EPISODE 3

Single European Sky Implementation support through Validation

Document information	
Programme	Sixth framework programme Priority 1.4 Aeronautics and Space
Project title	Episode 3
Project N°	037106
Project Coordinator	EUROCONTROL Experimental Centre
Deliverable Name	Simulation Report on Business Trajectory Management and Dynamic DCB - Main Report
Deliverable ID	D3.3.2-02
Version	1.00
Owner	
Gérard Mavoian	EUROCONTROL
Contributing partners	
EUROCONTROL, INECO, SICTA	

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

- This page is intentionally blank -

DOCUMENT CONTROL

Approval

Role	Organisation	Name
Document owner	EUROCONTROL	Gérard Mavoian
Technical approver	AENA	Pablo Sanchez-Escalonilla
Quality approver	EUROCONTROL	Catherine Palazo
Project coordinator	EUROCONTROL	Philippe Leplae

Version history

Version	Date	Status	Author(s)	Justification - Could be a reference to a review form or a comment sheet
1.00	16/12/2009	Approved	Stephen Kirby, Gerard Mavoian, Kirsteen Purves, Roger Guerreau Sara Luis Núnez Fabio Mangiaracina Jose Manuel Risquez	Approved by the Episode 3 consortium

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

TABLE OF CONTENTS

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

LIST OF TABLES

LIST OF FIGURES

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

EXECUTIVE SUMMARY

Introduction

This document provides the consolidated validation exercise report for Episode 3 WP 3.3.2 'Business Trajectory Management and Dynamic Demand-Capacity Balancing (DCB)', which contributes to the validation activities of work package 3 of Episode 3.

Two experiments were carried out in this exercise, hereafter referred to as 'Gaming' and 'Process Simulation'. A separate document for each has been produced, and these contain detailed information specific to each experiment. They, like this document, can be read without the need to refer to the other two. (However, for detailed information on one or other of the experiments, the specific document should be consulted.)

Purposes of the Exercise

There are two purposes to this exercise. The **first purpose** is to provide an initial contribution to clarify the dynamic DCB concept applied to arrival traffic management by providing answers to a set of fundamental questions, such as "How will airspace user business trajectory management interact with dynamic DCB and queuing?"

The **second purpose** of the exercise is to begin the construction of a validation infrastructure, such as methodologies, techniques and platforms, to support future validation work for SESAR network operations.

Method

The analysis of the dynamic DCB concept was performed through two parallel experiments using different techniques:

- **Platform-based gaming** (using a tool called **DARTIS**); DARTIS is a platform that is used as the means for people (game players) to deploy dynamic DCB measures against simulated imbalances and adapt business trajectories in consequences. Several games are played, with each game consisting of a different scenario and/or a different configuration of the dynamic DCB process. The games provide qualitative and quantitative information for scrutiny by analysts and operational experts;
- **Process Simulation**. Process simulations are particularly useful at revealing hidden incoherencies arising from the relations between actors involved and their responsibilities. PROMAS was developed to assess dynamic DCB measures and BT management against different scenarios (traffic samples, events, dynamic DCB strategies…). The outputs are principally quantitative but also qualitative.

Conclusions

Concept clarification was addressed through the qualitative (and partly quantitative) study of the following topics:

- Respective areas of responsibility of dynamic DCB and arrival manager (AMAN) processes in the management of congested arrival situations and their interface:

  => Main assumptions of the Detailed Operational Descriptions (DODs) and the operational scenario OS-11, that deals with the management of arrival congestion, are judged as acceptable. Some justifications and refinement are provided related to some of those assumptions;
- Roles and responsibilities of planners in arrival planning processes:

  => Some roles and responsibilities are clarified, particularly those related to the dynamic DCB process. Some open issues related to the respective roles of Sub-Regional Network Managers and local traffic managers were not addressed by the exercise;

- Interactions between DCB processes and business trajectory management:

A proposed process for the collaborative management of time-based arrival constraints in Business Trajectories (shared business trajectories, SBTs, and reference business trajectories, RBTs, partly) was studied during the Gaming experiment. Some major disagreements between experts remain about the implementation of the concept of business trajectory ownership by airspace users;

- Real-time network monitoring functions and support tools (e.g. NOPLA applications):

  => The Gaming experiment has highlighted the need for advanced tools in support of real-time network management and monitoring. High level requirements have been captured that could be implemented in the Gaming platform for further evaluation;

- The scope of User Driven Prioritisation Process (UDPP) and triggering conditions:

  => The scope of UDPP has not been clarified. No real consensus can be drawn on this topic. In the medium severity situations addressed in the exercise, airspace users consider that the triggering of a global negotiation process between airlines is unnecessary.

Two validation techniques were explored in the exercise:

- Gaming technique: due to the low maturity of the addressed concept elements two types of sessions were combined:
  - Structured discussions using the simulator and a predefined scenario as an aid to discuss the different steps of an operational scenario;
  - Real-time simulations involving network managers, airport operations' centres (APOCs) and aircraft operator centres (AOCs).
- **Process Simulation:** can be viewed as an advanced model-based technique.

The exercise demonstrated the ability of Gaming technique to provide structured discussions, and to help refine operational scenarios. The Process Simulation platform, PROMAS, showed its ability to model a large range of ATM processes.

Feedback to Other Work

The exercise mainly confirms the assumptions included in the Detailed Operational Descriptions (DODs) – mainly Medium and Short Term Planning (M2) and Network Management in the Execution Phase (E4) – and the operational scenario OS-11, which is related to business trajectory management and dynamic DCB in the context of arrival traffic management.

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

1 INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

This document provides the consolidated validation exercise report for WP 3.3.2 'Business Trajectory Management and Dynamic DCB', which contributes to the validation activities of Work Package (WP) 3. Two experiments were carried out in this exercise, which are hereafter referred to as 'Gaming' and 'Process Simulation'. A separate annex for each has been produced [1] [2], and these contain detailed information specific to each experiment. These annexes, like this document, can be read without the need to refer to the other two. However, for very detailed information on one or other of the experiments, the specific annex should be consulted. Additionally, the validation exercise plan [3] may provide useful further details about the experiments.

Regarding nomenclature, the term 'exercise' in this report is the collective term used to describe the two separate experiments, Gaming and Process Simulation.

The exercise combines human-in-loop gaming sessions and automatic process simulations conducted respectively by EUROCONTROL's Experimental Centre (EEC) and INECO. Those two activities address the same operational scenarios dealing with the management of arrival (mainly) and en-route (partly) demand-capacity imbalances that are predicted to occur in the short-term planning and execution phases.

1.2 INTENDED AUDIENCE

This document is intended for work package, sub-work package and exercise leaders of Episode 3 WP3 and WP2. Through WP2.2, it should also be of interest for WP4 and WP5 as it deals with transversal topics such as arrival congestion and business trajectory management.

In detail, the intended audience includes:

- Episode3 WP2 System Consistency;
    - Episode3 WP2.2 Leader (Clarification and Refinement of SESAR ConOps);
    - Episode3 WP2.3 Leader (Validation Process Management);
    - WP2.4.1 Performance Framework
    - Episode3 WP 2.5 Leader (Reporting and Dissemination);
- Episode3 WP 3 Collaborative Planning:
    - Episode3 WP 3 Leader;
    - Episode3 WP 3.2.1 Leader (WP3 Validation Strategy and Support);
    - Episode3 WP 3.2.2 Leader (Operational Concept Refinement);
    - Episode3 WP 3.3 Leader (Collaborative Planning Processes Activities);
    - Episode3 WP 3.3.1 Leader (Expert groups);
    - Episode3 WP 3.4 Leader (Results and Analysis Report);
- SESAR community.

1.3 DOCUMENT STRUCTURE

The document is structured as follows:

- Section 1 introduces the scope and justification of the validation exercise;

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

- Section 2 summarises important parts of the experimental plan;
- Section 3 and 4 describe briefly the Gaming experiment;
- Section 5 and 6 describe the Process Simulation experiment;
- Section 7 summarises the analysis of Gaming and Process Simulation results;
- Section 8 provides conclusions and recommendations for the exercise;

1.4 Experimental Background and Context

The document reports on the validation exercise Business Trajectory Management and dynamic DCB which is done within Episode 3 WP3 Collaborative Planning.

The SESAR definition phase ‘D1’ [4] identified main blocking points in the current ATM system. Among these, the Episode 3 WP3 validation strategy listed those that are directly related to collaborative planning and thus in the scope of Episode 3 WP3. Some of those blocking points are directly linked to the Episode 3 WP3.3.2 Business Trajectory Management exercise and concern both arrival and en-route dynamic DCB measures:

- Cooperation of all ATM roles in ATFCM processes at network level;
- Respect of ATFCM measures;
- Balanced approach between ATFCM and capacity management.

Moreover, the number of saturated airports operating at full capacity for most of the day should increase significantly by 2020/2025. This emphasises the need for dynamic and adaptive processes to manage efficiently short notice events that impact arrival capacity.

The SESAR ConOps introduces the following set of concept elements that will have a significant 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 Driven Prioritisation Process).

The combined application of these concepts should provide flexible and efficient arrival congestion management through DCB/sequencing time-based measures. These will be 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 dynamic DCB and queuing?
- As ground delays will remain the safest and most efficient means to resolve significant arrival demand/capacity imbalances, which collaborative decision making processes and functions will cover this aspect of demand-capacity balancing in the short term planning phase? And, how will UDPP be triggered in this context and to which situations should it apply?

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

- 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 investigation, such as:
  - The involvement of network managers in the process and their share of responsibilities;
  - The interface between DCB in the short term planning phase and traffic management/regulation processes in the execution phase.

The purpose of this exercise is to provide an initial contribution to concept clarification by providing some elements (mainly qualitative) to answer the above questions.

The second key objective of the exercise is to initiate the building of a validation infrastructure – including methodology, techniques and platforms – to support future validation work for SESAR network operations.

1.5 Concept Overview

Refer to SESAR D3 for further information on the SESAR concept [5].

This exercise looked principally at the management of arrival traffic congestion in the short term planning and execution phases from a few hours in advance up to the AMAN boundary.

Referring to Episode 3 WP3's Detailed Operational Descriptions (DODs) and the operational scenario OS-11 [6], three main processes can contribute to the management of arrival demand-capacity imbalances on the day of operations working at different look-ahead time horizons and level of granularity.

- DCB/UDPP processes applied to flights in planning phase and issuing TTAs;
- Dynamic DCB issuing TTAs and operating within the [2 hours, 40 minutes] timeframe, regarding the look-ahead to a detected imbalance. Dynamic DCB applies both to flights in planning and execution phases;
- AMAN operating within a look-ahead limited to 40 minutes (the exact value to be validated).

Figure 1 provides an illustration of the evolution from the current situation.

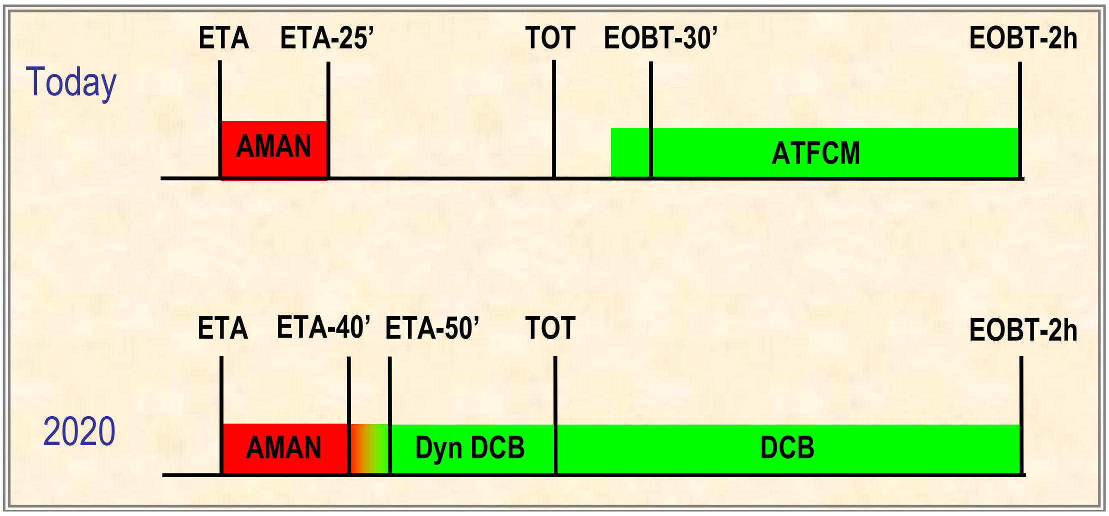

Figure 1: Evolution of arrival traffic regulation processes

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

The dynamic DCB solution for arrivals involves an airport alerting the network of a demand capacity imbalance resulting either from a capacity shortfall or a deviation from the network/airport operations plan. 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 times of arrival) by the AMAN. Figure 2 shows the interaction between the dynamic DCB queue and the AMAN queue.

