Demonstration Report (DEMOR) PJ24 NCM

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PJ24 NCM

NETWORK COLLABORATIVE MANAGEMENT

This demonstration report is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 733021 under European Union's Horizon 2020 research and innovation programme.

Abstract

PJ24 Network Collaborative Management (NCM) is a SESAR 2020 Very Large Scale Demonstration project based on a collaborative approach in Air Traffic Flow and Capacity Management (ATFCM), involving the whole spectrum of ATM actors: Airspace Users (AUs), Airports, Air Navigation Service Providers (ANSPs) and Network Manager (NM).

Nine exercises over a large part of Europe with the collaboration of major European airlines, have demonstrated, for several weeks in the timeframe 2017-2019, network performance benefits and opportunities of improved cooperation techniques supported by connected local and network tools. Exercises included demonstrations of:

- Targeted flow and flight measures such as level-capping re-routings, flow and flights ground delays, slot improvements, slot exclusions,
- Target Time of Arrival measures to reduce arrival delay and optimize arrival sequences,
- Early exchange of departure planning information for predictability improvements,
- Sub-regional FMP coordination improvements including meteo coordination.

The cooperative approach between all stakeholders to reduce existing network inefficiencies was seen as the major success factor of demonstration exercises, leading to network performance benefits. NCM operational demonstrations successfully resulted in **significant delay savings**, significant **positive impact on cost-efficiency** due to better (system-supported) workflow processes, **positive impact on predictability**, with **no impact on safety**. Airspace Users concluded that NCM demonstrations benefits outweighed possible negative impact on airlines' operational costs due to non-optimal flight routings.

PJ24 participants recommend operational implementation of successful demonstrated cooperative DCB functions, provided further optimisation of workflow processes.

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1 Executive summary

Introduction

The PJ24 Network Collaborative Management (NCM) project was executed under the SESAR 2020 Multi Annual Programme for Wave 1. It is part of the Very Large Scale Demonstrations (VLD) in the Industrial Research & Validation phase, developed under the SJU Private Public Partnership.

The NCM concept builds on connecting local (including airports) and network operations and improved coordination processes, enabling the application of flight-specific targeted and fine-tuned ATFCM measures. Main objective of this VLD was to demonstrate the maturity of NCM elements validated in the SESAR1 projects and to verify network performance benefits in a larger part of Europe. The concept elements included were ATFCM measures such as Level-Cappings (VP522), Airport – Network Planning integration and Target Times Measures (VP749, iStream), and improved data exchange linking network and local tools (VP700). In addition, NCM included elements that were close to operational introduction, such as Regulation proposals via B2B, targeted flow regulation using improved ATFCM NM Scenario Repository, flight improvements through exclusions and forced CTOTs.

Considering DCB activities from each of the major participants' perspectives, led to the identification of 9 demonstration exercises. These were executed in the timeframe 2016-2019, in a large part of Europe, involving 8 different ANSP's, 4 major airports, the European Network Manager, with the formal contribution (as part of SESAR 2020 program) of major European airlines (the Airline TEAM) representing about 70% of European air traffic and informal contribution of many other airlines. The formal contribution of airlines was introduced after 1 year of exercise preparation, limiting airlines' opportunities to co-design the exercises. Most exercises performed demonstration activities for a period from a couple of weeks to months, mainly at the end of the second quarter of 2019.

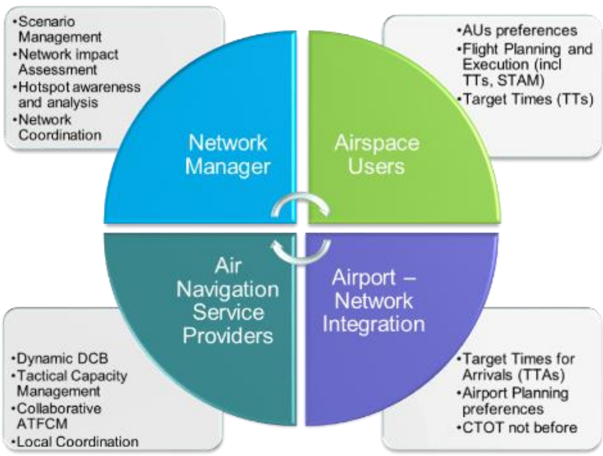


Figure 1: PJ24 scope

The demonstration exercises were performed as much as possible in the operational context to be able to confirm operational performance improvements. Each exercise addressed specific area of focus as indicated in the graph above. All exercises together are considered to address overall network operations and to highlight interactions between the specific exercise and overall network operations.

Exercise	Exercise Title (Demonstration of performance benefits of … and participants)	Focus area
EXE-VLD-24-001	Local measures as part of network collaborative workflow processes (NM, AU, DSNA, DFS)	Network Coordination AU Collaborative Processes
EXE-VLD-24-002a	Targeted measures following B2B data exchange with network collaborative workflow processes (MUAC, NM)	Tactical Capacity Management AU Collaborative Processes
EXE-VLD-24-002b	Targeted measures following B2B data exchange with network collaborative workflow processes in Pre-tactical and Tactical phases (NATS, NM)	Tactical Capacity Management
EXE-VLD-24-002c	Comparing Scenarios and Regulations using B2B data exchange with network collaborative workflow processes in Pre-tactical (DFS, NM)	Tactical Capacity Management
EXE-VLD-24-003a	Integrating airport target measures as part of network collaborative workflow processes (ENAIRE, INDRA, NM, AU)	Airport - Network integration
EXE-VLD-24-003b	Integrating airport target measures as part of network collaborative workflow processes (HAL, NATS, NM, AU)	Airport - Network integration
EXE-VLD-24-004	Targeted level-cap measures following B2B data exchange as part of network collaborative workflow processes (DSNA, ENAIRE, NM, AU)	Tactical Capacity Management AU Collaborative Processes
EXE-VLD-24-005	Sub-regional coordination of targeted measures following B2B data exchange as part of network collaborative workflow processes (AustroControl, COOPANS, SMATSA, NM)	Tactical Capacity Management
EXE-VLD-24-006	Enhanced Coordination of STAMs (ENAIRE, NM, AU)	Tactical Capacity Management AU Collaborative Processes

Table 1: List of exercises

- ***Network Coordination*** - The identification of a local DCB imbalance (possibly supported by automated local tools) initiate a local/network coordination process between relevant local stakeholders and the network based on pre-defined ATFCM scenario (i.e. ATFCM reroute measures) selections by local FMPs and based on network impact assessments (including What-If simulations). Coordinated implemented scenarios and measures will be monitored by both local stakeholders and NM to verify the operational results.

- ***Tactical Capacity Management*** (local level) – The identification of targeted measures to reduce ATFCM delay through optimisation workflow processes supported by integrated data exchange and the introduction of flow- and flight-specific measures as part of the STAM collaborative process in the ANSP local tools (i.e. iFMP, ECOSYSTEM, CAP, iACM and PLANTA).
- ***Airspace User Collaborative Processes*** - The intervention of AUs in the decision-making (STAM proposal, priority flights) was explored. Where appropriate, flexibility is given to select, based on minimized business impact, the flights to which specific measures will be applied.
- ***Airport Network Integration*** (local/network level) – Airport operations planning information (aligned with current processes as A-CDM, gate management, etc) is exchanged earlier with the network operations planning. Airport arrival requirements are shared with the network to optimize delivery of flights to airports with the aim to improve the usage of limited runway capacity and with the aim to enhance network performance, i.e. delay to airspace users.

Different ATFCM techniques have been demonstrated in the NCM demonstration exercises. The (locally) achieved performance results of the exercises all contributed to overall network performance improvements. The picture below shows the techniques and where they have been applied.

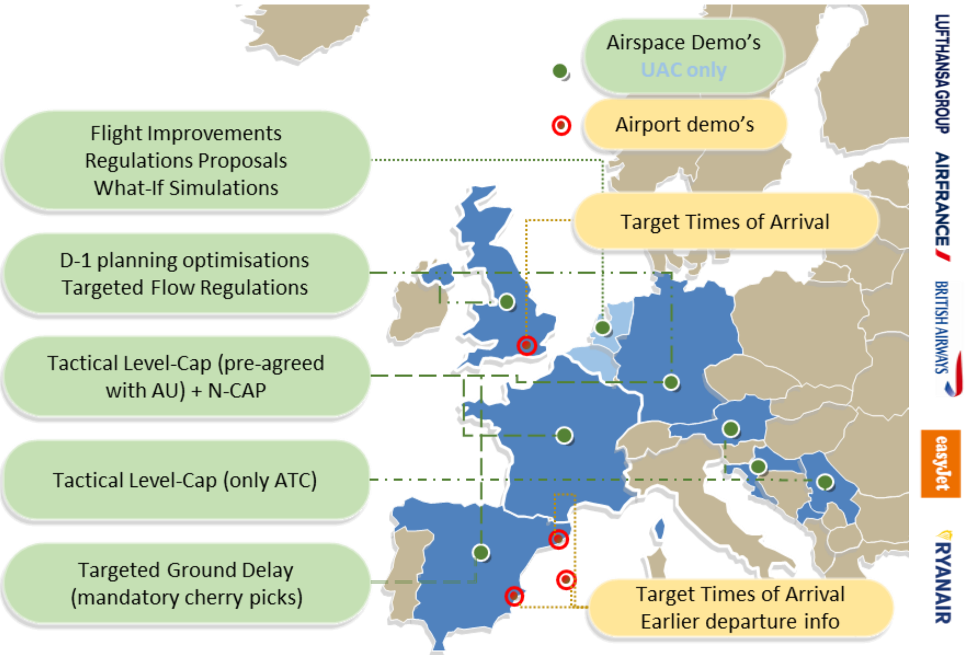


Figure 2: PJ24 geographical scope

Demonstration Users Feedback

Key enabler to the success of NCM demonstration results was undoubtedly the **cooperation between all participants**. Better understanding of different operations and viewpoints lead to identification of better solutions to deal with current network inefficiencies and find opportunities for operational improvements. Unfortunately, the late involvement of aircraft operators, due to the SESAR organisational set-up, limited to a certain extent opportunities for cooperation.

Pre-Tactical Planning Scenarios

FMP staff reported great potential to be able to improve network predictability, optimisation, reduce flight delays and fuel burn through more effective pre-tactical planning, before the day of execution of the flight. With collaborative toolsets, more effective measures (including capacity measures preferably to measures applied on traffic demand) can be proposed with better anticipation, thus reducing or maintaining workload to FMPs and bringing greater overall network benefit.

However, without an improvement in planning data accuracy this is difficult to achieve.

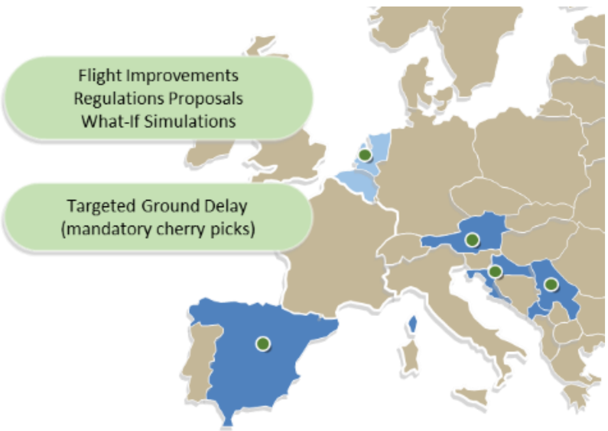
Tactical Targeted Flow Measures (Targeted CASA)

Having the ability to regulate flows rather than traffic volumes led, in some areas, to the observation of significant benefits, whilst respecting a fair distribution of delay to impacted flows and flights.

Targeted flow measures are essentially a "happy medium" between global regulation and cherry pick regulation. The advantage of targeted flow measures is that the FMP workload increase is small compared to measures on individual flights where FMP have to select the best candidate one-by-one, but the overall benefit over global regulation is large. Implementing targeted flow measures is also quite straightforward, as existing systems and processes need very little change as the fine-tuned scenarios can be added to the existing scenario repository, similar to re-route and flight level cap scenarios.

The FMP users were very positive and confident in the overall benefit of using fine-tuned flow measures and their ability to reduce delays and fuel burn penalty (if used instead of massive re-routeing and flight level capping scenarios to balance capacity).

Tactical Fine-Tuned Delay Measures



The system-supported coordination of flight improvements, Regulation and Mandatory Cherry Picking proposals procedures and the What-If simulations received very positive feedback. Measure coordination times were massively reduced, which significantly improved the FMPs' effectiveness.

Improved sector complexity monitoring combined with meteo impact information, resulted in identification of more tactical trajectory improvements in coordination with neighbouring ACC's. This improves the effectiveness of the impact of an FMP (more tactical STAM measures) and leads to reduced ATFCM regulations (less buffer required for sector capacity).

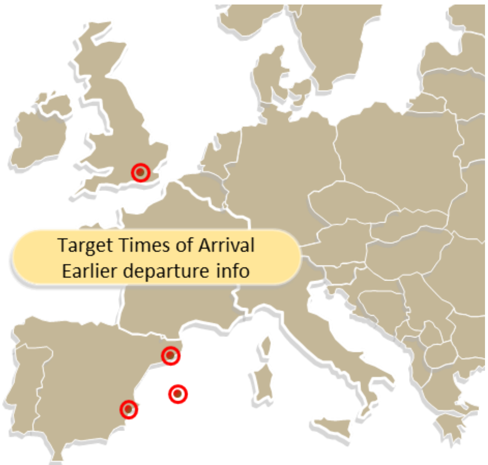
In the exercises where airlines participated, they perceived the collaborative coordination tool (i.e. ATM Portal) as a very good and valuable initiative. It allowed airlines to pick the most important flights on Network and Fleet Level. If a unified prioritization mechanism is devised for the entire European ATM Network, airlines could cover all flights in their schedules as this will help to enlarge the positive effects for the Airline and the Network, provided more integrated system-support is available.

<u>Tactical Level-Capping Measures</u>

Extended CAP Demonstration exercise aimed to demonstrate the benefits for (new) ATM partners, of using fine-tuned measures in the planning phase based on pre-defined flight level capping solutions at strategic phase to solve DCB issues. The demonstration showed that the solution helped to better distribute traffic among sectors and increase Network predictability while reducing the time it takes for FMPs to monitor, analyse, coordinate and implement measures. The easy-to-use solution also improved situational awareness between Area Control Centres and encouraged communication and team working spirit with the participating Airlines.

At a later stage, the opportunity to technically link the CAP tool to the Network was explored (N-CAP). Technically, the interoperability between systems was successful and it provided opportunities for further network performance benefits. Operationally, the exercise contributed to prepare the ground for a more standardised and wider cross-border collaborative process between ATM partners. The NM retrieved a central role in the process providing to the ATM Network with full visibility of partners constraints and needs and supporting standardized exchange between partners via SWIM services.

Target Times of Arrival measures and earlier sharing of airport (departure) planning



The exercise successfully demonstrated the feasibility of the TTA Management process in an extremely busy network period and highlighted where improvements can be made.

There were distinct advantages for participants in the VLD through a reduction of reactionary delay dispersion and ratio reactionary delay to total delay, reduction of delay compared to CASA regulations, a more definite Airport Plan through adherence to CTOTs at outstations, and a semi-automated TTA process. A reduction in AFTM delay of between 26-41% (EGLL) was measured when applying a TTA rule compared with conventional regulation. The Spanish TTA exercises have measured significant reductions in reactionary delays and maximum delays to flights. However, a slight increase of average delay per flight was measured.

From qualitative assessments, ANSP and Airport staff confirmed benefits to operations performance and recommended further optimisation and implementation of TTA operations.

The predictability results measured by the Spanish exercise team show quite clearly that the estimated times of arrival are more accurate when integrating API and DPI messages long in advance of the airport-CDM processes. However, it is not clear how accuracy improvements 9-3 hours before operations benefited airlines operations in terms of increased capacity (for example with less margins taken by ATC in case of capacity constraints or demand peaks) or reduced delay.

Performance results

Safety	Predictability	Fuel Efficiency	Cost-Efficiency	Capacity
=	↑	↑ ↓	↑	↑

NCM has demonstrated network performance benefits as a result of cooperation and better information exchange between operational actors (including Airspace Users) supported by local tools connected to the network. It enabled the application of targeted flow measures and improved cooperation at a European ATM network level with no impact on safety and positive effect on predictability.

Coordination improvements have resulted in massive reductions of time necessary for coordination per measure. This includes the identification, proposal, assessment, feedback and implementation of the measure. A single FMP or NMOC controller was capable of managing many more measure proposals as before, which enables the application of specific flight delay measures.

Over a relatively short period (couple of days/weeks), demonstration exercises were able to show solid delay reductions of **hundreds to a few thousand minutes of delay** by minimizing the impact of otherwise applied global regulation. In the exercises that included measures to many flights (e.g MUAC flight improvements, or Heathrow's TTA's) delay reductions are estimated to add to **thousands of minutes of delay savings**.

During the trials, fuel efficiency of impacted flights receiving reroute proposals dropped. Overall, it was estimated that several dozens of kg, sometimes well above 100kg **of additional fuel per flight** was required to fly at lower altitudes or re-routing to avoid ATFCM regulations. However, applying targeted measures and avoiding regulation could result in fuel savings. Demonstrations and simulations in the FABCE area and target time demonstrations at London Heathrow showed opportunities for fuel reduction resulting from more flights on optimal tracks and less holding time because of targeted measures and better managed arrival times.

For airlines, the reduced delay measures results in less impact to the passengers and less financial impact for the company. E.g. if a delayed flight is approaching crew duty time limitation or curfew, reduced delay measures could avoid costly measures as additional ferry flights, or other unplanned flights for positioning.

Overall conclusion of NCM demonstrations is that the cooperative and transparent approach to address current network inefficiencies, and to apply flight- and flow-specific targeted measures supported by integrated system-supported coordination processes, leads to significant network performance benefits.

Main conclusions:

- Cooperative approach of NCM involving all stakeholders is main contributor to reduce current network inefficiencies.
- Flight-specific Delay and Reroute measures contributed to significant reductions in delay and to improved operations coordination processes.
- Using airport arrival times in network operations (through TTA induced CTOTs) contributed to significant delay reductions compared to classical regulations.
- System-supported network coordination workflows (linking local and network tools) spectacularly improved efficiency of operational coordination processes.
- There is great potential to be able to improve network predictability, optimisation, reduce flight delays and fuel burn through more effective pre-tactical planning. However, currently predictive input data of NM systems is too inaccurate to produce a useful D-1 planning.
- Having the ability to regulate flows rather than traffic volumes led, in some areas, to the observation of significant benefits. Targeted flow measures are essentially a “happy medium” between global regulation and cherry pick regulation.

Main recommendations:

- Continuation of cooperative approach with all stakeholders to implement NCM’s successfully demonstrated functionalities.
- Ensure through establishment of high-level coordination body that NCM implementations provide a positive business case to all stakeholders, including Airspace Users.
- Invest in system-supported network coordination of delay and level-capping measures and study (semi-)automatic acceptance of measures proposals.
- Urgent need for ‘single’ interface of network operations, linking local tools to network systems, to provide transparency and coordination efficiency to all stakeholders, in particular airspace users.
- Clarify TTA implementation strategy at local and network level and deploy dedicated TTA implementation (not using MCP mechanisms).

