



Episode 3

D3.3.2-01 - Experimental Plan for Business Trajectory Management and Dynamic DCB

Version : 1.00

EPISODE 3

Single European Sky Implementation support through Validation



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EXECUTIVE SUMMARY

The exercise addresses the management of **arrival traffic congestion situations** –mainly at large or medium size airports- in the short-term planning and execution phases.

Several prospective studies predict a huge increase in the number of saturated airports operating at full capacity for most of the day. This emphasises the need for highly dynamic and adaptive processes to efficiently manage all short notice events that impact arrival capacity.

The SESAR CONOPS introduces the following set of concept elements that will have a deep impact on the way arrival traffic will be adapted to the available airport capacity both in the short term and execution phases:

- **Queue management** will allow a significant extension of the geographical and temporal scope for arrival congestion management in the execution phase;
- **Business trajectory management** both in the short-term planning (SBT) and the execution phases (RBT);
- **Dynamic Demand and Capacity Balancing (DCB);**
- **UDPP** (User Defined Prioritisation Process).

The combined application of these concepts should provide highly flexible and efficient arrival congestion management through DCB/queuing measures. These will be dynamically adapted to the magnitude of the congestion and the accuracy of the situation while integrating airspace users' business constraints and preferences.

Still a large number of high level open issues remain that prevent stakeholders from having a clear and commonly agreed picture of the associated ATM processes. The following questions are addressed by this exercise:

- How will airspace user business trajectory management interact with DCB / queuing?
- As ground delays will remain the safest and most efficient means to resolve significant arrival demand/capacity imbalances, which CDM processes and functions will cover this aspect of DCB in the short term planning phase? And how will UDPP be triggered in this context and to which situations should it apply?
- The extension of the geographical range of an arrival queuing process in the execution phase will fundamentally shift the nature of the process from a local to a network scale. This raises many issues requiring further investigations related to:
 - The involvement of network management actors in the process and induced share of responsibilities;
 - The frontier/interfaces between DCB in the short term planning phase and traffic management/regulation processes in the execution phase.

Therefore, considering the current maturity (stage V1 of E-OCVM) of the concept related to the aforementioned topics, the initial emphasis is on concept clarification activities. It should be noted that UDPP will only be partially addressed in the exercise; the objective is to identify the level of severity that would trigger the UDPP process.

The exercise proposes to combine two complementary validation techniques: **gaming and process simulation**.

Gaming has been chosen as an appropriate method to allow multiple stakeholders to take part in the proposed process. The roles include Sub-Regional Network managers for the functional airspace blocks (FABs), a Regional Network Manager with a view of the entire



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ECAC area, the APOC at the constrained airport and one airline involved in implementing the dynamic DCB solutions.

A simulation platform called DARTIS will be used. The validation scenarios will focus on medium severity arrival congestion situations following a sudden - or anticipated with short notice - airport capacity shortfall. The two selected airports are Rome Fiumicino and Madrid Barajas whereas network monitoring will cover a significant part of the ECAC area.

Process simulations using PROMAS will allow the designed processes to be modelled and tested in a wider area. They will enable a greater number of actors, roles, DCB problems, DCB solutions and network effects to be modelled.

Beyond the contribution to initial concept clarification, one of the key objectives of the exercise is to initiate the building of a validation infrastructure – including methodology, techniques and platform – to support further steps of the SESAR validation program related to network operations.



1 INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

This document combines the validation exercise plans for 1) dynamic demand and capacity balancing (DCB), and 2) dynamic DCB and Business Trajectory (BT) management, from Episode 3 (EP3) WP3.3.2. These exercises are focussing on SESAR Collaborative Network Planning in the Short Term Planning and Execution Phases.

These exercises will use different validation methods. The dynamic DCB exercise will employ gaming technique, whereas the dynamic DCB and BT management exercise will use process simulations. The two techniques are explained in detail in sections 3 and 4, respectively. An overview of both exercises can be found in Appendix A.

1.2 INTENDED AUDIENCE

The intended audiences for this document are:

- the teams involved in performing the two exercises;
- WP2 who oversee the other work packages in Episode 3;
- WP3.2.1 who manage WP3 validation activities;
- WP3.3.1 the Collaborative Network Planning Expert Group;
- WP3.3.5 the developers of the Network-wide macro model;
- the European Commission.

1.3 DOCUMENT STRUCTURE

There are six main sections:

- Section **0**: the Executive Summary;
- Section **1**: the Introduction;
- Section **2**: defines the scope and justification for the exercise;
- Section **3**: discusses the **gaming** exercise that will explore the dynamic DCB concept, led by EUROCONTROL;
- Section **4**: discusses the **process simulations** exercise that will explore the dynamic DCB and BT management concept, led by INECO;
- Section **5**: lists documents that are relevant to, or have been referred to in the experimental plan.

1.4 BACKGROUND

Episode 3 is charged with starting the validation of the operational concept expressed by SESAR Task 2.2 and consolidated in SESAR D3 [1].

The initial emphasis is on concept clarification activities as well as assessing operational feasibility. However, if the concept elements are sufficiently mature then the exercises may also provide initial information for the performance assessment.

The validation process as applied in EP3 is based on version two of the E-OCVM [2], which describes an approach to ATM Concept validation, and is managed and coordinated by EP3/WP2.3.



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In order to prepare for the validation exercises, an exercise plan should be produced according to steps 2.1 to 2.6 of the E-OCVM [3]. These steps guide the development of a more detailed description of a chosen solution including the definition of the exercise objectives and validation scenario. These plans provide more detail than is included in the WP3 Validation Strategy [4].

Both the exercises described in this document are looking at concept clarification and operational feasibility. Their results should help to develop answers to very high level questions, such as: What is a dynamic DCB solution? How is it implemented? How does it interact with other processes? Does it seem to provide operational benefit?

The gaming exercise involves human actors, supported by a platform, playing roles to assess the proposed procedures for the implementation of a dynamic DCB solution and their impact on the network. The exercise will benefit from the experience acquired through the European Commission 6th Framework CAMES project which organised human-in-the-loop simulations involving network management actors.

The process simulation is an automated activity, supported by a platform called PROMAS; hence it does not involve human actors. This tool will play roles, strategies and functions to assess the proposed BT management processes triggered during the implementation of a dynamic DCB solution and their impact on the network.

1.5 GLOSSARY OF TERMS

Term	Definition
ACAP	Arrival Capacity
ACC	Area Control Centre
AO	Aircraft Operator
AMAN	Arrival MANager
ANSP	Air Navigation Service Provider
AOC	Aircraft Operator Centre
APOC	Airport Operations Centre
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATA	AMAN Time of Arrival
AUO	Airspace User Operations
BT	Business Trajectory (whether shared SBT or reference RBT)
CAMES	Co-operative ATM Measures for a European Single Sky
CDA	Continuous Descent Approach
CDM	Collaborative Decision Making
CFMU	Central Flow Management Unit
CONOPS	Concept of Operations
CTA	Calculated Time of Arrival
CUPT	Current User Preferred Business Trajectory
DARTIS	Decision Aid to Real Time Synchronisation



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Term	Definition
DCB	Demand and Capacity Balancing
DMEAN	Dynamic Management of the European Airspace Network
DOD	Detailed Operational Description
ECAC	European Civil Aviation Conference
EOBT	Estimated Off Block Time
E-OCVM	European Operational Concept Validation Methodology
EP3	Episode 3 project from the European Commission
ETA /ETO	Estimated Time At / Estimated Time Over
FAB	Functional Airspace Block
FMP	Flow Management Position
FPFS	First Planned, First Served
HMI	Human Machine Interface
IP	Implementation Package
KPA	Key Performance Area
KPI	Key Performance Indicator
LVP	Low Visibility Procedures
MTV	Medium Term Validation
NOP	Network Operation Plan
OI	Operational Improvement
OS	Operational Scenario
PROMAS	Process Management Simulator
PRR	Performance Review Report
PRU	Performance Review Unit
QTA	Queuing Time of Arrival
RBT	Reference Business Trajectory
RNM	Regional Network Manager
SBT	Shared Business Trajectory
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
SRNM	Sub Regional Network Manager
SWIM	System Wide Information Management
TBV	To Be Validated
TMA	Terminal control Area
TOBT	Target Off Block Time
TOT	Take Off Time
TTA	Target Time of Arrival
UDPP	User Driven Prioritisation Process



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Term	Definition
WP	Work Package

Table 1: Acronyms and Abbreviations

Term ¹	Definition
Airline Default Delay Absorption Strategy (ADDAS)	This is similar to DDAS (see below) but for business trajectory calculation on the airline side. It shall be possible to define different strategies (mixed or “ground delay”) depending on airline preferences.
Aircraft Operator (AO)	The generic term for a user of airspace, which includes commercial airlines, business jets, military and private pilots.
Current User preferred BT (CUPT)	Corresponds to the trajectory (including off block/in-block times) without any DCB constraints. (Used within DARTIS)
DCB TTA Target Location	The reference location at which the QTAs and TTAs are calculated in the dynamic DCB process. Options include the AMAN boundary, the runway or the IAF.
Default Delay Absorption Strategy by ATM (DDAS)	This is a parameter used to determine how the delay (resulting from a TTA) to be absorbed is distributed between the air and ground segments of the BT calculated/revised by ATC (not the AOC). Two options shall be defined: <ul style="list-style-type: none"> • Ground delay: the whole delay is attributed to the ground. • Mixed delay: the delay is split between the air and ground segments of the trajectory.
Delay Threshold	The Delay Threshold is the minimum level of arrival congestion/delay beyond which the dynamic DCB process can be automatically triggered. It expresses the share of responsibility between local/network management for the management of congestion and represents an amount of delay that can be safely and smoothly managed by local/sub-regional planning processes.
Game	A simulation consists of Game Players, a game platform, i.e., DARTIS, a Game Scenario (set up by a Scenario Designer), Game Scripts, a set of playing rules, a Game Manager, and a traffic sample. The game will allow freedom of action for the Game Players.
Game Manager	The person in charge of the game.
Game Players	Humans and computer players that play a role in a game. An example of a role is an Aircraft Operator for Airline X.
Game Scenario	This is a scenario that will set the context of a game, giving the high level events that will or may occur in the game. The Game Scenario is set up by the Scenario Designer who pre-selects various DARTIS options (such as the rules by which Aircraft Operators can absorb delay) in order that these various dynamic DCB concept options can be explored for suitability and efficiency.
Game Script	A Game Script gives details of a Game Scenario. Different Game Players may have different Game Scripts (e.g., Game Players that are playing different Airline Operators may be instructed to adopt different delay absorption strategies). The Game Scripts may not necessarily be complete or accurate (this will depend on the game).

¹ Note that most of these terms are specific to this exercise and are not general SESAR terms.



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Term ¹	Definition
Process Simulation	A Process Simulation consists of a platform (i.e., PROMAS), a scenario (set up by a Scenario Designer), a set of Roles, Rules and Functions, and a traffic sample. The Process Simulation will allow a great number of roles and several strategies to be modelled in an easy and quick way.
PROMAS Scenario	The PROMAS Scenario, composed of a set of processes, roles, rules, strategies and actors, tries to model in a realistic way the BT management concept in some special conditions. It is set up by the Scenario Designer.
Roles and Actors (PROMAS)	Automated Roles and Actors. An example of a role is a Sub-Regional Manager (containing rules). An actor is the flight crew in the short-term planning phase (not containing rules).
Rules/Strategies	Different Roles may have different Rules, and their combination will lead to a strategy (e.g., Roles that model different Airline Operators may be instructed to adopt different delay absorption strategies).
Scenario Designer (DARTIS)	The person who selects specific parameter options in DARTIS to design a game for the Game Players to play.
Scenario Designer (PROMAS)	The person who models the different processes, roles, rules, strategies and actors to assess the BT management concept.

Table 2: Terms used for the dynamic DCB and BT management

Term ¹	Definition
ATA	AMAN Time of Arrival at the airport. This is the arrival time calculated by the AMAN.
CTA	Calculated Time of Arrival on the congested point. CTAs are sent to the aircraft / ATC based on ATAs calculated by the AMAN. CTAs are similar to TTAs sent by the dynamic DCB process.
ETA/ETO	Estimated Time over the congested point (airport, navigation point, sector entry). An ETA/ETO is extracted from the current user preferred trajectory.
QTA	“Queuing Time on Arrival”. This is the theoretical estimated time that an aircraft would be delayed at a (pre-defined) congested point. Thus, QTAs will be used as an indicator of likely congestion. If the level of delay is unacceptable, a dynamic DCB process could be implemented.
TTA	“Target Time of Arrival”. This is the arrival time at the “DCB TTA Target Location” allocated to an Aircraft Operator as a result of a dynamic DCB process. A TTA is based on a QTA but not necessarily equal to it.
EOBT	Estimated Off Block Time
ETOT / TOT	Estimated Take Off Time / Take off Time
TOBT	Target Off Block Time. This is the Off Block time provided by AOs in the business trajectory and takes into account any DCB constraints (TTAs) that exist.
TTOT	Target Take Off Time. This is the take-off time due to the TTA allocation process.

Table 3: Time Definitions used in Dynamic DCB and BT Management



2 EXERCISE SCOPE AND JUSTIFICATION

The exercise addresses the management of **arrival traffic congestion situations** in the short-term planning and execution phases and the definition of procedures for the implementation of business trajectory management and dynamic demand DCB solutions with a focus on the management of target times of arrival (TTAs).

The SESAR CONOPS introduces the following set of concept elements that will have a deep impact on the way arrival traffic will be adapted to the available airport capacity on the day of operations:

- **Queue management** will allow a significant extension of the geographical and temporal scope for arrival congestion management in the execution phase;
- **Business trajectory management** both in the short-term planning (SBT) and the execution phases (RBT);
- **Dynamic DCB**;
- **UDPP** (User Defined Prioritisation Process).

The combined application of these concepts should provide highly flexible and efficient arrival congestion management through DCB/queuing measures. These will be dynamically adapted to the magnitude of the congestion and the accuracy of the situation while integrating airspace users' business constraints and preferences.

Still a large number of high level open issues remain that prevent stakeholders from having a clear and commonly agreed picture of the ATM processes together with the roles and responsibilities of the involved actors.²

Therefore, considering the current maturity (stage V1 of E-OCVM) of the concept related to the aforementioned topics, the initial emphasis is on concept clarification activities. The exercise proposes to combine two complementary validation techniques: **gaming and process simulation**.

Gaming techniques have been chosen as an appropriate method to allow multiple stakeholders to actively take part in the proposed process. The roles include Sub-Regional Network managers for the functional airspace blocks (FABs), a Regional Network Manager with a view of the entire ECAC area, the APOC at the constrained airport and several airlines involved in implementing the dynamic DCB solutions.