The terms 'queue' and 'sequence' that appear in this report are used interchangeably with the terms 'AMAN' and 'DCB'. For example, no distinction is made between the two terms 'DCB sequence' and 'DCB queue'.

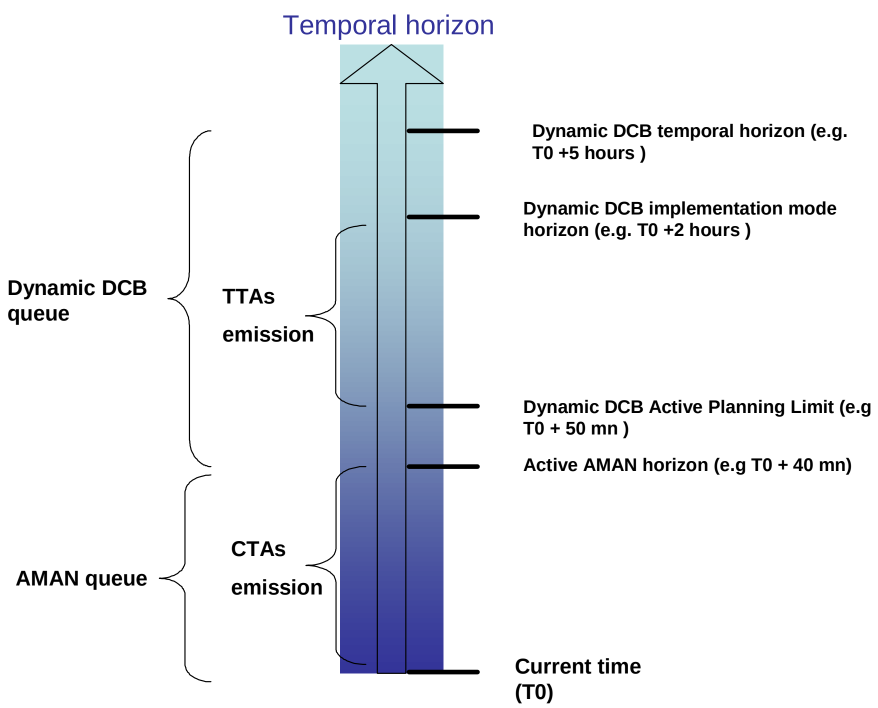

Figure 2: Temporal horizon of TTAs and CTAs

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 2 are given for example only.** It will be an objective of future exercises to determine appropriate values.

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

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

- TTAs are much less restrictive and accurate than CTAs: [-3mins, +3mn] for TTAs and [-30s,+30s] for CTAs;
- Business trajectory adaptation in response to a TTA must not interfere with tactical separation management processes for flights in the execution phase.

Dynamic 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; aircraft operators will decide how to meet them. The process of implementing dynamic DCB solutions will increase co-operation at local and regional levels.

There is potentially a performance conflict with a trade-off between individual area control centre (ACC) targets and network targets. There is also a question of how to ensure participation and acceptance 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.

Full UDPP process definition is out of the scope of this exercise. Therefore, the exercise focuses on managing 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, the exercise will investigate the conditions under which UDPP might be triggered.

Table 1 summarises the scope of the exercise:

	Episode 3 WP3.3.2 Business Trajectory Management
Leading organisation	EUROCONTROL
Validation objectives	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. It is assumed in this exercise that the capacity has been previously optimised to the maximum extent. Full UDPP process definition is out of the scope of this exercise. Therefore, the exercise focuses on managing 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, the exercise will investigate the conditions under which UDPP might be triggered.
Rationale	Two different simulation techniques are used and tailored to cover the need of the exercise: • **Gaming** human-in-the-loop exercise refining operational scenarios and providing elements to define behaviour models of participants using a model called **DARTIS**. The first step will be to focus on arrival congestion management through a gaming exercise, and the management of TTAs in relation to business trajectory management; • **Process Simulations** allowing modelling and incrementally refining the designed processes through the identification of gaps. The scope of the Gaming human-in-the-loop exercise will be extended (geographical extension and range of simulated dynamic DCB measures). At least 2D distortions of business trajectories would be addressed. The simulation of processes, relying on the **PROMAS** platform will assess the SESAR collaborative planning processes extending the conclusions obtained in the Gaming human-in-the-loop exercise. On the other hand, business

<table>
<tr><th></th><th>Episode 3 WP3.3.2 Business Trajectory Management</th></tr>
<tr><td></td><td>trajectories and network entities (sectors, airports) will be simulated in a high-level way, by means of exchanging data with an external and simplistic performance model.</td></tr>
<tr><td>Expected results</td><td>Results expected from this exercise are:
Refined operational scenarios, including the following elements:
The scope of dynamic DCB (what level of congestion should it address?);
The roles and responsibilities participants;
The method of operation (or more reasonably part of it) for dynamic DCB and business trajectory management, including an ordered sequence of actions;
The high level definition of system functions that support the process (queuing, network monitoring, users' interactions...);
Elements to refine behaviour models of roles, in particular related to network monitoring (network managers) and the management of dynamic DCB constraints in business trajectories (airspace users);
Initial assessment of the impact on performance (mainly efficiency) and ATC operations.
In addition, some outputs to the macro analytical model will be provided:
The identified processes that have been triggered during the Gaming & Process Simulation exercises;
A set of bottlenecks and gaps within the ATM Process Model;
Behaviour of Game Players recorded during the Gaming sessions;
Performance assessment results.</td></tr>
<tr><td>OI steps addressed</td><td>DCB-0208: Dynamic ATFCM.
AUO-0203: Shared Business / Mission Trajectory (SBT).
AUO-0204: Agreed Reference Business / Mission Trajectory (RBT).
AUO-0102 User Driven Prioritisation Process (UDPP) (very partly).
DCB-0103: SWIM enabled NOP.
DCB-0305: Network Management Function in support of UDPP (partly).</td></tr>
<tr><td>Validation Techniques</td><td>Gaming and fast-time modelling.</td></tr>
<tr><td>Supporting DOD / Operational Scenario</td><td>DOD M2: Medium/Short Term network planning.
DOD E4: Network management in execution phase.
Scenario OS-11: non-severe (no UDPP) Capacity shortfalls impacting arrivals in the short-term.
Scenario OS-36: non-severe (no UDPP) Capacity shortfall impacting multi-nodes in the short-term.</td></tr>
<tr><td>Geographical area – performance framework level</td><td>ECAC area</td></tr>
</table>

Table 1: Episode 3 WP3.3.2 Business Trajectory management exercise overview

1.6 GLOSSARY OF TERMS

Term	Definition
ACAP	Arrival Capacity
ACC	Area Control Centre
AIRAC	Aeronautical Information Regulation and Control
AO	Aircraft Operator
AMAN	Arrival MANager
ANSP	Air Navigation Service Provider
AOC	Aircraft Operator Centre
APOC	Airport Operations Centre
ASAT	Actual Start-up Approval time
ATA	AMAN Time of Arrival
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATS	Air Traffic Services
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
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
ETFMS	Enhanced Tactical Flow Management System
FAB	Functional Airspace Block

Term	Definition
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
OPLOG	Operational Log
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
RTA	Required Time of Arrival
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 Manoeuvre Area
TOBT	Target Off Block Time
TOT	Take Off Time
TSAT	Target Start-up Approval Time
TTA	Target Time of Arrival
TTO	Target Time Over
TWR	Tower
UDPP	User Driven Prioritisation Process
WP	Work Package

Table 2: 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 dynamic 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: • 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.

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 3: 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.
Delay	For a given flight, arrival delay resulting from the TTA allocation. Corresponds to the difference between the TTA allocated and time of arrival included the RBT/SBT.
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.
Simulated/informative delays	Arrival delays calculated by the dynamic DCB sequencing process prior to the application of any Dynamic DCB measure .Those delays provide an indicator of congestion.
TTA	'Target Time of Arrival'. This is the arrival time at the dynamic '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.
TOBT	Target Off Block Time. This is the Off Block time provided by AOs in the business trajectory and takes into account any dynamic DCB constraints (TTAs) that exist.
TTOT	Target Take Off Time. This is the take-off time due to the TTA allocation process.

Table 4: Time definitions used in dynamic DCB and BT management

2 SUMMARY OF EXPERIMENT AND STRATEGY PLANNING

2.1 OVERVIEW

Two separate experiments were carried out as a single exercise to explore Business Trajectory Management and dynamic DCB. This section gives an overview of these two experiments. Further details of each can be found in the dedicated Gaming and Process Simulation annexes [1] [2].

The analysis of the dynamic DCB concept described in section 1 was performed through two independent experiments:

- **Gaming** (using a tool called **DARTIS**) looking at dynamic DCB, and
- **Process Simulation** (using a tool called **PROMAS**) looking at dynamic DCB and BT management.

2.2 EXPERIMENTAL OUTCOMES

2.2.1 Gaming

The following are the expected outcomes of the Gaming experiment:

- Proposals for refining the concept:
- Exploration of new validation techniques in support to the clarification of the SESAR concept related to network operations in the day of operations;
- Identification of issues and priorities to be addressed in further steps of the SESAR validation process;
- Demonstration that numerical data can be collected automatically by the DARTIS platform and processed to provide useful metrics.

2.2.2 Process Simulation

The following are the expected outcomes of the Process Simulation experiment:

- Developing and refining the processes involved in applying dynamic DCB solutions;
- Assessing a new validation technique by using PROMAS (Processes Management Simulator).
- Qualitative results, such as highlighting 'incoherencies' between the Experts' opinions and the description of an Operational Scenario by assessing the dynamic DCB processes included in the ATM Process Model [7].
- Quantitative results (by post-processing), such as counting the number of negotiations/data exchanged between the different actors/functions (in potential bottleneck situations);

2.3 OPERATIONAL IMPROVEMENT STEPS

The outcomes in the previous section are linked to the operational improvement steps that have been addressed, to some degree, by the two Episode 3 WP3.3.2 Business Trajectory Management exercises, see Table 5. The +/+++ values in the Impacted KPAs' column indicate the size of the expected impact of the operational improvement step on the KPA. The

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

grey-coloured rows highlight the operational improvement steps related to UDPP; which were only partially addressed in the exercises.

OI-Step	Description	IP	Impacted KPAs (expected)[2]	How the OI step has been 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 experiment, those TTAs can be applied either at the destination airport or on en-route points. TTAs can by issued either automatically by a dynamic 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 control.
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 are 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 are provided with 'rough' facilities for planning/ re-planning shared business trajectories taking into account any TTAs. Re-planning of SBTs is limited to time 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 are provided with 'rough' facilities for planning/re-planning reference business trajectories taking into account all TTAs. Re-planning of RBTs is limited to time modifications (i.e., no 2D/3D management).
DCB-0103	SWIM enabled NOP	IP2	PRT +	In the simulations, the NOP contains all business trajectories, network

[2] 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.

