued either as a change to an RBT and, as a consequence, the NOP, or as an ATC clearance that may be needed to solve an imminent problem. In both cases the RBT and the NOP will be eventually changed and the instructions' effects on the Network stability are then revealed to all concerned actors.

The ATC process is a human-centred mechanism. Its complexities and associated workload dictate that the task in a congested airspace is distributed within a group of controllers.

This task distribution is done conventionally by dividing the controlled airspace into ATC sectors and arranging matters so that for each sector there is a distinct ATC resource (e.g. sector team). Task distribution needs a coordination process in which transfer of ATC responsibilities are coordinated as an aircraft transits different sector boundaries. The overall distribution of the different sectors and group of sectors is called sectorisation or Sector Configuration. In today's environment sectorisation is rigidly compartmentalised.

In the future environment the ATC sector confines are more fluid and whole sectors or predefined parts of them may be used to balance workload between ATC sector teams – even across ATC unit boundaries. The future system will also allow distribution of RBTs between controllers in the same airspace entity, on the basis of 'next-available-controller', i.e. each new RBT entry within the ACC Centre will be considered against the existing ATCO workloads and the new RBT will be assigned for instance to a controller with the lowest workload at the time of demand for service of that flight. These two balancing methods will minimise a need for adjusting air traffic demand in congested situations.

- Re-routing of a flow of air traffic, by assigning new entry and/or exit points for a group of flights on a route for a definable period;
- Re-routing one or several flights, by assigning new entry and/or exit points or new route segment.

5.1.1 Use Case "Unbalanced Demand"

During the day/night shift, the OPS Supervisor will be responsible for the Area of Interest (ACC/Sector Cluster) Sector Configuration planning for the Air Traffic Controllers (ATCos) afternoon and night/morning shifts and the monitoring of the morning and afternoon/night ones.

Imbalance Demand Problem Detected

Between 8 hours and 2 hours before traffic enters a predefined airspace (ACC/Sector Cluster), an imbalance demand problem is detected by:

- The process of planning and distribution of the sectorisation.
- Application of a local restriction which affects the planned sectorisation: for example, the number of controllers is decreased; or the sector capacity is modified by bad weather conditions.
- Monitoring of automated support tools displayed to Flow/Complexity Manager- OPS Supervisor.

Imbalance Demand Problem Analysis

Flow Manager/Complexity Manager/OPS Supervisor starts an analysis process to resolve the detected traffic imbalance demand problem with automation assistance, following a system advisory. This may involve selecting a suitable standard resolution or creating ad hoc measures in close coordination with the ACC/TMA Supervisor, Complexity Manager, or Planning Controller/Multi Sector Planner.

Imbalance Demand Problem Resolution
An imbalance demand problem resolution in Step 1 may include:

- A change to airspace structure, by implementing a different Sector Configuration;
- A change to airspace structure, by changing or cancelling a special use airspace block;

5.1.2 Use Case "Balanced Demand"

During the day/night shift, the OPS Supervisor will be responsible for the Interest Area (ACC/Sector Cluster) Sector Configuration planning for the air traffic controllers' afternoon and night/morning shifts and the monitoring of the morning and afternoon/night ones.

Balance Demand – Problem Not Detected
Between 8 hours and 2 hours before traffic enters a predefined airspace (ACC/Sector Cluster), a balance demand problem is not detected during:

- The process of planning and distribution of the sectorisation.
- Application of a local restriction which does not affect the planned sectorisation: for example, the number of controllers is higher than expected; or the weather conditions are optimum.
- Monitoring of automated support tools displayed to Flow/Complexity Manager- OPS Supervisor.

Balance Demand Analysis
Flow Manager/Complexity Manager/OPS Supervisor starts an analysis process to decide the optimum sectorization with automation assistance, following a system advisory. This may involve selecting a suitable standard resolution in close coordination with the ACC/TMA Supervisor, Complexity Manager, or Planning Controller/Multi Sector Planner.