PROMAS is being developed to offer, both EP3 and SESAR, an innovative platform that will support performance and process assessments. This platform will help to assess multiple management and operational roles, actors, rules and strategies involved in the addressed part of the concept. In the scope of this exercise, the roles include Sub-Regional Network managers for the FABs handling the arrivals to the constrained airport, a Regional Network Manager with a view of the entire ECAC area, the APOC at the constrained airport, the APOCs of the departure airports affected by the constraint, the AOCs based at the departure airports affected by the constraint, a generic ATC and the flight crews involved in implementing the dynamic DCB solutions. PROMAS supports the modelling of the designed processes and involved actors behaviour allowing automated simulation on a wider scope.

One of the key objectives of the exercise is to demonstrate how those two techniques – gaming and process simulation - can be efficiently combined to support concept clarification first in Episode 3 and, at a later stage, to support operability assessment and validation. For this purpose, it is essential that the two validation activities address the same ATM concepts and processes and share common assumptions and validation scenarios. Consequently,

² According for example to the list of research topics and open issues included in the SESAR CONOPS. A significant number of those are related to the topics addressed by this exercise.



most the elements developed in this section are applicable both to the gaming and process simulation exercises.

It has to be emphasised that this exercise is covering only a limited part of the DCB process. In particular, all aspects dealing with airspace congestion and capacity optimisation are only considered as far as they interact with arrival congestion management. UDPP will not be modelled.

2.1 DESCRIPTION OF ATM CONCEPT BEING ADDRESSED

Details on business trajectory management and dynamic DCB can be found in the M2/3 Detailed Operational Description (DOD) on Medium/Short Term Network Planning [5], in the E4 DOD on Network Management in the Execution Phase [6] and in the Operational Scenario OS-11 – Non-severe capacity shortfall impacting arrivals in the short term [7].

More precisely the following ATM processes in the M2/3 and E4 DODs are addressed:

- DOD M2/3 A2.1.2.2 Optimise SBT;
- DOD M2/3 A2.3.1.2 Detect Airspace Demand Capacity Imbalance;
- DOD M2/3 A2.3.2.1.3 Select/refine/Elaborate a DCB solution at Network Level;
- DOD M2/3 A2.3.2.2.1 Assess Network Impact of the DCB Solution;
- DOD M2/3 A2.3.2.2.2 Apply the DCB Solution;
- DOD E4 A3.1.1.1.2 Assess Airspace Capacity Load;
- DOD E4 A3.1.3.1.3 Select/refine/Elaborate a dynamic DCB solution at Network level;
- DOD E4 A3.1.3.2.1 Assess Network Impact of the Dynamic DCB Solution;
- DOD E4 A3.1.3.2.2 Apply the Dynamic DCB Solution.

It has to be emphasised again that the exercise will only partly cover each of the aforementioned processes as only one type of DCB solution will be addressed.

This exercise will look at dynamic DCB for arrivals in the short term planning and execution phases from a few hours in advance up to the AMAN boundary. It will focus on medium severity level capacity shortages, where:

- Low severity: managed locally by an AMAN;
- Medium severity: managed jointly by dynamic DCB, DCB and AMAN;
- High severity: user driven prioritisation process (UDPP).

2.1.1 Problem Description

Current arrival regulation processes in the day of operations (ATFCM slot allocation and AMAN) do not provide a method to manage efficiently a significant proportion of medium severity congestion problems and short notice severe problems. This leads to a gap between the application of ATFCM measures (i.e., regulations) and local management of arrival flows (AMAN), see Figure 1. ATFCM measures cannot be applied to flights that have received their pre-departure clearance while an AMAN has a limited horizon to manage arrival traffic. Currently there are no methods available to optimise the traffic at a network level during this time gap.

Further significant issues are the tendency for short haul flights to be penalised more heavily with current ATFCM measures – for short notice capacity shortfalls – as well as the fact that congestion management does not consider the airspace users' business constraints.

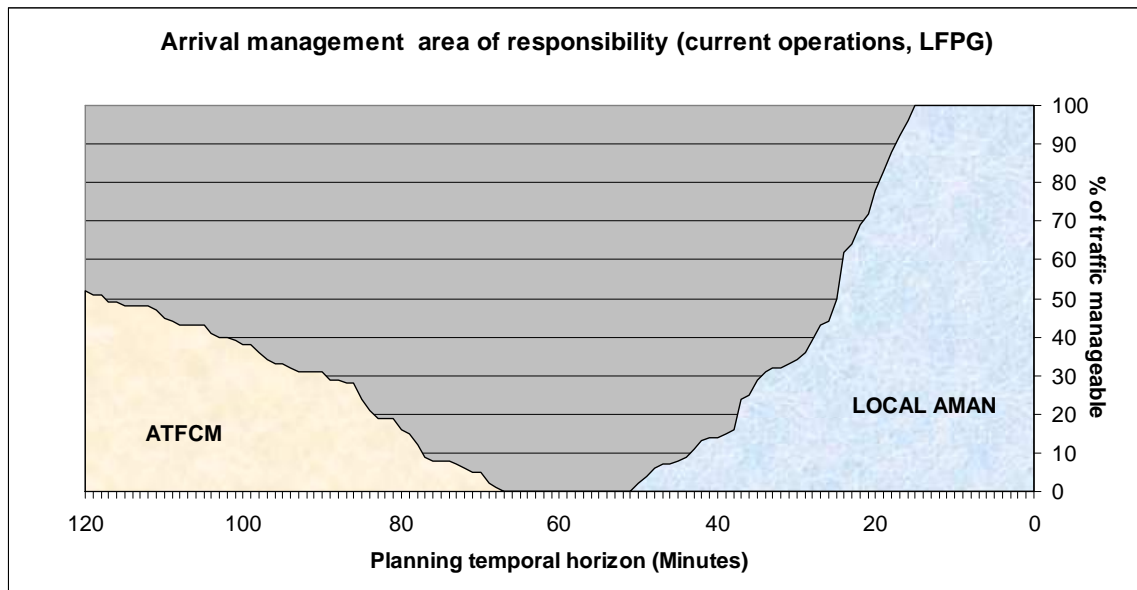


Figure 1: An example of the gap (grey area) between ATFCM measures and local AMAN measures

Figure 1 above is generated from an analysis of flight times for arrival traffic in the morning peak at Paris Charles de Gaulle (LFPG) airport. The two curves give the percentage of flights that can be regulated, if necessary, by an arrival traffic regulation process (either ATFCM or AMAN, depending on the look-ahead horizon considered (x-axis)). The zero on the x-axis indicates the arrival time of the aircraft, and to the left of zero, the time in minutes before landing.

The two main causes of the 'grey area' in Figure 1 are:

- Technical limitations, e.g., cannot notify taxiing and airborne flights; and
- Operational constraints, such as:
 - Co-ordination issues between and within ACCs;
 - Limitations on being able to implement solutions early.

2.1.2 Problem Quantification

The figures hereafter provide a high-level quantified view of the problem in the context of current operations or in the 2020 SESAR timeframe:

- In 2007, airport ATFM regulations caused 9.4 million minutes delays (source PRU [8]³);
- Around 2% of flights had an ATFM delay due to airport regulation between 0-15 minutes, 1% between 16 – 30 minutes (source PRU [8]⁴);
- Estimated cost of airport ATFM delays is: 600 million euros per year (source PRU [8]⁵);

³ PRR 2007; page 42, section 5.2.5, figure 54

⁴ PRR 2007; page 42, section 5.2.6, figure 55

⁵ PRR 2007; page 43, section 5.2.9, figure 56



- More than 40% of ATFM airport delays are due to weather factors and for a set of major airports (Frankfurt, Munich, Amsterdam, Heathrow, and Paris/CDG), this is the main source of ATFM delays (source PRU [8]⁶);
- More than 7% of the ATFCM delays are inappropriate and could be avoided (source PRU [8]⁷);
- In SESAR 2.3.1, the 'do nothing' scenario estimated the amount of airport delay to be around 13 minutes per flight (more than 600000 minutes per day). This represents around 97% of the overall calculated delay [9]⁸;
- More than 60% of the top 20 airports will not provide the sufficient capacity in 2020, even considering very optimistic assumptions (that is, all Operational Improvements (OIs) have been implemented and are providing the maximum expected performance improvement; and, all airports are at the level of 'best in class') and without considering any disruptions (source SESAR 2.3.1);
- 40% of ATFCM restrictions addressing weather problems are considered unsuccessful (source EUROCONTROL Review note on ATFCM performance assessment [10]⁹);
- By 2030, around 20 of the largest airports will be saturated, that is operating at full capacity, for 8 hours or more a day. About half of every day's flights will pass through one of these saturated airports (source Challenges of Growth study [11]¹⁰).

2.1.3 Proposed Solution

Based on the SESAR CONOPS, DODs and the relevant operational scenarios discuss three main processes/layers that can contribute to the management of arrival traffic congestion on the day of operations through queuing measures applied at different planning horizons and level of granularity:

- The AMAN process, which itself includes arrival traffic sequencing and metering services;
- The dynamic DCB process applied to flights in execution phase and working at network level in anticipation of an AMAN;
- The DCB process applied to flights in planning phase.

Figure 2 provides an illustration:

⁶ PRR 2007; page 96, Annex II – ATFM Delays, Airports table

⁷ PRR 2007; page 52, section 5.5, figure 67

⁸ SESAR 2.3.1; page 34, section 4.2.5.1, table 4

⁹ Review Note on ATFCM Performance Assessment, page 8, section 4.1.2, figure 4-2

¹⁰ Challenges of Growth; Summary Report; page 22, figure 10

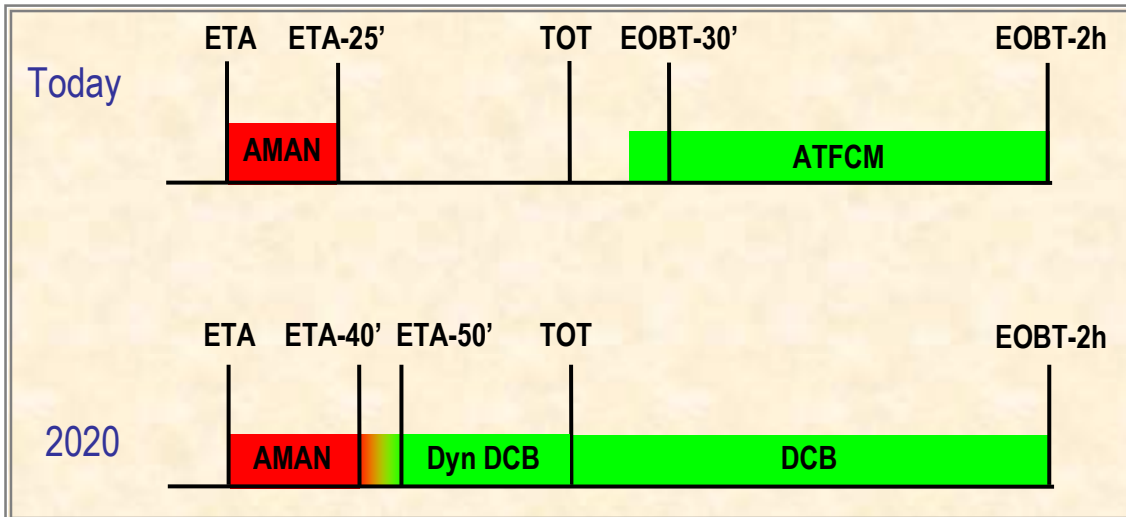


Figure 2: Evolution of arrival traffic regulation processes

The 'barrier' between planning and execution is not easy to delineate because many situations require a coordinated management of SBTs and RBTs. Therefore, to simplify matters, dynamic DCB and DCB processes are, in a first validation step, merged into a unique layer. This layer/process will be named interchangeably 'DCB' or 'dynamic DCB' in the rest of the document.

The dynamic DCB solution for arrivals involves an airport alerting the network of a capacity shortfall. The affected flights are then identified and each one is sent a TTA (target time of arrival) constraint which will indicate its delay. The airline operator then decides how to assign the delay; for example, a ground delay if the aircraft has not taken off, speed reduction or vectoring if they have already taken off or a combination of the two. The allocation of TTAs must also take into account the emission of CTAs (calculated time of arrival) by the AMAN. Figure 3 shows the interaction between the dynamic DCB queue and the AMAN queue.

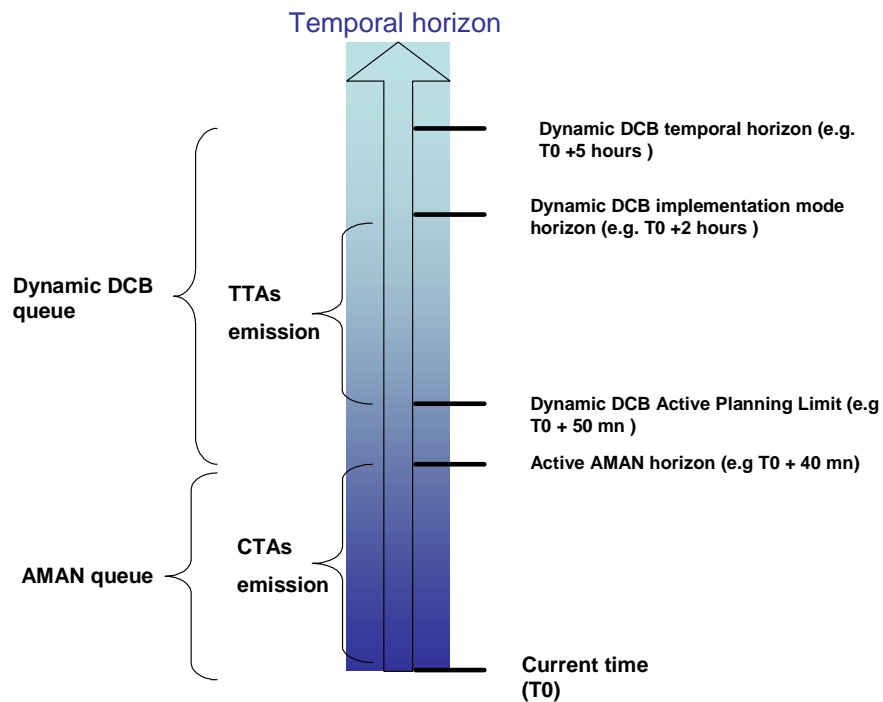


Figure 3: Temporal Horizon of TTAs and CTAs

It should be highlighted that:

- This decomposition between Dynamic DCB and AMAN must be viewed in terms of process, not necessary in terms of tools;
- **The parameter values in Figure 3 are given for example only.** It is one of the objectives of the exercise to determine what the appropriate values might be.