OI-Step	Description	IP	Impacted KPAs (expected)[2]	How the OI step has been addressed in the exercise
			PRD +++	node capacities, dynamic DCB constraints (TTAs), network monitoring indicators (as available in current operations) and overload alerts. All the NOP information evolves dynamically during the simulation and is shared by all the actors.
DCB-0305	Network Management Function in support of UDPP	IP2	FLX +++	The dynamic DCB queuing provides the default delay allocation as an initial basis for discussions/negotiations between airspace users (as previously mentioned this part is not simulated). In addition, the dynamic DCB queuing process supports individual requests from airspace users for sequence changes using a slot swapping process.

Table 5: Operational Improvement steps addressed by Episode 3 WP3.3.2 Business Trajectory Management.

The stakeholders want the results of the exercise to refine the concept description of dynamic DCB. The operational ATM stakeholders want a clearer idea of what the dynamic DCB solutions are, how they can be applied, and how they will impact their operations in the future. Episode 3 stakeholders (WP2, WP3) want to update the DODs and the operational scenarios as well as ensuring that the concept refinement is consistent across work packages.

2.4 Experimental Assumptions

The assumptions that are **common** to the Gaming and Process Simulation experiments are:

- The airspace around the Fiumicino (LIRF), Milan (LIML), Barajas (LEMD) and Barcelona (LEBL) airports does not include any prohibited/restricted/segregated areas. Furthermore, the sectorisation and route network are those currently (i.e., 2009) implemented operationally;
- Most anticipated/recurrent airport traffic demand-capacity imbalances are dealt with 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 is considered, leaving a significant proportion of low and medium severity imbalances to be managed on the day of operations when the picture of traffic and capacity is better known. Moreover, the number of major airports operating at full capacity most of the day should increase and in those airports short-notice disruptions may particularly impact operations and will require a dynamic and efficient management process in the short-term planning and execution phase;
- The unique central slot allocation mechanism based on ground delay assignment will be replaced by multi-scoped demand capacity balancing and queuing processes at regional and sub-regional level." The main difference with the AMAN process is that DCB/dynamic DCB queuing processes 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 high level description of the dynamic DCB process and the short-term planning phase. This leaves room for different interpretations;

- In situations that require the UDPP process to be triggered, the dynamic DCB queuing process provides 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 or traffic picture in the short term planning and execution phases. The concept mentions explicitly that airspace users can refine their business trajectories until shortly before off-block time, taking into account updated information (e.g., meteorological forecast), and that an RBT can be frequently updated during its life. Moreover, SESAR D2 [8] raises clear performance requirements related to the flexibility KPA;
- The required technical enabler of SWIM enabled NOP is in place;
- Functional airspace blocks (FABs) will be in place;
- In nominal conditions (UDPP not triggered), flights can only be exempted from meeting dynamic DCB solution constraints (refuse TTA) with good reason: emergency on-board, insufficient fuel to meet constraints, or through a slot swapping request; it is assumed that slot-swap is a CDM function implemented in IP1 and available as a baseline;
- Dynamic DCB solutions can only be applied to flights inside the ECAC region;
- 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);
- All aircraft in the 2020 traffic sample can implement the BT updates needed to meet their CTAs. In addition, Air and Ground are sufficiently equipped to be able to respect Target Times and to negotiate if they cannot be achieved;
- 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.

Assumptions that are specific to only one of the experiments (either Gaming or Process Simulation) appear in the document that covers that experiment in detail.

2.5 Experimental Objectives

2.5.1 Gaming Objectives and Hypothesis

The following high level objectives are specific to the Gaming experiment. These objectives relate to concept refinement rather than concept assessment.

ID	Objective Description
To Examine the Dynamic DCB Process	
O.G1	Define the system functions that are needed to support the dynamic DCB process (queuing, network monitoring, users' interactions...).
O.G2	Examine the interaction of the dynamic DCB process with other processes (such as AMAN).

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

ID	Objective Description
O.G3	Define an initial dynamic DCB and BT management process that covers implementing, amending and cancelling dynamic DCB solutions.
O.G4	Gain a better understanding of how participants work with the dynamic DCB process, and in particular, how they interact.
O.G5	Identify the issues/priorities for the next validation exercise, and the future platform requirements for DARTIS to support this exercise.
As Demonstrator	
O.G6	Provide a visualisation of the dynamic DCB process.
O.G7	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	
O.G8	Provide information that will help to refine the operational scenario.
O.G9	Provide information that will help to define what the content of the NOP should be.

Table 6: The high level objectives for the Gaming experiment

The following hypotheses are specific to the Gaming experiment.

ID	Hypotheses Description	Obj ID
H.G1	The proposed dynamic DCB process is feasible as a realistic means to apply dynamic DCB solutions.	O.G3
H.G2	The platform provides the necessary information for dynamic DCB solutions to be implemented.	O.G1 O.G5
H.G3	There is more operational benefit in having a dynamic DCB process than not having it.	O.G6
H.G4	In the execution phase, there are two distinct processes/layers addressing arrival queue management: • The AMAN process working at a local/sub-regional level; • The dynamic DCB process applied to flights in execution phase and working at network level in anticipation of an AMAN.	O.G2 O.G3
H.G5	The triggering of dynamic DCB solutions i.e. TTAs in the case of this experiment will be based on human decisions.	O.G3 O.G4
H.G6	The share of responsibilities between regional, sub-regional and local actors related to the definition and implementation of dynamic DCB solutions e.g. TTAs, will evolve in the context of SESAR.	O.G3 O.G4
H.G7	Different dynamic DCB queuing strategies may be implemented in SESAR context related to the mixed management of airborne and not airborne flights in dynamic DCB queues as well as the mixed management of SBTs and RBTs.	O.G3
H.G8	An airspace user as owner of the 4D business trajectory has a total freedom when planning/re-planning an SBT as far as the permanent/structural restrictions and dynamic DCB/ASM constraint(s) are respected.	O.G3 O.G4
H.G9	The triggering of UDPP will be based on human decisions.	O.G2

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

ID	Hypotheses Description	Obj ID
		O.G3
H.G10	The roles and responsibilities related to UDPP triggering have to be defined.	O.G2

Table 7: Hypotheses for the Gaming experiment

2.5.2 Process simulations Objectives and Hypothesis

The following objectives are specific to the Process Simulation experiment:

ID	Objective Description
Clarification of the concept:	
O.P1	Define the system functions that are needed to support the dynamic DCB process and BT management (queuing, network monitoring, interactions between APOC and users...).
O.P2	Define the interaction of DCB process (queue) with some execution phase processes (AMAN).
O.P3	Gain a better understanding of how actors work within the dynamic DCB process and BT management, and in particular, how actors interact.
O.P4	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.
O.P5	Provide some elements about which information should be exchanged, and when, to assure a successful synchronisation between AMAN and dynamic DCB Queue processes.
Assessment of process feasibility:	
O.P6	Define an initial dynamic DCB and BT management process that covers implementing, amending and cancelling dynamic DCB solutions (queue).
O.P7	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.
O.P8	Support the functional development of some of the functionalities that should be included in the future Network Management Function.
O.P9	Provide an assessment of the impact on BT management related to the different TTA Allocation Strategies being addressed.
O.P10	Analyse the relationship between the severity of the shortfall capacity and the delay to be managed by dynamic DCB queue measures.
O.P11	Study the timeframe when dynamic DCB queue measures can be implemented in an effective way (i.e. sudden shortfalls, anticipated shortfalls, short duration, long

ID	Objective Description
	duration, etc.).
O.P12	Identify the incoherencies and bottlenecks of the processes described in the OS-11 [6] what would support both the refinement of the concept and the updating of this operational scenario.
Exploration of new techniques:	
O.P13	Develop PROMAS, new process simulation tool for assessing complex systems able to simulate roles, procedures…
O.P14	Demonstrate that both planning processes and SBT/RBT data can be linked by PROMAS to be used in future studies.

Table 8: The high level objectives for the Process Simulation work

The following hypotheses are specific to the Process Simulation experiment:

ID	Hypotheses Description
H.P1	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.
H.P2	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.
H.P3	Dynamic DCB and BT management processes will allow airspace users to decide how they want to adapt their SBT/RBT to meet a constraint.
H.P4	AMAN and dynamic DCB Queue processes will be coordinated and synchronised by means of a clear procedure.
H.P5	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).

Table 9: Hypotheses for the Process Simulation experiment

2.6 Choice of Methods and Techniques

The emphasis of this exercise is to clarify the concept using two, complementary validation techniques: Gaming and Process Simulation. Gaming techniques allow multiple stakeholders to take part in the process, whilst Process Simulation models the designed processes and roles and allow automated simulation on a wider scope.

2.7 Quick Overview of Each Method

2.7.1 Gaming Experiment

To achieve the objectives of the gaming experiment a collection of techniques known as gaming[3] was employed. A software platform called DARTIS was used as the means for people (game players) to deploy dynamic DCB measures against simulated traffic samples.

Several games are played, with each game consisting of a different scenario and/or a different configuration of the dynamic DCB process. The games provide qualitative and quantitative information for scrutiny by analysts and operational experts.

[3] 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.

DARTIS is a bespoke tool that has been redeveloped by EUROCONTROL for this Episode 3 project. The tool should also be useful for future projects which address demand-capacity balancing problems.

The DARTIS platform supports a rudimentary fast-time mode where all the decisions are taken by modelled actors. This mode was used to produce the quantitative results. PROMAS – the model used in the Process Simulation experiment – differs because that focuses on processes, whereas DARTIS fast-time mode focuses on the characteristics of an already established process.

2.7.2 Process Simulation Experiment

The objectives of this experiment have been achieved through a new validation technique called process simulation. Process simulations are particularly useful at revealing hidden incoherencies arising from the relations between actors involved and their responsibilities. A software platform called PROMAS has been developed for Episode 3 by INECO and used to assess dynamic DCB measures and BT management against simulated traffic samples. Several simulations have been performed, based in OS-11 [6], with each simulation consisting of a different scenario and/or a different strategy of the dynamic DCB process. PROMAS offers both qualitative and quantitative results.

2.8 Metrics and Measurements

2.8.1 Gaming Experiment

Qualitative and quantitative data were collected and analysed.

As the gaming experiment focused on concept refinement rather than concept assessment much of the collected data are subjective. These data are captured from the game players during step-by-step gaming sessions, debriefing sessions and questionnaires. The collated qualitative data are then summarised. The *qualitative* assessment is the major part of the Gaming experiment.

Quantitative data were recorded by DARTIS in a game log file. These data were processed to provide 13 metrics, summarised in the table below.

Supported Metric / Measurement	Platform / Tool	Method or Technique
Dynamic DCB Arrival Queue Characteristics: (1) Number of flights in the dynamic DCB arrival queue; (2) Number of flights that received at least one TTA; (3) Number of TTAs (and revisions) sent; (4) Number of original and revised TTAs received; (5) Magnitude of change for TTA revisions.	DARTIS	Fast-Time
Equity: (6) Proportion of short, medium and long haul flights delayed; (7) Cumulative frequency of flight delay, by haul type.	DARTIS	Fast-Time
Delay: (8) Proportion of all flights delayed; (9) Mean delay per flight; (10) Mean delay per delayed flight;	DARTIS	Fast-Time

Supported Metric / Measurement	Platform / Tool	Method or Technique
(11) Total delay; (12) Distribution of delay.		
Efficiency: (13) Total ground, en-route and stack delay.	DARTIS	Fast-Time

Table 10: The metrics produced to assess performance within the fast-time games

More details about these metrics are given in chapter 4.1.2 in the Gaming annex). Performance assessment is out of the scope of the experiment so the metrics do not have to comply with the metrics defined in the performance framework document produced by WP2, [9].

The objectives of the quantitative part of the Gaming experiment are to: (a) demonstrate the range of capabilities of DARTIS, (b) demonstrate the sort of analyses that will be possible (and indeed needed) in the future (c) serve as a learning exercise for the analyst with respect to producing the metrics and identifying those that are important, and (d) where appropriate, provide information to update the dynamic DCB concept.