5.2 OPERATIONAL SCENARIO - UK/ IRISH OCEANIC AIRSPACE

The airspace will be that depicted below for aircraft in the en route phase. Figure 10 shows the airspace overlaid with a sample of southerly flights and their destinations. The red block identifies the location of a military danger area permanently active during 'working' hours. The sectors to the south of the danger area (the 'west end' sectors) may be experiencing high complexity/workload due to interacting traffic that requires separating into appropriate descending and over-flying flows. Figure 11 shows the airspace as it might appear after implementation of the concepts. The overflights are streamed to the north (green arrow), Heathrow arrivals are streamed in the centre (red arrow), and Paris arrivals are streamed to the south (blue arrow). The west end sectors have reduced complexity/workload.

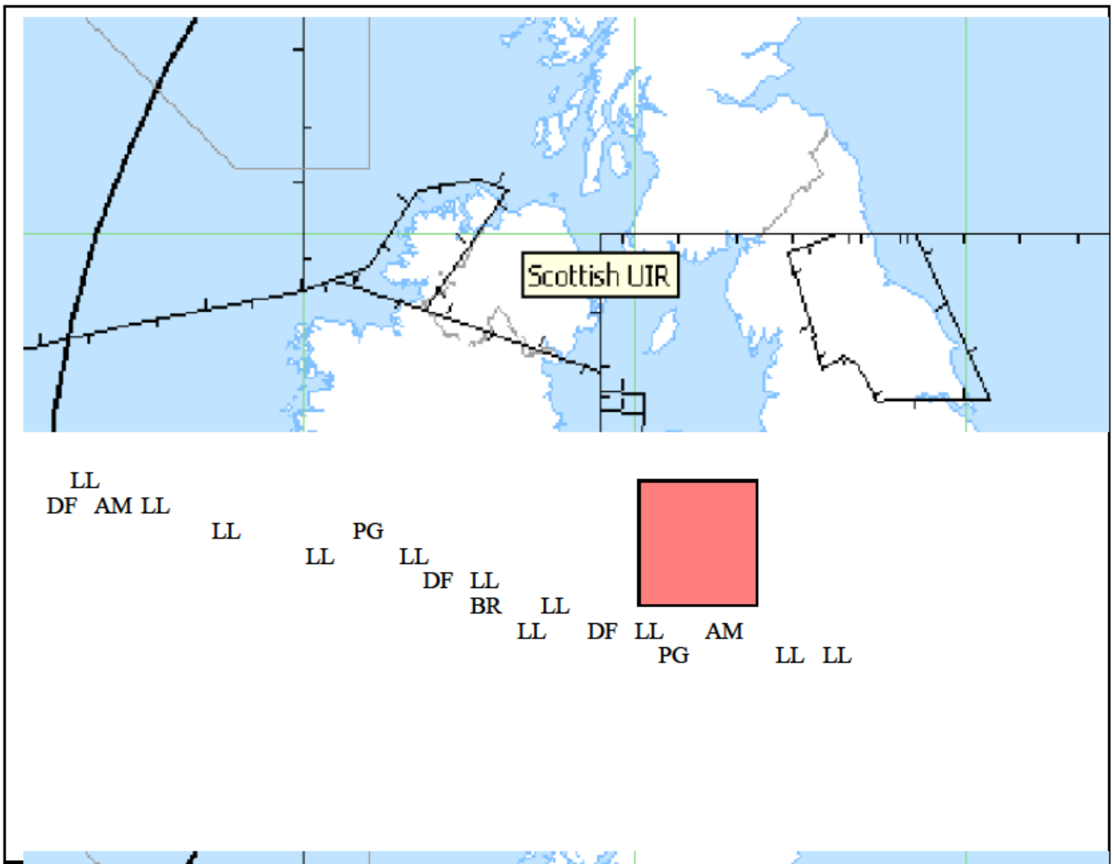


Figure 10 – Unadjusted Traffic Presentation Illustration

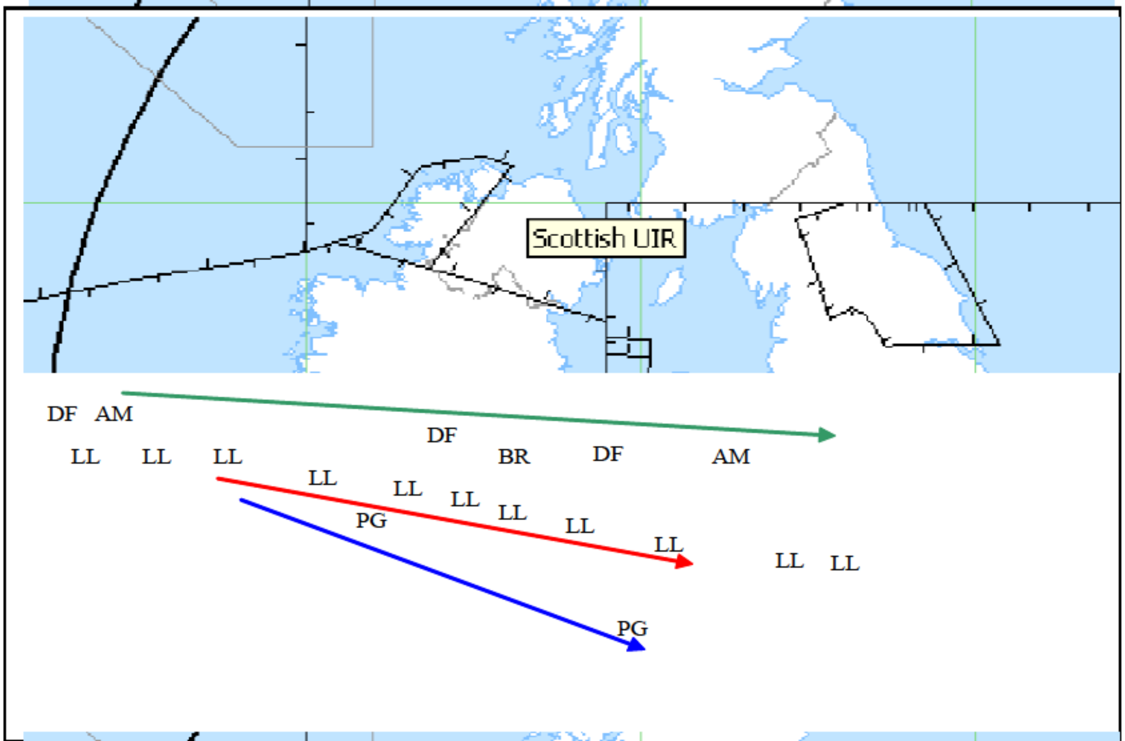
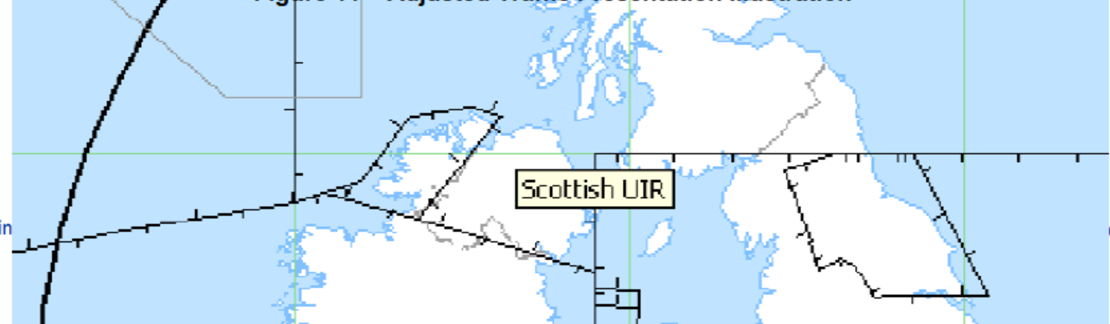