- Communicate and pursue wider operational notion on how to deliver TTAs to minimize airport disruptions.
- Recommendation to review next steps of TTA process (fly to TTA) with a focus on pre-notifications of impacted flights, dynamic and standardized process regarding prioritization of flights, and on integration with existing flight planning processes such as fuel planning, crew planning etc.
- ANSP's to analyse the feasibility of targeted flow measures and to add options to the network ATFCM toolbox.
- Study to improve D-1 traffic predictability to enhance network performance through more effective D-1 pre-tactical planning.

Next steps

For industrialization and deployment, a step-by-step implementation of DCB functionality is recommended. For implementation, attention to possible additional workload to assess re-route-, delay- or target-time-proposals by operational staff needs to be minimized to keep a positive balance, by increased automation and collaboration.

2 Introduction

2.1 Purpose of the document

This document is the Demonstration Report (DEMOR) of PJ24 Network Collaborative Management (NCM), which is a Very Large Scale Demonstration (VLD) project of SESAR 2020. It describes the scope, exercise observations and results of the performed NCM/PJ24 demonstrations[1] during 2016-2019.

2.2 Scope

The demonstrations addressed the essential elements of the Network Collaborative Management concept:

- identification, coordination and implementation of fine-tuned and targeted flight and flow measures as part of Network operations, encompassing all the points of view of participating ATM actors: NM, ANSPs, Airports and AUs
- benefit of connecting local (ANSP and Airport) tools and network tools through specifically designed and developed interfaces and using SWIM services
- bringing together the local (ANSP and Airport) and the network knowledge in order to ensure the implementation of the optimum ATFCM measure/set of measures
- facilitation of CDM process towards a collaborative management of the entire network
- integration of the local DCB and airport planning needs into the overall Network Plans
- where possible, AUs preferences taken into account and used for addressing their specific needs and requirements within the general context of network and airport operations.

2.3 Intended readership

The intended readership of the PJ24 demonstration report can be divided in two main categories:

- SESAR 2020 internal readers
- External readers.

Referring to the first category, the primary intended readers of this document are the SJU and the PJ24 NCM partners who can use the document as justification of achieved results.

[1] "The opinions expressed herein reflect the author's view only. Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein"

Other intended SESAR 2020 internal audiences will include:

- SESAR 2020 PJ25 Arrival Management Extended to En-Route Airspace
- Other SESAR 2020 interested projects such as PJ07 (Optimised Airspace User Operations), PJ09 (Advanced Demand & Capacity Balancing), PJ04 (Total Airport Management), etc.

The second category, the external readers, might include the following potential readers, other than the ones participating to the SESAR 2020 Programme:

- ANSPs
- Airports
- Industry
- AUs
- R&D institutes and organisations
- ATM professional organisations
- Trade publications and other media channels
- EU bodies.

2.4 Background

PJ24 Network Collaborative Management (NCM) is part of the SESAR 2020 Multi Annual Programme for the Wave 1 period (2016-2019). It is part of the Very Large Scale Demonstrations (VLDs) in the Industrial Research & Validation phase, developed under the SJU Private Public Partnership. It took into account the outcome of several projects and Operational Focus Areas (OFA) and activities already performed in SESAR 1 referring to the DCB processes and the different ATM actors involved, namely:

- OFA 5.1.1 Airport Operations Centre integration and management
- OFA 5.3.4 Enhanced ATFCM Processes
- OFA 5.3.7 Network Operations Planning
- Large Scale Demonstration FAIRSTREAM
- Large Scale Demonstration iSTREAM (CTOT to TTO part)
- Large Scale Demonstration TOPLINK (Enhanced Situation Awareness for FMP).

There was also a series of validation exercises conducted under these different SESAR 1 Projects, all addressing the DCB aspects from the local and/or network perspective:

- VP522 (STAM V3 Trial)
- VP700 (Interconnectivity local-network)
- VP749 (Arrival DCB hotspot, AOP-NOP integration).

The focus of PJ24 was to demonstrate the maturity of validated concepts and newly identified operational improvements, using mature concepts of SESAR 1, and their ability to be proofs of concept for the ATM Functionality #4 (Network Collaborative Management) of the PCP IR (EU) No 716/2014 [49].

PJ24 is a VLD project and, therefore, its demonstration activities go beyond "Industrial Research", using end-user systems. These systems aim to be integrated after the end of these SESAR 2020 demonstration activities into the current daily ATM operations. Therefore, demonstration preparation activities included compliance with current quality management processes for safety, security, certification, etc.

2.5 Structure of the document

Chapter 1 – Executive summary: this chapter provides an overview of the process of PJ24 demonstration activities.

Chapter 2 – Introduction: this initial content chapter of PJ24 DEMOR provides the main elements on which PJ24 activities are based upon: project purpose and scope, background information, structure and intended readership, as well as the used definitions and acronyms for a better understanding of the concept elements and the SESAR 2020 general framework.

Chapter 3 – VLD scope: this chapter focuses on the specific scope of the VLD and the identification of SESAR 1 Solutions and operational improvements that define the scope of NCM demonstration activities. The chapter also clearly identifies the project contribution to PCP.

Chapter 4 – Demonstration Results: the fourth chapter is dedicated to the project management specific processes, highlighting the project demonstration results. The content of the chapter is describing the results in terms of Stakeholder (Network, ANSPs, Airports and Airspace Users), per KPI expecting an impact. This chapter also details results of each of the objectives described in the DEMOPlan and the level of confidence.

Chapter 5 – Conclusions and recommendations: this chapter includes the overall conclusions at work package and project level, together with some lessons learnt for continuing the activities after PJ24.

Chapter 6 – Summary of communications and dissemination activities: it makes description of all the initiatives made during the project schedule in terms of communication activities.

Chapter 7 – References: this chapter contains all the reference documentation upon which this DEMOP was elaborated.

Appendix A to I – Individual exercises results. (Possibly in separate document because of size)

Appendix J – Chapter for the Safety Assessment

Appendix K – Chapter for the Security Assessment

Appendix L – Chapter for the Human Performance Assessment

Appendix M – It describes the activities for continuing the process of maturing the concepts included in the Report.

2.6 Glossary of terms

Term	Definition	Source of the definition
Network Collaborative Management	The collaborative approach to manage ATM network resources.	PJ24 Demonstration report
Mandatory Cherry Picking	The process of FMP's selecting a number of flights to reduce a peak in traffic demand in order to avoid or reduce the need for an ATFCM Regulation	PJ24 Demonstration report
ATFCM Scenario	A set of ATFCM measures to balance airspace capacity with predicted traffic demand	PJ24 Demonstration report
ATFCM Regulation	Setting of a maximum number of flight to enter into a certain pre-defined area or point, which could result in delay to flights	PJ24 Demonstration report
Targeted flow regulation	ATFCM regulation only applicable to a certain flow in a pre-defined area or point.	PJ24 Demonstration report
Flight Exclusion	Removal of a flight out of a regulation (and out of traffic counts)	PJ24 Demonstration report
Demand Capacity Balancing	The process of balancing the number of expected flighs with the available airspace capacity.	PJ24 Demonstration report

Network Operations	The overall of ATM activities occurring in the (European) network	PJ24 Demonstration report
Network Manager	The European Network Manager as indicated in the NM IR.	PJ24 Demonstration report
STAM	ATFCM measures that target only specific flows or flights instead of entire groups of flights (as in ATFCM regulations)	PJ24 Demonstration report
Level Cap	An ATFCM measure to lower the flightlevel of a flight to avoid the flight entering an overloaded or busy sector	PJ24 Demonstration report
Airport CDM	The collaborative decision making process at an airport.	PJ24 Demonstration report
Mandatory Cherry Pick (MCP) regulation	A regulation used as a measure to solve short peaks (e.g. 1h or 1h 30min) of limited number of flights in congested areas. It consists of selecting flights creating complexity and applying ATFCM measures only to those flights. It may be used in combination with other measures (e.g. regulation, scenario, etc.) or other options available to the FMP.	ATFCM OPS Manual ed. 20.0/05.04.2016
Pre-tactical	Time indication of activities on 1 day before the day op operations. E.g. Pre-tactical planning means the planning activities performed on the day before the day of operations.	PJ 24 Demonstration report
Tactical	Time indication of activities on the Day of Operations. E.g. Tactical Capacity Management are capacity management activities performed on the day of operations	PJ24 Demonstration report
Target Time	In A-CDM, a target time relates to the time of an airport milestone and serves as a "contract" between partners who are thus committed to achieving the milestone at this time. The time is derived only through a collaborative process and is used for milestone monitoring	SESAR, working package 6, Airport Definitions Team

Target Time Over	A planning time computed by ground systems for flight planning and execution to coordinate at network level and enhance the effectiveness of ATFCM measures for congestions at en-route locations..	SESAR Concept of Operations Step 1,Edition 2015
Target Time of Arrival	An ATM computed arrival time. It is not a constraint but a progressively refined planning time that is used to coordinate between arrival and departure management applications	SESAR Concept of Operations Step 2 Edition 2014 (Ed. 01.01.00)
Local	This refers to ATM activities without specific network focus, such as local ANSP and/or local Airport acti vities.	PJ24 Demonstration report

Table 2: Glossary of terms

2.7 List of Acronyms

Acronym	Definition
A-CDM	Airport Collaborative Decision Making
ACC	Area Control Centre
ACM	Airspace & Capacity Management
A-DCB	Airport Demand Capacity Balancing
AFUA	Advance Flexible Use of Airspace
AIP	Aeronautical Information Publication
AIRM	ATM information reference model
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider
AO	Aircraft Operator
AOC	Aircraft Operations Centre
AOLO	AO Liaison Officer (with EUROCONTROL/NMOC)
AOP	Airport Operations Plan
AOWIR	Aircraft Operator's What-If Rerouting tool
ALDT	Actual Landing Time
API	Arrival Planning Information

APOC	Airport Operations Centre
ASM	Airspace Management
AU	Airspace User
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATMP	ATM Portal (MUAC tool)
ATOT	Actual Take-Off Time
ATS	Air Traffic Services
AU	Airspace User
B2B	Business to Business
B2C	Business to Customer
BCN	Barcelona Airport (IATA code)
CAP	Collaborative Advanced Planning
CASA	Computer Assisted Slot Allocation
CCO	Continuous Climb Operations
CDO	Continuous Descend Operations
CDM	Collaborative Decision Making
CFSP	Computer Flight Plan Service Providers
CIAO	CFMU (NM) Interface for Aircraft Operators
CIFLO	CFMU (NM) Interface for Flow Controllers
CO2	Carbon dioxide
CONOPS	Concept of Operations
CP	Cherry Pick
CR	Change Request
CTM	Collaborative Traffic Management
CTOT	Calculated Take-Off Time
D-1	1 day before Day of Operations
D0	Day of Operations
dDCB	dynamic Demand and Capacity Balancing
DCB	Demand and Capacity Balancing

DEMOP	Demonstration Plan
DEMOR	Demonstration Report
DLA	Delay message
DOW	Description of work
DPI	Departure Planning Information (p-predicted, e-early, t-target, s-sequence)
DTW	
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
EC	European Commission
ECAC	European Civil Aviation Conference
E-DPI	Early-DPI
EFD	ETFMS Flight Data
EFPL	Extended Flight Plan
EGLL	London Heathrow Airport
ELDT	Estimated Landing Time
EOBT	Estimated Off-Block Time
E-OCVM	European Operational Concept Validation Methodology
ETFMS	Enhanced Traffic Flow Management System
ETOT	Estimated Take-Off Time
EU	European Union
EXE	Exercise
FIR	Flight Information Region
FL	Flight Level
FOC	Flight Operation Centre
FPL	Flight Plan
FLS	Flight Suspension
FMP	Flow Management Position
FSA	First System Activation message
GA	Grant Agreement
GD	Ground Delay
H2020	HORIZON 2020 (research and innovation program of the EU, 2014-2020)
HMI	Human Machine Interface

HOEC	Heathrow Operational Efficiency Cell (airport)
HP	Human Performance
HPAR	Human Performance Assessment Report
HPRM	HP reference material
iAMAN	Paris' ATFCM tool for Arrival Management
ICAO	International Civil Aviation Organization
iFMP	Integrated FMP tool (MUAC)
INTEROP	Interoperability Requirements
IP	Internet Protocol
IR	Industrial Research project
ISRM	Information service reference model
kg	Kilograms
KPA	Key Performance Area
KPI	Key Performance Indicator
LEAL	Alicante Airport (ICAO code)
LEBL	Barcelona Airport (ICAO code)
LEPA	Palma de Mallorca Airport (ICAO code)
LHR	London Heathrow airport (IATA code)
LTP	Linked Third Party
LVP	Low Visibility Procedures
MCP	Mandatory Cherry Pick
MET	Meteo
MPR	Most Penalizing Regulation
MUAC	Maastricht Upper Airspace Centre
N-CAP	Network Collaborative Advanced Planning (network-connected CAP tool (DSNA))
NCM	Network Collaborative Management
NEST	Network strategic Simulation Tool
NID	Network Impact Display
NMOC	Network Manager Operations Centre
NOP	Network Operations Plan
NOTAM	Notice to Airmen

NM	Network Manager
NMF	Network Management Function
NOP	Network Operations Plan
OCC	Airline Operational Control Centre
OFA	Operational Focus Area
OI	Operational Improvement
OPAR	Operational Performance Assessment Report
OPS	Operations
OSED	Operational Service and Environment Definition
PAR	Performance Assessment Report
PBN	Performance Based Navigation
PCP	Pilot Common Project
P-DPI	Predicted Departure Planning Information
PIRM	Programme Information Reference Model
PJ00	Project No. 00
PJ00-01	Solution No 01 in PJ00
PLANTA	Prototype Local And Network Tool for ATFCM
PoC	Point of Contact
Q	Quarter (e.g. Q1 is first Quarter)
QoS	Quality of Service
R&I	Research and innovation
R&D	Research and development
RAD	Route Availability Document
RDT	Rapid Development Thunderstorm
REG	Regulation
RR	Re-Route
RRP	Re-route proposal
SAC	Safety Criteria
SAM	Slot Allocation Message
SAR	Safety Assessment Report
SATCA	Spanish ATC system
SecAR	Security Assessment Report

SESAR	Single European Sky ATM Research Programme
SDD	Service Description Document
SE-DMF	System Engineering Data Management Framework
SID	Standard Instrument Departure
SIMEX	Simulation tool of NM system
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
SRM	Safety reference material
STAM	Short Term ATFCM Measure
STAR	Standard Arrival Route
STW	Slot Tolerance Window
SWIM	System Wide Information Model
TA	Transversal Action
TBS	Time Based Separation
TCM	Tactical Capacity Management
TLDT	Target Landing Time
TMA	Terminal Manoeuvring Area
TRL	Technology Readiness Level
TS	Technical Specification
TT	Target Time
TTA	Target Time of Arrival
TTO	Target Time Over
TTOT	Target Take-Off Time
TV	Traffic Volume
UDPP	User Driven Prioritisation Processes
UK	United Kingdom
UTC	Coordinated Universal Time (Zulu time)
VA	Volcanic Ash
VLD	Very Large Demonstration
VLSD	Very large-scale demonstration
WAN	Wide Area Network
WP	Work Package

XMAN	Cross- Border Extended Arrival Manager

Table 3: List of acronyms

3 Very Large Demonstration (VLD) Scope

PJ24 NCM VLD have been conducted through a series of (shadow) operational live trials, involving all the ATM actors described in the overall scope of the Network Collaborative Management:

- NM – through the involvement of NMOC OPS staff and operational systems
- ANSPs – through the involvement of OPS staff from the FMP positions and ATCOs
- Airports – through the involvement of OPS staff and APOC
- AUs – through a series of demonstration flights, through involvement of their FOC, coordinated and synchronised with the other ATM actors in support of the planned demonstration activities.

3.1 Very Large Demonstration Purpose

This VLD project is aimed at demonstrating that the dDCB concept elements validated in the SESAR 1 validation exercises VP522, VP632, VP700, VP749 and the Large Scale Demonstration (LSDs) FAIRSTREAM, iSTREAM and TOPLINK, as well as additional identified operational improvements, are ready to be deployed at a very large geographical scale in Europe, as depicted below in figure 2.

The demonstration exercises were performed in a network context (i.e. linking local with network).

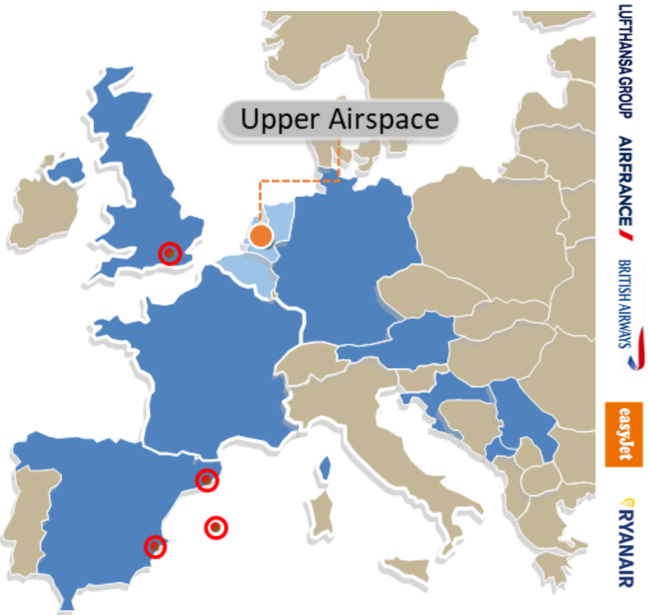


Figure 3: PJ24 geographical scope

3.2 SESAR Solution(s) addressed by VLD

For all the SESAR 1 Solutions listed below in the Table 3, the applicable Integrated Roadmap Dataset is Dataset (DS) 16, as this DS is considered as the baseline DS for SESAR 2020 activities. All the footnotes associated with Table 3 are coming from the Contextual Notes published on the SJU website for each of the selected SESAR Solutions. The EATMA version considered for the creation of the first version of PJ24 DEMOP is EATMA 8.0.

SESAR Solution ID and Title	SESAR Solution Description	OI Steps ref. (coming from EATMA)	Enablers ref. (coming from EATMA)
SESAR 1 **Solution #17** Advanced Short ATFCM Measures (STAM)	Advanced Short ATFCM Measures (STAM) supported by automated tools for hot spot detection at network level enabling ANSPs to optimise traffic throughput.	DCB-0308	NIMS-13b NIMS-27 PRO-22 PRO-247 SWIM-APS-03a SWIM-APS-04a SWIM-INFR-05a SWIM-NET-01a
SESAR 1 **Solution #18** CTOT and TTA	Transition from CTOT to CTOT & TTA.	DCB-0208 (* adherence to TT was removed from this OI)	ER APP ATC 17 NIMS-21a NIMS-38 AOC-ATM-13 AOC-ATM-20 SWIM-APS-03a SWIM-APS-04a SWIM-INFR-05a SWIM-NET-01a ER APP ATC 162 NIMS-43 SWIM-SUPT-01a SWIM-SUPT-03a

			SWIM-SUPT-05a
SESAR 1 **Solution #19** Automated support for Traffic Complexity Detection and Resolution	Automated tools support the ATC team in identifying, assessing and resolving local complexity situations.	CM-0103-A[2]	NIMS-37
			PRO-220a
			PRO-220b
			ER APP ATC 93
			SWIM-APS-03a
			SWIM-APS-04a
			SWIM-INFR-05a
			SWIM-NET-01a
			A/C-37a
			ER APP ATC 82
			ER APP ATC 100
			ER APP ATC 149a
			ER APP ATC 162
			SWIM-SUPT-01a
			SWIM-SUPT-03a
			SWIM-SUPT-05a
		CM-0104-A[3]	ER ATC 924
			PRO-220a
			PRO-220b
			A/C-37a
			ER APP ATC 82
			ER APP ATC 162
SESAR 1 **Solution #20** Collaborative NOP for	Collaborative NOP for Step 1.	DCB-0103-A	AIRPORT-38
			METEO-06b

[2] APP ATC 93 "Enhance Resource Management and Planning Tools to use Traffic Complexity Assessment" needs to be unlinked to CM-0103-A. It will remain linked only to CM-0102-A (and solution #66).