2.8.2 Process Simulation Experiment

Each process simulation provides the analyst with qualitative and quantitative information, that has been used to assess the feasibility and coherency of the processes addressed and described in OS-11 [6]. After each simulation, PROMAS captures which processes are triggered or resumed to help meet the hypotheses. Moreover, three TTA Allocation strategies have been developed to produce relevant information that could help in further studies to decide which should be the best strategy or strategies to implement.

Some quantitative data are logged by PROMAS in an ‘events’ file. One of the objectives for this experiment 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).

2.9 Validation Scenario Specifications

2.9.1 Gaming Experiment

Taking into account the inputs from the expert group sessions, and as described in the experimental plan, 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 low visibility procedural conditions that impacts only dynamic 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 low visibility procedures period – e.g. from a 30% capacity reduction to 100% available runway capacity where the original end time of 11:00 (TTAs issued) changes to 09:00.
    - Before end time update at 08h00: planned capacity was X (e.g., 70% capacity from 08h00 to 11h00;

- o 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 one and two are combined with situation three in the simulation runs to give an overview of the implementation and recovery of the entire dynamic DCB process. These three validation scenarios are in accordance with Episode 3's operational scenario OS-11 [6].

Validation scenarios focus on capacity shortfall/recovery events only because it is a convenient way to generate imbalances using current traffic samples. More generally the dynamic DCB process aims to address any situation of demand capacity imbalances detected with short notice.

2.9.2 Process Simulation Experiment

For the Process Simulation experiment, 12 validation scenarios have been defined, implemented in PROMAS and studied.

Three different strategies have been created and assessed. Strategy should be understood as the priority allocated to the aircrafts depending on their status (e.g. SBT/RBT):

- Strategy FPFS, First Planned, First Served;
- Strategy 1, which gives higher priority to airborne aircrafts, provided that ground flights are not delayed more than 15 minutes (assumption A-01 from Experimental Plan);
- Strategy 2, which gives total priority to airborne flights.

For each strategy, there are four scenarios assessed with different conditions. They have been defined based on the specifications of the Experimental Plan[4] [3]:

- Hail: 10% capacity shortfall. The shortfall is known and effective at 15:00 p.m., the recovery is known and effective at 17:00 p.m.;
- Snow: 30% capacity shortfall. The shortfall is known and effective at 15:00 p.m., the recovery is known and effective at 17:00 p.m.;
- Rain: 10% capacity shortfall. The shortfall is known at 14:00 p.m. and effective at 15:00 p.m., the recovery is known 16:00 p.m. and effective at 17:00 p.m.;
- Wind: 30% capacity shortfall. The shortfall is known at 14:00 p.m. and effective at 15:00 p.m., the recovery is known 16:00 p.m. and effective at 17:00 p.m.

The 12 validation scenarios results of the appliance of each strategy to each one of the four validation scenarios.

2.10 Traffic Samples

Gaming; Adapted traffic samples based on current traffic were used as there are no 2020 traffic samples available with all the CFMU message data information required by the platform. The traffic samples were built from recorded traffic on 16th January 2009 corresponding to the AIRAC 317 environment (used for training), and 20th, 25th and 26th March 2009 corresponding to the AIRAC 319.

Flight data are based on actual records from CFMU's Enhanced Tactical Flow Management System (ETFMS). Research identified the busiest time period within each traffic sample for Madrid, Barcelona, Rome and Milan airports. The busiest time period offered conditions where dynamic DCB might be used in future.

[4] To be easier to name in the report, each one of the four validation scenarios has an associated name

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. (This is given as an assumption in section 2.4).

Process Simulations; the 2020 traffic sample supplied by Episode 3 WP2 is used.

2.11 Roles

The roles that are involved with implementing dynamic DCB solutions include:

- Sub-Regional Network managers for the FABs handling the constrained airport's main arrival flows;
- The 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;
- ATC:
    - Gaming: one generic ATC role (when TTA is allocated to airborne flights, simplistic negotiation with the flight crew to agree the way of achieving it);
    - Process Simulations: specific ATC roles; ATS Supervisor (TWR), Executive Controller (Arrival TMA) and Executive Controller (ACC).

2.12 Procedures

The Gaming experiment explores the process for implementing dynamic DCB solutions and how dynamic DCB interacts with the AMAN process; a high level description is given below and shown in Figure 3.

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 Times of Arrivals (QTA) is above a pre-defined threshold then implementation mode is triggered, either automatically or manually. Target Times of Arrivals (TTAs) 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.

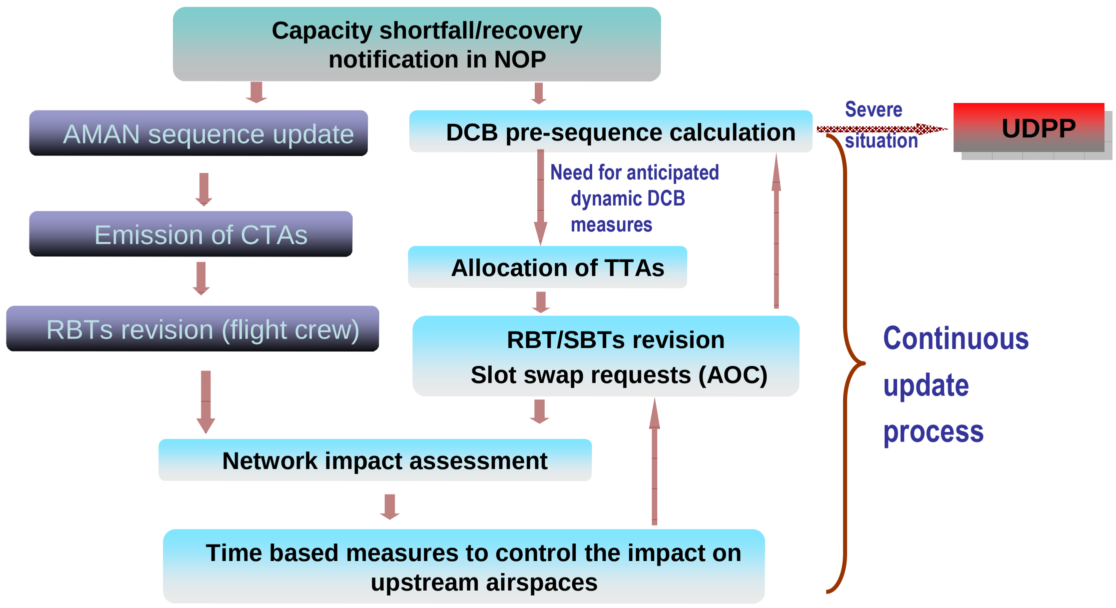

Figure 3: Overview of the dynamic DCB process

Several remarks can be made about the designed DCB processes and validation scenarios:

- Figure 3, the trigger of the process is a change in airport capacity. It must be emphasised that the designed dynamic DCB processes aim to apply to **any situation of demand capacity imbalances detected with short notice**;
- In the simulation, actors could evaluate imbalances using either classical functions (bar-charts, monitoring screen) or “monitoring” sequences. The second function is more adapted to assess dynamically the cumulative effect of imbalances in particular for arrival traffic;
- The process presented above and simulated in the gaming must not be viewed as a global synchronised process composed of a set of sequential steps but rather as a continuous, adaptive and decentralised planning process;
- The DCB measures used during Episode 3 gaming sessions employed only time-based traffic management measures (sequencing techniques). Other measures, such as re-routing or flight level changes, are planned for future exercises.

The following diagram presents a simplified view of business trajectory lifecycle as simulated in the platform.

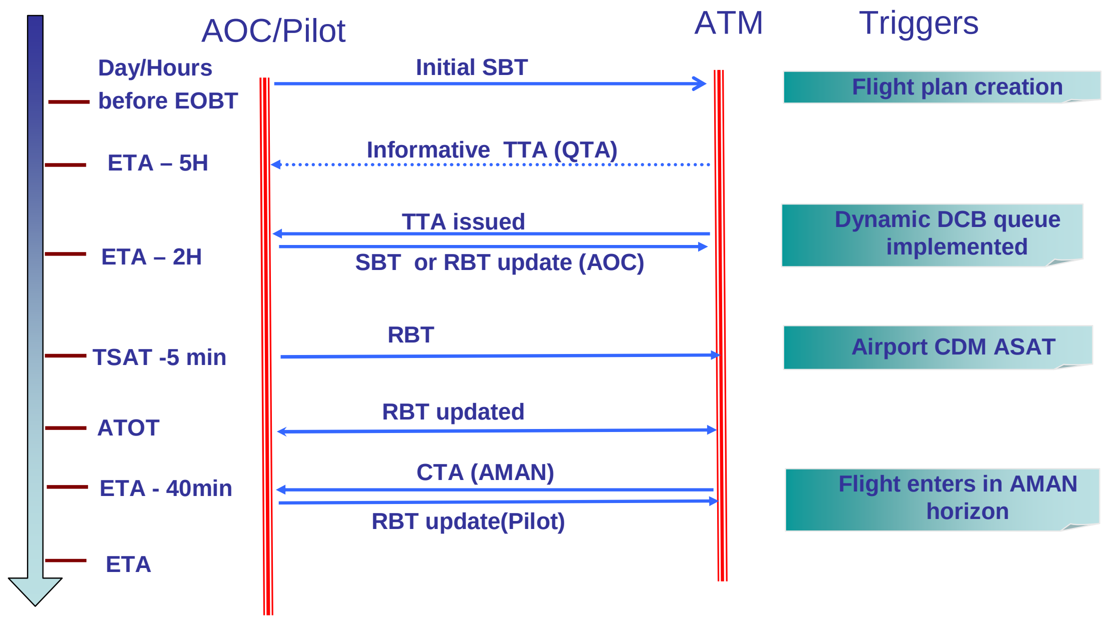

Figure 4: Overview of the business trajectory life-cycle in the gaming simulation

Some examples of procedures and rules related to business trajectory management as implemented in the platform are provided below. They must be viewed only as examples of the type of rules that can be studied in Gaming. Of course, **the definition of procedures is out of the scope of the exercise**.

- Airspace users were requested to change the business trajectory only if the TTA attributed was significantly different from the arrival time in the business trajectory (more than three minutes);
- In that case, the airspace users had five minutes to update the business trajectory in the NOP following the reception of a TTA. If not answer was received from the airspace user after this period, the BT was updated in the NOP by ATM according to some pre-agreed rules and parameters (the parameters could be set-up by an airline);
- The airspace user could also receive a TTO at any point of the 4D trajectory issued either by a gaming actor or by an en-route dynamic DCB tool. The previous rules applied to the management of a TTO;
- A flight could receive no more than two constraints in the BT (a TTO and a TTA). In case the airspace user was not able to send a BT that complied with all the constraints he had at least to comply with the closest constraint;
- In case an airspace user requested a slot swap, he had then to update the BTs of the two concerned flights in accordance;
- If a flight was in execution phase, the TTA/TTO received must be at a point that is at least 50 minutes ahead of the current position. The updated BT must not be modified in that case in the first segment (10 minutes length) starting from current position of the flight to avoid interaction with tactical ATC operations.

On the Process Simulation side 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 close future. They activate the restriction and, according to the ATM Process Model [7], all the required events before the DCB Queue solution are triggered. Target Time of Arrival (TTAs) are then calculated and sent to the relevant actors involved in the processes and the new TTAs are negotiated between the actors involved and finally accepted.

3 GAMING - CONDUCT OF THE EXPERIMENT

3.1 EXPLANATION OF GAMES

The programme consisted of five different games during the course of three days. The games are explained in detail in the Gaming Annex. The games were executed in two different ways – ‘step by step’ and ‘free’:

- Games that are played ‘free’ are those where DARTIS is played in real-time, and Game Players play their role in the game as best they can, without pause;
- Games that are ‘step by step’ are those where the Game Manager runs the game for a short while, and then stops. The pause is used to ask the Game Players technical questions. While the game is running the Game Players play their roles, following a detailed script. The script tells the Game Players what actions to carry out and when. There are several pauses during the course of the game, allowing the Game Manager to ask detailed questions on a variety of occurrences in the game. The duration of a step by step game is longer than that of a ‘free’ game.