There are major differences between TTAs issued by the dynamic DCB process and the CTAs issued by the AMAN process:

- The granularity/accuracy of the constraints is of a different nature. TTAs are much less restrictive and accurate than CTAs. An order of magnitude related to the degree of freedom around the constraint is [-3mn, +3mn] for TTAs and [-30s,+30s] for CTAs;
- Business trajectory adaptation in response to a TTA is of planning nature and must not interfere with tactical separation management processes for flights in the execution phase.

DCB solutions combined with business trajectory management are intended to enhance current operations. Currently, ATFCM provides ground regulations and gives implicitly the 'how' to resolve capacity problems. Dynamic DCB solutions extend the scope of action into the execution phase and provide constraints that the involved parties must meet; it is the aircraft operators that will decide 'how' to meet them. The process of implementing the dynamic DCB solutions will increase co-operation between local and regional levels.

Dynamic DCB solutions fall between SESAR-compliant BT management and Airport Planning Processes.

There is potentially a performance conflict with a trade-off between individual ACC targets and network targets. There is also a question of how to ensure participation and buy-in from ACCs as these measures will constrain their options and will require effort to put in place.



The key concept elements addressed in this exercise are business trajectory management and dynamic DCB. More precisely, the exercise addresses the collaborative processes to adjust the demand to the available capacity in the short-term planning and execution phases.

Due to technical planning constraints, full UDPP process definition is out of the scope of this exercise. Therefore, the exercise will mainly focus on the management of sufficiently significant demand / capacity imbalances that require the re-planning of business trajectories by airspace users, but are below the level of severity that would trigger the UDPP process. However, as the study of UDPP triggering conditions is included in the scope of the exercise, validation scenarios will include the simulation of progressively higher levels of congestion severity. This could give an idea of the conditions under which the UDPP process might be triggered.

2.1.4 Proposed Solution Risks

The following risks are associated with the proposed solutions, they are that:

- The proposed solution does not produce the required, expected results in terms of handling capacity shortfalls;
- Partner/stakeholder buy-in is not achieved;
- AOCs try to play the system for their own benefit;
- There may be unexpected interactions with other parts of the SESAR CONOPS (complexity management, airport planning, separation management);
- There may not be enough equipped aircraft to make the solution viable or beneficial.

2.1.5 Alternative Solutions

Dynamic DCB solutions are expected to provide an efficient method for handling medium severity congestion problems. If however, there is a need for an alternative solution the following options could be considered:

- Increase the AMAN range and provide an AMAN-like tool to all airports via SWIM;
- Be more restrictive on capacity;
- Improve the current methods which are based on the ATFCM slot allocation process and pre-defined ATFCM scenarios.



2.1.6 Expected Benefits per KPA

The following table shows the KPAs that are expected to be affected by dynamic DCB solutions.

KPA	Expected benefits
Safety	Reduced stacking ¹¹ . Better management of saturation. Smoother traffic and more comfortable / consistent workload for controllers (less peaks).
Efficiency	Reduced stacking. Reduce unnecessary ground delays. More efficient recovery after capacity reduction. Advancing some traffic at the start of the sequence to reduce delays by a few minutes for tailing flights.
Environment	Reduced emissions per flight due to increased rate of CDA, linear holding and the use of ground delays (only when relevant).
Flexibility	The airspace user can decide how to manage the delays (via speed changes, route extensions, or by holding on the ground). System is more reactive, allowing faster resolutions including those in the current 'gap' (see Figure 1), i.e., airborne flights can be acted upon. Able to respond to sudden changes (less than two hours' notice).
Capacity	The dynamic DCB solutions can help smooth out peaks and troughs allowing the capacity to be used more consistently. The impact will be on declared and global use capacity figures, i.e. daily values (not hourly). Dynamic DCB will allow unpredictable events to be better managed due to the introduction of more flexible means to manage both ground and airborne delays. Capacity buffers can be reduced.
Access and Equity	Improved capacity will increase the access that is available to airspace users. Reduce the penalisation of short-haul flights for short notice problems as airborne flights can also absorb some of the delay.
Predictability	The dynamic DCB solutions will improve predictability of arrivals.

Table 4: The KPAs that are expected to be affected by dynamic DCB solutions

¹¹ For airports and en-route where stacking is not used regularly.



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The following table of OI steps will be addressed by the two WP3.3.2 exercises. The +/- values in the Impacted KPAs column indicate the size of expected impact on the KPA. The grey lines highlight the OI-steps related to UDPP; these will only be partially addressed in the exercises.

OI-Step	Description	IP	Impacted KPAs (expected) ¹²	How the OI step is addressed in the exercise
DCB-0208	Dynamic ATFCM/DCB	IP2	CAP +++ SAF + EFF +	This OI Step is partially addressed. The exercise scope is limited to the adaptation of business trajectories to the available capacity – mainly airport arrival capacity – through the management of time constraints (TTAs) in the business trajectories. In the gaming exercise, those TTAs can be applied either at the destination airport or on en-route points. TTAs can be issued either automatically by a DCB queuing system or manually by network managers. TTAs can be applied to both SBTs and RBTs within a predefined window, which ends 40/50 min before ETA to avoid interactions with ATC tactical
AUO-0102	User Driven Prioritisation Process (UDPP)	IP2	EFF +++	The UDPP process is not simulated. In the Gaming, actors can simulate a “dummy” activation/deactivation action of the UDPP process. Gaming actors’ actions will be recorded – without any impact on the simulation - providing some elements related to the level of severity requiring the triggering of the UDPP process and the associated roles and responsibilities.
AUO-0203	Shared Business / Mission Trajectory (SBT)	IP2	FLX + PRD + EFF +++ ENV +	AOC gaming actors will be provided with “rough” facilities for planning/ re-planning shared business trajectories taking into account any TTAs. Re-planning of SBTs will be limited to times modifications in the business trajectories (no 2D/3D management).
AUO-0204	Agreed Reference Business / Mission Trajectory (RBT) through Collaborative Flight Planning	IP2	CAP + FLX + PRD +++ EFF + ENV +	AOC gaming actors will be provided with “rough” facilities for planning/re-planning reference business trajectories taking into account any TTAs. Re-planning of RBTs will be limited to times modifications (no 2D/3D management).

¹² CAP – Capacity, SAF – Safety, FLX – Flexibility, PRD – Predictability, EFF – Efficiency, ENV – Environmental Sustainability, PRT – Participation. The assessment of the expected impact on the KPAs was performed by SESAR Task 2.2.4; see The European Air Traffic Management Master Plan Portal www.atmmasterplan.eu.



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DCB-0103	SWIM enabled NOP	IP2	PRT + PRD +++	In the simulations, the NOP will contain all business trajectories, network nodes capacities, DCB constraints (TTAs), network monitoring indicators (as available in current operations) and overload alerts. All the NOP information will evolve dynamically during the simulation and will be shared by all actors.
DCB-0305	Network Management Function in support of UDPP	IP2	FLX +++	The DCB queuing will provide the default delay allocation as an initial basis for discussions/negotiations between airspace users (as previously mentioned this part will not be simulated). In addition, the DCB queuing process will support individual requests from airspace users for sequence changes (slot swapping)

Table 5: OI steps being addressed by WP3.3.2.

Other validation initiatives focused on ATFCM include:

- DMEAN (Dynamic Management of the European Airspace Network) is looking to release hidden ATM system capacity as a means to meeting the demand for capacity in the short-term (IP1). It aims to deliver additional capacity, release latent ATM system capacity, improve flight efficiency and introduce a new concept for the operational planning and management of the European ATM network.¹³
- CAMES - Co-operative ATM Measures for a European Single Sky. The objectives of the project were to demonstrate the feasibility of implementing Traffic Synchronisation techniques that would foster inter-centre co-operation in Europe. This project is trying to develop operational procedures and tools, which will enable the air traffic control centres, the airports and the aircraft operators, to work together in a dynamic manner, in order to maximise the efficiency of the System from the gate of departure until the gate of arrival of the aircraft.

¹³ http://www.eurocontrol.int/dmean/public/subsite_homepage/homepage.html



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2.2 STAKEHOLDERS AND THEIR EXPECTATIONS

Table 6 shows the stakeholders that have a stake hold in the dynamic DCB process and/or this particular exercise.

Stakeholder	Dynamic DCB			Exercise	
	Involvement	Why Interested?	Expectations	Role Represented?	Involvement ¹⁴
Airports: – Arrival	Requesting dynamic DCB solutions for their airports.	Smoother arrival flows help airports better manage their capacity. Reduced use of stacks may reduce controller workload.	Increased use of capacity.	Yes	Game Player in the gaming part of the exercise.
– Departure	(No direct control over the dynamic DCB process).	Will be affected by DCB solutions (e.g., through delay absorption on the ground).	No decrease of departure rate.	No (gaming) Yes (process simulations)	-
Aircraft Operators	Choosing how to absorb their allocated delays. (e.g., ground/air, speed/vector).	To have more say in how they manage their allocated delays.	Improved flexibility. Potential cost savings.	Yes	Game Player in the gaming part of the exercise.
ANSPs (ATC)	Implementing the dynamic DCB solutions, especially for aircraft without datalink capability.	Solutions will impose constraints on ATC. Smoother traffic flows and reduced use of stacks could reduce controller workload.	No decrease of their capacity due to DCB constraint management.	No (gaming) Yes (process simulations)	-
Sub-Regional Network Managers	(this role currently does not exist)	Overseeing impact of the DCB solution on the sub-regional network.	No decrease of their capacity due to DCB constraint management. General improvements in managing the traffic (e.g., fewer sector overloads).	Yes	Game Player in the gaming part of the exercise.
Regional Network Manager	(this role currently does not exist)	Overseeing impact of the DCB solution on the regional network.	Increase of network performance.	Yes	Game Player in the gaming part of the exercise.
WP3, WP4 and WP5 of Episode 3	Involvement via the expert group	DCB will affect how delay and capacity are managed in the en-route phase and TMA phase of operations	The M2/3 & E4 DODs and operational scenarios will be refined.	No	-
WP 3.3.1 Episode 3 Network Expert Group	Attending meetings regularly to provide advice and guidance.	To ensure assumptions and results are consistent with those of other work packages.		No	-

¹⁴ The stakeholders will not be involved directly in the Process Simulation (it will be developed by the process simulation tool). However, stakeholders roles are emulated and their expectations and opinions are taken into account in the definition of the exercise.



Stakeholder	Dynamic DCB			Exercise	
	Involvement	Why Interested?	Expectations	Role Represented?	Involvement ¹⁴
SESAR JU and European Commission			Customer of the validation report. (Their expectations are: <ul style="list-style-type: none"> • provide an initial clarification of some element of the concept; • provide an illustration of the dynamic DCB concept; • set-up a validation framework (methodology, models platform) for DCB/BT process definition). 	No	-

Table 6: Stakeholder expectations for dynamic DCB and this exercise

2.3 VALIDATION SCENARIO

The exercises will explore dynamic DCB solutions within the context of the scenario described below.

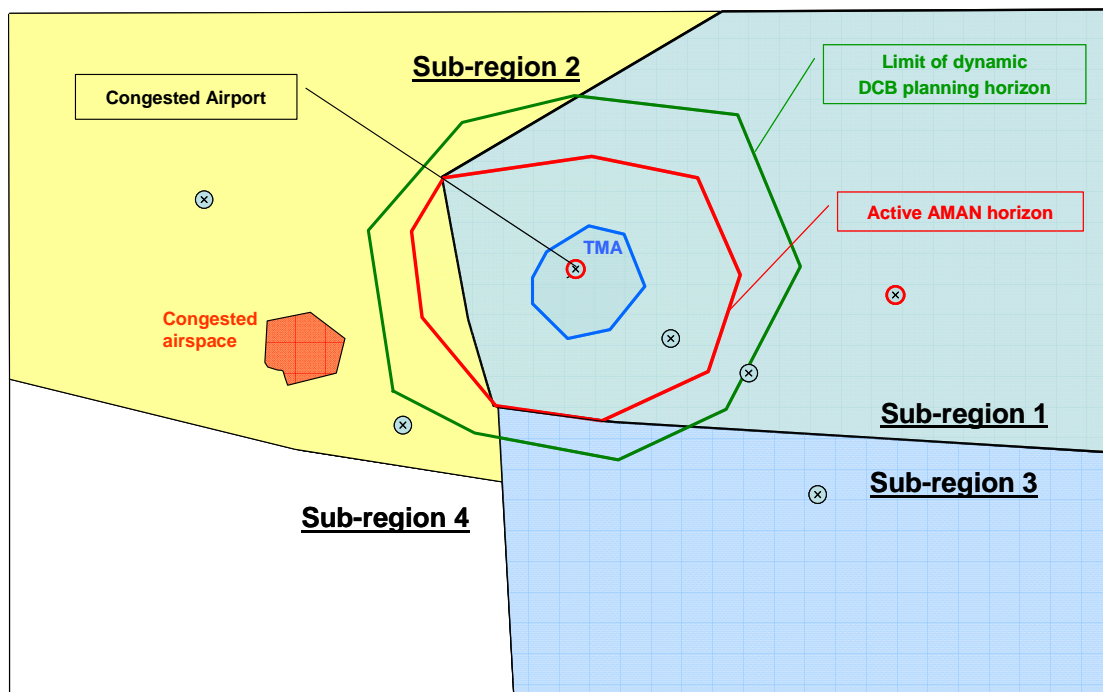


Figure 4: The different horizons around an airport

Taking into account the inputs from the expert group sessions, the three main situations to be simulated in both the gaming and the process simulations are:

1. **Sudden loss of capacity:** a non anticipated (and immediate) runway closure which impacts both AMAN and dynamic DCB – e.g. a 50% reduction in runway capacity.
2. **Short term loss of capacity:** a short notice prediction of LVP conditions that impacts only DCB – e.g. a 30% reduction in runway capacity placed at 08:00 for the period 09:30 to 11:00.



3. **Recovery from a loss of capacity:** a short notice modification of the LVP period – e.g. from a 30% capacity reduction to 100% available runway capacity where the original end time of 11:00 (TTA's issued) changes to 09:00.
 - Before end time update at 08h00: planned capacity was X (e.g., 70% capacity from 08h00 to 11h00).
 - At 08h00 planned capacity changes to X (e.g., 70% capacity) from 08h00 to 09h00 and then to X+Y (e.g., 100% capacity) after 09h00.

Situations 1 and 2 will be combined with situation 3 in the simulation runs to give an overview of the implementation and recovery of the entire dynamic DCB process.