Figure 11 – Adjusted Traffic Presentation Illustration



5.2.1 Use case “Oceanic Clearance Optimisation”

Aircraft departing North America request their oceanic clearance from Gander. They request clearance on the NAT track that closest matches their optimum trajectory. Rather than clear aircraft on a first come, first served basis, the Gander Oceanic Planner consults his Oceanic Domestic Interface Manager that suggests a NAT track and flight level that does not penalise the aircraft more than the traditional first come, first served basis. (Note that if the aircraft’s preferred flight level and route are not available, as another aircraft has requested it first, current practice is to allocate the next nearest level.) The Gander controller then clears this, and subsequent, aircraft in accordance with oceanic separation standards but using route/level allocations that ensure reduced complexity when aircraft leave oceanic airspace. Hence, where possible, as aircraft depart oceanic airspace, those destined for airports with a more northerly trajectory lie to the north of aircraft destined for more southerly airports. Aircraft inbound to the UK are lower than those over-flying. Note the important point that the tool does not suggest a route/level that is significantly different from that which an aircraft has requested. The aim is not to penalise the aircraft for its entire oceanic flight for the sake of reduced domestic complexity! The aim is to identify situations when a complexity benefit can be derived without penalising the aircraft.

5.2.2 Use case “High Level Direct Routing”

As aircraft leave oceanic airspace, overflights take up their flight-planned route that is much closer to their preferred trajectory than current practice permits. This is based upon further implementation of Flexible Use of Airspace (FUA) concepts. Danger areas and other forms of restricted airspace are now reserved for use only when required by the relevant user for a specific mission or activity; at other times the airspace is available for General Air Traffic (GAT) use. Implementation of this concept at higher flight levels over the UK ‘fills in the gap’ between Irish and Maastricht airspace where direct routing concepts are already operational practice. This implementation is also facilitated by the use of Medium Term Conflict Detection tools at Swanwick (iFACTS) that highlights conflicts to en route controllers based on aircraft trajectories.

This has the effect of reducing complexity through lateral separation, as flows to different destinations separate out.

5.2.3 Use case “Inbound Longitudinal Streaming”

As aircraft inbound to London airports leave oceanic airspace and fly through the AMAN horizon, they are passed their Target Times for the relevant metering point by an appropriate method. Pilots use their aircraft Flight Management System Required Time of Arrival (FMS RTA) functionality to calculate what changes are required to their aircraft trajectory to comply with the constraint time. Pilots then request the appropriate speed, and if necessary flight level, change in order to arrive at the London metering point, positioned just prior to the normal descent point, at the correct time.

This has the effect of reducing complexity through longitudinal smoothing.