Having executed the five games described above, it was decided to collect additional quantitative data by using DARTIS as a crude fast-time simulator. Thus, six new scenarios were constructed, and each one was run four times. These fast-time simulations were organised and managed by EUROCONTROL personnel without any design input from the Game Players. Further details of the games can be found in the document that details specifically the Gaming experiment [1].

3.2 DEVIATION FROM THE PLANNING

Some deviations from the experimental plan were introduced before the Gaming started as a result of lessons learnt from dry run testing of the Gaming method with the DARTIS platform. The main deviations were:

- there was less ‘free’ Gaming; ‘structured discussions’ using the DARTIS platform and a prepared scenario were introduced;
- the programme was reduced from four days to three (due to availability of participants);
- the number of games were reduced from ten to five (mostly as a result of the reduced programme time);
- using four airports instead of two;
- use of different dependent and independent variables – did not vary dynamic DCB implementation mode; did not vary the dynamic DCB Active Planning Limit;
- use of DARTIS as a fast-time simulator. This was an enhancement to what was planned;
- 75% equipped aircraft to 100% equipped, in coherence with assumption A-05 in OS-11 [6].

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

4 GAMING - EXPERIMENTAL RESULTS

4.1 QUALITATIVE RESULTS

Table 11 presents the key **qualitative** outputs from the Gaming experiment based on **the opinions of experts**. Due to the early stage of concept development, it is important that the findings are considered as starting points for future validation exercises and not as hard conclusions. They must be re-examined as the concept develops.

The findings are split between those related to the dynamic DCB concept and those related to DARTIS. There is no priority associated with the order.

For more information about the Gaming experimental results please refer to the document that describes the Gaming experiment in detail [1].

ID	Result	Objective/ Hypothesis
Dynamic DCB Concept		
Interface between Dynamic DCB and AMAN –Two Layered Process		
R.G1[5]	If a group of flights has simulated dynamic DCB delays of more than 5 minutes then TTAs should be sent (i.e. the dynamic DCB sequencer is put into implementation mode). This value is an initial consensus and requires further study.	O.G3 H.G5 H.G6
R.G2	The dynamic DCB process smoothed the imbalances and helped to organise the arrival queue so that the AMAN was able to handle the incoming traffic without the use of the stack.	O.G2 H.G4
R.G3	APOC liked the separate dynamic DCB and AMAN sequencer windows, AMAN showed their direct problems while the dynamic DCB queue showed what was coming up.	O.G4 -
Roles and Responsibilities		
R.G4	For airport capacity shortfalls the SRNM, not the APOC, should put the dynamic DCB sequencer into implementation mode because the SRNM will have oversight of the whole situation whereas the APOC will have a much more limited, local view.	O.G3 O.G4 H.G5 H.G6
R.G5	An AOC will respond to a TTA for a SBT flight, whereas the AOC or the pilot (depending on the airline) could respond to a TTA for an RBT flight.	O.G3 H.G6
Interactions between Business Trajectory Management and Dynamic DCB		
R.G6	Airline participants want the AOC flight priorities to be considered by the dynamic DCB sequencer when formulating a queue to reduce the number of subsequent slot swaps.	O.G3 H.G8
R.G7	in case of an arrival capacity shortfall anticipated at short notice, the AOC staff of the main airline operating at a congested airport will be overloaded and can only focus on a limited number of flights. Predefined solutions must be applied to other flights	O.G4 H.G8
R.G8	An AOC has five minutes to reply to a TTA before the ATM system provides a revised BT. This five-minute time-out is too short for SBTs (see R.G7), but too long for RBTs.	O.G3 O.G4 H.G1 H.G8
R.G9	Guidance should be given to AOCs on the best way to absorb the delay (ground delay / air delay / slot swap / while taxiing).	O.G3 O.G4 H.G6 H.G8

[5] 'R' stands for 'result', and 'G' stands for 'Gaming'.

ID	Result	Objective/ Hypothesis
	The most efficient route modifications to absorb a delay (speed change, lateral and/or vertical re-routing) could be proposed to the AOC by the ATM system as it would know which sectors have sufficient capacity to handle extra flights.	
R.G10	The only reason an AOC can send back a non-compliant TTA (i.e., an RBT including an arrival time earlier than the allocated TTA and outside the tolerance window) is that the aircraft does not have enough fuel to comply.[6]	O.G4 H.G8
R.G11	The question of whether an AOC's revised SBTs/RBTs need to be validated, and if so by whom (ATC, SRNM, system) is still open.	O.G3 O.G4 H.G6 H.G8
Real-time Network Monitoring Function and Support Tools		
R.G12	Any collaborative decision making processes used to determine when to go into implementation mode would need pre-defined rules.	O.G3 O.G4 H.G5 H.G6
R.G13	A human operator (SRNM/RNM) should take the decision to implement a dynamic DCB queue and update the system; the decision and implementation should not be fully automated in order to keep flexibly (experts opinion).	O.G4 H.G5 H.G6
R.G14	How long the sequencer stays in implementation mode is still an open question. Two options are (a) a set/defined period that is reviewed by the SRNM/RNM, or (b) a sliding window until arrival queue delay delays drop to zero. During the gaming a sliding window was used.	O.G3 H.G5
R.G15	The SRNM/RNM require more support tools including what-if functions to allow them to see the effects of the sequencers and various parameter changes on traffic in their traffic volumes before they are implemented/changed. E.g. could increasing capacity in a sector by one or two movements reduce delays?	O.G1 O.G5 H.G2
R.G16	Actors need more advanced monitoring tools to assess the impact of capacity shortfalls and dynamic DCB measures on traffic volumes; both their own and those of other actors (e.g. in adjoining FABs).	O.G1 O.G5 H.G2
R.G17	Context-oriented alerts are required to highlight network changes to the actor.	O.G1 O.G5 H.G2
UDPP Scope and Triggering Conditions		
R.G18	A threshold for triggering UDPP might be 20+ flights with a delay of 15 minutes or more for the same airport. The major airline at an airport could be one of the actors who flag such situations, and trigger UDPP application by the RNM through the APOC.	O.G2
Sequencing and TTA Allocation Strategies		
R.G19	The aim of the chosen sequencing strategy is to optimise the balance between airborne and ground delays. First Planned First Served should be the default sequencer strategy when no delay exists. However, when there is some delay the strategy mixed can be used to give some priority to airborne flights. When there is a lot of delay (but less than would warrant UDPP) the sequencer strategy should be Airborne Flights Have Priority.	O.G3 O.G4 H.G7
Multi-constraint Management – Interaction between En-route DCB process and Arrival DCB process		
R.G20	The method for applying manual TTAs/TTOs within the platform was understood by the participants but the logic of knowing when to apply it and to which flights has still to be defined. The knock-on effects of giving manual TTOs in en-route sectors was not evident in the platform, solving one problem can create too much delay and a peak in the	O.G1 O.G5 H.G2

[6] It is assumed that there will be other procedures for emergency situations.

ID	Result	Objective/ Hypothesis
	protected or another traffic volume. This is an area that needs what-if functions.	
Delay Absorption Strategies		
R.G21	AOC actors want to know the cause of demand-capacity problems (e.g. weather, incident), preferably with an associated uncertainty to help them assess how the delay will evolve. They do not want to absorb delay on the ground if they do not believe the poor weather will last.	O.G4 H.G8
R.G22	The question of at what point a flight can be stopped before take-off remains open (e.g. at the gate, while taxiing?). The decision could be based on whether a flight has an SBT or an RBT, or alternatively on take-off time, which then removes differences due to taxi-time	O.G3 H.G8
R.G23	Slot swapping is seen as a process for the dynamic DCB sequence, not the AMAN sequence.	O.G3 H.G4
R.G24	Different levels of co-ordination will be needed for slot swaps depending on the status of the flights (both on ground, both in air, one on ground and the other in the air). E.g. Slot swaps where both flights have SBT's may not need ATM agreement unlike those involving RBT flights. However, the impact on the network will have to be assessed.	O.G3 O.G4 H.G6 H.G8
DARTIS		
Functionalities		
R.G25	Re-routing and other non-time based solutions need to be supported by the platform.	O.G1 O.G5 H.G2
R.G26	APOC would like stack usage information.	O.G1 H.G2
R.G27	All decision support functions mentioned previously (R.G.1 - R.G24) and missing in the platform.	O.G1 H.G2

Table 11: Qualitative Gaming results – dynamic DCB process

4.2 Quantitative Results

Thirteen metrics were developed (see 2.8.1). These belong to four different areas of interest: sequencer, equity, delay and efficiency. The last three categories are SESAR-like, sharing the name with SESAR KPAs. The first category is a technical area of interest which is necessary to explore the workings of the dynamic DCB sequencer.

Some metrics were hard to produce, requiring several intermediary stages and certain assumptions. There was a lot of discussion and gradual improvement in the way the metrics were calculated by the scripts. This learning will benefit follow-on exercises.

For further information about the metrics please refer to the Gaming annex [1], section 4.1.2.

Due to the immaturity of the concept, and of the models implemented in DARTIS, and the fact that some of the metrics were not sophisticated enough to provide clinical performance information, the fast-time quantitative results are not presented in this report.

5 PROCESS SIMULATION - CONDUCT OF EXPERIMENT

5.1 EXPERIMENTAL PREPARATION

The main activities to perform the Process Simulation experiment based on the OS-11 [6] are organized in three phases:

- Phase 1: Preparatory activities, sub-divided in the following tasks:
    - Definition of the experiment: by a deep analysis of the OS-11 [6], identifying the simulation scenarios to be modelled by PROMAS, identifying the main variables to be controlled and the metrics to be measured, as well as stating the hypothesis that should be tested;
    - PROMAS Development: to finish the interim PROMAS development and to tune up and prepare the platform capabilities in order to be able of modelling the defined simulation scenarios;
    - Adaptation of the Traffic for the Simulation;
        - While the appropriate 2020 traffic sample to be injected in PROMAS was delivered by SICTA, some pre-scenarios were run with a real traffic sample to test the platform;
        - When the traffic sample was ready, the files were adapted to the properly data format and introduced in the scenario model and in PROMAS simulator as inputs;
    - Modelling of Scenarios. This includes:
        - Definition of the general program structure and its programming;
        - Definition of each strategy and its programming;
        - Coordination with Gaming assumptions;
        - Pre-execution of each strategy in a stand alone platform to perform a preliminary verification;
        - Implementation of the different strategy functions in the platform;
        - Definition and implementation in PROMAS of the relevant part of negotiation processes, according to ATM Process Model Diagrams [7];
- Phase 2: Execution activities, including:
    - Simulation Execution for each validation scenario. Once they have been correctly modelled, each scenario is run, and the final results obtained;
- Phase 3: Post-Experiment Activities, which include:
    - Output data post-processing to obtain the selected metrics;
    - Analysis of processes simulation results;
    - Analysis of performance simulation results;
    - State the conclusions, issues, key findings and recommendations.

For more information about the Process Simulation experiment the document that presents the Process Simulation experiment in detail should be consulted.

5.2 Deviations from the Planning

During the conduct of the experiment one independent design variable from the Experimental Plan for Business Trajectory Management [1] was modified.

Based on the analysis of the traffic sample that was produced for the experiment, it was decided to adopt a 30% reduction in capacity compared to the planned 20%, and also to change the duration of the restriction from three to two hours. The reasoning was that the results obtained by using the 20% shortfall capacity were similar to 10% shortfall capacity and had short effect in the recovery process. Also with 10%, and even 20% shortfall capacity the delay was assumed by the less saturated hours.

To have a better understanding of the results the flight status was simplified by considering that the SBT status corresponds to non-airborne flights, and RBT status to airborne flights.