[3] According to the Solution #19 Contextual [52] published on SJU's website, note APP ATC 92 "ATC tools to re-organize traffic flows to reduce complexity". Not addressed by the solution. The enabler should be unlinked to CM-0104-A and linked to CM-0104-B as a backlog to be addressed in SESAR2020

[4] ER ATC 92 needs to be limited to the scope of the solution #19: traffic complexity resolution in the planning phase. It has been proposed to be split.

Step 1			MIL-0502
			NIMS-13b
			NIMS-14b
			NIMS-25
			PRO-028
			REG-0518
			SWIM-APS-01a
			SWIM-APS-02a
			SWIM-APS-03a
			SWIM-APS-04a
			SWIM-INFR-05a
			SWIM-NET-01a
			MIL-0501
			SWIM-SUPT-01a
			SWIM-SUPT-03a
			SWIM-SUPT-05a
SESAR 1 **Solution #21** Airport Operations Plan and AOP-NOP Seamless Integration	Airport Operations Plan (AOP) and Integration of airports into ATM (AOP-NOP Integration) through Monitoring of Airport Transit View and Collaborative Airport Performance Management.	AO-0801-A; AO-0802-A; AO-0803; DCB-0310	AIRPORT-02
			AIRPORT-03
			AIRPORT-35a
			AIRPORT-04
			AIRPORT-40
			CTE-C06b
			HUM-003
			HUM-007
			HUM-014
			HUM-015
			HUM-016
			NIMS-41
			REG-0510
			AIRPORT-31 (pre-SESAR)
			AERODROME-ATC-57
			AIRPORT-38 (Solution #20)
			AOC-ATM-13 (solution #18)
			PRO-028 (Solution #20)

			PRO-073a
			METEO-03 (Solution #35)
			METEO-04b (Solution #35)
			SWIM-APS-03a (Solution #31)
			SWIM-APS-04a (Solution #31)
			SWIM-INFR-05a (Solution #31)
			SWIM-NET-01a (Solution #31)

Table 4: SESAR Solution(s) under Demonstration

3.2.1 Deviations with respect to the SESAR Solution(s) definition

PJ24 demonstration aimed to align with the SESAR 1 solutions that were identified as the baseline for the NCM demonstration activities. However, some additional DCB concepts have been added to the scope of PJ24 that were identified by operational staff as mature (e.g. ATFCM scenario usage in DCB context, Targeted Flow regulations, flight improvements/exclusions from regulations, etc.).

With regard to solution 18, from CTOT to TTA, some results regarding elements related to the solution are still being discussed. For the exercises in PJ24 it was decided to include Target Time as part of the scope. The project team considered Target Time planning sufficiently promising to demonstrate performance benefits in specific circumstances for participating airports.

3.3 Contribution to PCP

The project addressed the enhanced DCB procedures in a collaborative environment and the definition and development of the Complexity and Capacity solutions at the local and network level. It paves the way for assessing the benefit of the Network Collaborative Management concept as described in the Pilot Common Project (PCP) and the demonstrations executed in this project will serve as proof of concept for the ATM Functionality **AF#4 (Network Collaborative Management)** as defined in the PCP IR .

3.4 Summary of Demonstration Plan

3.4.1 Demonstration Plan Purpose

Please refer to section 3.1

3.4.2 Operating method description

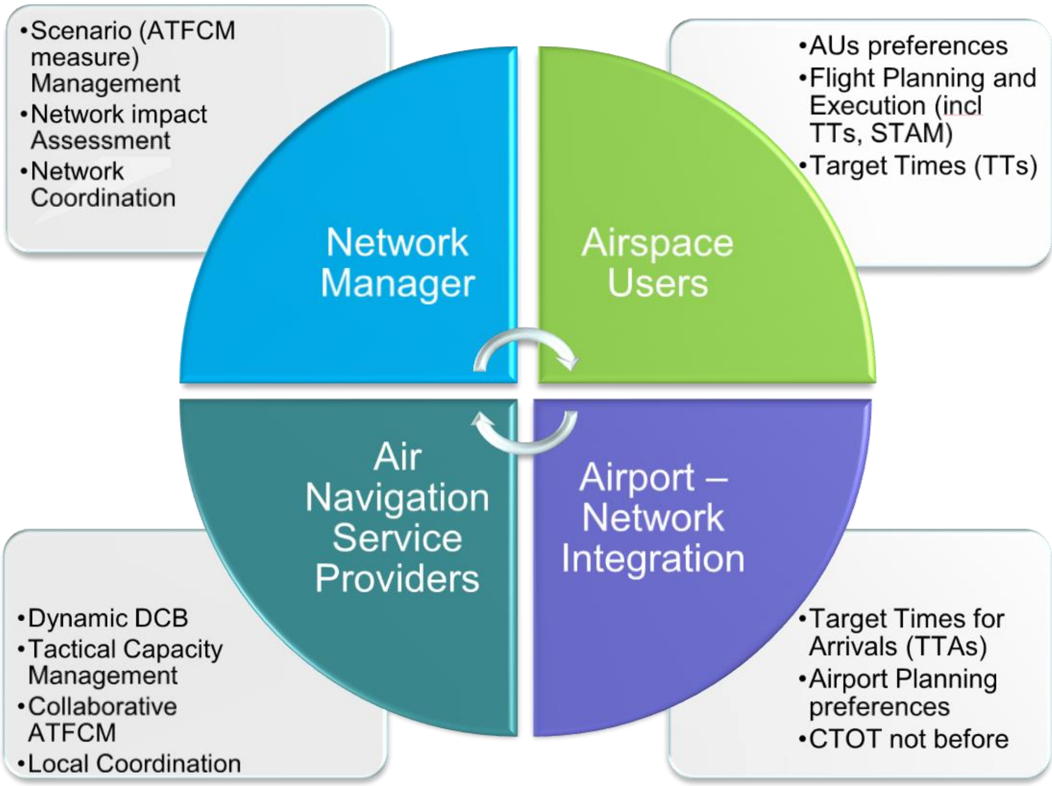


Figure 4: NCM Scope

Network Collaborative Management brings different planning operations by main actors in Network Operations together in a network operations environment. In this paragraph the use cases are described for the planning functions from the perspective of the individual actor.

The planning functionality of the Network Manager typically takes place in the strategic and pre-tactical domain, preparing and optimising the network for operational usage. In the tactical domain the NM mainly supports the FMP function in operating and using network.

In the more dynamic Demand Capacity Balancing operational concept as developed and validated in SESAR1, the NM needs to further develop the optimization and support functions to network operations to facilitate network operations with fine-tuned and targeted measures following a dynamic workflow process with all relevant operational stakeholders.

The use cases addressed from the perspective of the NM focus on improved and more dynamic Scenario Management functions to support transparency in the network for the benefit of performance improvements for Airspace Users.

ANSPs started already moving towards fine-tuned management of traffic towards targeted measures for individual flights instead of rough measures for groups of flights with STAM. The STAM processes have been applied generally in a local context between ANSP and relevant AU or between adjacent ANSPs on a tactical basis without the connection with network operations.

SESAR 1 validation trials were performed to test STAM processes in a network operational environment, mainly between ANSPs and AU's. The concept of network-wide STAM was successfully validated; however major improvements are required to be able to demonstrate the STAM workflow processes in an operational environment. Main improvements suggested are the simplification of the STAM coordination process and to tailor the workflow coordination process to include the relevant stakeholders (including NM and airports) and not always all the stakeholders, depending on the operational context.

In addition, while initial STAM validation trials focussed on a network-wide platform for coordination processes, later validation trials tested the feasibility of connecting local tools (via SWIM data exchange) with network systems.

The addressed STAM use cases have been originated from the validation results, but tailored to the current operational workflow processes. They are addressing local optimisation processes using simplified STAM workflow processes, including also the network perspective in the coordination processes where required, and using both network and local tools in the coordination processes, always addressing the planning phase and not the airborne phase of flights.

Through the A-CDM programme, improvements were implemented enhancing the link between airport operations and network operations. A-CDM mainly focusses on linking of the airport ground processes to achieve an end-to-end workflow process at an airport level with all relevant airport operational actors. Concretely the arrival phase was linked to the departure phase through the turn-around process. For the En-Route part of network operations this resulted in improved information about the departures from A-CDM airports.

In a more dynamic network operational environment, airport and network planning processes needed to be further linked to include also airport arrival requirements in network operations. The demonstration exercises related to Airport – Network integration focused on integrating airport arrival requirements into network planning processes and identifying resulting Target Times measures. Measures for airport arrival requirements could be any measure, but typically Target Times measures seem to apply.

The use cases for airport network integration focus on bringing airport proposed measures (target times mainly) in the network coordination processes and on the monitoring of the delivery of arriving flights according to the requested target times.

Use Cases identified in the DEMOP to be covered by the different exercises are the included in the following table.

UC Id	Use Case title	Focus
UC-1.1	Implementation of optimised measures from AU perspective	Network Manager Airspace Users
UC-1.2	Network Optimisation supported by improved transparency and impact assessment.	Network Manager Airspace Users
UC-2.1	ACC-NM Coordination of CASA Regulations. NM network impact assessment and data distribution	ANSPs
UC-2.2	ACC-NM Coordination of Ground Delay STAMs. NM network impact assessment and data distribution	ANSPs
UC-2.3	ACC-AO Coordination of Ground Delay STAMs. NM network impact assessment and data distribution	ANSPs
UC-2.4	ACC-ACC Coordination of Flight Level Capping STAMs. NM network impact assessment and data distribution	ANSPs
UC-2.5	ACC-NM-AO Coordination of Flight Level Capping STAMs/Scenarios. NM network impact assessment and data distribution	ANSP
UC-2.6	ACC-ACC Coordination of Horizontal Re-routing STAMs. NM network impact assessment and data distribution	ANSP
UC-2.7	ACC-AO Coordination of Horizontal Re-routing STAMs. NM network impact assessment and data distribution	ANSP
UC-2.8	ACC-NM Coordination of Flow Specific CASA Regulations. NM network impact assessment and data distribution	ANSP
UC-2.9	ACC-ACC Coordination of Ground Delay STAMs	ANSP
UC-2.10	Automatic update of local configuration plan	ANSP
UC-2.11	Managing Atmospheric/Met impact	ANSP
UC-2.12	Complexity	ANSP
UC-3.1	Detect Arrival Demand & Capacity imbalance during the planning phase	Airports
UC-3.2	Analysis and Coordination of the A-DCB management proposals during the planning phase	Airports
UC-3.3	NM acceptance of the A-DCB management proposals during the planning phase	Airports
UC-3.4	Detect and Resolve Arrival and Departure Demand & Capacity imbalance between multiple airports during the Short Term planning and Execution phases. Depart to	Airports

	CTOT and FLY to TTA	
UC-3.5	Dynamic Exchange of arrival and departure information from airport to network as from FPL reception	Airports
UC-3.6	Dynamic Exchange of arrival and departure information from airport to network before FPL is filed	Airports
UC-3.7	Multi-airport integration through linking dynamic exchange of early departure information and estimated landing times	Airports

Table 5: NCM VLD Use Cases

The exercises were iteratively built towards supporting the following use case areas:

- **UC-1.1 Implementation of optimised measures from an AU perspective.** Measures received from the network (local FMPs) are assessed, analysed by AU staff and, if necessary, alternatives are proposed and coordinated.
- **UC-1.2 Network optimisation supported by improved transparency and impact assessment.** The connection of local tools and measures as input to the network systems allow for transparency to network actors (NMOC, AU, FMPs, APOCs). Local measures that are identified by FMP supported by local tools are with NM B2B services shared and coordinated with the network.
- **UC-2.1 ACC-NM Coordination of CASA Regulations.** NM network impact assessment and data distribution. This use case area includes workflows required for ACC FMPs to electronically coordinate CASA regulations with NM NMOCs. The NMOC would perform a network impact assessment before approving the regulation request. The NM infrastructure would be used for the coordination (B2B service) mechanism and to distribute the resulting flight planning updates across the network.
- **UC-2.2 ACC-NM Coordination of Ground Delay STAMs.** NM network impact assessment and data distribution. This use case area includes workflows required for ACC FMPs to electronically coordinate ground delay STAMs (i.e. MCP) with NM NMOCs. The NMOC would perform a network impact assessment before approving the regulation request. The NM infrastructure would be used for the coordination (B2B service) mechanism and to distribute the resulting flight planning updates across the network.
- **UC-2.3 ACC-AU Coordination of Ground Delay STAMs.** NM network impact assessment and data distribution. This use case area includes workflows required for ACC FMPs to electronically coordinate ground delay STAMs (i.e. MCP) with AUs. The NMOC would perform a passive network impact assessment and in the unlikely event of any issues, they would contact the ACC FMP by telephone. The NM infrastructure would be used for the

coordination (B2B service) mechanism and to distribute the resulting flight planning updates across the network.

- **UC-2.4 ACC-ACC Coordination of Flight Level Capping STAMs.** NM network impact assessment and data distribution. This use case area includes workflows required for ACC FMPs to electronically coordinate flight level capping STAMs (i.e. MCP) with other ACCs. The NMOC would perform a passive network impact assessment and in the unlikely event of any issues, they would contact the ACC FMP by telephone. The NM infrastructure would be used for the coordination (B2B service) mechanism and to distribute the resulting flight planning updates across the network.
- **UC-2.5 – ACC-AU Coordination of Flight Level Capping STAMs.** NM network impact assessment and data distribution. This use case area includes workflows required for ACC FMPs to electronically coordinate flight level capping STAMs (i.e. MCP) with AUs. The NMOC would perform a passive network impact assessment and in the unlikely event of any issues, they would contact the ACC FMP by telephone. The NM infrastructure would be used for the coordination (B2B service) mechanism and to distribute the resulting flight planning updates across the network.
- **UC-2.6 – ACC-ACC Coordination of Horizontal Re-routing STAMs.** NM network impact assessment and data distribution. This use case area includes workflows required for ACC FMPs to electronically coordinate horizontal re-routing STAMs (i.e. MCP) with other ACCS. The NMOC would perform a passive network impact assessment and in the unlikely event of any issues, they would contact the ACC FMP by telephone. The NM infrastructure would be used for the coordination (B2B service) mechanism and to distribute the resulting flight planning updates across the network.
- **UC-2.7 - ACC-AU Coordination of Horizontal Re-routing STAMs.** NM network impact assessment and data distribution. This use case area includes workflows required for ACC FMPs to electronically coordinate horizontal re-routing STAMs (i.e. MCP) with AUs. The NMOC would perform a passive network impact assessment and in the unlikely event of any issues, they would contact the ACC FMP by telephone. The NM infrastructure would be used for the coordination (B2B service) mechanism and to distribute the resulting flight planning updates across the network.
- **UC2.8 - ACC-NM Coordination of Flow Specific CASA Regulations (Targeted CASA).** NM network impact assessment and data distribution. This use case area includes workflows required for ACC FMPs to electronically coordinate CASA regulations, that are limited to specific flows, with NM. The NMOC would perform a network impact assessment before approving the regulation request. The NM infrastructure would be used for the coordination

(B2B service) mechanism and to distribute the resulting flight planning updates across the network.

- **UC-2.9 - ACC-ACC Coordination of Ground Delay STAMs**. This use case area includes workflows required for ANSP FMPs to electronically coordinate Ground Delay STAM (Take-off Not Before) with other ANSPs. Network impact will be assessed in post-ops by checking affected flights against other ATFCM Measures on the Network effective during the flight.
- **UC-2.10 - Automatic update of local configuration plan.** This use case explores the benefit of having true configuration updated in NM through a B2B connection in real-time every time the configuration is changed in the ACC Ops Room. Such dynamic information benefits the Network and the accuracy of RRP Proposals.
- **UC-2.11 - Managing Atmospheric/Met impact** – this use case explores the benefits of integration of MET and ATFCM information coupled with new developed functions of ECOSystem platform. These functions will allow more accurate prediction and better management of flows impacted by Rapid Developing Thunderstorm-RDT, turbulence and jet stream, VA cloud, probabilistic convection etc, aiming in the long term to integrate local MET information and sources.
- **UC-2.12 Complexity** – in this use case two indicators are assessed, complexity of individual flights in a hotspot, and complexity of sectors in different sector configurations. Complexity on individual flights will allow FMP to quickly pick the most complex flight and achieve most impact on complexity of a particular hotspot. It will also allow testing of procedures for Multisector Planner or Extended Sector Planner functions, as described in other SESAR Solutions.
- **UC-3.1 Detect Arrival Demand & Capacity imbalance during the planning phase.** This Use Case will seek to test how the A-DCB Monitoring via the local **AOP or FMP** detects a future demand/capacity imbalance and generates an empty regulation. Specifically, to test the integration of airport and network operations by timely exchange of relevant airport and network information, rolling mechanism.
- **UC-3**.2 **Analysis and Coordination of the A-DCB management proposals during the planning phase.** This Use Case will seek to test how the demand/capacity imbalance is dealt with via the **DCB** management proposal. When an imbalance is detected, the Airport and FMP will coordinate a resolution process with the airport launching the AIMA to solve it during the Planning phase. Specifically, this is to test replacement of ATFCM measures (flow rate) with A-DCB management proposals resolved by TTA.
- **UC-3.3 NM acceptance of the A-DCB management proposals during the planning phase.** This Use Case will seek to test how to implement A-DCB. The integration of airport and

network operations by exchange of operational regulations originated in both the NM and the AOP.

- UC-3.4 **Detect and Resolve Arrival and Departure Demand & Capacity imbalance between multiple airports during the Short Term planning and Execution phases.** Depart to CTOT and FLY to TTA. This Use Case will seek to test how the A-DCB Monitoring detects a future demand/capacity imbalance, generates an alert or warning and how local A-DCB Management proposal seeks to resolve it during the Short Term planning and Execution phases (i.e. the day of operation). Specifically, this is to test replacement of ATFCM measures (flow rate) with A-DCB management proposals resolved by TTA. Furthermore, this use case aims to assess the viability of A-DCB management proposal with that of the ACTUAL FLOWN Program
- UC-3.5 **Dynamic Exchange of arrival and departure information from airport to network as from FPL reception.** This use case applies to planning phase. Exchange starts as soon as FPL is received by origin or destination AOP and departure and arrival time estimates, taxi times, SID, STAR and runways allocated, etc. and ATV status are exchanged with eDPI and API messages from AOP to NOP.
- UC-3.6 **Dynamic Exchange of arrival and departure information from airport to network before FPL is filed.** The Exchange is based on up-to-date airport flight prediction or base schedule data as on corresponds to the COB the day before operations. New data or updates are provided as they become available at airport.
- UC-3.7 **Multi-airport integration through linking dynamic exchange of early departure information and estimated landing times.** This UC starts in the planning phase around 10 h before destination airport reference time. This UC supports airport ground operation planning from the early morning by airport providing early departure planning data and network providing with more accurate estimated arrival times (ELDT).