6 Requirements

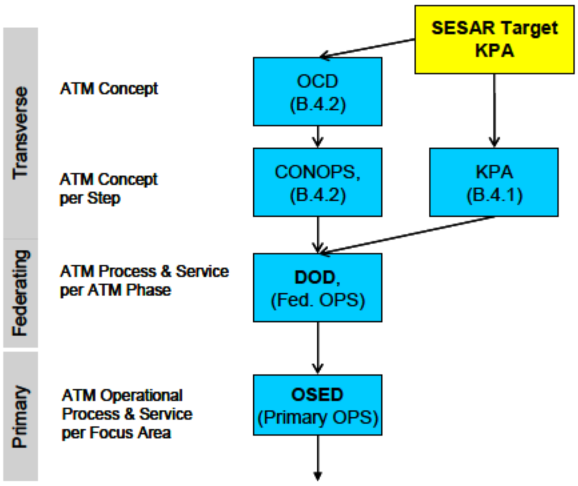


Figure 12 – Requirements Traceability

6.1 Requirements for Process Dynamic Capacity Management

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0001
Requirement	The System shall calculate and display the expected demand indicators per sector and per time interval for a given operational environment (sector configuration)
Title	To predict demand indicators
Status	<In Progress>
Rationale	The demand indicators are the key factor in decision making support
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0002
Requirement	The predicted demand indicators shall be compared against the maximum reference level configured as acceptable for each of the sectors
Title	Comparison of predicted demand and declared capacity
Status	<In Progress>
Rationale	Indicators are measured against declared capacity in order to define if a determined sectorization plan is feasible.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0003
Requirement	All demand indicators shall be calculated in terms of occupancy.
Title	Definition of indicator
Status	<In Progress>
Rationale	The workload should be calculated in the same terms that the declared capacity is.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0004
Requirement	The system shall calculate the predicted demand for each operative sector in all the operational sector configurations available.
Title	Calculation of indicators for each sector
Status	<In Progress>
Rationale	Every sector is calculated
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0005
Requirement	The system shall be able to propose the optimal configurations from a predefined list of all possible sector configurations, based on the workload indicators ("Traffic Demand")..
Title	Optimal sector configuration calculation
Status	<In Progress>
Rationale	The system is able to suggest a sector configuration, therefore supporting decision making
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0006
Requirement	The system shall provide output for each configurable time interval.
Title	Output granularity
Status	<In Progress>
Rationale	The indicators will be typically provided per a configurable time interval, for each of the sectors listed in a particular sector configuration.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0007
Requirement	When proposing an optimal solution, the system shall be able to consider operational restrictions (i.e, maximum changes of configurations in a time interval, or a minimum sector configuration time when no more changes can be done).
Title	Definition of restrictions to the optimum solution calculation
Status	<In Progress>
Rationale	The restrictions must be taken into account and be reconfigurable, as different local tools can have different restrictions.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0008
Requirement	The system shall take into account for its demand prediction both historical traffic data and actual system data (that available in advance)
Title	System sources of information
Status	<In Progress>
Rationale	The system will have access to all the information so it can combine in several ways to provide better solutions by refinement of information.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0009
Requirement	The system shall be able to define different mixes of historical data and actual system data (configurable)
Title	Degree of sources of information combination
Status	<In Progress>
Rationale	The user will be able to select the percentage of each information to be taken into account for the demand prediction. The system will do the combination internally. Sensitivity analysis can be performed on validation.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0010
Requirement	The system shall be able to work with only one of the two sources of information available.
Title	Minimum number of sources of information
Status	<In Progress>
Rationale	The system can work only with historical data (in case there is a lack of connection to actual ATC system) or only with actual system data (in case of no historical data available).
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0011
Requirement	The system shall be able to predict demand with a configurable advance, according to the available information.
Title	Time advance when the system works
Status	<In Progress>
Rationale	Typically, this system will work with a 6-8 hours advance window in relation to time of applicability
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0012
Requirement	The system shall be able to provide a ‘what-if’ demand calculation for every possible pre-defined sector configuration, after manual selection of it.
Title	‘What-if’ configurations capabilities
Status	<In Progress>
Rationale	Apart from optimum sector configuration calculation, the user of the system will be able to manually check a determined sector configuration, and graphically check predicted demand against declared capacity, pr sector.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0013
Requirement	The system shall receive the list of possible operational sector configurations (pre-defined)
Title	List of possible sector configurations
Status	<In Progress>
Rationale	The system needs to know in advance the sector configurations that need to be calculated.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0014