6 PROCESS SIMULATION - EXPERIMENTAL RESULTS

6.1 Measured Experimental Results

For more detailed information about the Process Simulation experimental results the document that presents the Process Simulation experiment in detail should be consulted [2].

Twelve validation scenarios have been simulated:

Three different strategies have been created and assessed. Strategy should be understood as the priority allocated to the aircrafts depending on their status (e.g. SBT/RBT):

- Strategy FPFS, as currently;
- Strategy 1, which gives higher priority to airborne aircrafts, provided that ground flights are not delayed more than 15 minutes (assumption A-01 from Experimental Plan);
- Strategy 2, which gives total priority to airborne flights.

For each strategy, there are four scenarios assessed with different conditions. They have been defined based on the specifications of the Experimental Plan[7]:

- Hail: 10% capacity shortfall. The shortfall is known and effective at 15:00 p.m., the recovery is known and effective at 17:00 p.m.;
- Snow: 30% capacity shortfall. The shortfall is known and effective at 15:00 p.m., the recovery is known and effective at 17:00 p.m.;
- Rain: 10% capacity shortfall. The shortfall is known at 14:00 p.m. and effective at 15:00 p.m., the recovery is known 16:00 p.m. and effective at 17:00 p.m.;
- Wind: 30% capacity shortfall. The shortfall is known at 14:00 p.m. and effective at 15:00 p.m., the recovery is known 16:00 p.m. and effective at 17:00 p.m.

The 12 validation scenarios results of the appliance of each strategy to each one of the four validation scenarios (see section 2.4 of the processes simulation annex for further detail [2]).

The results are summarised in the table below.

ID	Result	Measurement / Metric	Objective / Hypothesis
Dynamic DCB Concept			
R.P1	DCB Queue process smoothes the traffic to be managed by AMAN in all the three strategies.	Number of flights per hour. Information exchanged between AMAN and DCB queue functions. Delay to be managed by AMAN	Results relate to hypotheses H2 and H4.

[7] To be easier to name in the report, each one of the four validation scenarios has an associated name

ID	Result	Measurement / Metric	Objective / Hypothesis
Results on Validation Scenarios			
R.P2	Validation Scenarios in which restriction is known in advance presents the highest aircrafts delays later.	Delay Distribution generated	Result relates to hypotheses H2, H3 and H5.
R.P3	Flights affected by both shortfall and recovery period receive, at least, two TTAs, one during the capacity shortfall and other during the recovery period, trying to adjust the traffic demand to the airspace capacity.	Number of negotiations/data exchanges performed during the Implementation of a DCB queue.	Result relates to hypotheses H1, H2 and H3.
R.P4	In Validation Scenarios in which peak-off delay is higher, the average delay is smaller.	Delay Distribution generated.	Result relates to hypothesis H5.
R.P5	Depending on the strategy, non airborne flights can absorb their delay on ground according to recommendations (not delayed more than 15 minutes). However, the number of flights that fit this statement varies depending on the strategy.	Percentage of flights that have suffered SBT changes.	Result relates to hypotheses H2 and H3.
Results on Strategies			
R.P6	Each strategy provides a different traffic sequence (modifies flights arrival order).	Delay Distribution generated	Result relates to hypotheses H2, H3 and H5.
R.P7	In strategy 1 non airborne flights are not delayed more than 15 minutes but this output causes higher delays in airborne flights. Only applicable at local level since this is the result of .	Delay Distribution generated	Result relates to hypotheses H2 and H3.
R.P8	In strategy 2 airborne flights are not delayed more than the recommendations but this output causes higher delays in non airborne flights. Only applicable at local level since this is the result of .	Delay Distribution generated	Result relates to hypotheses H2, H3 and H5.
Results on delays			
R.P9	Each strategy generates a different delay distribution depending on the aircraft status.	Delay Distribution generated	Result relates to hypotheses H2, H3 and H5
R10	Peak-off delays exceed delays recommendations in every validation scenario (15 minutes for non-airborne flights and no more than 3% of remaining time of flight).	Delay Distribution generated. Number of flights that are able to meet a proposed TTA to recover the capacity after a shortfall.	Result relates to hypotheses H2, H3 and H5.
R.P11	Recovery period lasts approximately the same in all the three strategies.	Delay Distribution generated.	Result relates to hypotheses H2, H3 and H5.

ID	Result	Measurement / Metric	Objective / Hypothesis
R.P12	The highest aircrafts delays exceed delays recommendations.	Delay Distribution generated. Number of flights that are able to meet a proposed TTA to recover the capacity after a shortfall.	Result relates to hypotheses H2, H3 and H5.
R.P13	Information exchanged between AMAN and DCB queue functions is mainly the mounted up delay generated and the new arriving traffic sequence.	Information exchanged between AMAN and DCB queue functions.	Result relates to hypothesis H4.
R.P14	When the capacity is recovered, most of the flights are not able to reach their original ETA. Only applicable at local level since this is the result of .	Delay to be managed by DCB queue process.	Result relates to hypothesis H5.
R.P15	72% of traffic sample used in this exercise are non airborne flights when managed by DCB Queue[8]. This traffic makes the results only applicable at local level and in the specific validation scenarios of the exercise.	Affecting SBTs, Affecting RBTs.	Result relates to hypothesis H5.

Table 12: Summary of Measured Experiment Results.

[8] Taking into account ETOT, ETA and the time when the aircraft is managed by the DCB processes.

7 ANALYSIS OF EXPERIMENT OUTCOMES

7.1 ANALYSIS OF OUTCOMES ON THE BASIS OF DETERMINED HYPOTHESES

This section summarises the analysis of the experimental outcomes for the two experiments. If more detailed information is required the document that presents the particular experiment in detail should be consulted [1], [2].

Table 13 and Table 14 list the hypotheses and outcomes for each for the Gaming and Process Simulations, respectively.

The possible outcomes are:

- Accept – the results from the gaming support the hypothesis;
- Accept (partial) – the results support the hypothesis to some extent however there is some limitation to be taken into account;
- Open – the results do not provide sufficient evidence to accept or reject the hypothesis so further study is required;
- Reject – the evidence is contrary to the hypothesis.

ID	Gaming Hypotheses	Outcome
H.G1	The proposed dynamic DCB process is feasible as a realistic means to apply dynamic DCB solutions.	**Accept (partial)**
H.G2	The platform provides the necessary information for dynamic DCB solutions to be implemented.	**Accept (partial)**
H.G3	There is more operational benefit in having a dynamic DCB process than not having it.	**Accept**
H.G4	In the execution phase, there are two distinct processes/layers addressing arrival queue management: • The AMAN process working at a local/sub-regional level; • The dynamic DCB process applied to flights in execution phase and working at network level in anticipation of an AMAN.	**Accept (partial)**
H.G5	The triggering of dynamic DCB solutions (i.e. TTAs in the case of the Gaming experiment) will be based on human decisions.	**Open**
H.G6	The share of responsibilities between regional, sub-regional and local actors related to the definition and implementation of dynamic DCB solutions e.g. TTAs, will evolve in the context of SESAR.	**Accept**
H.G7	Different dynamic DCB queuing strategies may be implemented in the SESAR context related to the mixed management of airborne and non-airborne flights in dynamic DCB queues as well as the mixed management of SBTs and RBTs.	**Accept**
H.G8	An airspace user as owner of the 4D business trajectory has total freedom when planning/re-planning an SBT as far as the permanent/structural restrictions and dynamic DCB/ASM constraint(s) are concerned.	**Open**
H.G9	The triggering of UDPP will be based on human decisions.	**Open**

ID	Gaming Hypotheses	Outcome
H.G10	The roles and responsibilities related to UDPP triggering have to be defined.	**Open**

Table 13: Gaming hypotheses and outcomes

ID	Process Simulation Hypotheses	Outcome
H.P1	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.	**Accept (partial)**
H.P2	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.	**Accept (partial)**
H.P3	Dynamic DCB and BT management processes will allow airspace users to decide how they want to adapt their SBT/RBT to meet a constraint.	**Accept (partial)**
H.P4	AMAN and DCB Queue processes will be coordinated and synchronised by means of a clear procedure.	**Accept**
H.P5	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).	**Open**

Table 14: Process Simulation hypotheses and outcomes

7.2 Analysis of Consequences of Outcomes for Experiment Objectives and Assumptions

Table 15 and Table 16 list the objectives of the Gaming and Process Simulation experiments, respectively, and describe to what extent they were met.

The possible outcomes are:

- Met;
- Partially met;
- Not met.

ID	Objective Description	Progress
To Examine the Dynamic DCB Process		
O.G1	Define the system functions that are needed to support the dynamic DCB process (queuing, network monitoring, users' interactions...);	**Met**
O.G2	Examine the interaction of the dynamic DCB process with other processes (such as AMAN);	**Met**
O.G3	Define an initial dynamic DCB and BT management process that covers implementing, amending and cancelling dynamic DCB solutions;	**Met**

ID	Objective Description	Progress
O.G4	Gain a better understanding of how participants work with the dynamic DCB process, and in particular, how they interact.	**Met**
O.G5	Identify the issues/priorities for the next validation exercise, and the future platform requirements for DARTIS to support this exercise.	**Met**
As Demonstrator		
O.G6	Provide a visualisation of the dynamic DCB process.	**Met**
O.G7	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).	**Met**
Provide Outputs		
O.G8	Provide information that will help to refine the operational scenario.	**Met**
O.G9	Provide information that will help to define what the content of the NOP should be.	**Partially met**

Table 15: Objectives addresses by Gaming

ID	Objective Description	Progress
Clarification of the Concept		
O.P1	Define the system functions that are needed to support the DCB process and BT management (queuing, network monitoring, interactions between APOC and users...);	**Partially met**
O.P2	Define the interaction of DCB process (queue) with some Execution phase processes (AMAN).	**Partially met**
O.P3	Gain a better understanding of how actors work within the dynamic DCB process and BT management, and in particular, how actors interact.	**Met**
O.P4	Measure the number of information exchanged 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.	**Met**
O.P5	Provide some elements about which information should be exchanged, and when, to assure a successful synchronisation between AMAN and DCB Queue processes.	**Met**
Assessment of process feasibility		
O.P6	Define an initial dynamic DCB and BT management process that covers implementing, amending and cancelling dynamic DCB solutions (queue);	**Partially met**
O.P7	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	 **Partially met** **Partially met** **Partially met**

ID	Objective Description	Progress
O.P8	Support the functional development of some of the functionalities that should be included in the future Network Management Function.	**Partially met**
O.P9	Provide an assessment of the impact on BT management related to the different TTA Allocation Strategies being addressed.	**Met**
O.P10	Analyse the relationship between the severity of the shortfall capacity and the delay to be managed by DCB queue measures.	**Partially met**
O.P11	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.).	**Partially met**
O.P12	Identify the incoherencies and bottlenecks of the processes described in the OS-11 [6].	**Partially met**
O.P13	Suggest some modifications that could be used for both refining the concept and updating OS-11 [6].	**Met**
Exploration of new techniques		
O.P14	Demonstrate that both planning processes and SBT/RBT data can be linked by PROMAS to be used in future studies.	**Met**

Table 16: Objectives addresses by Process Simulation

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 consortium.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 KEY FINDINGS

This section provides a collective view of the conclusions and recommendations of the Gaming and Process Simulation experiments.

The main outcomes of the exercise can be split up into two distinct categories:

- The outcomes that relate to the concept and evaluation of the operational scenarios. Conclusions are mainly derived from expert judgement collected during the Gaming experiment;
- Conclusions about the validation techniques and platforms used in the exercise.

These two categories are discussed below separately.

8.1.1 Key Findings – Concept Clarification and Operational Scenarios

The whole exercise was defined as an initial building block in support to the SESAR validation programme rather than as a self-contained validation activity that would provide definitive answers to a set of validation questions. So, the conclusions presented in this section should be taken very cautiously. **Further investigation is required before the conclusions can be truly accepted as valid.**

The conclusions are presented in various groups, centred round common themes.