3.4.3 Summary of Demonstration Objectives and success criteria

DEMO objectives have not changed from those that were identified in the Demonstration Plan. Please refer to section 5.2 of the DEMOP [46].

Identifier	Objective definition	Associated KPAs
OBJ-VLD-01-001	Impacts of using enhanced DCB measures and TTs on ATM workload (NM, ATC and Airport)	***Safety***

OBJ-VLD-01-002	Assess the impact of using enhanced DCB measures and TT on speed changes in ACCs	***Safety***
OBJ-VLD-01-003	Assess the impact of using enhanced DCB measures and TT in APPs	***Safety***
OBJ-VLD-01-004	Transparent coordination processes	***Safety***
OBJ-VLD-02-001	Improve predictability of flights and traffic load in Network	***Predictability***
OBJ-VLD-02-002	Improve predictability of flights for an ANSP	***Predictability***
OBJ-VLD-02-003	Improve predictability of flights for an Airport	***Predictability***
OBJ-VLD-03-001	Reduce extra fuel burn in the European Network	***Efficiency*** (Fuel) ***Environmental sustainability***
OBJ-VLD-03-002	Reduce extra fuel burn over an ANSP traffic flow	***Efficiency*** (Fuel) ***Environmental sustainability***
OBJ-VLD-03-003	Reduce extra fuel burn over an Airport traffic flow	***Efficiency*** (Fuel) ***Environmental sustainability***
OBJ-VLD-04-001	Increased cost-efficiency from more efficient processes for NMOC	***Efficiency*** (Cost)
OBJ-VLD-04-002	Increased cost-efficiency from more efficient processes for Airlines	***Efficiency*** (Cost)
OBJ-VLD-04-003	Increased cost-efficiency from more efficient processes for ANSPs	***Efficiency*** (Cost)
OBJ-VLD-04-004	Increased cost-efficiency from more efficient processes for Airport (APOC)	***Efficiency*** (Cost)
OBJ-VLD-05-001	Increase the use of available airspace capacity for the network	***Capacity***
OBJ-VLD-05-002	Increase the use of available airspace capacity for an ANSP	***Capacity***
OBJ-VLD-05-003	Increase the use of available Airport capacity	***Capacity***
OBJ-VLD-05-004	Increase the use of available multi-Airport capacity	***Capacity***

OBJ-VLD-05-005	Increase the use of available FIR capacity in adverse weather	***Capacity***
OBJ-VLD-06-001	Airline preferences	***Flexibility***

Table 6: NCM demonstration objectives

3.4.4 Demonstration Assumptions

The following assumptions are applicable for the demonstration project and may have an impact on the demonstration exercises. The assumptions are applicable to all the demonstration exercises that are contained in the demonstration plan. Additional demonstration assumptions at the exercise level shall be captured in the Appendices

Identifier	Title	Description
P24-A1	Current operational procedures apply	Demonstration exercises have to fit with current operational procedures
P24-A2	Airline Participation	Participation of pilots and OCCs from partners and of other airlines to the greater extent
P24-A3	Flights from participating airlines	Cherry-picking measures will be coordinated to flights from participating airlines (to be further decided during the preparatory phases of the DEMO EXEs).
P24-A4	No major technical evolution required	Although technical changes need to be implemented to support demonstrations, the NCM scenarios must be developed taking into account currently available technical infrastructure and tools (OPS) and the development potential of the current system.
P24-A5	Use of prototypes in operation	The demonstration exercises are not considered as full operational implementations requiring integration of demonstration requirements with the current technical/procedural ATM system. Prototypes may be necessary to perform exercises
P24-A6	Transparent coordination processes	As identified in the STAM CONOPS, coordination processes should be transparent to all actors by sharing operational information
P24-A7	No multiple constraint resolver available	There will be no automatic or agreed standard algorithms available to solve conflicting network constraints (PJ09 will address this in validation exercises)

P24-A8	From operational concept point of view, all constraints are considered as equally important (only impact may vary)	The current NM system handles constraints different. Some type of constraint can be overwritten by others, suggesting a different priority. From operational concept point of view, constraints are considered to be equal
P24-A9	No specific procedures for ATC	For TWR (DEP and ARR) and ATC En-route units, ATC provides best effort to support TT compliance, but the flight trials will not require specific procedures application All ATC units are informed of the trials, and mitigations actions are taken to mitigate the potential increase of unadvised speed changes
P24-A10	ATC can be informed of target time flights by manual intervention by the local FMP (DCB actor)	dDCB mechanisms do not include direct electronic communication with ATC. The assumption is that local FMPs will communicate directly (based on local preferences) to their ATC when necessary
P24-A11	No technical evolution on CWP position	CWP positions will not be modified to provide information as used in the demonstration exercises
P24-A12	No change in standard operating procedures for flight crews	No revision of operating manuals is necessary. Special crew task will be briefed separately. No release of NSA necessary
P24-A13	TT information available to flight crews	TT is available to the flight crews in the phases of flight defined by the scenarios
P24-A14	Network data exchange protocols apply	New data elements required for exercises must comply with NM data exchange protocols
P24-A15	No major development of network-wide available flight profiles expected	For NCM demonstrations it is important to have shared flight profiles as input to DCB. Current developments regarding ext-FPL, FF-ICE , local optimizations are not available during the exercises and the current NMOC profiles are expected to the best available network shared profiles.

Table 7: Demonstration Assumptions overview

3.4.5 Demonstration Exercises List

Exercises/Objectives	OBJ-VLD-01-001	OBJ-VLD-01-002	OBJ-VLD-01-003	OBJ-VLD-01-004	OBJ-VLD-02-001	OBJ-VLD-02-002	OBJ-VLD-02-003	OBJ-VLD-03-001	OBJ-VLD-03-002	OBJ-VLD-03-003	OBJ-VLD-04-001	OBJ-VLD-04-002	OBJ-VLD-04-003	OBJ-VLD-04-004	OBJ-VLD-05-001	OBJ-VLD-05-002	OBJ-VLD-05-003	OBJ-VLD-05-004	OBJ-VLD-05-005	OBJ-VLD-06-001
EXE-VLD-24-001: Demonstration of performance benefits of linked local measures as part of network collaborative workflow processes (NM)	X			X	X			X			X	X	X	X	X	X	X	X		F
EXE-VLD-24-002a: Demonstration of performance benefits of targeted measures following B2B data exchange with network collaborative workflow processes (MUAC, NATS, DFS, DSNA NM)	X	X		X		X			X				X			X				
EXE-VLD-24-002b: Demonstration of performance benefits of targeted measures following B2B data exchange with network collaborative workflow processes in Pre-tactical and Tactical phases (NATS, NM)	X			X		X			X				X			X				
EXE-VLD-24-002c: Demonstration of performance benefits of comparing Scenarios and Regulations using B2B data exchange with network collaborative workflow processes in Pre-tactical (DFS, NM)	X			X		X			X				X			X				
EXE-VLD-24-003a: Demonstration of performance benefits integrating airport target measures as part of network collaborative workflow processes (ENAIRE, INDRA, NM)	X		F	X	X	X	F				X	X	X					X		

Exercises/Objectives	OBJ-VLD-01-001	OBJ-VLD-01-002	OBJ-VLD-01-003	OBJ-VLD-01-004	OBJ-VLD-02-001	OBJ-VLD-02-002	OBJ-VLD-02-003	OBJ-VLD-03-001	OBJ-VLD-03-002	OBJ-VLD-03-003	OBJ-VLD-04-001	OBJ-VLD-04-002	OBJ-VLD-04-003	OBJ-VLD-04-004	OBJ-VLD-05-001	OBJ-VLD-05-002	OBJ-VLD-05-003	OBJ-VLD-05-004	OBJ-VLD-05-005	OBJ-VLD-06-001
EXE-VLD-24-003b: Demonstration of performance benefits integrating airport target measures as part of network collaborative workflow processes (HAL, NATS, NM)	X		X	X	X	X	X	X		X	X		X	X			X			
EXE-VLD-24-004: Demonstration of performance benefits of targeted collaborative level-capping measures following B2B data exchange as part of network collaborative workflow processes (DSNA, ENAIRE)	X			X	X							X	X		X					
EXE-VLD-24-005: Demonstration of sub-regional coordination of targeted measures following B2B data exchange as part of network collaborative workflow processes (COOPANS, SMATSA, NM)	X	X		X		X			X				X			X			F	
EXE-VLD-24-006: Enhanced Coordination of STAMs (ENAIRE, NM)				X		X			X				X			X				

Table 8: VLD Exercise List: Objectives coverage

Identifier	EXE-VLD-24-001
Title	Better Network Measures
Description	Demonstration of performance benefits of linked local measures as part of network collaborative workflow processes in NM to assess the impact of measures and the optimisation of targeted measures linking areas of network issues

Demonstration Technique	Demonstration in the (shadow) operational environment in NM and FOC's
KPA/TA Addressed	Network Performance, Capacity, Efficiency (fuel and costs)
Number of flights	Applicable to all flight in the participating operational centres
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	EUROCONTROL/NM + Airline TEAM
Demonstration Platform	NM Systems, PJ24 network coordination tool (PLANTA), Flight Planning Systems AU's, N-CAP
Demonstration Location	Europe
Status	Completed
Dependencies	Linked (not dependent) to EXE-VLD-24-002, EXE-VLD-24-003, EXE-VLD-24-004, EXE-VLD-24-005, EXE-VLD-24-006
Identifier	EXE-VLD-24-002a
Title	Local & Network coordination of fine-tuned ATFCM measures (MUAC)
Description	Demonstration of performance benefits of targeted measures following B2B data exchange with network collaborative workflow processes in MUAC AoR.
Demonstration Technique	Demonstration in Maastricht Upper Area Control Centre apply targeted measures coordinated via B2B with the network
KPA/TA Addressed	Capacity, Efficiency (fuel and costs)
Number of flights	Applicable to all flight planned for crossing MUAC airspace
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	EUROCONTROL/MUAC
Demonstration Platform	NM Systems, MUAC iFMP tool, ATM Portal
Demonstration Location	Maastricht UAC
Status	Completed
Dependencies	Linked (not dependent) to EXE-VLD-24-001, EXE-VLD-24-002b, EXE-VLD-24-002c
Identifier	EXE-VLD-24-002b
Title	Local & Network coordination of fine-tuned ATFCM measures (NATS)
Description	Demonstration of performance benefits of targeted measures following B2B data exchange with network collaborative workflow processes in Pre-tactical and Tactical phases (NATS, NM)
Demonstration Technique	Shadow mode trial undertaken at NATS UK using NM PLANTA system.

KPA/TA Addressed	Capacity, Efficiency (fuel and costs), Workload
Number of flights	This is a shadow mode trial so no flights will be affected. Data used is applicable to all flight operating the FIR UK.
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	NATS
Demonstration Platform	NM Systems , PLANTA
Demonstration Location	NATS UK Swanwick Site
Status	Completed
Dependencies	Linked (not dependent) to EXE-VLD-24-001, EXE-VLD-24-002a, EXE-VLD-24-002c
Identifier	EXE-VLD-24-002c
Title	Local & Network coordination of fine-tuned ATFCM measures (DFS)
Description	Demonstration of performance benefits of comparing Scenarios and Regulations using B2B data exchange with network collaborative workflow processes in Pre-tactical (DFS, NM)
Demonstration Technique	Shadow mode trial undertaken at DFS using NM PLANTA system.
KPA/TA Addressed	Capacity, Efficiency (fuel and costs), Workload
Number of flights	This is a shadow mode trial so no flights will be affected. Data used is applicable to all flight operating the MUAC ACC.
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	DFS
Demonstration Platform	NM Systems , PLANTA
Demonstration Location	MUNICH ACC
Status	Completed
Dependencies	Linked (not dependent) to EXE-VLD-24-001, EXE-VLD-24-002a, EXE-VLD-24-002c
Identifier	EXE-VLD-24-003a
Title	AOP-NOP integration and Arrivals Management
Description	Demonstration of performance benefits integrating airport target measures and multi-airport coordination as part of network collaborative workflow processes
Demonstration Technique	Live demonstration with airports LEBL, LEPA, LEAL for multi-airport coordination and to propose target times for arriving traffic coordinated with the network.

KPA/TA Addressed	Capacity, Efficiency (fuel and costs), Flexibility, Predictability, Environmental Sustainability
Number of flights	Applicable to all flight arriving to LEBL (Barcelona), LEPA (Palma de Mallorca), LEAL (Alicante.).
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	ENAIRE
Demonstration Platform	NM Systems, Indra AOP tool
Demonstration Location	Barcelona, Alicante and Palma de Mallorca.
Status	Completed
Dependencies	Linked (not dependent) to EXE-VLD-24-001, EXE-VLD-24-003b, EXE-VLD-24-006
Identifier	EXE-VLD-24-003b
Title	AOP-NOP integration and Arrivals Management
Description	Demonstration of performance benefits integrating airport target measures
Demonstration Technique	Live demonstration at LHR to propose target times for arriving traffic coordinated with the network.
KPA/TA Addressed	Capacity, Efficiency (fuel and costs), Flexibility, Predictability, Environmental Sustainability
Number of flights	Applicable to all flights in a hotspot period
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	HAL
Demonstration Platform	NM systems, HAL AOP tool
Demonstration Location	Heathrow Airport
Status	Completed
Dependencies	Linked (not dependent) to EXE-VLD-24-003a
Identifier	EXE-VLD-24-004
Title	Extended Collaborative Advanced Planning
Description	Demonstration of performance benefits of targeted flight level capping measures following CDM exchange as part of network collaborative workflow processes.
Demonstration Technique	Live demonstration in French UAC and adjacent Spanish UAC (Madrid ACC) to apply Collaborative Advanced Planning (CAP) measures in cooperation/coordination with AU’s.
KPA/TA Addressed	Safety, Capacity, Efficiency, Predictability

Number of flights	Applicable to all flight in the participating operational centres
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	DSNA
Demonstration Platform	DSNA CAP tool
Demonstration Location	France
Status	Completed
Dependencies	Linked to EXE-VLD-24-001, EXE-VLD-24-006
Identifier	EXE-VLD-24-005
Title	Sub-Regional Coordination of Fine-tuned Measures
Description	Demonstration of sub-regional coordination of fine-tuned and targeted measures following B2B data exchange as part of network collaborative workflow processes.
Demonstration Technique	Shadow mode Excercse via NM PreOps System in 3 participating ACC's (Austrocontrol, CroatiaControl and SMATSA) to apply sub-regional coordinated fine-tuned and targeted measures coordinated with the network
KPA/TA Addressed	Capacity, Efficiency (fuel and costs), Safety, Predictability, Environmental Sustainability
Number of flights	This is a shadow mode trial so no flights will be affected
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	COOPANS (Thales, CCL, Austrocontrol, SMATSA)
Demonstration Platform	NM Systems, Thales ECOsystem
Demonstration Location	Austria, Croatia, Serbia, Montenegro
Status	Completed
Dependencies	Linked to EXE-VLD-24-001
Identifier	EXE-VLD-24-006
Title	Enhanced coordination of STAMs (ENAIRE, NM)
Description	Live demonstration in ENAIRE to propose STAMs (Ground Delays and Level Cappings) in enhanced network by coordinating procedures with adjacent ANSP's (DSNA). Shadow Mode in ENAIRE to propose Ground Delay STAMS and to reduce the number of constrained flights, as a result of replacing conventional CASA regulations with more targeted MCP measures. Coordination procedures with NM is required.coordination procedures with NM and/or adjacent ANSP's (DSNA).

Demonstration Technique	Two different techniques: - Life trial in the joint exercise between ENAIRE/DSNA by means of the CAP tool (UC2.4) - Shadow mode in the exercise with the NM, either (using PLANTA (UC2.2 and UC2.8) and/or iACM (UC2.2)).
KPA/TA Addressed	Capacity, Efficiency (costs), Safety, Predictability, Environmental Sustainability (fuel)
Number of flights	Applicable to all flights operating in Madrid ACC (UC2.2 and UC2.4) and Barcelona ACC (UC2.8)
Start Date	01/11/2016
End Date	31/12/2019
Demonstration Coordinator	ENAIRE
Demonstration Platform	NM Systems, PLANTA (NM), iACM (Indra), CAP tool (DSNA)
Demonstration Location	Spain
Status	Completed
Dependencies	Linked (not dependent) to EXE-VLD-24-001 Linked (dependent) to EXE-VLD-24-004

Table 9: Demonstration Exercise layout

3.5 Deviations

3.5.1 Deviations with respect to the SJU Project Handbook

Not applicable.

3.5.2 Deviations with respect to the Demonstration Plan

Exercises developed and matured after the finalization of the demonstration plan, taking into account feasibility of planned activities and emerging opportunities. Major cause to change the demonstration was, obviously, the late involvement of the airline community only after the formal milestones of the demonstration plan delivery, caused by the overall organisational set-up of the Wave 1 VLD's.

In general, the scope of demonstration exercises stayed aligned with the main objectives of the overall scope of Network Collaborative Management. At detailed planning and timing level, adjustments have been made to respond to operational feasibility, resources availability, and changing quality management requirements (such as increased focus on safety assessments, etc.).

Some UC's have not been demonstrated. This was the case for UC2.3, UC2.7, UC3.5, and UC3.6.

Most exercises were depending on operational system implementations milestones of which some were not met. This resulted in some exercises to demonstrate in shadow operational mode.

To ensure alignment and easier readability with the demonstration report, an update of the demonstration plan has been produced in Q1 of 2019.

Major deviations between the first and updated demonstration plan were:

- Airline Team involvement (as part of different VLD project but in full collaboration with NCM).
- Exercises 1 was adapted to include and focus on airline contribution in NCM, to link local tools with network tools to provide measure transparency.
- Exercise 2 was split in 3 sub-exercises to be able to add and optimize exercise organisation and contributions from NATS and DFS that were initially not foreseen.
- Exercise 3 was split in 2 sub-exercises to optimize the organisation and output of demonstrations at Spanish airports and London Heathrow airport.

- Exercise 4 has added analysis activities and contribution to Exe1
- Exercise 5 shifted demonstration activities to June 2019 to maximize demonstration output.
- Exercise 6 performed planned exercises in shadow-mode, and added operational exercises in collaboration with exercise 4. Iteration 3 was downscaled.

3.5.2.1 Additional Activities (not initially planned in the Demonstration Plan)

3.5.2.1.1 Linking DSNA's CAP tool to NM systems for network transparency: N-CAP

PJ24 activities objectives aimed to facilitate coordination between partners, especially at network level with airline contributions and with NM.

EXE4 participants (DSNA) created the opportunity to link the CAP tool, using NM B2B services that were developed as part of the DCB activities, towards Network Collaborative Management, with the objectives to:

- Standardize as much as possible the process and interface to limit the additional workload and the costs associated to human and technical resources (for both AUs and ANSPs).
- Give Network Visibility to CAP measures, for better traceability and post operations analysis,
- Secure the slot for AUs refiling according to CAP Proposal, to avoid the 'Late Updater Status', and more generally speaking, any 'double penalty' for the flights.