2.3.1 Actor Roles

Actors involved in implementing dynamic DCB solutions include:

- Sub-Regional Network managers for the FABs handling the constrained airport's main arrival flows;
- A Regional Network Manager, with a view of the entire ECAC area;
- The APOC of the constrained airport;
- APOCs of the departure airports affected by the constraint (no human actor in the gaming);
- Several airlines (AOC and flight crew) who will be involved in implementing the dynamic DCB solutions;
- One generic ATC role (when TTA is allocated to airborne flights, simplistic negotiation with the flight crew to agree the way of achieving it).

More detailed descriptions of these roles are provided in Appendix B.

2.3.2 Process Description

The exercise will explore the process for implementing dynamic DCB solutions and how dynamic DCB will interact with the AMAN process; a high level description is given below and shown in Figure 5. A more detailed description of the proposed process can be found in Appendix C.

The APOC identifies the need to alter runway capacity (either a reduction or increase back up to the declared capacity), either immediately or in the very near future. They input the change into the NOP where the impact of the delays associated with the change is assessed in simulation mode. If the level of delay based on the Queuing Time on Arrival times (QTAs) is above the pre-defined threshold then implementation mode is triggered, either automatically or manually. Target Time of Arrival (TTA's) are then calculated and sent to the relevant AOCs. The AOCs then update the relevant BTs in the NOP where the impact of the changes can be assessed.

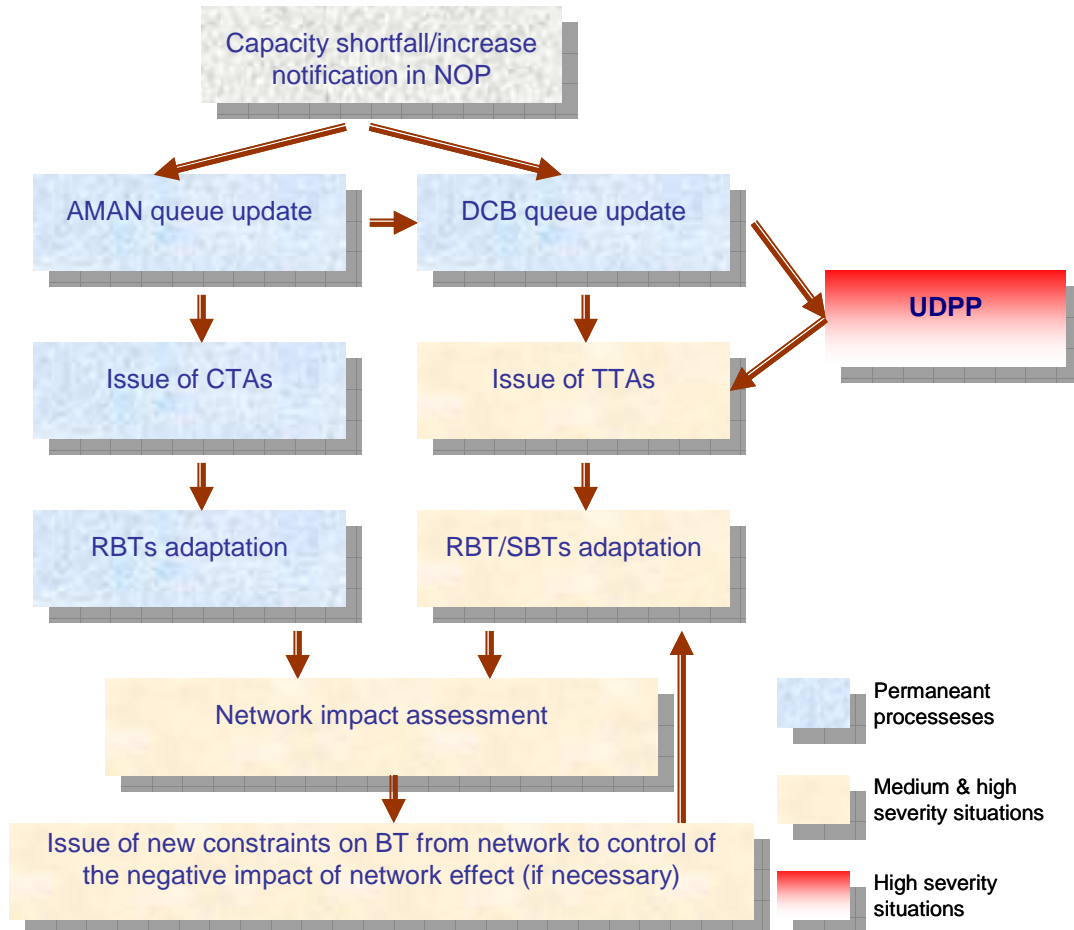


Figure 5: Overview of the dynamic DCB process

2.3.3 Baseline

As rigorous performance assessment is not an objective of the exercise, a baseline is not mandatory, although it is desirable. The baseline may be obtained by:

- Considering for the AMAN, a planning horizon of 25/30 minutes;
- The dynamic DCB queuing process handled as the current ATFCM slot allocation process (arrival airport regulation) and thus applied only to flights in planning phase;
- No business trajectory management in place and delays are fully managed on the ground.

2.3.4 Airport Information

Two arrival airports have been chosen, endorsed by the expert group: Fiumicino (Rome) and Barajas (Madrid). Two have been chosen because evidence suggests that the airports have different traffic profiles during the day (Fiumicino has a traffic profile with sharp peaks and troughs during the day, compared to Barajas, which has a plateau).

The departure runways will not be modelled; they will simply accept the on-ground delay decided by AOCs.



Neither Fiumicino nor Barajas currently have AMANs in place.

2.3.5 Airspace Information

Procedures

ATC procedures will not be simulated.

ATFCM/DCB/flight planning procedures will evolve according to the SESAR CONOPS.

Network Monitoring Function

Current traffic load indicators will be used to monitor the network (i.e. traffic counts and occupancy counts¹⁵). A limited set of new network monitoring functions are included, such as the provision of overload alerts according to occupancy counts indicators.

2.3.6 Traffic Information

75% of the traffic is equipped to ATM capability level 2 or above in 2020 and can implement the BT updates needed to meet their TTAs. Aircraft which are not equipped to apply dynamic DCB solutions autonomously (lower capability levels) will receive instructions from ATC to enable them to meet their TTAs.

- **Gaming side;** Adapted traffic samples based on current traffic will be used as there are no 2020 traffic samples available with all the CFMU message data information required by the platform. The samples should be chosen preferably from periods where the current planning methods (AMAN and ATFCM) did not adequately resolve the congestion. They will be adapted as necessary to support the validation objectives. Apart from technical considerations, two main reasons justify the use of current traffic:
 - The designed DCB process mainly depends on the magnitude of the capacity/demand imbalance to be treated (rather than on the absolute amount of traffic). Adequate overload levels can be simulated with current traffic by reducing the capacity of the chosen airports;
 - Due to the flexibility required by airspace users and the unavoidable uncertainties of airport operations, the accuracy/stability of the traffic picture in the short-term planning phase will not be significantly higher in 2020 than in current operations. Therefore using current traffic records to simulate the uncertainty/instability of the traffic picture in SESAR 2020 context is acceptable.
- **PROMAS side;** the 2020 traffic sample supplied by WP2 of Episode 3 will be used. It will be adapted as necessary to support the validation objectives.
 - Planned Arrival demand will be as maximum the arrival capacity of the airport (ACAP).

¹⁵ Occupancy counts are used in the context of current ATFCM operations. An occupancy count corresponds to the number of flights planned to be in a CFMU airspace traffic volume during a given time-step period.



2.3.7 Scenario Assumptions

The following assumptions are made about the scenarios:

- The airspace around the Fiumicino and Barajas airports will not include any prohibited/restricted/segregated areas. Furthermore, the sectorisation and route network are those currently implemented operationally;
- Most of anticipated / recurrent airport traffic demand /capacity imbalances will be handled in the long and medium term planning phases through the layered planning process. Nevertheless, in order to ensure an optimal utilisation of airport resources, a margin will be considered, leaving a significant proportion of medium/ low severity imbalances to be managed on the day of operations when the traffic/capacity picture is better known. Moreover, due to the reduction of troughs in the daily traffic demand at major airports; the negative impact of unanticipated capacity shortfalls will be significantly increased if not treated adequately by DCB in the short-term planning phase;
- There will no longer be a centralised ATFCM slot allocation process. The DCB regulation of arrival traffic in the short-term phase (and partly in the execution phase) can be viewed as a decentralised queuing process. The main difference with the AMAN process is that it works at a different level of granularity, accuracy and time horizon and implies different actors and CDM processes. This is not explicitly described in the CONOPS which provides a very high level description of the DCB process and the short-term planning phase leaving room for different interpretations;
- In situations that require the triggering of the UDPP process, the DCB queuing process will provide the default delay allocation as a basis for negotiation between airspace users and the default measure in case of no agreement. The CONOPS explicitly mentions this as part of the network management function;
- The implementation of the SESAR concept will not necessarily induce a stable NOP / traffic picture in the short term planning and execution phases. The concept mentions explicitly that airspace users can refine their business trajectory until shortly before off-block time taking into account updated information (meteorological forecast, ...), and that an RBT can be frequently updated during its flight life. Moreover, SESAR D2 [12] raises clear performance requirements related to the flexibility KPA;
- The required technical enabler of SWIM enabled NOP is in place;
- Airlines must have Business Trajectory management for most of their flights to see benefits from dynamic DCB solutions;
- FABs will be in place;
- In nominal conditions (UDPP not triggered), flights can only be exempted from meeting DCB solution constraints (refuse TTA) with good reason; emergency on-board, insufficient fuel to meet constraints or through a slot swapping request;
- Dynamic DCB solutions can only be applied to flights inside of ECAC;
- Departure airports can accommodate all requests for on-ground delays (i.e., there are no constraints on how many aircraft can be delayed on the ground and for how long).

2.4 LINKS TO OTHER VALIDATION EXERCISES

The following links to other work packages and validation exercises are identified:

- WP3.2.2: WP3.2 exercise should provide elements in support to the refinement of the DODs – M2/3 and E4 – and operational scenarios – OS11 mainly;



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- WP3.3.5 – Global performances at network-wide level: WP3.3.2 exercise contribution to concept clarification will feed the macromodel developed in WP3.3.5;
- WP4.3.3 and WP4.3.4 - gaming and prototyping on queue trajectory and separation management: these exercises and WP3.3.2 address some similar topics – such as the management of TTAs and 4D business trajectories – in a complementary way. WP3.3.2 addresses these issues from a network management point of view and considers only planning actors whereas the WP4 exercises focus on local ATC processes and actors;
- WP 3.3.1 – the Network Expert Group;
- WP3.3.4 – gaming exercise on Airport Planning: this exercise and WP3.3.2 will both consider UDPP within network DCB management. Within the gaming WP3.3.4 will focus on collaborative planning from an airport point of view considering both arrivals and departures. Within WP3.3.2 the gaming will take a wider network view of the impact of a capacity shortfall on arrival queuing. There may be some common topics of investigation, e.g. SBT management.

2.5 REPORTING

For the two exercises that are discussed in sections three and four, a single Simulation Report will be produced. This report will be delivered for EP3 Internal review on the end of July 2009 according to the template provided by EP3 WP2.

The detailed plan of the report is not yet finalised. The minimum content is the following:

- Aim of the document – the aim of the report is to summarise the performed exercise and to objectively present the key findings. It is not meant to state conclusions about whether or not a concept is worth pursuing.
- Target Audience – A distribution list of the target audience should be drawn up before work commences on the report. This list will typically involve the internal stakeholders and management in EP3 WP3/4/5. This report should always be made easily available to interested parties.
- Scope – The report concerns a particular phase in the development of the concept. The results of the work done during previous phases can be referred to in order to show progress and development. Recommendations for future work should also be outlined.
- Detailed results - The report will include in separate sections:
 - results and information collected from gaming sessions;
 - Results and information collected from process simulations.
- Key global results, conclusions and recommendations. Two main aspects will be considered and developed in dedicated sections:
 - An operational section will include main findings related to concept clarification and processes definition;
 - A validation section will provide feedback about the validation methodology; techniques and platforms used in the exercise and will draw recommendations for further SESAR validation activities.



3 GAMING EXERCISE

3.1 OBJECTIVES

3.1.1 High level objectives

The gaming exercise has the following objectives:

To Examine the Dynamic DCB Process

- Define the system functions that are needed to support the dynamic DCB process (queuing, network monitoring, users interactions...);
- Examine the interaction of the dynamic DCB process with other processes (such as AMAN);
- Define an initial dynamic DCB and BT management process that covers implementing, amending and cancelling dynamic DCB solutions;
- Gain a better understanding of how participants work with the dynamic DCB process, and in particular, how they interact;
- Identify the issues/priorities for the next validation exercise, and the future platform requirements for DARTIS to support this exercise.

As Demonstrator

- Provide a visualisation of the dynamic DCB process;
- Demonstrate that numerical data can be collected automatically by the DARTIS platform, and that these data can be processed to give useful metrics (this will be important for future studies).

Provide Outputs

- Provide information that will help to refine the operational scenario;
- Provide information that will help to define what the content of the NOP should be.

3.1.2 Detailed objectives

This paragraph gives the detailed gaming exercise objectives, which are specific points of interest in the gaming exercise. All of these objectives will not be fully explored during the gaming exercises due to time and platform limitations. However, the intention is to discuss as many of them as possible with the gaming actors.

Concept Clarification Objectives: Within the dynamic DCB process

The concept clarification objectives of the exercise are to:

- Examine what level of congestion DCB can address?
- Define the roles and responsibilities of the actors as well as identifying changes in working methods due to dynamic DCB solutions.
- Study the time window during which DCB solutions can be effectively implemented. What determines the earliest and latest times? How does this interact with knowledge of the traffic? How early is too early?
- Investigate how dynamic DCB solutions will mix short / medium and long hauls?



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- Investigate the effect of the Regional or Sub-Regional Network Manager setting new, or amending or cancelling current TTAs.
- Consider if dynamic DCB is the most appropriate method to be applied in the following 'capacity change' situations?

Peaks and troughs: Will there be a geographical aspect to dynamic DCB solutions? Can they be applied to handle seasonal peaks at large and medium airports?

Sudden Shortfalls: DCB solutions to cope with low visibility conditions and unexpected runway closures.

Daily fluctuations: Operational drift due to unexpected events.

Concept Clarification Objectives: Interactions with other processes

The objectives listed above relate to assessing the dynamic DCB process itself, the following set relate to assessing the interactions of dynamic DCB solutions with other processes, e.g. AMAN.

Consider the scope and boundary of dynamic DCB in relation to:

AMAN: What will be the interface/synchronisation measure between dynamic DCB and local AMAN processes?