8.1.1.1 Scope of Dynamic DCB, AMAN and their Interface

The DOD E4 as well the OS-11 [6] both identify at least two ATM processes that can contribute to the management of arrival congestion when an imbalance is detected at relatively short notice. These processes are:

- A continuous AMAN process working mainly on airborne flights within a limited look-ahead time horizon. This AMAN process manages accurate arrival sequences and issues CTAs that are managed on the airborne side by required times of arrival (RTAs);
- An upstream Dynamic DCB process. This process pre-sequences flights (only when a significant imbalance is detected) through the dynamic allocation/re-allocation of TTAs and the consequent adaptation of business trajectories by airspace users. The TTAs can be allocated/re-allocated to flights in the short-term planning and execution phases before they are subject to the AMAN process (mainly long/medium haul flights).

Those two processes were simulated in the Gaming experiment to provide a clear demonstration of how they could be combined. The gaming participants considered that this breakdown was relevant for the following reasons:

- It allows the definition of a clear boundary between network and local/tactical processes and the clarification of roles and responsibilities;
- It allows the design of a seamless arrival management process covering both the short-term planning and execution phases, whilst allowing the type of measure/time constraint to be adapted to the level of the congestion and the accuracy of the traffic picture;

- By coherently managing flights in the short-term planning and execution phases, it allows time-based measures to be dynamically adapted to achieve an optimum balance between ground and airborne delays.

The two processes were viewed by most of the experts as two constituent elements of the queue management concept mentioned in the CONOPS. No definitive statement was produced related to the system support needed for these processes. Some of the experts considered that a unique tool (an AMAN tool) could provide support to both processes. In that case, operational requirements, pre-defined rules and parameters related to the "dynamic DCB function" implemented in the tool must be agreed at network level.

The experts considered that the following KPAs should be positively impacted by the implementation of these processes:

- Efficiency through an optimal management of delays when any exist;
- Predictability.

The experts were asked a set of questions about the interaction between the AMAN and a dynamic DCB process. The consensus was that having two separate processes to address arrival queue management was acceptable. The following list provides some of the most important points:

- The area of responsibility of the AMAN process was defined by a temporal parameter expressing a time before landing. This time parameter was an airport-dependant value defined such that most (at least 95%) of the flights managed in the AMAN horizon are airborne. In the Gaming experiment, this parameter value was set to 35 minutes for Fumicino and 40 minutes for Madrid, based on the proportion of very short haul flights in the arrival traffic. An extended horizon of 60 minutes was also tested with these airports to see the impact;
- In normal conditions (i.e. no sudden capacity shortfalls), the AMAN process should be able to manage very limited delays thanks to better upstream planning. Most of the experts considered that the delays managed by the AMAN should not exceed a few minutes (3-4 minutes is an order of magnitude). This delay threshold parameter determines the triggering conditions and the objectives of the dynamic DCB process as well as the margins and time tolerance windows that have to be considered when issuing arrival time constraints (TTAs);
- The transition between the dynamic DCB TTA allocation process and the AMAN sequence should be done through Reference Business Trajectories: for a flight entering in its horizon, the AMAN process should take in input the arrival time in the RBT which is compliant with a TTA –if any - previously allocated by dynamic DCB.

8.1.1.2 <u>Roles and Responsibilities</u>

The conclusions that can be drawn about roles and responsibilities are as follows:

- The AMAN sequence (even considering an increased horizon) is under the responsibility of the APOC/TMA manager. Network managers are not directly involved in the process;
- The actor triggering and managing the dynamic DCB TTA allocation process should be the Sub-Regional Network Manager of the sub-region that has the congested airport. The decision to trigger the dynamic DCB solution must be coordinated with the APOC and the Regional Network Manager;
- Airspace users are owners of their business trajectories and are in charge of re-planning the business trajectories to take into account the DCB time-based constraints. Only the flight crew is involved in the management of constraints issued by the AMAN process. However, the management of time-based constraints issued by the dynamic DCB process (TTAs) would be primarily under the responsibility of

the AOC. For flights in execution phase, the AOC must work in close cooperation with the flight crew. This represents the most likely situation, but it may vary between airspace users depending on their organisation;

8.1.1.3 Interactions between Business Trajectory Management and Dynamic DCB

- The procedures implemented in the simulations allowed the airspace users to decide how to absorb arrival delays through 4D business trajectory re-planning. The procedures were judged as globally acceptable from an airspace user point of view. However, some operational parameters need to be refined, in particular, the maximum response time allowed following the reception of a TTA (five minutes was played in the Gaming). It was also identified that in case of a capacity shortfall anticipated at short notice, the AOC staff of the main airline operating at a congested airport would probably be overloaded and could only focus on a limited number of flights (the most critical ones from a business point of view).
- The network managers expressed their disagreement about the business trajectory management procedures implemented in the gaming platform. Their opinion is that, in order to increase efficiency of the overall process and reduce risk of increased complexity in terminal airspace, business trajectories respecting TTAs should first be determined by ATM taking into account network constraints and then proposed to airspace users who could then make counter-proposals.
- Following the conclusions of an ad-hoc expert group meeting, the exercise considered the assumption that the SBT becomes an RBT at the Start-Up Approval Time (so approximately five minutes before Target-Off Block Time referring to airport collaborative decision making concept milestones). The airspace users involved in the simulations considered that this transition should be as seamless as possible towards ATM. The implications of this in the simulated scenarios were:
    - o In normal conditions, the initial RBT is the same as the last SBT and there is no need for the initial RBT to be validated by the network;
    - o The defined procedures relating to the interactions between dynamic DCB and BT management were the same whatever the flight phase (i.e., planning or execution). The only differences reside in the use of different values for some operational parameters.
- All participants agreed on the necessity to consider two additional key aspects that were not addressed in the Gaming experiment (due to platform limitations) to get a more complete view of the feasibility of the overall process:
    - o The interaction with departure airports' planning processes;
    - o The management of business trajectories in 2D/3D dimensions.

8.1.1.4 Real-Time Network Monitoring Function and Support Tools

- The need to define advanced tools/applications (i.e., NOPLA applications) in support of the network/traffic monitoring tasks and the collaborative management of business trajectories was clearly identified. The Gaming platform included network monitoring functions that were close to functions available in current CFMU systems (e.g., CHMI). Those functions did not allow network managers/APOCs to assess easily in real-time the combined impact of the dynamic DCB and business trajectory management processes. Some high-level requirements for advanced functions in support of the future network monitoring tasks were identified including:
    - o Advanced what-if functions allowing the impact of DCB measures and airspace users' replies to be assessed;

- Advanced traffic monitoring indicators including complexity and performance factors, both for en-route and TMAs;
- Context-oriented alerts highlighting network changes and analysing accurately the impact of business trajectories modifications.

8.1.1.5 UDPP Scope and Triggering Conditions

- As the nature of UDPP is not yet clarified, experts could not determine to any level of detail in which conditions it should be triggered;
- What can be concluded from the exercise is that, at least in the situations simulated (i.e., medium severity imbalances, no delays exceeding 20 minutes, no need to cancel flights), the airspace users did not see the potential gain of triggering an "overall negotiation process". The possibility to decide individually for each flight how to manage the arrival delay combined with the availability of a slot-swap function (usable at the level of an alliance, for example) and applied to a default TTA allocation process provided by ATM seemed to respond to airspace users' business needs;
- Therefore, UDPP application should be reserved for severe situations. No consensus was reached about who should initiate the UDPP process. Most of the experts think that the initiator of the process would depend on the type of situation.

8.1.1.6 TTA Allocation Strategies

- This topic was not an initial objective of the exercise. However as the topic was addressed by the Process Simulations and discussed by experts during the Gaming sessions, some conclusions can be drawn, although with caution because of the low maturity of the sequencing models implemented in both platforms;
- Three basic strategies can be identified impacting the way flights in the planning and execution phases are merged in dynamic DCB arrival sequences. Depending on the severity of the situation addressed and the reliability of the predictions (both in terms of demand and capacity) one of the strategies should be selected in order to achieve an optimum balance between airborne and ground delays.

8.1.1.7 Multi-Constraint Management - Interaction between the En-Route DCB Process and the Arrival DCB Process

- This topic was partly addressed in the gaming simulations through the activation of DCB time-based measures (Target Time Over a specific location) applied to en-route traffic flows interacting with congested arrival flows. The Gaming platform included an initial implementation of this approach but the low maturity of the models and associated HMIs prevented any "operational" feedback from being obtained at this stage. However, all the participants considered this topic to be very important and needing further investigation.

8.1.2 Key Findings – Validation Techniques and Platforms

8.1.2.1 GAMING Technique

At this stage of maturity of the concept (lifecycle phase V1 in the E-OCVM) it is inadequate to address all elements in the Gaming experiment uniquely through real-time simulation. Detailed procedures are not yet precisely defined and the platform obviously cannot include mature models of SESAR IP2 systems or planning working positions. Therefore, running real-time sessions provides limited outcomes in terms of concept clarification or operability. Real-time sessions are however interesting to capture the temporal aspects of the designed processes such as:

- The duration of CDM processes;

- The continuous refinement of the network operation plans and real-time network monitoring tasks;
- The study of the temporal transition between DCB and AMAN processes;

The organisation of Episode 3 WP3.3.2 Business Trajectory Management Gaming sessions revealed that a good approach at this stage was to mix two types of sessions:

- Structured discussions using the simulator and a predefined scenario as an aid to discuss the different steps of an operational scenario;
- “Pseudo” real-time simulations to capture the temporal aspects.

The experts involved in the Gaming experiment considered that it was very useful for concept clarification and refinement, and for the identification of issues related to concept implementation. The experiment also allowed the identification of some issues related to the use of the technique for the purpose of low maturity concept refinement:

- The designed processes and procedures are very far from the current ones. Therefore, a significant training period is required for the gaming actors to understand fully the impact of those new procedures and concept elements;
- Gaming participants tend to reproduce current practices through different processes and procedures;
- Gaming participants tend to focus on detailed system requirements (e.g., queuing algorithms, graphical representations) rather than on general concept refinement;
- Some of the findings may be very dependant on the models implemented in the platform.

8.1.2.2 GAMING Platform (DARTIS)

The DARTIS platform can be viewed as one of the main outcomes of the experiment as it may provide support to SESAR validation activities. Initially developed for a European Commission project (called CAMES) to study Short Term ATFCM measures (IP1), the platform was progressively upgraded to integrate SESAR features (Business trajectory management and AOC working position, DCB and AMAN queuing processes). Although DARTIS cannot be considered as mature, the platform offers potentially very interesting and unique features:

- It allows the simulation of different interacting planning processes operating at network level and addressing en-route and/or airport arrival congestion;
- It allows the organisation of simulations that cover a large geographic area (up to the whole ECAC area) and a large range of planning roles;
- It simulates different processes operating at different time horizons in either the short-term planning or execution phases and allows the interactions between those processes to be studied;
- It provides a realistic simulation of the continuous update of the traffic demand as the simulation can be fed with actual plans, plan messages and traffic events occurring throughout a day;
- DARTIS could be used in the context of shadow mode on-site simulations and even live-trials (this was the case in the CAMES project);
- DARTIS can be used in fast-time simulation mode to study different hypotheses and produce quantitative results. Such simulations have been performed in the context of Episode 3 for demonstration purposes, but the low maturity of the model prevents an operational interpretation of the results at this early stage.

Conversely, the platform presents some important limitations at this stage:

- As it is very close to current operations in terms of environment (e.g., airspace structures), the platform can be used for the validation of very advanced SESAR DCB concept elements. Referring to the SESAR SJU storyboard three-phases concept development, the platform could be used in the context of the step one (time based operations) and step two partly (trajectory based operations) but certainly not yet in the context of step three (performance based operations);
- There is a need to implement some important missing components such as the management of business trajectories in 2D/3D and the simulation of departure planning processes at departure airports;
- The platform does not include the simulation of ATC operations. Therefore it can only be used (in simulation mode) for the purpose of assessing the operability of DCB processes and not the feasibility of those processes or the feasibility of the implementation of the DCB solutions. For those purposes the platform must be used either in the context of live trials or in conjunction with other ATC oriented platforms.