This resulted in the development of the Network-connected CAP tool (N-CAP), that was used in Exercise 1 to demonstrate network coordination benefits (for local, NMOC, AU) to connect local tools to network systems.

Note: To secure realistic use of resources and avoid impact on operational NM Ops environment, it is important to note that the scope of this additional activity in SESAR 2020 PJ24 was limited to the technical feasibility.

4 Demonstration Results

4.1 Summary of Demonstration Results

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Demonstration Results	Demonstration Objective Status
OBJ-VLD-01-001	Impacts of using enhanced DCB measures and TTs on ATM workload (NM, ATC and Airport)	CRT-VLD-01-001	The usage of enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload.	Different levels of increase in workload reported. However, generally, the workload increase is acceptable considering operational benefits achieved. Where enhanced DCB measures were already used, tools support generally reduced workload.	OK
OBJ-VLD-01-002	Assess the impact of using enhanced DCB measures and TT on speed changes in ACCs	CRT-VLD-01-002	No increase in workload for ATC because of non-nominal speed profiles flown by participating airline flights.	n/a	n/a
OBJ-VLD-01-003	Assess the impact of using enhanced DCB measures and TT in APPs	CRT-VLD-01-003	The usage of TTs does not have a negative impact on ATC TWR/APP operational staff workload, e.g. reduced vectoring, holding, changes to departure sequences, etc.	FMPs agreed that the increase in workload when applying a proposed TTA measure was acceptable. As well, ATCs implied in TTA measure coincide in stating that the workload was very similar to the experienced when using standard CASA regulations.	OK

OBJ-VLD-01-004	Transparent coordination processes	CRT-VLD-01-004	Positive feedback from all actors regarding DCB overall processes.	Generally, very positive feedback from all operational stakeholders that sharing measures via SWIM solutions or shared interfaces improves situational awareness. Only at network manager level the concern exists that many different specific fine-tuned measures could also lead to a complex network situation.	OK
OBJ-VLD-02-001	Improve predictability of flights and traffic load in Network	CRT-VLD-02-001	The distribution of early/late arrivals at coordination points or the airport of destination is better centered and narrower than current operations. The distribution of difference between estimated and actual load is better centered and narrower than current operations.	Significant predictability improvements of departure planning information were observed in the time bracket -9 to -3 hours before actual take-off at all participating airports. **(OK)** Load analysis wasn't performed. **(n/a)**	OK
OBJ-VLD-02-002	Improve predictability of flights for an ANSP	CRT-VLD-02-002	The distribution of early/late arrivals at the entry points of the AoR of ANSPs is narrower than current operations.	Pre-Tactical D-1 planning requires a higher level of planned data accuracy to achieve this objective to its full capability. Tactical targeted flow measures demonstrated great potential to reduce flight impact and delays. Regarding improvements of accuracy of planned arrival times through API message exchanges; despite the fact	Partially OK

				that the AOP can provide more accurate information on ELDT, the improvement is only of decimals and it is around 100 minutes before landing when the aircraft in is execution. It should be further evaluated to decide if this improvement could bring benefit to NM or other stakeholders to consider including the ELDT coming from General API messages into ETFMS flight data.	
OBJ-VLD-02-003	Improve predictability of flights for an Airport	CRT-VLD-02-003	The distribution of early/late arrivals at the runway of an airport is narrower than current operations.	Regarding improvements of accuracy of planned arrival times through API message exchanges; despite the fact that the AOP can provide more accurate information on ELDT, the improvement is only of decimals and it is around 100 minutes before landing when the aircraft in is execution. A-DCB has been proven to provide an accurate traffic forecast. Analysis undertaken during the VLD has shown that aircraft have largely complied with their TTAs, and A-DCB has provided a stable solution.	OK
OBJ-VLD-03-001	Reduce extra fuel burn in the European Network	CRT-VLD-03-001	The cumulated additional fuel consumption due to DCB constraints, is reduced.	Fuel consumption measurements have not been 'scientifically' performed, therefore no results available.	NOK

				Non-optimal reroute proposal to flights logically result in an increase of fuel consumption that in many specific flight cases seemed acceptable considering the capacity benefit. Also, exercises showed that by applying targeted measures, some regulations were avoided supporting the shortest route options to otherwise impacted flights, resulting in an overall reduction of fuel consumption.	
OBJ-VLD-03-002	Reduce extra fuel burn over an ANSP traffic flow	CRT-VLD-03-002	The cumulated additional fuel consumption over the whole traffic flow overflying a FIR, due to DCB measures, is reduced.	Fuel consumption measurements have not been 'scientifically' performed, therefore no results available. Taking into consideration that less flights are impacted and more flights can use an optimised trajectory, there are indications (FABCE simulations) of fuel reduction.	NOK
OBJ-VLD-03-003	Reduce extra fuel burn over an Airport traffic flow	CRT-VLD-03-003	The cumulated additional fuel consumption over the whole traffic flow to/from an airport, due to DCB measures, is reduced.	n/a	n/a
OBJ-VLD-04-001	Increased cost-efficiency from more efficient processes for NMOC	CRT-VLD-04-001	Positive feedback from NMOC staff to apply measures Reduced time to achieve the DCB	Positive feedback from NMOC staff regarding implemented delay measures into ETFMS. In addition the visibility of local level cap measures in	OK

			workflow process	the NM system will improve identification of appropriate network measures to flights and coordination with Aircraft Operators and FMP's.	
OBJ-VLD-04-002	Increased cost-efficiency from more efficient processes for Airlines	CRT-VLD-04-002	Positive feedback from AU staff to apply measures Reduced time to complete a DCB workflow process	Tool support (N-CAP, CAP, ATMP, etc), preferably integrated in network HMI, helps AU staff to reduce the time to monitor, analyze, coordinate and implement fine-tuned DCB measures. However, more automation needed to further reduce required time in case flight measures amounts would increase. **(OK)** Some exercises increased workload for monitoring flight-specific measures beyond acceptable levels. **(NOK)**	Partially OK
OBJ-VLD-04-003	Increased cost-efficiency from more efficient processes for ANSPs	CRT-VLD-04-003	Positive feedback from FMP staff to apply measures Reduced time to complete a DCB workflow process	Generally very positive. ATFCM simulation, creation and coordination integrated in a local tool and shared at network level where necessary significantly improves the local and network coordination processes. The increase of efficiency leads to a significant increase of updates and specific flight measures proposals as these require hardly any time. The management of many measures proposals and updates in the network	OK

				needs to be further discussed.	
OBJ-VLD-04-004	Increased cost-efficiency from more efficient processes for Airport (APOC)	CRT-VLD-04-004	Positive feedback from APOC staff to apply measures. Reduced time to achieve the DCB cycle	n/a	n/a
OBJ-VLD-05-001	Increase the use of available airspace capacity for the network	CRT-VLD-05-001	The accumulation of ATFM delay due to DCB issues in the network is reduced due to the application of advanced network collaborative management.	Although applied at local level, the various exercises all contributed to network performance with a reduction of delay. It is not possible to quantify the overall network effect on capacity (delay reduction). However, the accumulated results add up to several thousands minutes of delay reduction, achieved in a relatively short period of demonstration activities.	OK (however not quantified as a whole)
OBJ-VLD-05-002	Increase the use of available airspace capacity for an ANSP	CRT-VLD-05-002	The usage of enhanced DCB reduces sector delay compared to regulations.	Pre-tactical simulations results could not be achieved due to inaccuracies of planning data. **(NOK)** Tactical targeted flow measures show significant potential of delay reduction. **(OK)** Tactical Level-Cap process has a positive impact on the reduction of regulations and ATFM delays of the network. **(OK)** Tactical fine-tuned delay measures showed significant delay reduction.	OK

				(OK)	
OBJ-VLD-05-003	Increase the use of available Airport capacity	CRT-VLD-05-003	The usage of enhanced DCB and TT reduces airport delay compared to airport regulations.	Application of TTA measures to optimise delivery of arrivals showed a significant reduction of average delay per flight compared to global arrival regulations at Heathrow and a slight increase in average delay at Spanish airports (but with a reduction of reactionary and max delay). **(OK)** Results seem very depending on local arrival optimisation calculations and simulation limitations. **(Partially OK)**	OK
OBJ-VLD-05-004	Increase the use of available multi-Airport capacity	CRT-VLD-05-004	Overall delay reduction for group of airports compared to baseline scenario	n/a. (recommended to analyse, however dropped from the demonstration activities because of lack of resources).	n/a
OBJ-VLD-05-005	Increase the use of available FIR capacity in adverse weather	CRT-VLD-05-005	The degradation of FIR or sector capacity, during adverse weather events reducing the available capacity compared to plan, is mitigated by 5 to 15 %, depending	n/a. (recommended to analyse, however dropped from the demonstration activities because of lack of resources).	n/a

			on the ANSP		
OBJ-VLD-06-001	Reduce arrival delays over an airline fleet[5]	CRT-VLD-06-001	Reduction in operating costs resulting from network issues creating airline resource problems , connection of priority flights, better alignment of airline processes (ground/airborne), etc	Evaluation for Flexibility: Apart from the collaborative decision making procedures, two mechanisms of AU flexibility were to be tested: "Priority flights" in Exe 2A and "AU input into AIMA in Exe 3A" (the latter not applied during the exercise because of implementation limitations). The airlines of the ATEAM could not measure any indicator associated with this objective.	n/a

Table 10: Summary of Demonstration Exercises Results

[5] Objective OBJ-VLD-06-001 is labeled "Fleet delay" in some locations in the Demo Plan or Demo Report: this refers to the fact that the purpose of AU flexibility is to drive the constraints to affect those flights where their impact is minimum; in theory, one of the sought optimizations could be to reduce total delay on a day of operations. The NCM trials did not put in place this approach as such, after all.

4.1.1 Network

Currently, many operational ATFCM activities only take place at local level or at bilateral level between local stakeholders without taking the network situation into consideration. The NCM demonstrations aim to improve the integration of local ATFCM functions into a network wide coordination context. The main results from the demonstration exercises are expected from improvements to transparency of planning and execution actions and improved coordination between stakeholders, on the basis of a shared awareness of the traffic situation, stretching beyond the current limits of their respective domains. All the demonstration exercises aimed to interface local ATFCM functions with network ATFCM functions and therefore contributed to network operations. This included activities by actors at Airports, ANSPs, Aircraft Users and NMOC.

The exercises in the demonstration were executed geographically in a very large part of Europe. The figure below presents the areas of the actors that participated to the demonstration exercises. The airspace users involved in the exercises together represent more than 70% of European air traffic.

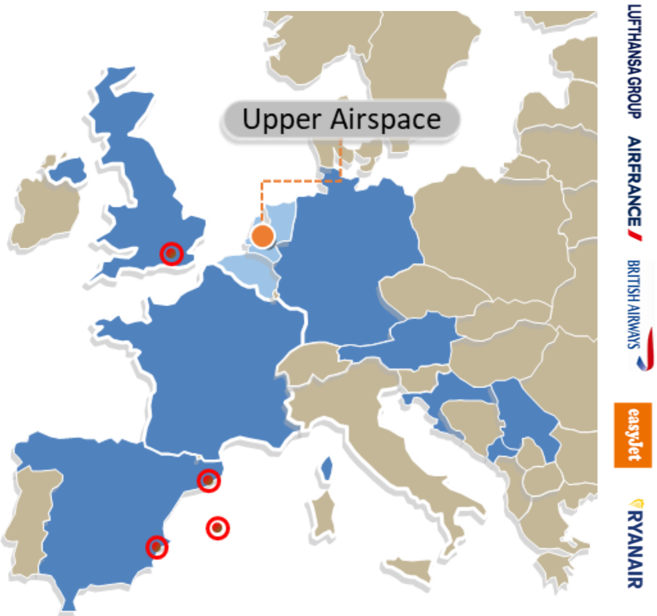


Figure 5: PJ24 airspace and airports and participating airlines

By linking together local initiatives and sharing operational information at a network level, all actors have a better view of DCB initiatives. This enables improvements in network coordination.

Through transparent sharing of local and network information, stakeholders are better equipped to find optimal measures in a given network situation.

Demonstration exercises were prepared and performed with a focus on sharing local measure proposals at network level and to improve coordination with stakeholders:

- Transparency of measures from Network perspective, e.g. Regulation proposals via B2B, exclusions from REG, Cancel regulations, level capping measures at local level,
- Better understanding of measures from AU perspective, e.g. impact of scenario's, multiple measures to flights.

Transparency of measures from Network perspective

The transparent overview of (proposed) local measures enabled network actors to have a better overview of proposed or implemented measures to solve DCB issues in the network.

The demonstration exercises contributed to increase the visibility/awareness in the NM systems. This network information is available to local users via SWIM/B2B exchange of data or, in some cases, by current B2C interfaces as CIFLO, CIAO, NOP portal etc.

The automatic exchange of measure data via B2B replaced phone conversations, email exchanges and automated some manual activities, offering significant gains in workload and time for local NMF. The focus of the demonstrations was on STAM measures that have shown already some mature application in operation, and on pre-agreed STAM measures using the improved ATFCM Scenario Repository in the NM system. Measures that have been included and demonstrated in more efficient measure data exchange were:

- Regulation proposals
- Mandatory Cherry Picking (MCP) proposals
- What-If (measures) Simulation
- Flight Exclusions from Regulations
- Flight improvements by Forced CTOT in Regulations
- Query / Apply ATFCM Scenarios resulting in flight reroute proposals

Overall results were very positive. All the involved participants expressed the huge potential of system-supported coordination processes. Main results:

- The situational awareness of all actors was significantly improved as (all) proposed measures are now visible to relevant actors.

- What-If simulations access via B2B data exchange make it possible to first locally assess the impact of a draft measure on local and network performance, avoiding unnecessary coordination for ineffective measures.
- Effectiveness of measures was improved because of verification of measures against network issues and updates are considered as updates and not as new measures. Without a link to network systems, updated measures are considered as new measures which could be considered as late measures with additional negative results.
- The time needed for proposing local measures reduced significantly from 5-15 minutes of telephone conversations (including sometimes waiting time, and interruption of the on-going task for the receiver of the call) to seconds for a click of a button, or even milliseconds in case of ‘automatic’ measures (e.g. Target Times for arrivals)
- Time needed to assess measures was significantly reduced because manual input could be avoided.
- Coordination of measures results is easier because results are shared.

To support transparency and to avoid that airlines need a wide array of different local tools for local coordination, integration of local tools with network system was tested. Using the implemented NM SWIM/B2B services, the CAP tool connected successfully to the NM system. Reroute suggestions previously sent by CAP directly to airspace users have now been validated by the network systems, transparent to all operational stakeholders (including NMOC), and reroute proposals were automatically sent to airspace users while keeping their slot in the sequence. Because of the success of technical test and operational benefits of connecting the CAP tool to NM system, the operational implementation of Network CAP (N-CAP) will be accelerated immediately after this VLD.

The improved coordination workflow that was demonstrated resulted also in many additional proposed measures and measure updates, because the workflow is easier to execute. This could potentially overload coordination activities, beyond the quantity that is considered as acceptable. The old coordination process with telephone communication and manual input and actions took some minutes. The new coordination process makes it possible to initiate and update measure proposals with the click of a mouse, and does not require telephone communication. Still, in current network operations, all measures need to be assessed for the impact on the network, causing unacceptable level of workload.

More coordination actions are expected from the wider deployment of system-supported targeted flight and flow measures. With the current network coordination system, initial implementation with only a few actors already causes network coordination saturation and overloads. Therefore, more effective coordination solutions are necessary, such as improved local and network assessment of measures at local level, automatic acceptance of flight (and flow) measures, automatic network impact assessment, etc.

Better understanding of measures from AU perspective

Improved and transparent coordination processes at network level were of particular interest to the AU participants. Currently, AUs are unaware of the context and content of ATFCM measures imposed on them. Some AUs are in contact with local FMPs, especially at airlines' HUB airports to coordinate in case of major disturbances to airline planning. But, generally, AUs are blind when it comes to ATFCM measures.

The demonstrations showed AUs the opportunities of being involved in network collaborative processes. The late involvement of the formal ATEAM to the PJ24 project unfortunately resulted in insufficient time for participating airlines to develop tools to explore the full potential of network measures data exchange. However, the involvement to the exercises and the 'manual' interpretation and usage of the coordination information already provided benefits to the AU's operations.

The information available to AUs during the demonstrations, focused on flight suspensions and re-route proposals resulting from the application of ATFCM scenario on D-1, and re-route proposals resulting from pre-agreed STAM measures on the day of operations. In addition to the final messages to AUs (FLS and RRP), during the demonstrations, more information was available to clarify the measure context. This resulted in a better situation (planning) awareness to participating aircraft operators.

During the demonstrations, AU reported opportunities for improvements to:

- avoiding unnecessary AU actions. Currently, AU's sometimes anticipate network issues and take action without exactly knowing the operational situation.
- optimising measures with AU preferences. The improved context improves the decision process at AOC to accept measures or to optimize flight profiles from network point of view filing an alternative FPL.
- fleet management performance resulting from improved situational awareness. Also on other flights not (yet) impacted, the overall improved situational awareness to the network improves the decision making process at the AOC's.

Airspace users were able to use increased transparency of applied measures to improve the assessment on their operations with current available tools. However, the coordination workflow with current system support still required too much time per ATFCM measure to apply in AU operations. Increased system support with a focus to optimize automatic exchange of information between AU systems (flight-, fleet-planning tools) and network system further automation of coordination activities is necessary to be able to implement operationally.

4.1.2 ANSPs

Demonstration objectives of the ANSPs were to improve local performance through application of more effective ATFCM measures and optimisation of local – network coordination supported by local and network tool support.

Some ANSP's already used local tools before the demonstrations. However, the coordination with the network, i.e. with NM, AU's and other ANSPs, currently takes place through conventional means of communication (telephone, email) and only bilaterally without network transparency.