How do dynamic DCB solutions and the AMAN horizon interact? Do different AMAN horizon settings affect dynamic DCB differently?

Will the dynamic DCB process be different depending on whether or not there is an AMAN?

What will be the impact of Extended AMAN?

UDPP: Identify potential trigger conditions (and combinations) for UDPP? What level of severity of capacity imbalance would trigger the UDPP process?

En-route Processes: How would dynamic DCB solutions co-ordinate with other processes, e.g. complexity scenarios?

What interactions will there be at different levels e.g. what happens if an en-route complexity scenario and a dynamic DCB scenario both try to act on the same aircraft for different reasons and are asking for different actions?

Other Discussion Points

- What will be the scope of dynamic DCB solutions to see in which situations they will be most useful? i.e. Will the raft of operational improvements introduced in the SESAR concept mean that dynamic DCB is only needed in non-nominal/degraded situations? Can it be assumed that other methods/concept elements will be sufficient during nominal situations?
- How could the dynamic DCB process differ with and without an AMAN at the arrival airport?
- Where the DCB constraint should be placed. That is, at the runway, at the IAF or the AMAN horizon?



How the sequencing principles of 'first planned, first served' and 'mixed'¹⁶ will differ from the principle implemented in the platform - 'airborne flights have priority'.

3.2 HYPOTHESES

The hypotheses below will be explored in the gaming sessions.

- H1. The proposed DCB process is feasible as a realistic means to apply dynamic DCB solutions;
- H2. The platform provides the necessary information for dynamic DCB solutions to be implemented;
- H3. There is more operational benefit in having a dynamic DCB process than not having it.

3.3 METHOD

3.3.1 Overview of Method

The objectives of the gaming exercise will be achieved through a collection of techniques known as gaming¹⁷. A software platform called DARTIS will be used as the means for people (game players) to deploy dynamic DCB measures against simulated traffic samples. Several games will be played, with each game consisting of a different scenario and/or a different configuration of the dynamic DCB process. The gaming exercise will collect qualitative and quantitative information from the games, which will be scrutinised by analysts and operational experts.

3.3.2 Setting Up and Playing the Games

A pre-requisite for the gaming exercise is a working and tested DARTIS platform. The delivery of DARTIS v5.2 is planned for January 2009. There will be a review of the capabilities of the delivered platform, and the requirements for DARTIS v5.3 will be passed on to the DARTIS developers. The platform that will be used for the exercise will be DARTIS v5.3, which is expected to be delivered (having been fully tested) in early May 09.

The gaming material will be completed once the specification for DARTIS v5.3 has been passed on to the developers. In addition, there will be some gaming dry runs to ensure that DARTIS, the scenarios, the traffic samples and gaming material are fit for purpose. These activities are planned for January to April 2009, inclusive.

The gaming exercise will require experts to play the roles in the games. Participation from airlines is highly desirable. The gaming exercise is planned to last for four days, with the first day set aside for training. The following three days will be for the games. Details of the

¹⁶ 'mixed' refers to a strategy which is like 'first planned, first served' until airborne flights start having delays that exceed a defined limit, at that point airborne flights get priority.

¹⁷ Gaming describes a broad range of similar techniques that are able to explore real-life situations where two or more parties must *interact* (with at least some choice of action) in order to meet their objectives. Thus, the purpose of gaming is to *gain useful insight* into a past, current or a future possible real-life situation where the outcome depends on human interaction. Gaming is particularly adept at revealing hidden, implicit or otherwise unexpected behaviours of the participants arising from the antagonism/competition between participants' objectives. For more information on gaming, visit the SESAR-EP3 Information Navigator at <http://www.episode3.aero/project/navigator/sesar-navigator>.



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programme are given in 3.9.3. There will be some flexibility in this programme, if any is needed.

The gaming participants will receive training on the first morning, which will include:

- The purpose of the gaming exercise;
- Some background to SESAR;
- An explanation of the dynamic DCB concept;
- A description of gaming;
- An overview of DARTIS.

The first afternoon will be an opportunity for Game Players to familiarise themselves with the DARTIS platform and the dynamic DCB concept.

The next three days will be set aside to play the games. Games are expected to last for about one hour each. The Game Manager will decide when to stop each game, possibly letting the game continue if there is some merit in doing so.

Each game will require:

- **The DARTIS v5.3 platform (with a specific configuration);** importantly, each game will have its own specific configuration of DARTIS. The configuration will be used to explore different options of the dynamic DCB process;
- **A Game Manager;** ensures that the rules of the game are obeyed and that the game is managed in order to achieve the purpose of the game;
- **Game Observers;** faithfully record what happens during a game, which will be analysed afterwards;
- **Game Players;** will be chosen because of their expertise in the roles they will play;
- **A Game Scenario;** a scenario gives the context against which the players play the game. It also contains the events that may be played out, some of which may be kept secret from players until an appropriate point in the game;
- **A set of rules;** these are necessary to constrain the behaviour of players;
- **A traffic sample;** there will be one traffic sample for the gaming exercise. Two airports will be played: Fiumicino (Rome), and Barajas (Madrid). Two have been chosen so that the results might be more generally applicable than if only one had been chosen. The airports have different traffic profiles during the day. Fiumicino has a traffic profile with sharp peaks and troughs during the day, compared to Barajas, which has a plateau;
- **Game Scripts;** each game player will have his/her own unique script (which may differ from those of other Game Players); the script will contain details such as the opening position of the game, the specific configuration of DARTIS for the game, and the strategy that the Game Player must adopt (if applicable); the Game Manager and Game Observers will also have their own scripts but these will not have any hidden information.

For an overview of the games that will be played (describing the main settings of each game), see 3.9.2. Full game material won't be completely available until April 2009.

3.4 ASSUMPTIONS

The assumptions given here are those that specifically relate to the gaming exercise. Assumptions about the whole exercise (i.e., gaming and process simulations combined) or about the SESAR concept appear in section 2.



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- A1. DARTIS platform requirements have been specified in the DARTIS requirements/HMI specification [13]. It is assumed that only the user requirements marked as high priority will be available in May 2009 for the gaming exercise;
- A2. The DARTIS platform was used in the CAMES project to allow dynamic en-route flow co-ordination across several ACCs and the CFMU. The DARTIS functionalities need to be extended to support the dynamic DCB solutions related to arrival aircraft. This includes the provision of an AMAN sequencer to model the interaction between dynamic DCB and AMAN processes;
- A3. The DARTIS platform needs only basic modelling of dynamic DCB, AMAN and Aircraft Operators to give informative results (i.e., it does not need to be fully realistic).

3.5 ROLES AND RESPONSIBILITIES

Table 7 hereafter shows the roles required for the gaming exercise, the main responsibilities of the roles, and who will be performing them.

Role	Who?	Responsibilities
Management	EUROCONTROL	<ul style="list-style-type: none"> o Co-ordination with EP3 partners; o Ensure that DARTIS is fit for purpose for the gaming exercise; o Ensure that the validation exercise is coherent with the overall EP3 validation strategy and SESAR concept; o Write the report.
Platform preparation	EUROCONTROL	<ul style="list-style-type: none"> o Select and test traffic scenarios; o Prepare and test environment data from an operational point of view.
Analyst	EUROCONTROL	<ul style="list-style-type: none"> o Review the DARTIS platform to suggest improvements; o Write the material for the gaming exercise; o Analyse the game data; o Write report.
Game Manager	EUROCONTROL	<ul style="list-style-type: none"> o In charge of running the games.
Game Observer	EUROCONTROL INECO SICTA	<ul style="list-style-type: none"> o Watch the games, making notes (there will be no participation in the games themselves); o Assist the Game Manager during the running of the games (EUROCONTROL only).
Game Player	EUROCONTROL	<ul style="list-style-type: none"> o Play games as Regional Network Manager.
Game Player	ENAV	<ul style="list-style-type: none"> o Play games as Sub-Regional Network Manager
Game Player	DSNA	<ul style="list-style-type: none"> o Play games as Sub-Regional Network Manager.
Game Player	AENA	<ul style="list-style-type: none"> o Play games as Sub-Regional Network Manager.
Game Player	LVNL	<ul style="list-style-type: none"> o Play games as APOC.
Game Player	IBERIA	<ul style="list-style-type: none"> o Play games as AOC.
Internal Reviewers	INECO SICTA LVNL AENA	<ul style="list-style-type: none"> o Review final report.



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3.7 RISKS

The following risks to the success of the gaming exercise have been identified.

Risk 1:	Lack of platform functionality		
Description:	DARTIS is the platform that will be used in the gaming exercise. Without a useful DARTIS the exercise won't be able to take place.		
Impacted Area:	<input checked="" type="checkbox"/> Own Exercise	<input checked="" type="checkbox"/> Other Exercise	<input type="checkbox"/> WP
Level of Impact:	<input type="checkbox"/> Low	<input type="checkbox"/> Medium	<input checked="" type="checkbox"/> High
Possibility of occurrence:	<input checked="" type="checkbox"/> Low	<input type="checkbox"/> Medium	<input type="checkbox"/> High
Contingency Actions:	None.		
Mitigation Actions:	<p>A detailed review of DARTIS v5.2 functions in November 2008 should ensure that DARTIS v5.3 (platform that will be used for gaming), has sufficient functionality to ensure that the platform will be useful.</p> <p>In addition, DARTIS 5.3 will be developed with 'agile development', which should ensure that functions are implemented in order of priority for the gaming exercise.</p>		
Responsible Party:	EUROCONTROL		

Risk 2:	Platform not working correctly.		
Description:	DARTIS will require adequate testing and debugging to ensure that it will be sufficiently accurate and robust for the gaming.		
Impacted Area:	<input checked="" type="checkbox"/> Own Exercise	<input checked="" type="checkbox"/> Other Exercise	<input type="checkbox"/> WP
Level of Impact:	<input type="checkbox"/> Low	<input type="checkbox"/> Medium	<input checked="" type="checkbox"/> High
Possibility of occurrence:	<input checked="" type="checkbox"/> Low	<input type="checkbox"/> Medium	<input type="checkbox"/> High
Contingency Actions:	There may be scope to use DARTIS v5.2.		
Mitigation Actions:	DARTIS 5.3 will be developed using 'agile development'. Thus, a working platform (that has been tested) should always be available for use.		
Responsible Party:	EUROCONTROL		



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Risk 3:	Lack of gaming participants.		
Description:	To get the best out of gaming will require genuine experts to play the roles of (Sub) Regional Network Manager, APOC and the AOCs.		
Impacted Area:	<input checked="" type="checkbox"/> Own Exercise	<input checked="" type="checkbox"/> Other Exercise	<input type="checkbox"/> WP
Level of Impact:	<input type="checkbox"/> Low	<input type="checkbox"/> Medium	<input checked="" type="checkbox"/> High
Possibility of occurrence:	<input checked="" type="checkbox"/> Low	<input type="checkbox"/> Medium	<input type="checkbox"/> High
Contingency Actions:	Staff within the EUROCONTROL could play the gaming roles (although this would not be as good as having the appropriate experts).		
Mitigation Actions:	The mitigation is to recruit game players in 2008.		
Responsible Party:	EUROCONTROL		

Risk 4:	The exercise produces no useful data because of a lack of experience in running games.		
Description:	Gaming is a new technique to EUROCONTROL and so there is a risk that the game is badly organised.		
Impacted Area:	<input checked="" type="checkbox"/> Own Exercise	<input checked="" type="checkbox"/> Other Exercise	<input type="checkbox"/> WP
Level of Impact:	<input type="checkbox"/> Low	<input type="checkbox"/> Medium	<input checked="" type="checkbox"/> High
Possibility of occurrence:	<input type="checkbox"/> Low	<input checked="" type="checkbox"/> Medium	<input type="checkbox"/> High
Contingency Actions:	None. If the games are not working, it will probably be too late to use an alternative method.		
Mitigation Actions:	There will be some initial gaming sessions organised with the Game Players a few weeks before the actual gaming exercise starts. This should reveal weaknesses in the platform and the game management, and should give enough time for the problems to be addressed.		
Responsible party:	EUROCONTROL		

Table 10: Risks identified for the gaming exercises



3.8 ANALYSIS SPECIFICATION

3.8.1 Data Collection and Analysis Method

Each game will provide the analyst with qualitative and quantitative information. Qualitative data will be used as the primary means to explore the hypotheses, with quantitative data playing a secondary role. These different sorts of data are described separately below.

Qualitative Data

These data will be captured by:

- A debriefing session after each game, run by the Game Manager to get feedback from the Game Players;
- A short questionnaire after each game, filled in by the Game Players;
- Observation by the Game Observers and Game Manager.

Questions will relate to the game just played, as it is unlikely that a fair, direct comparison between games can be made during a debriefing session.

The qualitative data will be collated and summarised. The analyst will be particularly keen to identify how well games went (well in the sense that the traffic in the scenario were managed well; delay was kept to a low level), and to identify/summarise why this might have been so. With this approach, games that go well or badly have equal merit because insights can be gained from each.

Hypotheses H1, H2 and H3 will be addressed with the qualitative data. The importance of asking the right questions cannot be overstated if these hypotheses are to be properly explored. Careful consideration will be given to the design of the questionnaire and debriefing sessions.

No tests for statistical significance will be applied to the data.

Quantitative Data

Some quantitative data will be recorded by DARTIS in a game log file. One of the objectives for this exercise is to demonstrate that numerical data recorded by DARTIS can be processed to give useful metrics. The numerical data will not be used to test the hypotheses in this exercise with statistical rigour. However, it is very likely that the capture and analysis of such data will be important for subsequent exercises.

3.8.2 Data logging requirements

DARTIS will store game information in a log file. The data captured will be:

- The name of the Game Player who requests a refresh of the AMAN or dynamic DCB sequence, and the time of the request;
- A change to a BT in the NOP for flights with the status 'NOT DCB' will have the following recorded:
 - The time at which the change occurred;
 - The reason for the change;
 - All the details related to the CUPT and BTs, i.e.:
 - The 4D profile;
 - Off-block time;
 - In-block time (if applicable);



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- The BT type (either “shared” or “reference”);
- The DCB status (either not DCB or DCB or TTA);
- Zero, one TTA;
- Stack duration parameter (minutes);
- TTA management field (either AOC or ATM);
- BT update status (either IDLE or Request new TTA or Wait for AOC reply or No AOC reply);
- BT originator (AOC or ATM);
- “Linear holding not allowed” field.
- Successive dynamic DCB sequences, including:
 - The time at which the sequence was calculated;
 - For each flight in the sequence:
 - Flight ID;
 - ETA;
 - Time of arrival in BT;
 - QTA;
 - TTA (if any);
 - Status (airborne, non-airborne);
 - BT type (SBT, RBT).
- Successive AMAN sequences, including:
 - The time at which the sequence was calculated;
 - For each flight in the sequence:
 - Flight ID;
 - ETA;
 - Time of arrival in BT;
 - ATA;
 - CTA (if any);
 - Status (airborne, non-airborne);
 - BT type (SBT, RBT).
- Occupancy of traffic volumes;
- The changes that are made to airport capacities, and the time the change is made;
- The Game Player who clicks the UDPP button, and the time this is done. Also, the monitoring displays visible to that Game Player will be recorded;
- Finally, the following times will be recorded for the game: start time, stop time, the time a game was paused, the length of the simulation.