Requirement	Individual sector capacities (thresholds) shall be configurable manually, as a reaction to some sector operations restrictions (i.e., weather, military, ...)
Title	Edition of declared capacity
Status	<In Progress>
Rationale	The capacity can vary and, therefore, convenience of a sector configuration or another may vary.
Category	<Performance>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0015
Requirement	The system shall be able to provide several proposals of sectorisation plans, according to the time advance considered
Title	Several proposals according to time advance
Status	<In Progress>
Rationale	The system can display short-term predictions and long-term predictions, taking into account different input data or different subsets of it.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0016
Requirement	The system shall take into account the network effects locally or at a sub-regional level
Title	Local/Sub-regional Tool scope
Status	<In Progress>
Rationale	The network effects are taken into account at a local/sub regional level
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0017
Requirement	The system shall allow an increase in the level of information displayed, up to a predefined maximum.
Title	Increase in amount of information displayed
Status	<In Progress>
Rationale	This allows to analyze the potential causes of problems or potential imbalances.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0018
Requirement	The system shall perform data acquisition automatically, with no user intervention, from all the available sources.
Title	Automatic data acquisition
Status	<In Progress>
Rationale	The user will not be involved in data retrieval processes
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM1.0019
Requirement	The system shall perform acquired data storage automatically, with no user intervention.
Title	Automatic data storage
Status	<In Progress>
Rationale	The user will not be involved in data storage processes
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0001
Requirement	The system shall display graphically the predicted demand for each sector of a selected sector configuration, including the declared capacity value as a line.
Title	Graphical Display of Predicted Sector Demand
Status	<In Progress>
Rationale	The user shall see graphically if all sectors are balanced or, if there is an imbalance.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0002
Requirement	The system shall be able to provide the predicted demand for each sector as tables, showing the values per time interval.
Title	Tabular Display of Predicted Sector Demand
Status	<In Progress>
Rationale	Numerical values can provide useful information, complementary with graphic view.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0003
Requirement	The system shall be available both in the FMP position and in the ATC Supervisor position
Title	Physical system availability
Status	<In Progress>
Rationale	The system may have several different HMI, as long as results in all of them are coherent
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0004
Requirement	The time taken to calculate the optimal sector configuration shall be no more than 3 minutes
Title	Time taken for optimal calculation
Status	<In Progress>
Rationale	A solution must be provide in a time that is user-friendly enough
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0005
Requirement	The system shall avoid the possibility of implantation of a sector configuration from the system HMI.
Title	No implantation of configurations
Status	<In Progress>
Rationale	The system is intended as a decision support tool, and should avoid implantation functionalities.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0006
Requirement	The system shall have an analysis function to compare the actual sector configurations operated against those proposed by the system
Title	Post-operation analysis
Status	<In Progress>
Rationale	Analysis and comparison of solutions may show operational opportunities to improve demand-capacity balancing
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0007
Requirement	The system shall provide recording facilities with a level of granularity compatible with after runs analysis
Title	Recording Facility Granularity
Status	<In Progress>
Rationale	Log and records may show ways of improving demand predictions
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0008
Requirement	The system shall be capable of displaying errors, warnings and system messages.
Title	Display of system messages
Status	<In Progress>
Rationale	The user needs to be aware of the status of the system
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0009
Requirement	The system shall provide a way to compare indicators in every analyzed time interval for different data sources
Title	Indicators comparison
Status	<In Progress>
Rationale	Comparison may show details on sectorization plans proposed by the system, as well as a necessary refinement level of information.
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-DCM2.0010
Requirement	In the case of errors, a visual indication shall be available.
Title	Display of system messages
Status	<In Progress>
Rationale	The user needs to be aware of the status of the system
Category	<Operational>
Validation Method	<Real Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0005.0001	<Full>