Measure and coordination improvements by ANSPs during the demonstrations were:

- D-1 measure assessments (application of ATFCM Scenarios)
- Regulation proposals and targeted flow regulations
- Mandatory Cherry Pick proposals
- Flight improvements through Flight Exclusions and forced CTOTs
- Flight Level cappings, tactical ATFCM coordination between FMPs in flight-planning phase (and pre-agreed including AU's) and testing of Network connected CAP tool, N-CAP
- Flight Level capping, tactical coordination FMP-FMP implemented by ATC

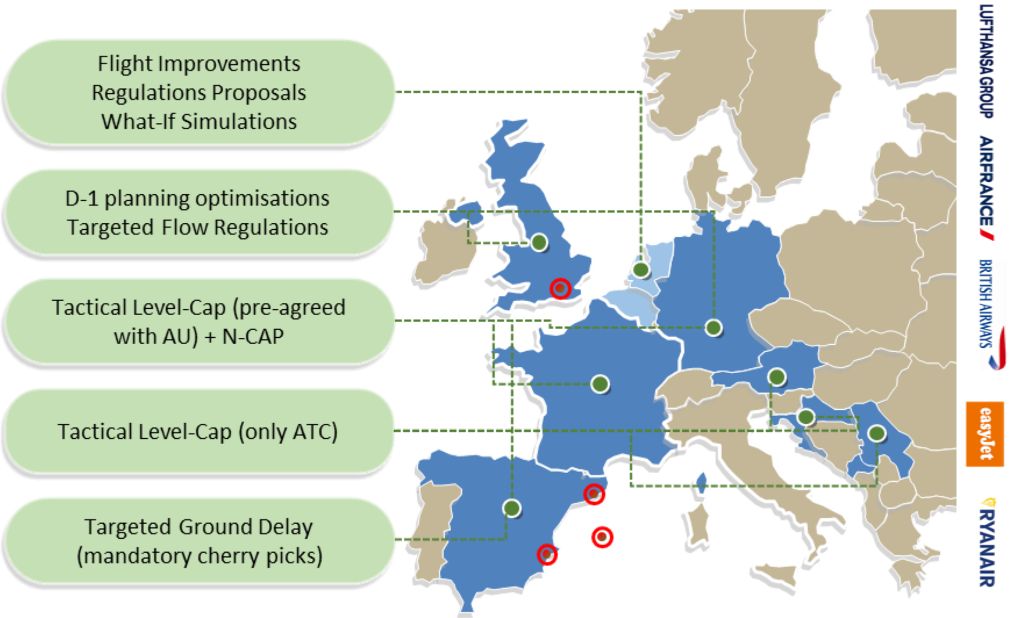


Figure 6: PJ24 airspace and airports and participating ANSPs

Demonstration exercises were split into pre-tactical improvements and tactical improvements. The pre-tactical improvements focused on using ATFCM scenarios and network impact information to assess the effectiveness of proposed measures on predicted traffic demand for the next day. The tactical improvements focussed on improving current coordination processes (phone/mail) by linking local and network systems and optimised coordination procedures and on targeted measures (flow, flight improvement, level-caps, mandatory cherry picks) avoiding or reducing classical regulations.

Pre-Tactical Planning Scenarios

Proposed rerouted flights were rerouted in the prediction of traffic and the impact shown. Currently, the impact is only known on an expert judgement basis which doesn't provide a good basis for further optimisations and coordination. The ability to show the impact of measures was perceived as very valuable and the potential performance improvement benefits are expected to be significant. However, the accuracy of the traffic predictions at D-1 is not sufficient to consistently use on the day of operations. In many cases the operational situation at the tactical day is completely different which leaves the D-1 planning irrelevant. As a result, the resources necessary for the preparation of the D-1 plan cannot be justified without significant improvement of D-1 traffic predictions.

Tactical Fine-Tuned Delay Measures

Data exchange improvements and NM system improvements were implemented to support the more dynamic flight and flow measure proposals. These coordination improvements were operationally applied to regulation proposal procedures and to flight improvement procedures, both supported by data exchanges between local and network systems. The more efficient coordination enabled continuous optimisation of local measures and the easier application of flight specific measures. The measures applied in the demonstration were already part of the toolbox of the FMP, however, not extensively used as during the demonstrations. The normal coordination of measures is via telephone or email-coordination that block the possibility for extensive and very dynamic coordination. In Maastricht Upper Area Control Centre, who mainly operationally demonstrated the improved coordination local/network procedures and estimated total delay reductions of 150.000 minutes to 5000 flights during the Summer 2018. However, workload by NMOC was considered too high. Changes were implemented to improve the efficiency of the workflow for flight measures including the impact of these flight measures on the network. NMOC controllers reported an improved accessibility to the measures applied and proposed and to the correct network impact information. In Summer 2019, coordination procedures further improved, fully integrating local and network systems and reducing workload for NMOC to acceptable levels. This had a positive impact on measure acceptance rates that increased to more than 90%. Delay reductions have not yet been measured, but are expected to be not as high as 2018 because of network operations measures to strategically re-route flight out of busy areas as MUAC by RAD measures (e-NM/ANSP Plan 2019). As a result, there is less need for flight measures at MUAC compared to 2018. However, RAD solutions to re-route all traffic is not necessarily better for AU's than to find solutions impacting only a few flights.

In FABCE coordination, improved sector complexity monitoring resulted in identification of more tactical trajectory improvements in coordination with neighbouring ACC's. This improves the effectiveness of the impact of an FMP (more tactical STAM measures) and leads to reduced ATFCM regulations (less buffer required for sector capacity). Sector complexity was monitored in combination with MET support tools that further increased the confidence of FMP's to implement tactical measures at short notice.

Tactical Targeted Flow Measures

Tactical improvement also demonstrated maturity of new measures as targeted flow measures using the SWIM/B2B capabilities of the newly implemented scenario repository of the NM system to store pre-agreed ATFCM measures. With this measure repository, FMPs were able to compare different flow measures in their local tools. In a number of occasions, significant delay reduction opportunities were identified by specifically applying a regulation rate to a flow rather than a traffic volume (i.e. the entire piece of airspace). In some cases, even the impacted flow was positively benefitting from flow regulations. The opportunities for targeted flow regulations are very specific to the local area and should be analysed by FMP and users on desired outcome. It is possible that some flights receive an unacceptable and unfair amount of delay.

Tactical Level-Capping Measures

The results of Extended CAP demonstration exercise by DSNA in France and ENAIRE in Spain showed that Collaborative Advanced Planning process improves situational awareness beyond ACC boundaries, it encourages communication and team working between ACCs and airlines and it leads to an increase of transparency and trust between Flight Management Positions and AU Flight Dispatchers. Once familiarised with CAP, the tool is considered easy to use and flexible, contributing to the efficiency to solve DCB issues.

Most of Flow Managers perceived that CAP measure helped reducing the quantity of regulations or its strength as well as the ATFM delays to the network. Quantitatively, 15 days of CAP assessment in Summer 2017 showed that CAP process avoided 12 potential regulations corresponding to 4111min of delay on a single traffic flow. In Spain, they found the tool very helpful for autumn and spring traffic where normally the demand is average. A higher number of participating airlines will increase the opportunities to find CAP measures and further decrease ATFM delay.

PJ24 joint DSNA/ENAIRE Extended CAP exercise have brought interesting clues to further enhance the tool and process, paving the way for a more standardized and wider cross-border collaborative process, where flight level capping and re-routing proposals could be supported by NM B2B services.

Overall, ANSPs demonstrated significant ATFM delay savings, through avoiding or reducing ATFCM regulations by identifying effective targeted, fine-tuned measures using network collaborative coordination processes. Local issues have been solved with more targeted measures, reducing the need for regulations and/or improving the standard mechanism of regulations (e.g. targeted CASA) improving the performance of the ANSP.

The new demonstrated coordination workflows showed the following results:

- Visualisation of the impact of planned measures in D-1 predicted demand significantly improves and strengthens the D-1 planning process. Coordination with the relevant operational stakeholders is improved, even at a local level because different expert judgement interpretations were minimized. Although not operationally demonstrated, this is expected to lead to better pre-tactical measures.

- Improved coordination process of delay measures (regulation proposals, flight improvements, etc.) impacted over 5000 flights with estimated delay reductions of over 150.000 minutes
- FMP's are capable of asynchronous coordination of local measures with the network using an efficient and time-limited workflow process.
- Targeted measures reduced the need for ATFCM regulation (cherry picking, level capping, re-routing proposals) or reduced the impact of ATFCM regulation (lower rates, exclusions, forced CTOTs) to airline operators
- Linking locally proposed measures with the network manager's systems validates the local measures against the network situation. Unforeseen network issues from a local perspective are avoided, and a more efficient measure identification process is available, that is transparent to other operational stakeholders in the network and to the benefit of the end-users.
- The improved coordination process enabled an efficient measure update process that was not initially foreseen as major improvement. Currently, the conventional means are too time-consuming to justify the optimisation of measures after implementation. With the demonstrated improved coordination workflow, updating measure is very efficient and therefore used widely during the demonstrations. This has a positive effect on the effectivity of the applied measures. Multiple updates to regulations now appear regularly, contributing to continuous optimisation of network regulation measures and thus performance.
- Improved impact assessment possibilities to test the impact of local measures at network level was seen as very important and resulting in avoiding unnecessary coordination. In the demonstrations some ANSPs simulated the proposed local measures to assess the impact on the network. This improves significantly the local-network coordination as the different actors are assessing the same network impact results. In some cases, it avoided unnecessary coordination as the negative impact on the network would be clearly unacceptable.
- Enhanced impact assessments improved identification of effective local measures. With simulation possibilities the local FMP, supported with the local tool, can identify by trial-and-error (either serial or in parallel), the best measure to solve the local issue and with the minimum network impact.

4.1.3 Airports

Whereas airports in current operations often are considered traffic delivery and absorption nodes in the en-route network, the PJ24 demonstration exercises aim to provide a network planning process that includes airport planning as part of the overall network planning, instead of 'black-boxed' nodes. This improves transparency of planning to all actors in the network and enables improved coordination that will deliver operational benefits to the stakeholders if possible.

Demonstration exercises in Spain and the UK were performed with the following airports; London Heathrow, Barcelona El Prat, Alicante and Palma de Mallorca as indicated in the picture below.

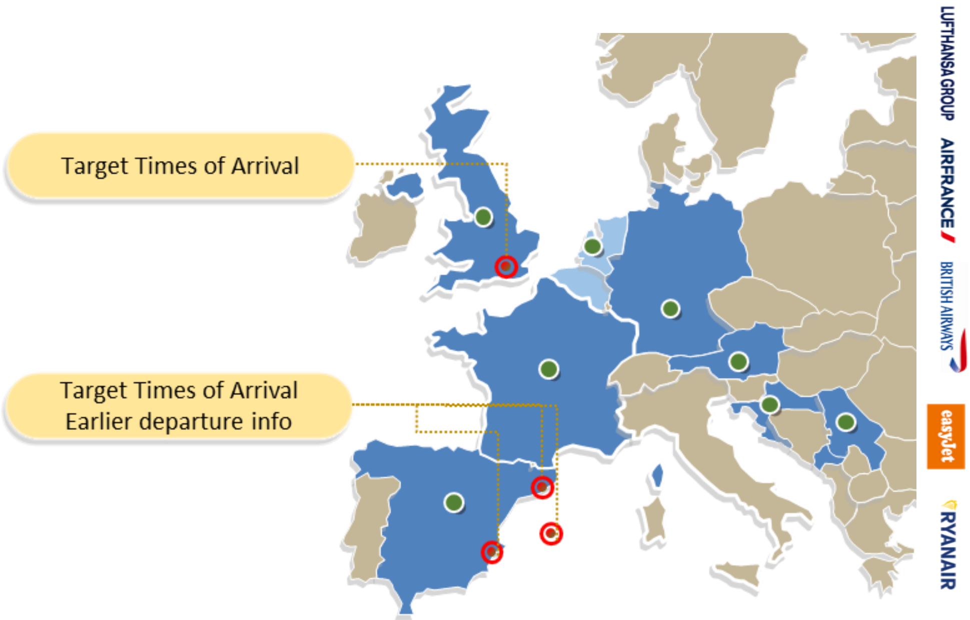


Figure 7: PJ24 airports and participating ANSPs

These airports are currently developing rapidly towards the next steps for advanced A-CDM processes. A-CDM provided an airport planning view to airport partners and exchanged departure planning information with the network, but cooperation between airport actors was still limited. The Advanced CDM processes, supported by AOP planning systems, focus on implementing cooperative planning processes supporting all airport actors with improved predictive capabilities.

Spanish Airports

The Spanish demonstration exercises focused on improved delivery of arrival flights as a result of improved airport planning process. This generated Arrival Planning Information (API) messages to the network. Where possible, the network (AU, ANSP's, other airports) supported the implementation of the arrival planning. In addition, the exercises focused on earlier integration of airport planning into the overall network planning with the aim to find better response from the network to accommodate the airport planning, and to optimize multi-airport coordination. NM and Spanish airports implemented Extended DPI messages to provide the possibility to update off-block times and the expected departure of a flight into the network 12 hours before operations. With earlier flight planning in the network the impact of network issues is earlier available to relevant actors and (multi-airport) planning can be optimized. The extended DPIs provide more accurate information **between 9 and 3 hours** before the flight. The gain achieved during the trial compared to the baseline days reaches for LEBL 10 minutes of improvement on average in the brackets 9 to 6 hours and 11 min in the brackets 6 to 3 hours. For LEPA and LEAL similar gains of accuracy were measured. In the A-CDM period, the additional gain that the AOP with the extended DPIs can bring to the legacy A-CDM is positive but minor. This is an expected result as the extended DPI concept builds on – and extends- the current A-CDM.

The exercise has also demonstrated that the TTA regulations provide benefits regarding the reactionary delay and contribute to the efficiency of Airspace Users and ANSPs processes to solve DCB issues. The confidence in the results is high for the reactionary delay calculation as they are provided by the mature CODA application.

The main observations regarding reactionary delay for TTA regulations in LEBL are significant reduction in reactionary delay dispersion and a reduction of the maximum and high reactionary delays. This means that TTA provides a much more balanced and concentrated range of reactionary delay repartition, reducing significantly the high reactionary delays.

Regarding the ratio reactionary delay to total delay, we observe a systematic reduction in the ratio at all delay levels, minimum, central and maximum. Reactionary delays are especially harmful for the overall network because of its propagation; reducing the proportion of reactionary delay is an important goal and these results align to this goal

Regarding the overall delay compared to classic regulation, a slight increase of average delay per flight was measured. However, these measurements involve simulation scenarios that have known limitations, hence further runs and techniques would be needed to confirm the mentioned results.

From qualitative assessments, ANSP and Airport staff confirmed benefits to operations performance and recommended further optimisation and implementation of TTA operations.

London Heathrow Airport

The Heathrow demonstrations ran from March 27th until June 16th 2019 during which 1081 TTA have been issued. The Heathrow demonstrations aimed for improved delivery of arrival flights by issuing target time of arrival times to flights computed and coordinated with support of the Heathrow DCB tool, shared with the network via API messages.

When proposing candidate flights, Heathrow Operational Efficiency Cell (HOEC) found that some had more penalising regulation from elsewhere, so the proposed TTA was cancelled for that individual flight (HOEC process).

Major results from the demonstration exercises show that, in general, as part of ATFCM planning processes the network is capable of supporting Airport operations with targeted measures when required. The demonstration procedures to optimise airport planning as part of network planning were designed not to measure flights that already received earlier network measures. Although this concept of multiple measures has to be still further studied, the demonstration showed significant numbers of arriving flights to the airport that were eligible for airport measures. This allowed having a significant impact on airport operations as aimed for.

The exercise successfully demonstrated the feasibility of the TTA Management process in an extremely busy network period and highlighted where improvements can be made. The concept of airport stakeholders operating in a paradigm that looks at optimisation of runway utilisation for the benefit of the wider airport community is proved.

There were distinct advantages for participants in the VLD through a reduction in delay compared to CASA regulations, a more definite Airport Plan through adherence to CTOTs at outstations, and a semi-automated TTA process. A reduction in AFTM of between 26-41% was measured when applying a TTA rule compared with conventional regulation.

4.1.4 AU

This Very Large Scale Demonstration project has shown the benefits for the aviation community with respect to collaboratively dealing with all facets of the ATM Network when it comes to capacity issues, disruptions and the need of dealing adequately with those issues. Over 6200 demonstration flights were performed comprising revenue flights from all participating ATEAM members. Additionally a very wide range of flights were re-planned, handled and evaluated by the respective

Airline OCC`s. Flights took place in Winter and Summer Flight schedules to reflect the year round OPS picture. Using data, collected during the demonstration campaign, the accuracy as well as feasibility of new tools, procedures and concepts (from OCC and ATC perspective) were evaluated. In addition to that, simulations and "shadow mode trials" took place to generate data where live traffic would not allow to do so.

Several benefit simulations and benefit studies focusing on environmental impact, cost benefits or airport accessibility and capacity aspects supported all trials. Thanks to the synergy of various stakeholders present in the project consortium, this deliverable provides a holistic view on the wide range of technologies and their capabilities with the goal to help speed up their deployment. It can be said, above all, that the VLD performed in this PJ24/NCM project brought a positive impact in understanding each other's needs and to increase acceptance of this new technology by the market. This will stimulate an increased deployment in the market, taking early advantage of the actual realization of the benefits, and thus support the ultimate goal of SESAR ATM modernization.

4.1.5 Key Performance Area Results

4.1.5.1 Safety

NCM performance objectives were aimed to maintain at least the current levels of safety performance. Regarding new fine-tuned DCB measures being applied, overall, a similar to slightly higher workload was reported. However, in many cases the increase in situational awareness and the operational benefit to deal with overload situation outweighed, from a safety perspective, the slight increase in workload.

Feedback based on expert judgement regarding new workflow techniques (particularly using SWIM/B2B data exchange and support by local/network systems) shows that respondents were generally very satisfied with demonstrated improvements and claimed that these would support safety performance significantly. This is mainly because of improved efficiency of coordination workflow processes and the reduced number of manual copy/paste actions, resulting in improved network operational (planning) awareness and reduces misunderstanding between operational stakeholders

ATEAM Members did Risk evaluations prior to Trials and no showstoppers were identified. Mainly due to the nature of concepts and FPL Data used, it can be said, that as in standard operations all quality and safety assurance concepts apply unchanged. Namely, that AIP Data was used and routine

ATM Concepts and workflows applied. In the OCC`s as well as in the Cockpit some additional demonstration tasks needed to be performed but this was also seen to be uncritical to safety.

Nevertheless, in some cases the extra workflows and the high number of (updated) measures, more information/options and necessary coordination activities created extra workload. Especially in the OCC`s, the additional workload for the trials could not be handled as staff was too busy with routine daily operations. Please find more information in the respective Annexes for each exercise.

That said, one must be aware, that practically all concepts need as much automation as possible and the tools/interfaces/etc. must be designed accordingly and deeply validated against workability and reduction in manual interference before being implemented. Any non-compliance to that may lead to undesirable negative effects on safety due to overload of people involved.

On the other hand, the improved coordination exercises resulted in actors more connected and aimed collaboratively to achieve higher usage of available capacity. This showed better alignment of overall network operational (planning and situational) awareness, which reduces misunderstanding between operational stakeholders and therefore can (if implemented wisely) even reduce workload.

4.1.5.2 Predictability

Current predictability values are perceived to be low in the en-route network. Results from predictability studies to support FPL Adherence project-activities indicate that only 50% of traffic planned for a certain sector actually flies through this sector in the given timeframe planned time. In current operations, the other 50%, because of tactical profile changes (including time) by ATC and requested by pilots, will not show up in the planned sector in a certain timeframe, or do not show up at all in the sector.

The low value of predictability of en-route traffic had an impact on the scope of NCM demonstrations. The exercises that aimed to improve en-route measures to specific flights were not always supported by FMP and ATC operations as the likelihood of flights not appearing in the sector was high. Instead, focus shifted more to flow-specific measures (included in recommendations) or ‘reversed’ STAM measures (flight specific fine-tuning in case of global regulated, i.e. taking measures away from specific flights).

Whereas low predictability in general remains an issue, local expert judgement (by FMP’s, ATCO, NM controllers) was able in some cases to compensate this and select potentially relevant candidates with an acceptable success rate. In more automated solutions with system support, low predictability is a showstopper.

In the pre-tactical exercises, current predictability levels blocked a successful demonstration. Often, the D-1 predicted traffic situation completely differed from the day of operations, minimizing added value of 'optimized' D-1 planning. The preparation performed at D-1 was often unusable on the day of operations as more accurate operational information significantly differed from the predictions available at D-1 .