3.8.3 Metrics of interests

The numerical data recorded in the game log files will be processed to demonstrate that useful metrics can be produced: The list below gives the metrics which are likely to be tried and tested in this exercise.

1) **DCB Measures:**

- a. Total number of flights that are subject to at least one DCB measure;
- b. Proportion of total flights that are subject to at least one DCB measure;
- c. Total number of flights that are subject to 'n' DCB measures (n=1,2,3,...);
- d. Proportion of total flights that are subject to 'n' DCB measures (n=1,2,3,...);
- e. Time to receive a revised BT from an Aircraft Operator following the issue of a Dynamic DCB TTA;
- f. Time to receive a revised BT from an Aircraft Operator following the issue of a TTA (where the TTA is NOT due to a dynamic DCB measure);
- g. The number of TTAs received per flight for a particular DCB solution;
- h. For each revision of a dynamic DCB TTA, by how much is the TTA extended or shortened?

2) **Equity:**

- a. Equity of delay for short, medium and long haul flights (information on the number and proportion of flights affected);
- b. Equity of delay for short, medium and long haul flights (information on the size of delay).

3) **Delay:**

- a. Number of delayed flights and the proportion of the total resulting from dynamic DCB;
- b. Total number of delay minutes in the game;
- c. Mean delay per flight, per airline.

4) **Fuel Burn:**

- a. Total number of delay minutes absorbed on the ground;
- b. Total number of delay minutes absorbed, in a stack;
- c. Total number of delay minutes absorbed in the en-route phase.

5) **Impact on traffic load:**

- a. Traffic volume load over time (for monitored traffic volumes only).

Performance assessment is **out of the scope** of the exercise. Therefore, those metrics can't be assimilated to performance metrics and do not have to comply with the metrics defined in the performance framework document produced by WP2 [14].

3.8.4 Representativeness

As the exercise is dealing with network operations, its nature is to address processes and procedures at the scale of the ECAC area. Though the validation scenarios will focus on the congestion at two specific airports - Fiumicino and Barajas - the network management



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function simulated will cover a significant part of the ECAC area including at least Spain, Portugal, France and Italy and possibly the FAB Central.

Moreover, it is planned to get some feedback related the representativeness of the designed processes in the context of the network expert group.

No extrapolation of the quantitative data to an ECAC-wide context is planned.

3.9 DETAILED GAMING EXERCISE DESIGN

3.9.1 Dependent and independent variables

Two main independent variables have been chosen for the gaming exercises:

- The AMAN active horizon delineating the frontier with the DCB process;
- The DCB implementation mode: two options are possible;
 - Automatic: DCB solutions (i.e issuing TTAs) are triggered automatically based on a delay threshold agreed by the actors in the long/medium term planning phase;
 - Manual: in that case, the issuing of TTAs is triggered by human actors following (possibly) a CDM process.

As shown in Table 11 under the DARTIS Configuration title two other independent variables will also be varied across the games. While still interesting these variables are less important in terms of the exercise objectives. They are:

- DCB queue active limit: indicates whether there is a 10 minute window before the AMAN active horizon during which time TTAs cannot be given;
- Airborne flights can receive a TTA; only applies to games 9 and 10 which aim to reflect the current situation.

The dependent variable that will be observed during the gaming is 'arrival delay', as measured by the DARTIS platform and experienced by the game players.

3.9.2 Length and number of runs

Table 11 provides the list of planned games. The duration of each game will be approximately 1 hour.

	Game Configuration									
	Game 1	Game 2	Game 3	Game 4	Game 5	Game 6	Game 7	Game 8	Game 9	Game 10
Airport	LIRF	LEMD	LIRF	LEMD	LIRF	LEMD	LIRF	LEMD	LIRF	LEMD
Scenario (for all games, the original capacity will be reinstated later in the game)	immediate loss of capacity	deferred loss of capacity	immediate	deferred	immediate	deferred	immediate	deferred	immediate	deferred
DARTIS Configuration:										
Aman active horizon (minutes)	40	40	>40	>40	40	40	>40	40	n/a	n/a
DCB queue active limit (minutes)	10	10	10	0	10	0	0	0	n/a	n/a
DCB implementation mode activation	manual	manual	manual	manual	auto.	manual	auto.	auto.	manual	manual
Airborne flights can receive a TTA?	yes	yes	yes	yes	yes	yes	yes	yes	no	no
-	(All other DARTIS options and parameters are the same across the games)									

LIRF = Fiumicino (Rome)
LEMD = Barajas (Madrid)

Table 11: Planned Games



3.9.3 Time planning for the exercise

The table shows the schedule for the four days of gaming. Areas of blue indicate a lunch break or coffee break. Questionnaires will be completed at the start of the debriefing sessions.

Time	DAY 1	DAY 2	DAY 3	DAY 4
0900-0915	Arrival & coffee	Review of yesterday	Briefing	Briefing
0915-0930			Game 4	Game 8
0930-0945		Briefing		
0945-1000		Game 1		
1000-1015	Introduction & presentations			
1015-1030			Debriefing	Debriefing
1030-1045				
1045-1100		Debriefing	Break	Break
1100-1115			Briefing	Briefing
1115-1130		Break	Game 5	Game 9
1130-1145		Briefing		
1145-1200		Game 2		
1200-1215				
1215-1230			Debriefing	Debriefing
1230-1245				
1245-1300	Lunch	Debriefing	Lunch	Lunch
1300-1315				
1315-1330		Lunch		
1330-1345				
1345-1400	Training		Briefing	Briefing
1400-1415			Game 6	Game 10
1415-1430				
1430-1445		Game 3		
1445-1500				
1500-1515			Debriefing	Debriefing
1515-1530				
1530-1545		Debriefing		(end of day)
1545-1600			Briefing	
1600-1615		(end of day)	Game 7	
1615-1630	(end of day)			
1630-1645				
1645-1700				
1700-1715			Debriefing	
1715-1730				
1730-1745			(end of day)	

Table 12: Proposed Gaming Programme



4 THE PROCESS SIMULATION EXERCISE

The Process Simulation exercise will address in detail the operational scenario OS-11 Non-severe capacity shortfall impacting arrivals in the short term [7].

4.1 OBJECTIVES

The Process Simulation exercise has the following objectives:

Clarification of the concept:

- Define the system functions that are needed to support the DCB process and BT management (queuing, network monitoring, interactions between APOC and users...);
- Define the interaction of DCB process (queue) with some Execution phase processes (AMAN);
- Gain a better understanding of how actors work within the dynamic DCB process and BT management, and in particular, how actors interact;
- Measure the number of information exchanges between the different involved actors and the number of triggered processes to detect the main processes and actors that could be supposed to be likely bottlenecks;
- Provide some elements about which information should be exchanged, and when, to assure a successful synchronisation between AMAN and DCB Queue processes.

Assessment of process feasibility:

- Define an initial dynamic DCB and BT management process that covers implementing, amending and cancelling dynamic DCB solutions (queue);
- By designing three different TTA allocation algorithms:
 - To assess both the effectiveness and the delay impact on the different type of flights;
 - To launch specific issues to refine these strategies regarding the airborne priority subject;
 - To support the functional development and refinement of the best TTA allocation Strategy.
- Support the functional development of some of the functionalities that should be included in the future Network Management Function;
- Provide an assessment of the impact on BT management related to the different TTA Allocation Strategies being addressed;
- Analyse the relationship between the severity of the shortfall capacity and the delay to be managed by DCB queue measures;
- Study the timeframe when DCB queue measures can be implemented in an effective way (i.e. sudden shortfalls, anticipated shortfalls, short duration, long duration, etc.);
- Identify the incoherencies and bottlenecks of the processes described in the OS-11;
- Suggest some modifications that could be used for both refining the concept and updating OS-11.



Exploration of new techniques:

- Demonstrate that both planning processes and SBT/RBT data can be linked by PROMAS to be used in future studies.

4.2 HYPOTHESES

The list below contains the main hypothesis identified for this exercise:

- H1. The Dynamic DCB and BT Management part of the ATM Process model establishes without incoherencies or loops-without-end who is responsible for carrying out any process, which information is required for it, what information is output and to whom, and the duration of the process.
- H2. Dynamic DCB and BT management processes will improve the management of the current DCB problems, by means of implementing some planning/execution solutions. Specially, although not only, those processes triggered once a flight has taken-off until it reaches the AMAN active horizon.
- H3. Dynamic DCB and BT management processes will allow airspace users to decide how they want to adapt their SBT/RBT to meet a constraint.
- H4. AMAN and DCB Queue processes will be coordinated and synchronised by means of a clear procedure.
- H5. Non-severe capacity shortfalls can be solved without UDPP. Severity can be defined as the maximum admissible delay per flight (e.g. 15 minutes of ground delay).

4.3 METHOD

4.3.1 Overview of Method

The objectives of the Process Simulation exercise will be achieved through process simulations. Process simulations are particularly useful at revealing hidden incoherencies arising from the relations between each actor involved and their responsibilities. A software platform called PROMAS will be used to assess dynamic DCB measures and BT management against simulated traffic samples. Several simulations will be performed, based in the OS-11 “Non-severe capacity shortfall impacting arrivals in the short term”, with each simulation consisting of a different scenario and/or a different strategy of the dynamic DCB process. PROMAS will offer qualitative and quantitative information, which will be scrutinised by analysts and operational experts.

Because there are two complementary parts to the overall exercise (i.e., gaming and process simulations) it is worthwhile to highlight the benefits specific to process simulations:

- A higher number of actors can be included in the analysis. Regarding this exercise:
 - The different AOCs of those flights whose SBT is affected by the DCB Arrival Queue;
 - The flight crew of those flights whose RBT is affected by the DCB Arrival Queue;
 - The different APOCs of those airports, from where some flights are going to depart and whose SBT is affected by the DCB Arrival Queue.
- A 24-hour traffic sample can be easily used;
- Different strategies and role behaviours can be emulated and analysed;



- By modifying and combining the implemented input variables, many simulations can be easily performed;
- Because the simulation model is absolutely automated, the objectivity of the result is guaranteed;
- Management processes, flight events, algorithms and functions live together allowing PROMAS to analyse in an automated way how some operational values impact on the ATM Process Model and vice versus.

4.3.2 Setting Up and Executing the Process Simulations

The delivery of an initial PROMAS version is planned for April 2009. There will be a refinement of the capabilities of the delivered platform as the exercise is carried out. The refined PROMAS version is expected to be delivered in July 09.

The Process Simulation exercise will not require experts to play the roles in the simulation.

Each Process Simulation will require:

- **The PROMAS platform (with a specific configuration);** importantly, each simulation will have its own specific configuration. The configuration will be used to test different options of the dynamic DCB process and BT management;
- **A PROMAS Scenario;** a scenario is composed by the set of rules, actors and the traffic sample, as well as the set of parameters that defines the strategy to be assessed;
- **A set of rules;** these are necessary to constrain the behaviour of actors;
- **A traffic sample;** there will be one 2020 traffic sample. Taking into account that process analysis, concept refinement and assessment of innovative techniques are the main objectives of this exercise, the selection of the fictive constrained airport is not relevant. However, in order to model a realistic case to test the platform Madrid-Barajas airport has been chosen due to its European significance and the availability of information;
- **Actors;** each actor will have his/her own unique behaviour strategy that they must adopt (if applicable).

4.4 ASSUMPTIONS

The assumptions given here and supported by the expert groups are those that specifically relate to the Process Simulation exercise. Common assumptions are given in section 2.

- A-01. The acceptable limit of ground delay is 15 minutes.
- A-02. For a flight already in air, it should be better not to increase the remaining flight time by more than the 10% neither decrease the remaining flight time by more than the 3%.
- A-03. During one PROMAS simulation, there will be only one capacity shortfall and one capacity recovery.
- A-04. The AMAN system will take over flights in execution 40 min prior to arrival in terminal airspace, provided that the RBT has been published (case of very close departure aerodromes). This parameter is called the "AMAN Advisory Active Horizon".
- A-05. Flights can be submitted to a DCB Queue Management Process at the latest 50 min before their ETA/TTA. This parameter is known as the "DCB queue active limit".



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A-06. Flights between the AMAN Advisory Active Horizon and the DCB Queue active limit will not be assigned a TTA since they will receive a CTA in a few minutes.

A-07. The DCB Queue Management process only provides a TTA if the flight has reached a time horizon of 2 h (TBV) before ETA.

4.5 ROLES AND RESPONSIBILITIES

The following are the roles and responsibilities that will be automated by means of PROMAS tool (reference OS-11):

- The APOC Staff as the requestor of a relevant DCB Solution;
- Approach Control, which manages arrivals at the constrained airport;
- The Sub-Regional Network Manager as the provider of a DCB Solution. The Sub-Regional Network Manager triggers the DCB solution negotiation if it is known to have impact on the network stability either at sub-regional or regional levels. However this is not the case in the scenario text as the DCB solution is predefined.
- The Regional Network Manager arbitrates its application in case of concerned actors' disagreement, and will get involved if there is likely to be a knock-on effect in other sub-regions. However this is not the case in the scenario text as the DCB solution is predefined.
- The Flight Crews and AOC Staff, who are subject to the DCB Solution and adjust their trajectories to meet the new constraints;
- The APOC Staff at departing airports who coordinate with the Airspace Users before their SBTs are adjusted;
- Controllers, who coordinate with the Airspace Users before their RBTs are adjusted.

INECO's effort will be focused, mainly in the Process simulation itself, developing the following specific tasks:

- To develop the PROMAS platform;
- To implement in PROMAS the relevant part of the ATM process model (i.e. DCB and BT);
- To implement in PROMAS the TTA allocation function;
- To run the PROMAS model;
- To post-process and analyse the outputs;
- To consolidate in the Final Report Deliverable.

SICTA will be in charge of the following tasks:

- To pre-process the 2020 traffic (PROMAS model requires for each flight arriving to Madrid (LEMD) the following information: Callsign, origin APT, departure time, arrival time, total flight time, cruise flight time, non-cruise flight time, used IAF name, IAF time, Cruise time, EndOfCruise time, aircraft type, aircraft capability);
- To research the ECAC TMAs that may have the same characteristics in comparison with those studied (i.e. Rome and Madrid);
- To extract some others refined indicators through modelling techniques.