6.2 Requirements for Process Layered Planning

The requirements identified in this section are related to ODIM and High Level Direct Routing. Requirements from the Inbound Longitudinal Streaming concept are not included as they have been developed within SESAR 5.6.4.

[REQ]

Identifier	REQ-04.07.07-OSED-ODIM.0004
Requirement	ODIM shall plan routes, clearances and level distributions in order to minimise the need to descend aircraft past overflying aircraft and consequently the need for tactical deconfliction.
Title	Oceanic clearance proposal – routes, clearances and levels
Status	<In Progress>
Rationale	Providing a seamless flow of traffic from the Oceanic sector to the UK/Irish FIR and reducing the complexity of onwards routing
Category	<Operational>
Validation Method	<Fast Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-ODIM.0006
Requirement	ODIM shall calculate the fuel burn difference in kilograms that ODIM proposal clearances would result in for each flight.
Title	ODIM fuel burn differences
Status	<In Progress>
Rationale	Allowing comparisons to be drawn and managing/minimising any potential for an increase in fuel burn.
Category	<Operational>
Validation Method	<Fast Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-ODIM.0015
Requirement	ODIM shall take aircraft level in relation to its destination into account when optimising oceanic clearances
Title	Optimisation – level distribution
Status	<In Progress>
Rationale	Eliminating the need to descend or climb an aircraft through another's level affecting both trajectories.
Category	<Operational>
Validation Method	<Fast Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-HLDR.0005
Requirement	The HLDR concept shall enable users to fly their preferred trajectories to the greatest extent possible
Title	HLDR enables user preferred trajectories.
Status	<In Progress>