In the tactical en-route exercises, predictability levels generally improved as a result of the exercises. The level-cap exercises reported a perceived reduction of volatility of flights. The targeted measure exercises reported higher confidence in the planning and impact of measures. This is mainly due to collaborate efforts and better awareness of the situation. Because of cooperation and shared awareness of network issues, airlines are less tempted to submit uncoordinated alternative FPL's and then ask for deviations to the FPL in the airborne phase. FMPs and ATC are less likely to propose or accept deviations into the network issues and were seen to be more supportive to network issues downstream. This created higher predictability in the bottlenecks of the network and possibly in other parts of the network.

The earlier sharing of departure data in airport exercises resulted in a significant higher predictability of the daily planning 9 to 3 hours before operations and a minor improvement in the last 3 hours before operations.

4.1.5.3 Efficiency (Fuel) Environmental sustainability

A general approach to sustainability one must look into some historic data. Namely, the continuous increase in Air Traffic over the past years, leading to an increase in capacity related problems. Even though it was NOT part of the project to scientifically evaluate weather changes it can be said, that disruptions in the ATM system due to weather have also increased. Both factors come along with an ATM System in Europe that has to deal with various systems and concepts used in all fields of ATM thus not really providing seamless Air Traffic Services. Taking into account the immense amount of extra mileage and longer routes flown in standard operations (routings across Europe inefficient by AIP/RAD design) it is more than obvious, that in a disruptive environment with increasing traffic like in the Summer schedules this inefficiency increases with the consequences of even flying longer routes and increasing costs due to delays. So anything that can be done to avoid extra miles to be flown, has a positive effect on fuel efficiency. Same applies to Holdings and delay vectoring.

The AU`s have to deal with those disruptions and are more than happy to support concepts that may improve the situation, especially when it comes to punctuality and fuel efficiency.

Some of the concepts tested in NCM have shown an increase in Fuel burn (Lower levels flown, routings planned to avoids hotspots) and subsequent environmental effects due to the induced emissions. So it must be of highest priority to have a fuel burn decrease as a consequence when looking at a network level. That said: it is important to have an open, transparent, equal and fair system for AU`s that support the network thinking actively and those not following or applying the concepts and still having the benefit of better network performance. Therefore, AUs need to be integrated more closely within the governance layers for process design and overall IT evolvement.

The demonstrated reroute proposals to optimise the use of airspace capacity logically lead to a less optimal flight profile and that has to be balanced against the capacity gains (that may at some other point lead to more efficient flight OPS). During the trials, for impacted flights, receiving reroute proposals, fuel efficiency has dropped. Overall, it was estimated that several dozens of kg, sometimes well above 100kg of **additional fuel per flight** was required to fly at lower altitudes or re-routing to avoid ATFCM regulations.

However, applying targeted measures and avoiding regulation could result in fuel savings at network or fleet level. In some areas, if informed on time, AO's choose to circumnavigate areas of high delay, which increases fuel consumption due to longer trajectories. By applying targeted measures, some regulations were avoided supporting the shortest route options. In the COOPANS/SMATSA cooperation, simulations showed potential fuel benefits for an average European flight between selected city pairs. Also, Target Times of Arrival could lead to reductions in holding time with positive impact on fuel consumption.

Fuel efficiency is a very important factor in the airlines business model. Analysis of NCM demonstrations resulted in various fuel consumption impacts that have not been verified with AU's system, therefore an overall collaborative conclusion of wider fuel consumption impact as a result of NCM has not been reached. However, Aircraft Operators concluded that for measures applied during the demonstration the decrease of fuel efficiency was outweighed by the increase of capacity and decrease in delays.

4.1.5.4 Cost-Effectiveness

Coordination improvements have resulted in significantly less time necessary for coordination per measure. This includes the identification, proposal, assessment, feedback and implementation of the measure. Support tools showed a great increase in confidence of operational FMP in their ability to manage the sector load. A single FMP or NMOC controller was capable of managing more coordination actions as before.

For the airlines, during trials, coordination improvements have not directly resulted in significantly less time necessary for coordination per measure. This must be achieved with sophisticated automation and interfaces directly linked to the flight planning software to keep manual interaction to a minimum, that were not available during the demonstrations. This is particularly important due to the low staffing numbers within airline OCCs and the related needs for efficient and automatized processes.

Taking away the factor of manual work, it can be said that any delay decrease that enhances network performance and overtakes the extra fuel burn impact can result in better cost effectiveness. This means that any cost for delay, such as passenger compensation, crew duty times, etc. must also be taken into account. So in general the aim should be to increase punctuality and predictability resulting in cost effectiveness and not necessarily increase traffic volume.

4.1.5.5 Capacity

The participating ANSP's and Airports have saved thousands minutes of delay or identified opportunities for delay reduction, through avoiding or reducing ATFCM regulations by identifying targeted flow measures using network collaborative coordination processes.

These savings have been achieved in nominal operational situations. In case of larger disruptions or specific network events, normally the 'heavier' machinery has to balance traffic and capacity. These scenarios were not in scope of the NCM demonstration.

For reference, a normal day in the network, taking European performance targets (max 0.5 min/flight, >30,000 flights) into consideration, has between 10k and 30k minutes of delay.

Over a relatively short period, most demonstration exercises were able to show solid delay reductions of minimizing the impact of otherwise applied global regulation that would cause hundreds or a few thousand minutes of delay. In the exercises that included measures to many flights (e.g. MUAC flight improvements, or Heathrow's TTA's) delay reductions easily added to thousands of minutes of delay.

The Spanish TTA exercises have measured significant reductions in reactionary delays and maximum delays to flights. However, a slight increase of average delay per flight was measured.

It is difficult to quantify network capacity performance benefits as a result from Network Collaborative Management practices as the limited application in the demonstration activities can't easily be extrapolated to network level. However, all operational stakeholders considered impact in their local area as significant and useful to implement and a wider implementation of NCM practices would further contribute to delay reductions.

4.2 Detailed analysis of Demonstration Results per Demonstration objective

4.2.1 OBJ-VLD-01-001 Results

Identifier	OBJ-VLD-01-001	KPA category: Safety	
Title	Impacts of using enhanced DCB measures and TTs on operational staff's workload (NM, ATC and Airport)		
Objective	Acceptable increase in workload for network operations planning actors to apply enhanced DCB and TT measures to optimally use network capacity.		
Success Criterion	Identifier: CRT-VLD-01-001	The usage of enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload.	
Results	Different levels of increase in workload reported. However, generally, the workload increase is acceptable considering operational benefits achieved. Where enhanced DCB measures were already used, tools support generally reduced workload.		**OK**

<u>**Pre-Tactical Planning Scenarios**</u>

The workload experienced to assess and propose DCB measures at the Pre-Tactical stage using a collaborative tool is comparable to existing methods employed today. However, the ability to have greater visibility of the entire network, rapid prototyping and a single system data source to be used as a 'single point of truth' far outweighs any workload increases incurred.

The optimisations that a collaborative tool can provide essentially reduces workload, allowing for more time to be spent trialling options and refining the plan.

In addition, a collaborative tool contributes to shared operational view with other operational stakeholders, reducing coordination complexity and thus workload.

<u>**Tactical Targeted Flow Measures**</u>

The overall workload for the entire measure timeline was perceived to be lower. At the assessment stage before the measure is applied there is a workload increase. However, the traditional method using a global measure is to pessimistically apply a rate and then improve the rate as confidence grows that the capacity imbalance has been balanced. This method requires constant overview and multiple communications with NM for rate refinement. The targeted method led to a confidence increase and lower delay which if operational would have resulted in less monitoring and refinement with NM resulting in a workload decrease.

Tactical Level-Cap measures

Similar results were obtained from the French and Spanish exercises. As a conclusion, CAP process does not create an excessive workload for the FMP and, if the quantity of work or mental workload increases, this is mainly perceived as acceptable. The feedback received from the AUs shows CAP Tool processes and Procedures were in line with the operating methods. In addition, the AUs describe the tool as intuitive and easy to use. They found the information that the Chat box provides clear and easy to understand.

In relation to the NCAP feasibility exercises, depending of the flight planning system, the workload for airline staff was more or less time consuming to calculate the performances, fuel consumption, flight time, etc., of the new route proposed by NM. With higher amount of traffic and the resultant higher amount of RRP`s that must be worked on, the effect of extra manual work vs. automation will increase.

Tactical Fine-tuned delay measures

Operational staff report that the process of flight improvement procedures using MUAC's ATMP was significantly more efficient than using telephone. The workload of NMOC operator was reported to be too high due to use of email mechanism. This was improved and reported as significantly lower and fully acceptable workload by NMOC operators during the 2019 iteration of flight improvement procedures due to use of SWIM/B2B mechanism and consequent integration with ETFMS.

In the COOPANS/SMATSA exercises, initial workload increased due to familiarization with new tool support, but quickly workload reduced to levels lower than before introduction of the tool.

Target Time measures

Although some comments reported TTA's as additional workload, the majority of FMPs and NMOC controllers reported that the increase in workload is acceptable when applying a proposed TTA measure to optimally use network capacity. The overall actors implied in the process (76%) gave a positive feedback, stating that the TTA measure did not interfere with their other tasks. TTA regulations are feasible and can work in an operational environment, with a non-negligible impact.

4.2.2 OBJ-VLD-01-002 Results

Identifier	OBJ-VLD-01-002	KPA category: Safety	
Title	Assess the impact of using enhanced DCB measures and TT on speed changes in ACCs		
Objective	The implementation of Target Times and associated speed changes doesn't create extra workload for ATC.		
Success Criterion	Identifier: CRT-VLD-01-002	No increase in workload for ATC because of non-nominal speed profiles flown by participating airline flights.	
Results	n/a		**n/a**

Results were not reported.

4.2.3 OBJ-VLD-01-003 Results

Identifier	OBJ-VLD-01-003	KPA category: Safety	
Title	Assess the impact of using enhanced DCB measures and TT in TWRs, APPs		
Objective	Reduction of necessary ATC interventions to de-bunch and optimally sequence traffic entering en-route and arrival sectors.		
Success Criterion	Identifier: CRT-VLD-01-003	The usage of TTs does not have a negative impact on ATC TWR/APP operational staff workload, e.g. reduced vectoring, holding, changes to departure sequences, etc.	
Results	FMPs agreed that the increase in workload when applying a proposed TTA measure was acceptable. As well, ATCs implied in TTA measure coincide in stating that the workload was very similar to the experienced when using standard CASA regulations.		**OK**

Regarding the reduction of necessary ATC interventions to de-bunch and optimally sequence traffic entering departure and arrival sectors, the results are very positive. From all ATCs implied in the TTA measure, more than 60% largely agreed that the workload was similar compared to a standard CASA regulation. Only 20% of them slightly disagreed and the other 20% gave a neutral feedback.

FMPs agreed that the increase in workload when applying a proposed TTA measure was acceptable. As well, ATCs implied in TTA measure coincide in stating that the workload was very similar to the experienced when using a standard CASA regulation.

4.2.4 OBJ-VLD-01-004 Results

Identifier	OBJ-VLD-01-004	KPA category: Safety	
Title	Transparent coordination processes		
Objective	Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied.		
Success Criterion	Identifier: CRT-VLD-01-004	Positive feedback from all actors regarding DCB overall processes.	
Results	Generally, very positive feedback from all operational stakeholders that sharing measures via SWIM solutions or shared interfaces improves situational awareness. Only at network manager level the concern exists that many different specific fine-tuned measures could also lead to a complex network situation.		**OK**

<u>**Pre-Tactical Planning Scenarios**</u>

Visibility of other measures was considered very important by the Planning Manager. Often within the operational world, measures are applied by FMPs as late as reasonably practicable to allow for other FMPs to implement measures in advance. This would result to implement a smaller or less restrictive measure resulting in less penalising severity. For effective pre-tactical planning and stability it is advantageous for all FMPs to propose and implement measures as early as reasonably practicable.

<u>**Tactical Targeted Flow Measures**</u>

The FMP agreed that situational awareness and implication of measures applied across the network are improved over traditional tool sets and processes. A collaborative tool allows for visualisation of applied measures across the network allowing for more efficient planning of local measures to apply.

Tactical Level-Capping Measures

The French and Spanish CAP exercises show similar results. From a CDM point of view, CAP is considered an efficient enabler for collaborative decision making: all participants have a '*feeling of working together'* between ATM actors thanks to CAP and they raised that it helps to have a better situational awareness, interaction with AUs and to improve the trust level between all participants.

Tactical Fine-Tuned Delay Measures

Users report that having delay measure information integrated into their local tool or demonstration tool greatly increases their situational awareness, especially in regards to delay and network performance. Regarding the process to determine if an ATFCM measure is required, FMPs were able to maintain situational awareness through the analysis of traffic as well as the preparation of an ATFCM measure.

ATEAM would also like to support the initiative, which has been running between NMOC and ANSPs, to get many actions via SWIM services instead of having the traditional phone call or email exchange to coordinate the requests between both stakeholders (most of them to allocate flights on empty slots and therefore improve the delay situation). For the ATEAM this is seen as a big step forward and should be extended to all FMPs and to all other ATM Stakeholders.

In the FABCE area, the use of the demo platform allowed for an increased situational awareness to FMPs. Relevant ATFM information (automatic hotspot detection, weather (incl. CB's) forecasts, traffic complexity, etc.) is displayed in an intuitive way, and displayed information increases the knowledge about neighboring and own Area, which has shown to be increasingly important for an FMP. Information is displayed on a Map interface, which is not often used in current operations and existing CHMI due to poor Map response time.

Target Time Measures

As for situational awareness, regarding the TTA measure applied, FMPs strongly agreed that the situational awareness was maintained compared to the current situation (90%). Of participating NM staff, 42% think that TTA measures maintains the level of situation awareness.

Transparency in the operational network

The exercises at network level were mainly to improve the situational awareness of all the involved actors by sharing level-capping measures, via the NM system, with all operational actors. Before this exercise there was only a bilateral coordination between Airspace User and the FMP. The solution proposed by this exercise leads to a big improvement in terms of information sharing and network situation for all the actors:

- FMP – When the Airspace User accepts or rejects the rerouting proposal after the activation of the scenario, FMP is aware of the intentions of the AU by means of the update of the FPL.
- NM – With the utilization of the scenario from the scenario repository and the utilization of SWIM mechanisms, NM systems reflect not only the intentions of the FMPs but also the changes in trajectories by Airspace User.
- AU – With the reception of RRPs and the capability of knowing the constraints of the scenario, AUs is able to assess and solutions that are optimized from the airspace user's perspective and balance different solutions.

Further steps are required in order to agree the operational guidelines and the environment in which network transparency and the operational use of re-route proposals could succeed and provide benefits to the network, ANSPs and AOs. The operational procedures and current frameworks are not yet mature enough.

Some implementation improvements are recommended, in particular not to limit the solutions to reuse existing automated communication support when they have proved insufficient.

4.2.5 OBJ-VLD-02-001 Results

Identifier	OBJ-VLD-02-001	KPA category: Predictability
Title	Improve predictability of flights and load in Network.	
Objective	Reduce the margins between planning and actual for flights and load due to unforeseen changes in the execution of the European Network operations.	
Success Criterion	Identifier: CRT-VLD-02-001	The distribution of early/late arrivals at coordination points or the airport of destination is better centered and narrower than current operations. The distribution of difference between estimated and actual load is better centered and narrower than current operations.

Results	Significant predictability improvements of departure planning information were observed in the time bracket -9 to -3 hours before actual take-off at all participating airports. **(OK)** Load analysis wasn't performed. **(n/a)**	**OK**

For TTA based operations at Heathrow during the VLD, aircrew at airports of origin were issued with intelligent Calculated Take-Off Times (CTOT), derived from TTA values that were determined by the A-A-DCB solution and published to NM via the integrated AOP/NOP. Standard tolerances for adherence to CTOTs, assumed by NM and A-CDM airports, are -5 minutes/+10 minutes. The demonstrations provided no evidence of deterioration of information at Heathrow. The use of TTA operations to resolve hotspots and its success in such resolution infers improvement.

The AOP-NOP exercises in Spain (Barcelona, Palma de Mallorca and Alicante Airports) have demonstrated that the extended DPI concept significantly and consistently increases the predictability- take off time predictability- of the legacy A-CDM in the extended horizon. The confidence on the results is high as the trial spread over 28 days for LEBL, LEPA, and 5 days for LEAL.

The extended DPIs provide more accurate information **between 9 and 6 hours** before the flight. The gain achieved during the trial compared to the baseline days reaches for LEBL 10 minutes of improvement on average; for LEPA 6,8 minutes of improvement on average. **Between 6 and 3 hours** before the flight, the improvement achieved through the P-DPIs is even higher for **LEBL with 11 minutes** gain in average and **6,3 min for LEPA**. In the A- CDM period, the additional gain that the AOP with the extended DPIs can bring to the legacy A-CDM is minor. This is an expected result as the extended DPI concept builds on – and extends- the current A-CDM.

For LEAL that is an Advanced Tower airport, the extended DPIs provide similar gains than for the LEBL and LEPA CDM airports, a gain of over **7,9 minutes between 9 and 6 hours** before flight that increases to **10,2 min in the next 3 hours**.

Interesting to point out that, for all airports, the highest the inaccuracy from the flight plans due to days with high ATFM delays, the better the gain from the AOP and the P-DPIs.

The AOP-NOP exercise has demonstrated that General API messages providing arrival-planning information need to be improved for the arrival STAR and RWY, before it can reliably integrate data in the network. The ELDT provided in the API message is marginally more accurate than the current ELDT.

4.2.6 OBJ-VLD-02-002 Results

Identifier	OBJ-VLD-02-002	KPA category: Predictability	
Title	Improve predictability of flights for an ANSP.		
Objective	Reduce the margins between planning and actual for flight entering the ANSP's AoR due to unforeseen changes in the execution of the European Network operations.		
Success Criterion	Identifier: CRT-VLD-02-002	The distribution of early/late arrivals at the entry points of the AoR of ANSPs is narrower than current operations.	
Results	Pre-Tactical D-1 planning requires a higher level of planned data accuracy to achieve this objective to its full capability. Tactical targeted flow measures demonstrated great potential to reduce flight impact and delays. Regarding improvements of accuracy of planned arrival times through API message exchanges; despite the fact that the AOP can provide more accurate information on ELDT, the improvement is only of decimals and it is around 100 minutes before landing when the aircraft in is execution. It should be further evaluated to decide if this improvement could bring benefit to NM or other stakeholders to consider including the ELDT coming from General API messages into ETFMS flight data.		**Partially OK**

During the trial it was observed that the imposition of a targeted measure had the opportunity to save a significant amount of delay to flights, as detailed in EX2-OBJ-VLD-05-002 Results. The application of this measure would also have significantly reduced the margins between the plan and the execution phase and improved overall network performance.

The Level-Cap measures demonstrations also evaluated the hypothesis that traffic volatility, caused by a regulation, can be avoided thanks to applying a CAP measure instead. Results show that this assumption is not completely perceived likewise by FMPs and AUs (resp. +- 50% and <20% agree), both in the French and Spanish exercises. Answers from the FMP and AU questionnaires show that CAP process is perceived as contributing only lightly (or neutrally) to the reduction of traffic volatility.