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4.7 RISKS

The following risks to the success of the Process Simulation exercise have been identified.

Risk 1:	Lack of platform functionality		
Description:	PROMAS is the platform that will be used in the process simulations. Without a useful PROMAS the exercise won't be able to take place.		
Impacted Area:	<input checked="" type="checkbox"/> Own Exercise	<input checked="" type="checkbox"/> Other Exercise	<input type="checkbox"/> WP
Level of Impact:	<input type="checkbox"/> Low	<input type="checkbox"/> Medium	<input checked="" type="checkbox"/> High
Possibility of occurrence:	<input checked="" type="checkbox"/> Low	<input type="checkbox"/> Medium	<input type="checkbox"/> High
Contingency Actions:	Combined FTS and ad hoc modules may meet at least some of the objectives.		
Mitigation Actions:	A detailed review of PROMAS functions in January 2009 should ensure that the platform will be useful.		
Responsible Party:	INECO		

Risk 2:	The exercise produces no useful data because of a lack of relevant information for each process.		
Description:	In any study, to obtain interesting and non-obvious results depends strongly on the quality and detail of the inputs.		
Impacted Area:	<input checked="" type="checkbox"/> Own Exercise	<input type="checkbox"/> Other Exercise	<input type="checkbox"/> WP
Level of Impact:	<input checked="" type="checkbox"/> Low	<input type="checkbox"/> Medium	<input type="checkbox"/> High
Possibility of occurrence:	<input type="checkbox"/> Low	<input checked="" type="checkbox"/> Medium	<input type="checkbox"/> High
Contingency Actions:	Using internal expertise and the sensitiveness analysis technique, some useful and relevant results could be shown.		
Mitigation Actions:	Send a series of values for specific parameters to Experts to be validated.		
Responsible party:	INECO		

Risk 3:	The exercise takes more time than expected.		
Description:	PROMAS is a new platform based on a new technique so there is a risk that the exercise takes more time than expected.		
Impacted Area:	<input checked="" type="checkbox"/> Own Exercise	<input type="checkbox"/> Other Exercise	<input type="checkbox"/> WP
Level of Impact:	<input type="checkbox"/> Low	<input type="checkbox"/> Medium	<input checked="" type="checkbox"/> High
Possibility of occurrence:	<input type="checkbox"/> Low	<input checked="" type="checkbox"/> Medium	<input type="checkbox"/> High

Contingency Actions:	To perform only the Madrid scenario. Taking into account that this exercise tries to analyse the ATM process model, it is clearly unnecessary to perform a different scenario.
Mitigation Actions:	To perform the whole Madrid scenario and once it is finished, to start with Rome scenario.
Responsible party:	INECO

Risk 4:	The PROMAS input data supplied by SICTA arrive late.		
Description:	PROMAS requires a specific input data that have to be supplied by SICTA. If this input arrives late, the Process Simulation will suffer an equivalent delay.		
Impacted Area:	<input checked="" type="checkbox"/> Own Exercise	<input type="checkbox"/> Other Exercise	<input type="checkbox"/> WP
Level of Impact:	<input type="checkbox"/> Low	<input type="checkbox"/> Medium	<input checked="" type="checkbox"/> High
Possibility of occurrence:	<input type="checkbox"/> Low	<input checked="" type="checkbox"/> Medium	<input type="checkbox"/> High
Contingency Actions:	INECO should create this input data ASAP using its own effort. To perform only the Madrid scenario. Taking into account that this exercise tries to analyse the ATM process model, it is clearly unnecessary to perform a different scenario.		
Mitigation Actions:	To plan SICTA's task just after the Experimental Plan is approved. To check 2 weeks before deadline to assure that everything seems OK.		
Responsible party:	INECO		

Table 15: Risks identified for the process simulations

4.8 ANALYSIS SPECIFICATION FOR PROCESS SIMULATION

4.8.1 Data Collection and Analysis Method

Each Process simulation will provide the analyst with qualitative and quantitative information, that will be used to test the feasibility and coherency of the processes addressed and described in the OS-11. These different sorts of data are described separately below.

Qualitative Data

After each simulation, PROMAS will capture data in the following areas to help meet the hypotheses listed in section 4.2:

- Processes triggered or resumed; which ones?
- Processes interrupted or blocked: which ones and why?

The qualitative data will be collated and summarised. The analyst will analyse these data in order to meet the objectives listed in section 4.1.

Qualitative data will be faced by a group of experts (users and network experts) to the hypotheses established, and will verify/falsify them. Moreover, three strategies will be triggered to choose the most suitable, selected by the experts and according to the data result, so as to improve the management of the current DCB problems. So that, by means of



comparing the current and the future situation the improvements and verifications will be shown.

Quantitative Data

Some quantitative data will be logged by PROMAS in an Events file. One of the objectives for this exercise is to demonstrate that numerical data offered by PROMAS can be processed to give useful metrics. The numerical data will be used to compare different scenarios (i.e., different strategies, active horizons, severities, prediction times, local characteristics).

The responsible for verifying/falsifying the quantitative data obtained on the basis of the hypotheses will be a group of experts. Several quantitative data will be provided by the three strategies so as to the experts will be able to verify/falsify the hypotheses. Furthermore, an internal INECO expert group will also validate the data.

4.8.2 Data logging requirements

PROMAS will store information in a log file. The data captured will be:

- The name of the Actor who requests a refresh of the AMAN or dynamic DCB sequence, and the time of the request;
- For every flight involved in the DCB queue process:
 - The time at which the sequence was calculated;
 - For each flight in the sequence:
 - Flight ID;
 - ETA;
 - TTA (if any);
 - Status (airborne, non-airborne);
 - BT type (SBT, RBT);
 - If non-airborne:
 - TOBT proposed by AOCs to satisfy TTA;
 - The time at which AOC negotiates TOBT with APOC;
 - The time at which APOC agrees with the proposed TOBT;
 - how much delay is absorbed and where (air or ground).
 - If airborne:
 - Manoeuvre proposed by Flight Crew to satisfy TTA;
 - The time at which flight crew negotiates manoeuvre with ATC;
 - The time at which ATC agrees with the proposed manoeuvre.
- For every flight involved in the AMAN process:
 - The time at which the sequence was calculated;
 - For each flight in the sequence:
 - Flight ID;
 - ETA;
 - CTA (if any).
- The changes that are made to airport capacities, and the time the change is made.



4.8.3 Metrics of interests

The numerical data recorded in the PROMAS log files will be processed to demonstrate that useful metrics can be produced. The list below gives the metrics which are likely to be tried and tested in this exercise.

The following are the main specific outputs:

Process view

- Functional Process Model for every TTA Allocation Strategy;
- Number of negotiations/data exchanges performed during the Implementation of a DCB queue;
- Information exchanged between AMAN and DCB queue functions.

Operational view

- Number of flights that are able to meet a proposed TTA to recover the capacity after a shortfall;
- Delay Distribution generated (CAP.LOCAL.APT.PI 10: Arrival Airspace Delay):
 - Delay to be managed by AMAN;
 - Delay to be managed by DCB queue process;
 - Delay induced by AMAN on the DCB queue process;
 - Affecting SBTs;
 - Affecting RBTs.
- Percentage of flights that have suffered changes to meet the constraint with respect to the original arrival order; (FLX.ECAC.ER.PI 3);
- TTA Allocation list.

Performance assessment is not the main objective of the exercise. Therefore, some metrics can't be assimilated to performance metrics and do not have to comply with the metrics defined in the performance framework document produced by WP2 [14].

4.8.4 Representativeness

As the exercise is dealing with network operations, its nature is to address processes and procedures at the scale of the ECAC area. Though the validation scenarios will focus on the congestion at the specific airport - Barajas - the network management function simulated will be relevant, from the point of view of processes, for any other airport of the ECAC.

No extrapolation of the quantitative data to an ECAC-wide context is planned.

4.9 DETAILED DESIGN FOR PROCESS SIMUATION

4.9.1 Dependent and independent variables

The independent variables are:

- TTA Allocation Strategy:
 - FPFS (First Planned, First Served);



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- Flights-in-air have more priority than flights-on-ground;
- Flights-in-air: Absolute priority.
- Level of the severity of the shortfall capacity (during 3 hours):
 - 20%;
 - 10%.
- The time in advance when the shortfall is known:
 - Suddenly;
 - 1 hour in advance.

The dependent variable is the arrival delay.

4.9.2 Length and number of runs

12 different simulation scenarios will be executed. They are obtained by means of combining the independent variables.



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5 REFERENCES AND APPLICABLE DOCUMENTS

Ref.	Document	Status
Reference Documents		
[1]	SESAR D3: The ATM Target Concept, DLM-0612-001-02-00, September 2007	Public
[2]	European Operational Concept Validation Methodology E-OCVM, 2nd Edition, February 2007	Public
[3]	"Guidance Material for steps 2.1 to 2.8 of the E-OCVM", E3-WP2-D2.3-1.1-GUI, November 2008	Draft (V1.0 approved)
[4]	Episode 3. M2/3 DOD – Medium and Short Term Network Planning, E3-D2.2-023	Draft
[5]	Episode 3. WP3 Contribution to EP3 Validation Strategy, D3.2.1-01, V1.0, October 2008	Under acceptance
[6]	Episode 3. E4 DOD – Network Management in the Execution Phase, E3-D2.2-026	Draft
[7]	Episode 3. Operational Scenario – Non-severe capacity shortfall impacting arrivals in the short term, OS-11	Draft
[8]	Performance Review Report 2007, Final Report, 21 May 2008	Public
[9]	SESAR definition phase, Task 2.3.1: Compute and Map Operational Concepts & Airspace KPIs, DLT-0612-231-00-09, September 2007	Public
[10]	Review Note on ATFCM efficiency performance, EEC Note 2008/12, December 2008	Public
[11]	EUROCONTROL: Challenge of Growth 2008, Summary report, 2008	Public
[12]	SESAR D2 Air Transport Framework: The Performance Target, DLM-0607-001-02-00, November 2006	Public
[13]	DARTIS Requirements/HMI Document, NET_DARTIS_V5.2_URD, Version 1.96, Sept 2008	Draft
[14]	Episode 3. EP3 Performance Framework cycle 1, D2.0-03, V2.2, 21 April 2008	Public

Applicable documents		
[A]	EP3, Contract Annex 1, DoW, Revision 3.0, July 2008	Approved
[B]	EP3 Guidance Material for identification of Validation issues at WP and programme level: steps 0.1 to 1.7 of the E-OCVM, E3-WP2-D2.3-10-WKP, January 2008	Approved
[C]	EP3 Consolidated Validation Strategy, D2.0-01, Version 1.0, December 2008	Approved
[D]	SESAR D4 The ATM Deployment Sequence, DLM-0706-001-02-00, January 2008	Approved
[E]	SESAR D5 SESAR Master Plan, DLM-0710-001-02-00, April 2008	Approved
[F]	The SESAR Performance Booklet: Performance Objective and Targets, RPT-0708-001-01-01, November 2007	Approved
[G]	SESAR WP2.2.2/D3: Concept of Operations, DLT-0612-222-01-00, July 2007	Approved
[H]	SESAR WP2.2.3/D3 Definition phase, DLT-0707-008-01-00, July 2007 (9 Scenarios illustrating the SESAR CONOPS)	Approved

1 Appendix A Exercise Overview Table

2 The following table provides a summary and overview of the scope of the exercise.

Validation Scenario	Summary/Purpose	Hypothesis	Metrics/Indicators	SESAR OI	SESAR KPI	DOD References
Gaming Sudden arrival capacity shortfall (medium severity congestion)	To examine how SESAR collaborative processes (Dynamic DCB, AMAN, BT management, UDPP) can be combined in the short term planning and execution phases to manage such a medium severity congestion situation. To examine the roles and responsibilities of processes and actors.	H1: The proposed DCB process is feasible as a realistic means to apply dynamic DCB solutions; H2: The platform provides the necessary information for dynamic DCB solutions to be implemented; H3: There is more operational benefit in having a dynamic DCB process than not having it.	Because the work is only at stage 0.2 in the E-OCVM lifecycle ('Understanding the Proposed Solution'), no metrics from the Performance Framework document have been selected. Rather, metrics specifically tailored for this exercise have been devised.	DCB-0208 AUO-0102 AUO-0203 AUO-0204 DCB-0103	Safety: reduction of stacking. Better management of saturation. Efficiency: reduced stacking. Reduce unnecessary ground delays. More efficient recovery after capacity reduction. Advancing some traffic at the start of the sequence to reduce delays by a few minutes for tailing flights. Environment: reduced emissions per flight due to increased rate of CDA, linear holding and the use of ground delays (only when relevant). Flexibility: the airspace user can decide how to manage the delays (via speed changes, route extensions, or by holding on the ground). The system is more reactive, allowing faster resolutions including those in the current 'gap' i.e. airborne flights can be acted upon. Able to respond to sudden changes (less than two hours' notice). Capacity: Dynamic DCB will allow unpredictable events to be better managed. Capacity buffers can be reduced. Access and Equity: Reduce the penalisation of short-haul flights for short notice problems. Predictability: the dynamic DCB solutions will improve predictability of arrivals.	M2/3 DOD – Medium and Short Term Network Planning E4 DOD – Network Management in the Execution Phase OS-11: Non-severe (no UDPP) capacity shortfall impacting arrivals in the short term
Gaming Short notice (one hour) arrival capacity shortfall (medium severity congestion)	Same as above, except no examination of UDPP.					
Gaming Short notice arrival capacity shortfall (medium/high severity congestion)	UDPP triggering			DCB-0305		M2/3 DOD – Medium and Short Term Network Planning



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Validation Scenario	Summary/ Purpose	Hypothesis	Metrics/ Indicators	SESAR OI	SESAR KPI	DOD References
Process simulation FPFS- 10%-NOW	To asses different TTA allocation strategies under a sudden arrival capacity shortfall (10%) during 3 hours.	H1: the Dynamic DCB and BT Management part of the ATM Process model establishes without incoherencies or loops-without-end who is responsible for carrying out any process, which information is required for it, what information is output and to whom, and the duration of the process.	Airport resource utilization ratio between the maximum airport throughput and the airport capacity.	DCB-0208	CAP +++, SAF +, EFF + The challenge in terms of capacity in the airspace environment is to meet the traffic growth demand and to limit the en-route delay. The strategy aims at widening the current notion of Traffic Flow and Capacity Management from the mere allocation of slots to the optimisation of traffic patterns and capacity management with the emphasis on optimising the network capacity through collaborative decision-making processes.	OS-11: Non-severe (no UDPP) capacity shortfall impacting arrivals in the short term DOD M2/M3: Specifically chapter 4.4. ATM processes (from ATM process model) A2.1.1 A2.1.2.4 A2.3
Process simulation FPFS- 10%-1H	To assess different TTA allocation strategies under an arrival capacity shortfall (10%) during 3 hours that is known one hour in advance.	H2: dynamic DCB and BT management processes will improve the management of the current DCB problems, by means of implementing some planning/execution solutions. Specially, although not only, those processes triggered from a flight that has taken-off till the AMAN active horizon, because nowadays there are no relevant planning processes affecting trajectory in that flight phase. So there is more operational benefit in having a dynamic DCB process than not having it.	Arrival delays metrics: % of delayed flights; Delays distribution.			
Process simulation FPFS- 20%-NOW	To asses different TTA allocation strategies under a sudden arrival capacity shortfall (20%) during three hours.	H3: dynamic DCB and BT management processes will allow airspace users to decide how they want to adapt their SBT/RBT to meet a constraint.	Frequency of speed, heading and altitude clearances.			
Process simulation FPFS- 20%-1H	To assess different allocation strategies under an arrival capacity shortfall (20%) during three hours that is known one hour in advance.	H4: AMAN and DCB queue processes will be coordinated and synchronised by means of a clear procedure. H5: non-severe capacity shortfalls can be solved without UDPP. Severity can be defined as the maximum admissible delay per flight (e.g. 15 minutes of ground delay).				