8.1.2.3 Process Simulation Technique

The Process Simulation validation technique was used in the scope of this exercise to study different TTA allocation strategies and their impact on the negotiation of business trajectories.

From a general point of view, this technique can be viewed as an advanced model-based technique focusing on the interaction between processes. The simulation runs quite fast once the model has been created, and also the value of certain parameters can be easily changed in a fast and easily way.

It is complementary to the Gaming technique as it enables the generation of quantitative elements in support of concept clarification and possibly, at a later stage, operability assessment. However, this technique is limited and can not provide support to the Gaming sessions on-line. For any future ATM assessment, the ideal way of using PROMAS platform to complement Gaming would be after Gaming analyses are concluded. Then, PROMAS would implement the detailed storyboards (i.e. sub-processes, actors, process-durations, protocol of de-blocking prioritisation to be used in case an actor cannot perform a process because it is performing another one) and agreed assumptions coming from Gaming, and would apply the assessment to larger scenarios.

8.1.2.4 Process Simulation Platform

The PROMAS platform was used in the context of the exercise to implement the process simulation validation technique. The experiment demonstrated the ability of PROMAS to perform the modelling of a large range of ATM processes in a very short time frame.

This platform provides qualitative and quantitative results, in the scope of this exercise it could be stressed:

- Qualitative results:
  - Highlight incoherencies;
  - Detection of bottlenecks;
  - Contribution to the concept, DODs and Operational Scenarios refinement.
- Quantitative results (by post-processing):
  - Process view:
    - Number of negotiations/data exchanges;
  - Operational view:
    - Number of flights able to complete certain tasks;
    - Delay distribution generated;

- Percentage of flights that have suffered changes when running the processes;
- Others, depending on the definition of the exercise.

The simulation runs quite fast once the model has been created. However, the development of the model implies a great effort, since it is required to learn the PROMAS language and to define the scenarios in an accuracy level to obtain an optimum model.

This platform has been developed in the scope of this exercise and it has not yet achieved a high level of maturity at this stage, although the main characteristics have already been established. In addition, qualitative results are obtained by post-processing which requires an extra effort apart from the development of the scenario.

It is a promising platform to be used, and particularly in the context of rapid prototyping activities.

8.2 Issues

Some issues or point of interests are identified as follows:

- By nature, the processes designed are generic and can quite easily be extended to the whole ECAC area. However, the validation scenarios focused on a small number of airports that are located at the periphery of the core ECAC area. There may be some specific issues (related for example to inter-FAB co-ordination) that are more critical in the centre of the core area. Further simulations should be set up to focus on airports or airspace located in the core area;
- The Gaming validation scenarios were based on current traffic samples and imbalances were generated by simulating capacity shortfalls. Therefore 2020 traffic patterns were not simulated. Furthermore, it will be worthwhile to study how the defined processes apply to an airport where the demand is close to the capacity most of the day (a situation that is likely to be faced by a significant number of airports by 2030);
- 2D/3D re-routing options were not available in the Gaming platform. This limited the possibility to re-plan business trajectory to cope with TTAs;
- Business trajectory management was mainly considered in relation to the constraints at the arrival airport. Coordination with collaborative decision making processes at departure airports is a key factor to be considered in the overall business trajectory management process;
- Multi-constraint management (i.e., interactions between en-route DCB processes and arrival DCB processes) must be further investigated;
- Advanced network monitoring functions (NOPLA applications) must be integrated in order that collaborative decision making network management processes can be undertaken efficiently (in particular for network managers);
- Despite the significant efforts produced by all Episode 3 WP3.3.2 Business Trajectory Management partners to define a combined and complementary approach for the Gaming and the Process Simulation activities and the close coordination between the validation teams involved, the results provided by the two techniques cannot really be aggregated or combined at this stage. This shows the limits of the initial bottom-up approach and highlights the need to coordinate validation work in detail (including the technical coordination at the level of platforms). Each activity included a significant number of underlying assumptions related to the interpretation of the concept and the limitations of the simulation platforms.

8.3 RECOMMENDATIONS

8.3.1 General Recommendations

8.3.1.1 Concept Clarification on Dynamic DCB and Business Trajectory Management

Most of the operational conclusions provided in the report cannot yet be considered reliable. Additional Gaming simulations are required to have more confidence in these conclusions. Due to the complexity of the issues and the wide range of interconnected processes and concept elements to be considered, an incremental and iterative process should be set-up to include the following validation activities:

- Organisation of iterative gaming/simulations allowing the progressive refinement of the concept elements and models in the platform. Different airports/airspace located in the centre of the core area should be included in the validation scenarios;
- Extension of the scope of the Gaming/DARTIS by considering the interaction with departure airports or complexity management in en-route;
- Set up model-based simulations to study quantitatively the relationship between different operational factors such as the accuracy of 4D business trajectories (SBTs and RBTs), DCB time-based constraint tolerance windows, and requirements related to the traffic to be "delivered" by DCB to an ATC planning process (AMAN, en-route complexity).

8.3.1.2 Validation Techniques

The main recommendations are:

- Even in early stage of concept definition, the use of gaming techniques based on the use of a simulation platform is recommended as it allows crucial temporal aspects to be captured;
- The combined use of Gaming and automated Process Simulation model-based techniques is recommended to have qualitative and quantitative information to draw operational conclusions. However, a full top-down approach should be followed and the techniques should be supported by platforms/tools that share common models to ensure coherency of the qualitative and quantitative outcomes as well as reduced development costs in the context of an iterative validation process.
- For any future ATM assessment, the ideal way of using the Process Simulation model-based technique to complement Gaming would be after Gaming analyses are concluded. Then, PROMAS would implement the detailed storyboards (i.e., sub-processes, actors, process-durations, protocols of de-blocking prioritisation for actors who cannot perform a process because another one is running) and agreed assumptions coming from Gaming as well as would apply the assessment to larger scenarios.

8.3.2 Recommendations to Support the DODs and Operational Scenarios

The exercise mainly confirms the assumptions included in the DODs (mainly [10], [11]) and the operational scenario OS-11 [6] related to business trajectory management and dynamic DCB in the context of arrival traffic management.

In addition, the exercise allowed some elements to be refined (operational parameters, justifications), and also identified/confirmed some open issues related to:

- Regarding the planning processes contributing to the management of arrivals on the days of operations, the DODs consider three layers:
  - A DCB layer working uniquely on flights in the planning phase;
  - A dynamic DCB layer working with a time horizon ranging from 40 minutes to 2 hours ahead of the congested area and managing both flights in the short-term planning and execution phases (with a focus on flights in execution);
  - The "AMAN" process;

  The exercise highlighted the fact that the boundary between dynamic DCB and DCB is not so evident. During the simulations, the actors tended to use the possibility to extend the time planning horizon of dynamic DCB as a function of the severity of the congestion and thus to overlap significantly with the DCB process;

  The exercise also allowed the definition of the boundary between dynamic DCB and AMAN processes to be refined;
- The transition from SBT to RBT. Some elements in the DODs related to the transition from SBT to RBT should be reviewed;
- Concept clarifications: the gap between the AMAN Active Horizon and DCB Queue Active Limit should be higher than 10 minutes;
- Different ad-hoc TTA Allocation Strategies should be allowed in any ECAC airport when a shortfall happens and a DCB Queue process is activated;
- Any TTA Allocation Strategy based on a priority different from 'first planned first served' can receive along its flight many different TTAs. To minimise this from happening there should be a specific period of time before delivering the TTA proposal until is assured that, even with priority, it will be definitive;
- Each ECAC airport should be allowed to allocate different ad-hoc DCB Queue Active Horizons in order to strategically select the preferred sectors where negotiating the best way of adapting to the new TTA;
- Each airport should be able to allocate a different ad-hoc TTA Allocation Strategy, DCB Queue Active Horizon and conditions to trigger UDPP.

8.4 Conclusions

Table 17 below provides an overview of the conclusions for the two very high level exercise objectives.

Objective Description
Concept clarification
Concept clarification was addressed through the qualitative (and partly quantitative) study of the following topics: • **Respective areas of responsibility of dynamic DCB and AMAN processes in the management of congested arrival situations and their interface:** **=>** Main assumptions of the DODs and the operational scenarios are judged as acceptable. Some justifications and refinement are provided related to some of those assumptions; • **Roles and responsibilities of planners in arrival planning processes:**

Objective Description
=> Some roles and responsibilities are clarified, particularly those related to the dynamic DCB process. Some open issues related to the respective roles of Sub-Regional Network Managers and local traffic managers were not addressed by the exercise; • **Interactions between DCB processes and business trajectory management:** **=>** A proposed process for the collaborative management of time-based arrival constraints in BTs (SBTs and partly RBTs) was studied during the Gaming experiment. Some major disagreements between experts remain about the implementation of the concept of business trajectory ownership by airspace users; • **Real-time network monitoring functions and support tools (e.g. NOPLA applications) and automation of network management tasks:** => The Gaming experiment has highlighted the need for advanced tools in support of real-time network management and monitoring. High level requirements have been captured that could be implemented in the Gaming platform for further evaluation; • **UDPP scope and triggering conditions:** => The scope of the UDPP has not been clarified. No real consensus can be drawn on this topic. In the medium severity situations addressed in the exercise, airspace users consider that the triggering of a global negotiation process between airlines is unnecessary.
Exploration of new validation techniques

Two validation techniques were explored in the exercise:
• **Gaming technique:** due to the low maturity of the addressed concept elements two types of sessions where combined:
  o Structured discussions using the simulator and a predefined scenario as an aid to discuss the different steps of an operational scenario;
  o Real-time simulations involving network managers, APOC and AOC.
• **Process Simulation:** can be viewed as an advanced model-based technique.
The exercise demonstrated the ability of Gaming technique to provide structured discussions, and to help refine operational scenarios. The Process Simulation platform, PROMAS, showed its ability to model a large range of ATM processes.

Table 17: Overview of the conclusions for the high level exercise objectives

9 REFERENCES AND APPLICABLE DOCUMENTS

[1] **Episode3** Simulation Report on Business Trajectory Management and Dynamic DCB - Annex A: Gaming Experiment, D3.3.2-02a

[2] **Episode3** Simulation Report on Business Trajectory Management and Dynamic DCB - Annex B: Process Simulation Experiment, D3.3.2-02b

[3] **Episode3** Experimental Plan for Business Trajectory Management and Dynamic DCB, D3.3.2-01, Version 1.00, 05 March 09

[4] **SESAR** D1 - Air Transport Framework: The Current Situation, Edition 3, 31/07/2006;

[5] **SESAR** D3 - The ATM Target Concept, DLM-0612-001-02-00, September 2007;

[6] **Episode 3** OS11 **-** Non-severe capacity shortfall impacting arrivals in the short term Operational Scenario, part of Annex to SESAR DOD G - Operational Scenarios - D2.2-050

[7] **Episode3** ATM Process Model Diagrams, D2.2-01b

[8] **SESAR** D2 - Air Transport Framework: The Performance Target, DLM-0607-001-02-00a, Version 2a, 12/2009

[9] **Episode3** Episode 3 Performance Framework, D2.4.1-04

[10] **Episode 3** SESAR DOD M2 - Medium and Short Term Network Planning Detailed Operational Description, D2.2-043

[11] **Episode 3** SESAR DOD E4 - Network Management in the Execution Phase Detailed Operational Description, E3-D2.2-046.

10 ANNEX A: DETAILED REPORT ON GAMING EXPERIMENT

Please refer to separate document:

Simulation Report on Business Trajectory Management and Dynamic DCB - Annex A: Gaming Experiment [1].

11 ANNEX B: DETAILED REPORT ON PROCESS SIMULATION EXPERIMENT

Please refer to separate document:

Simulation Report on Business Trajectory Management and Dynamic DCB - Annex B: Process Simulation Experiment [2].

END OF DOCUMENT