Rationale	So as not to penalise any one company on a particular route.
Category	<Operational>
Validation Method	<Fast Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-HLDR.0035
Requirement	The HLDR concept shall be flexible enough to provide ATC capacity to meet major demand flows.
Title	HLDR design flexibility
Status	<In Progress>
Rationale	Allowing the concept to be manipulated so that in high flows the functionality can be maintained as such that the controller is not required to unduly increase their capacity.
Category	<Operational>
Validation Method	<Fast Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-HLDR.0045
Requirement	The HLDR concept shall avoid funnelling traffic flows as much as possible by enabling traffic dispersal.
Title	Traffic dispersal
Status	<In Progress>
Rationale	Preventing aircraft arriving in clusters in certain sectors instead fanning aircraft trajectories.
Category	<Operational>
Validation Method	<Fast Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-HLDR.0060
Requirement	The HLDR concept shall take into account the transition of aircraft between high level sectors and underlying airspace structures
Title	High level and underlying airspace interface
Status	<In Progress>
Rationale	Transiting from high level sectors to underlying airspace would require an aircraft to pick up an airway system and so the 'optimal trajectory' needs to be selected to avoid large amounts of repositioning to low level tracks.
Category	<Operational>
Validation Method	<Fast Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

[REQ]

Identifier	REQ-04.07.07-OSED-HLDR.0065
Requirement	The HLDR concept shall optimise level allocation and not be constrained by uni-directional flight levels.
Title	Optimise FL allocation
Status	<In Progress>
Rationale	Reducing constraints put in place by current regulations.
Category	<Operational>
Validation Method	<Fast Time Simulation>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>			N/A
<SATISFIES>	<ATMS Requirement>	REQ-04.02-DOD-0006.0001	<Full>

6.3 Information Exchange Requirements

N/A

7 References

7.1 Applicable Documents

This OSED complies with the requirements set out in the following documents:

[1] Template Toolbox 03.00.00
https://extranet.sesarju.eu/Programme%20Library/SESAR%20Template%20Toolbox.dot

[2] Requirements and V&V Guidelines 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Requirements%20and%20VV%20Guidelines.doc

[3] Templates and Toolbox User Manual 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Templates%20and%20Toolbox%20User%20Manual.doc

[4] SESAR SEMP v2.0

[5] B4.2 Initial Service Taxonomy document

[6] European Operational Concept Validation Methodology (E-OCVM) - 3.0 [February 2010]

7.2 Reference Documents

The following documents were used to provide input/guidance/further information/other:

[7] B4.1 [Initial] Baseline Performance Framework (Edition 0) D12.

[8] SESAR WP04.02 D07 Detailed operational description, Version 00.05.00, 29th October 2012.

[9] SESAR WP07.02 D07 Detailed operational description, Version 00.01.00, 15th October 2011.

[10] SESAR P04.07.07 D21 V2 Validation Report, Version 00.02.00, 21 December 2012

[11] SESAR P04.07.07 D23 V3 Validation Plan, Version 00.02.00, 1st August 2012.

[12] SESAR P04.07.07 D20 Preliminary OSED, Version 00.01.00, 23rd December 2011.

[13] SESAR P04.07.07 D22 Preliminary SPR, Version 00.01.00, 12th January 2012.

[14] SESAR P04.07.07 D24 V3 Validation Report 00.01.01, 12st February 2013.

[15] SESAR, Operational Focus Area, Version 03.00.00, 4th May 2012.

[16] WPB.01 Integrated Roadmap, DS8.

[17] SESAR D06-05.06.04 – Step 1 Initial OSED, Version 00.01.00, 22nd December 2010

[18] SESAR Target Concept DLM-0612-001-02-00, 4th September 2007.

[19] SESAR Definition Phase Task 2.2.2/D3, "SESAR Concept of Operations", DLT-0612-222-01-00, SESAR Consortium, Toulouse, July 2007

[20] IAA website http://www.iaa.ie/index.jsp?p=158&n=517&a=946 referenced on 26th May 2011.

[21] Eurocontrol website: http://www.eurocontrol.int/mil/public/standard_page/LARA.html referenced on 20 Oct 2011.

[22] Eurocontrol website http://www.eurocontrol.int/articles/free-route-airspace-maastricht-fram referenced on 20 Oct 2011.

[23] Commission Regulations EC N 1032/2006 and 30/2009.

[24] European Commission Regulations No 29/2009 .

Appendix A Justifications

N/A

Appendix B New Information Elements

N/A

-END OF DOCUMENT-