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Table 16: Overview of exercise scope



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1 Appendix B Detailed DCB Roles and Tools

2 This Appendix provides more detail on the roles of each actor involved in dynamic DCB
3 solutions. It also provides an initial list of the support tools that each would require.

4 **Regional Network Manager (RNM)** - has an ECAC wide view working position.

5 RNM roles:

- 6 • Monitor traffic load indicators;
- 7 • Trigger / accept to trigger / abort dynamic DCB queuing (in simulation and
8 implementation mode);
- 9 • Mitigate any resulting negative network effects by:
 - 10 ○ Setting new TTAs;
 - 11 ○ Cancelling TTAs;
 - 12 ○ Setting limitations on specific flights.
- 13 • Negotiate business trajectories with AOCs, i.e. accept or refuse queue order
14 changes;
- 15 • Change the sequencing strategy;
- 16 • Set the UDPP threshold.

17

18 RNM tools:

- 19 • DCB queue visualisations;
- 20 • Visualisation of network traffic loads;
- 21 • Visualisation of business trajectories;
- 22 • Tools to support modifications of business trajectories.

23

24 **Sub-Regional Network Manager (SRNM)** - has a sub-regional/FAB view working position.

25 SRNM roles (the same as for the RNM but limited to their sub-region):

- 26 • Trigger / accept to trigger / abort dynamic DCB queuing (in simulation and
27 implementation mode);
- 28 • Mitigate any resulting negative network effects by:
 - 29 ○ Setting new TTAs;
 - 30 ○ Cancelling TTAs;
 - 31 ○ Setting limitations on specific flights.
- 32 • Negotiate business trajectories with AOCs, i.e. accept or refuse queue order
33 changes;
- 34 • Change the sequencing strategy;
- 35 • Set the UDPP threshold.

36



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1 SRNM tools:

- 2 • Visualisation of DCB queue;
- 3 • Visualisation of network traffic loads;
- 4 • Visualisation of business trajectories;
- 5 • Tools to support modifications of business trajectories.
- 6

7 **Airlines (AOC)** - has an airline view working position.

8 AOC roles:

- 9 • Re-plan business trajectories taking into account the TTA constraints. In the
- 10 exercise, the AOC can only constrain the off-block time and the departure time for
- 11 non-airborne flights. They propose a distribution of delay between parking, taxiing
- 12 and en-route;
- 13 • Manage only non-airborne flights (is this in all cases?);
- 14 • Request a slot swap or queue jump¹⁸;
- 15 • Cancel a flight.
- 16

17 AOC tools:

- 18 • Visualisation of network queue;
- 19 • Visualisation of network traffic loads;
- 20 • Visualisation of business trajectories;
- 21 • Tools to support modifications of business trajectories:
- 22 ○ Constraint on the off-block time;
- 23 ○ Constraint on the departure time.
- 24

25 **Airport Operations Centre (APOC)** - an airport view working position.

26 APOC roles:

- 27 • Monitor traffic load indicators for their area of responsibility;
- 28 • Manage (declare/update) the capacity of the runways, airport and the TMA;
- 29 • Monitor and interact with the 'local' arrival sequence;
- 30 • Trigger / abort network queue management.
- 31

32 APOC tools:

- 33 • Visualisation of AMAN sequence;
- 34 • Visualisation of network queue;
- 35 • Ability to:
- 36 ○ Update parameters related to AMAN; arrival rates, runway closure;
- 37 ○ Update network queue parameter (airport capacity);
- 38 ○ Trigger network queue.

¹⁸ Queue jumping will not be simulated in this exercise.



1 Appendix C Detailed Description of Proposed 2 dynamic DCB Process

3 The flow diagrams on the following pages provide an initial view of a proposed DCB process
4 for arrival management. The diagram is split into three separate diagrams so that it is easier
5 to read.

6 Diagram 1, in Figure 7, starts the process with the notification of a runway capacity reduction
7 (shape 1) and moves through to the point where the Implementation mode is run (shape 15).

8 Diagram 2, in Figure 8, starts with running the Implementation mode (shape 15). The process
9 then continues until the implementation mode is cancelled (various shapes). This involves
10 the aircraft implementing the necessary measures and the updating of the TTA calculations.

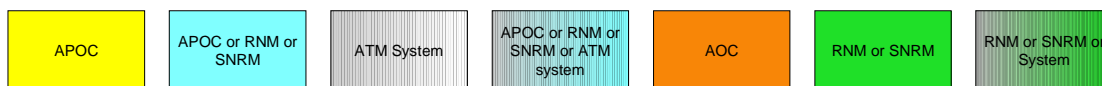
11 Diagram 3, in Figure 9, details the BT update process referenced in shape 21 of diagram 2 as
12 well as the Network Management Function process.

13 The different shapes used in the diagrams have different meanings, these are described
14 below.



15
16 The diamond does not always represent a decision, for example shape 3 'Apt has AMAN?',
17 however the question posed in the diamond can be answered with a discrete set of responses
18 (e.g. yes/no).

19 The different colours used in the diagrams indicate which actor performs the process. The
20 grey shading implies that the process could be performed by the ATM system. When
21 combined with another colour it implies that either the actors or the ATM system could
22 perform the process.



23
24 **Figure 6: Colour key for Figure 7, Figure 8 and Figure 9**

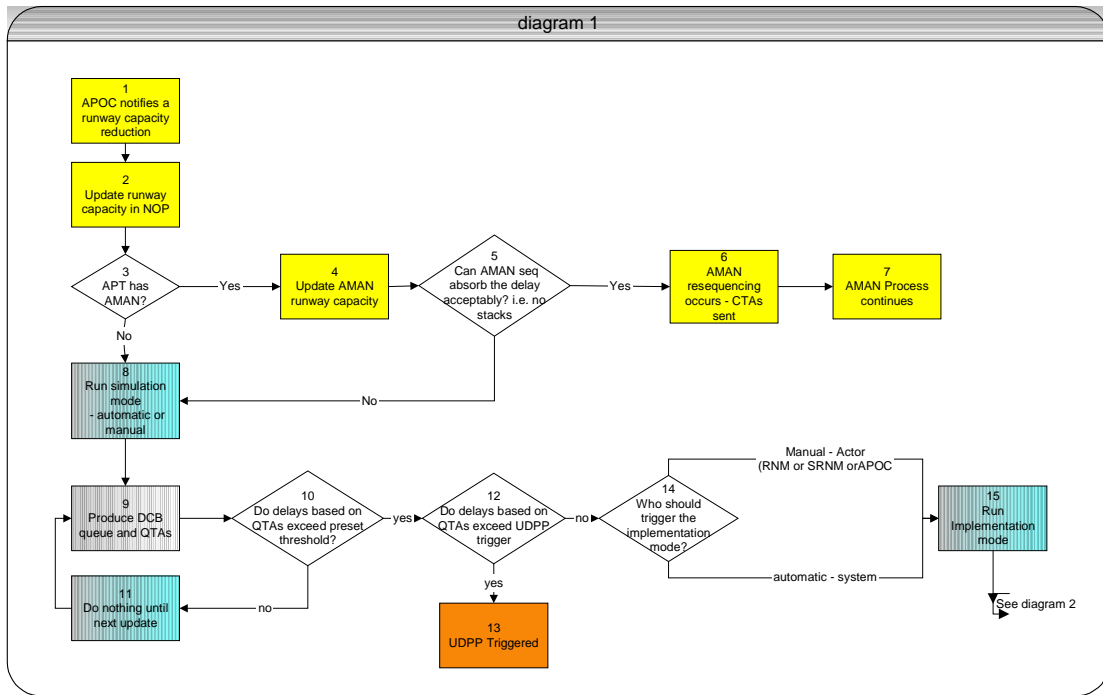
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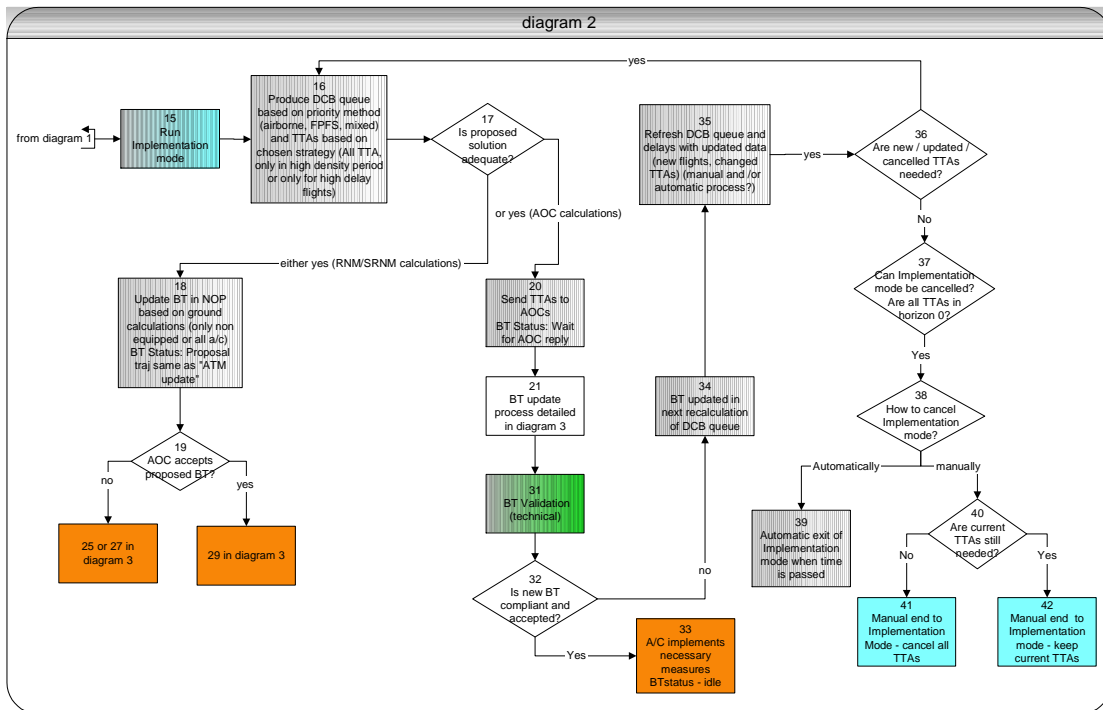
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Figure 7: Proposed dynamic DCB process - diagram 1



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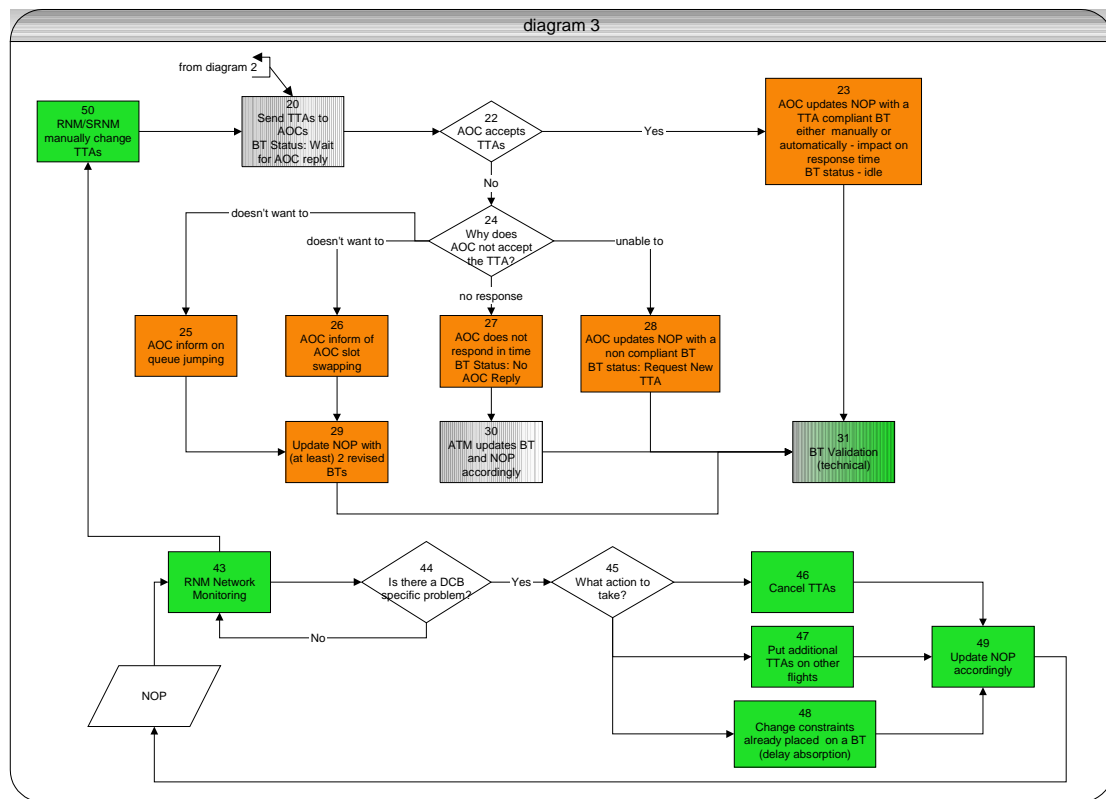
Figure 8: Proposed dynamic DCB process - diagram 2



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Figure 9: Proposed dynamic DCB process - diagram 3



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