Despite the fact that the AOP can provide more accurate information on ELDT, the improvement is only of decimals and it is around 100 minutes before landing when the aircraft in is execution. It should be further evaluated to decide if this improvement could bring benefit to NM or other stakeholders to consider including the ELDT coming from General API messages into ETFMS flight data. It should also be evaluated if incorporating airlines estimates to the ELDT calculations in the AOP (for instance, those currently received through MVT and ACARS messages) could improve this predictability, especially for long haul flights.

4.2.7 OBJ-VLD-02-003 Results

Identifier	OBJ-VLD-02-003	KPA category: Predictability	
Title	Improve predictability of flights for an Airport.		
Objective	Reduce the margins between planning and actual for flight landing on the runway due to unforeseen changes in the execution of the European Network operations.		
Success Criterion	Identifier: CRT-VLD-02-003	The distribution of early/late arrivals at the runway of an airport is narrower than current operations.	
Results	Regarding improvements of accuracy of planned arrival times through API message exchanges; despite the fact that the AOP can provide more accurate information on ELDT, the improvement is only of decimals and it is around 100 minutes before landing when the aircraft in is execution. A-DCB has been proven to provide an accurate traffic forecast. Analysis undertaken during the VLD has shown that aircraft have largely complied with their TTAs, and A-DCB has provided a stable solution		**OK**

See also Section VLD-02-002.

The results measured in terms of increased predictability also show that the estimated times of arrival are more accurate when integrating API and DPI messages long in advance of the airport-CDM processes. The goal of better demand predictions due to AOP-NOP integration was achieved.

However, also due to the limited timeframe of the exercise, the exercise did not show how this increased predictability translates into benefits for the airspace users, in terms of increased capacity (for example with less margins taken by ATC in case of capacity constraints or demand peaks) or reduced delay.

4.2.8 OBJ-VLD-03-001 Results

Identifier	OBJ-VLD-03-001	KPA category: Efficiency (Fuel)	
Title	Reduce extra fuel burn in European Network.		
Objective	Reduce the extra fuel consumption in the European Network due to network issues or to unforeseen changes in the execution of the European Network operations		
Success Criterion	Identifier: CRT-VLD-03-001	The cumulated additional fuel consumption due to DCB constraints, is reduced.	
Results	Fuel consumption measurements have not been 'scientifically' performed, therefore no results available. Non-optimal reroute proposal to flights logically result in an increase of fuel consumption that in many specific flight cases seemed acceptable considering the capacity benefit. Also, exercises showed that by applying targeted measures, some regulations were avoided supporting the shortest route options to otherwise impacted flights, resulting in an overall reduction of fuel consumption.		**NOK**

NCM exercises focused mainly on reducing the impact of ATFCM delay in the European network, by proposing alternative solutions to specific flights and/or flows. This resulted in specific measures as delay, target times or re-route measures. The impact on fuel consumption was not measured in case of specific delay or target time measures, although it could be argued that an improved network performance in terms of capacity and predictability would have a positive impact on flight planning and therefore fuel consumption. But, an complex analysis of this relation was not part of the demonstration exercises.

4.2.9 OBJ-VLD-03-002 Results

Identifier	OBJ-VLD-03-002	KPA category: Efficiency (Fuel)
Title	Reduce extra fuel burn over an ANSP traffic flow.	
Objective	Reduce the extra fuel consumption due to DCB measures for the whole traffic flow overflying a FIR	
Success	Identifier: CRT-VLD-03-	The cumulated additional fuel consumption over the whole

Criterion	002	traffic flow overflying a FIR, due to DCB measures, is reduced.
Results	Fuel consumption measurements have not been ‘scientifically’ performed, therefore no results available. Taking into consideration that less flights are impacted and more flights can use an optimised trajectory, there are indications (FABCE simulations) of fuel reduction.	**NOK**

Tactical Level-Capping Measures

The demonstrated reroute proposals to optimise the use of airspace capacity logically lead to a less optimal flight profile and that has to be balanced against the capacity gains (that may at some other point lead to more efficient flight OPS). During the trials, for impacted flights, receiving reroute proposals, fuel efficiency has dropped. Overall, it was estimated that several dozens of kg, sometimes well above 100kg of **additional fuel per flight** was required to fly at lower altitudes or re-routing to avoid ATFCM regulations.

However, applying targeted measures and avoiding regulation could result in fuel savings at network or fleet level.

Tactical Delay measures

In the COOPANS/SMATSA area, by using STAM a reduction in the number ATFM regulations was possible and tactical coordination was closer to real time events. If informed on time, AO’s choose to circumnavigate areas of high delay, which increases fuel consumption due to longer trajectories. By applying targeted measures, some regulations were avoided supporting the shortest route options to other flights. In the COOPANS/SMATSA cooperation, simulations showed potential fuel benefits for an average European flight between selected city pairs.

Since real fuel expenditure data is not available, a simulation was made in NEST to support the above claims. The results of the fuel calculation show a potential for saving between 106kg and 268kg of fuel on an average European city pair.

4.2.10OBJ-VLD-03-003 Results

Identifier	OBJ-VLD-03-003	KPA category: Efficiency (Fuel)	
Title	Reduce extra fuel burn over an Airport traffic flow.		
Objective	Reduce the extra fuel consumption due to DCB issues at an Airport by better coordination between airports/network		
Success Criterion	Identifier: CRT-VLD-03-003	The cumulated additional fuel consumption over the whole traffic flow to/from an airport, due to DCB measures, is reduced.	
Results	n/a		**n/a**

The measurement and analysis has not been part of the demonstration exercises.

4.2.11OBJ-VLD-04-001 Results

Identifier	OBJ-VLD-04-001	KPA category: Efficiency (Cost)	
Title	Increased cost-efficiency from more efficient processes for NMOC.		
Objective	Reduction in time for NMOC staff to monitor, analyze, coordinate and implement measures to balance demand - capacity		
Success Criterion	Identifier: CRT-VLD-04-001	Positive feedback from NMOC staff to apply measures Reduced time to achieve the DCB workflow process	
Result	Positive feedback from NMOC staff regarding implemented delay measures into ETFMS. In addition, the visibility of local level cap measures in the NM system will improve identification of appropriate network measures to flights and coordination with Aircraft Operators and FMP's.		**OK**

<u>**Targeted Level Capping Measures**</u>

The availability of proposed local measures (e.g. level-cappings, flight improvements, etc.) to flights improves the coordination of NMOC and AOLO with aircraft operators. This has a positive effect on the identification of appropriate network measures avoiding overlap in targeting flights with different measures from different operational actors. Airline participants were comfortable with the technical feasibility (connectivity) of the trial. There is room for improvement, where most of the recommendations focus on technical improvements to bring operational benefits.

Tactical fine-tuned Delay measures

Regulation simulation, creation and coordination via SWIM/B2B message exchange has been operationally implemented and demonstrated. The amount of coordination via the telephone has been significantly reduced resulting in a significant increase of workflow efficiencies.

Initially flight improvement coordination was performed via automatic email exchange in 2018 causing a too high workload for NMOC controllers. The 2019 demonstration saw improvement by integrating flight improvement requests into the NM system, enabling significant workflow efficiency improvements. Integration into the NM system led to significant NM operators workload reduction compared to 2018 iteration and consequently approx. 90% requests accommodated so far.

4.2.12OBJ-VLD-04-002 Results

Identifier	OBJ-VLD-04-002	KPA category: Efficiency (Cost)	
Title	Increased cost-efficiency from more efficient processes for Airlines.		
Objective	Reduction in time for airline staff to monitor, analyze, coordinate and implement measures to balance demand - capacity		
Success Criterion	Identifier: CRT-VLD-04-002	Positive feedback from AU staff to apply measures Reduced time to achieve the DCB cycle	
Result	Tool support (N-CAP, CAP, ATMP, etc.), preferably integrated in network HMI, helps AU staff to reduce the time to monitor, analyze, coordinate and implement fine-tuned DCB measures. However, more automation needed to further reduce required time in case flight measures amounts would increase. **(OK)** Some exercises increased workload for monitoring flight-specific measures		**Partially OK**

	beyond acceptable levels. **(NOK)**	

Tactical Fine-Tuned Delay Measures

Participating airlines the perceived ATM Portal as a very good and valuable initiative. It allowed airlines to pick the most important flights on Network and Fleet Level. If extended to the entire European ATM Network, airlines could cover all flights in their schedules as this will help to enlarge the positive effects for the Airline AND the Network.

For airlines, the reduced delay measures can have a huge financial impact for the company. E.g. if a delayed flight is approaching crew duty time limitation or curfew, reduced delay measures could avoid costly measures as additional ferry flights, or other unplanned flights for positioning.

ATEAM would also like to support the initiative, which has been running between NMOC and participating ANSPs, to get many actions via SWIM services instead of having the traditional phone call or email exchange to coordinate the requests between both stakeholders (most of them to allocate flights on empty slots and therefore improve the delay situation). For the ATEAM this is seen as a big step forward and should be extended to all FMPs and to all other ATM Stakeholders.

Targeted Level-Capping Measures

The demonstration exercise has successfully proved that CAP helps AU staff to reduce the time to monitor, analyze, coordinate and implement fine-tuned DCB measures. However, dispatchers still need to allocate time to test the new route, assess the best option from the AUs' point of view, and if decided so, to submit the new flight plan. The coordination of the various options in the strategic phase, between NM, AUs and FMPs facilitate these steps (which should be at least partly, or even fully, automated). The NM B2B messages will support the standardization and further automation of the process, as demonstrated in EXE1 with NCAP.

Looking at the wider context of airlines receiving multiple and different types of flight measures, it was clearly demonstrated that there was an increase in workload and tasks to be completed by OCC staff to fulfil the required changes to the original flight plan. This can only be dealt with for future implementation by automation (e.g. validated RRPs directly sent to AUs flight planning tool/recalculated automatically and dispatcher only selects the optimum route based on flight and network efficiency). Dispatchers work in the future shall just be a decision-making process (accept/decline/counter propose based on all the information available from the network) in an integrated tool rather than recalculating flights using multiple systems and HMI's.

Target Time Processes

The distribution of TTAs to AUs uses the same channel as traditional CASA regulations: SAM/SRM messages. In these messages, it is not possible to distinguish cherry-picking / TTA-based measures from traditional CASA computations. Therefore, the airlines (OCC back office and crew) do not have a way to act specifically upon TTA measures. Although special behaviour is not required by the concept (only recommended to secure the exercise results), this information sharing could bring some efficiency in the airline processes. A dedicated message format, containing all the necessary TTA information, would be necessary to obtain this.

4.2.13OBJ-VLD-04-003 Results

Identifier	OBJ-VLD-04-003	KPA category: Efficiency (Cost)	
Title	Increased cost-efficiency from more efficient processes for ANSPs.		
Objective	Reduction in time for FMP staff to monitor, analyze, coordinate and implement measures to balance demand - capacity		
Success Criterion	Identifier: CRT-VLD-04-003	Positive feedback from FMP staff to apply measures Reduced time to achieve the DCB workflow process	
Results	Generally very positive. ATFCM simulation, creation and coordination integrated in a local tool and shared at network level where necessary significantly improves the local and network coordination processes. The increase of efficiency leads to a significant increase in the frequency and numbers of updates and specific flight measures proposals as these are much quicker. The management of such an increased quantity of measures proposals and updates in the network needs to be further discussed.		**OK**

Pre-Tactical Planning Scenarios

As discussed in previous objective results the workload experienced to assess and propose DCB measures at the Pre-Tactical stage using a collaborative tool is comparable to existing methods employed today as the overall user process has not changed. However, the ability to have greater visibility of the entire network, rapid prototyping and a single system data source to be used as a 'single point of truth' far outweighs any workload increases incurred.

The optimisations that a collaborative tool can provide essentially reduces workload, allowing for more time to be spent trialling options and refining the plan. The possibility for local ANSPs to access pre-defined scenario data and to simulate local measures pre-tactically results in increase of effectiveness of local measures in addition to easier coordination with relevant operational partners, including aircraft operators.

Tactical Targeted Flow Measures

The conclusion from the NATS FMPs was that although there is a small workload increase due to having an increased number of measures to assess and simulate the network benefits far outweigh increased workload. In some situations, the workload for the measure lifecycle would be reduced, as the user may not be required to continuously refine the applied measure.

Also the Spanish exercises with targeted measures showed positive results in relation with the improvement in cost-efficiency for ANSPs. This is due to the reduction in time for FMP staff to monitor, analyse and coordinate measures, the average of answers from the FMPs is positive ranging between neutral and positive regarding STAM workload.

Tactical Level-Capping Measures

For the FMPs that have been using CAP tool for few years, CAP is considered very useful and easy to use. They raised the benefits of CAP process against the implementation of Scenarios (compared to Scenarios, CAP process eases the FMP workload in terms of flight identification and assessment of additional complexity for ATC implementation) and they suggested to the new FMP CAP users to replace Scenarios by CAP process whenever appropriate.

Most of FMPs consider CAP tool easy to use and flexible. They appreciate the CDM chat, knowing the needs and constraints of the adjacent ACCs and AUs is an added value to solve the DCB issue in a more efficient and coordinated way.

However, when choosing the most appropriate ATFCM measure to solve the DCB issue, the two groups of FMP have different points of view. Several years of usage eases the FMP workload in terms of flight identification and complexity assessment compared to the implementation of a Scenario. On the other hand, the new users think that CAP process does not completely match their working methodology to solve a light traffic peak, they prefer to activate an Scenario or to wait for the peak to either smoothen or rise before taking an action.

Tactical Fine-tuned delay measures

The integration of simulation, creation and coordination of regulation proposals, flight improvements has a massive positive impact on the efficiency of the ANSP's workflow.

The processes are so efficient that over-usage of the functionality is occurring, causing too many unnecessary coordination moments and rethinking of roles and responsibilities, especially regarding triggering point of relevant operational actors. Normally, NMOC staff received concrete proposals via telephone to which they obviously respond. Updates to earlier proposals are not common given the workload of coordination. With the improved efficiency it is very easy to remove the coordination limits and to optimize proposals via updates. Together with multiple flight measures in addition to only measure proposals, creates an overflow of flight- and measure coordination at network level that has to be channelled differently in the future.

In the Spanish exercises, the confidence of FMPs in the CASA regulation to be able to solve the Demand and Capacity imbalance is very positive. Concerning workload, FMPs have shared that the workload experienced during the implementation of the STAM was acceptable and did not interfered in any other of their tasks. Nevertheless, it has been suggested during the debriefings that a possible improvement would be the automation of the initial flight selection and even a proposal of the delay required for each flight to lower the peak. This is due to the fact that to perfectly adjust the measure to the imbalance, some estimations need to be done, which might be time consuming in some occasions. However, all FMPs concurred in the potential of the demonstration tool (PLANTA) and its intuitive and visual use.

Regarding roles and responsibilities, the integration of the processes and procedures in local or demonstration tools reflected perfectly the organizational sequence to be followed, being clear and consistent in every moment the areas of responsibility of each role, contributing to transparency in coordination of measures.

In the COOPANS/SMATSA exercises, automated processes for hotspot ID and basic CDM exchange through a simple message exchange has shown a great increase in confidence of operational FMP in their ability to manage the sector load. The results of the FMP questionaries' show a reduction of time to carry out their regular duties to monitor and analyze the oncoming traffic. Even more gains are expected once the "popular" functionalities are integrated in future solutions (e.g. Prompt for Flight List by clicking at the Load Bar.

4.2.14OBJ-VLD-04-004 Results

Identifier	OBJ-VLD-04-004	KPA category: Efficiency (Cost)	
Title	Increased cost-efficiency from more efficient processes for Airport (APOC).		
Objective	Reduction in time for APOC/airport planning staff to monitor, analyze, coordinate and implement measures to balance demand - capacity		
Success Criterion	Identifier: CRT-VLD-04-004	Positive feedback from APOC staff to apply measures. Reduced time to achieve the DCB workflow process.	
Results	n/a		**n/a**

Demonstration measurements have not been performed on APOC staff satisfaction and APOC processes.

4.2.15 OBJ-VLD-05-001 Results

Identifier	OBJ-VLD-05-001	KPA category: Capacity	
Title	Increase the use of available airspace capacity for the network.		
Objective	Reduce ATFM delay in the network.		
Success Criterion	Identifier: CRT-VLD-05-001	The accumulation of ATFM delay due to DCB issues in the network is reduced due to the application of advanced network collaborative management.	
Results	Although applied at local level, the various exercises all contributed to network performance with a reduction of delay. It is not possible to quantify the overall network effect on capacity (delay reduction). However, the accumulated results add up to several thousands minutes of delay reduction, achieved in a relatively short period of demonstration activities.		**OK** (not quantified as a whole)

The innovative use of newly available local and network functions and interfaces all contributed to delay reduction when comparing with the situation when only global regulations are applied.

It is difficult to extrapolate local results to a network situation as for correct comparison the measures need to be implemented in an exact similar ATM situation. However, obviously it is not possible to apply different measures at the same time in the network and compare the outcomes. Estimates of the impact of a measure are possible to achieve via simulation results.

Because it is difficult to even compare the impact of a local measures, the extrapolation at network level is exponentially more complex and not part of the scope of these demonstration exercises.

Different exercises were performed in the demonstrations focussing on different measures and coordination workflows that connect to the European ATM Network:

- Pre-tactical Planning Scenarios
  - Performance benefits not confirmed due to lack of accurate D-1 planning data
- Tactical Targeted Flow Measures
  - NATS: Significant potential for reductions observed (an example: 1800 vs 48 minutes)
  - ENAIRE: potential for reduction of delay observed in about 40% of cases, resulting in 10% delay reduction per flight (but with slight increase of delay for flights that receive delay).
- Tactical Level-Capping Measures
  - In 12 days of exercises in France 4111 min of delay were avoided.
- Tactical Fine-Tuned Delay Measures
  - Significant delay reduction from flight improvements at Maastricht UAC (in collaboration with Customer Initiative 2018, 2019 Program). 2018: 150,000 minutes reported impacting over 5000 flights.
- Target Time Measures
  - Heathrow: over 1000 flights with TTA on 12 days.
    - NEST: around 30% less delay compared to global regulation of EGLL (+-4500 min reduction)
    - SIMEX: around 40% less delay compared to global REG EGLL (+- 10000 min reduction)

For airlines, the reduced delay measures can have a huge financial impact for the company. E.g. if a delayed flight is approaching crew duty time limitation or night curfew, reduced delay measures could avoid costly measures such as rebooking of PAX, additional ferry flights, or other unplanned flights for positioning.

Better use of the capacity, by filling the empty slot with important flights is a very valuable approach, which has positive effects on a network level. If a flight with critical passenger connections at destination does have a reduced delay, it is obvious to say that this reduced delay will positively affect all the outbound flights, waiting for connecting passengers. This will create an enhanced reduction of delay across the entire network including airports.

4.2.16 OBJ-VLD-05-002 Results

Identifier	OBJ-VLD-05-002	KPA category: Capacity
Title	Increase the use of available airspace capacity for an ANSP.	
Objective	Reduction of sector (arrival, en-route) delay resulting from DCB issues by using enhanced DCB and TT mechanism.	
Success Criterion	Identifier: CRT-VLD-05-002	The usage of enhanced DCB reduces sector delay compared to regulations.
Results	Pre-tactical simulations results could not be achieved due to inaccuracies of planning data. **(NOK)** Tactical targeted flow measures show significant potential of delay reduction. **(OK)** Tactical Level-Cap process has a positive impact on the reduction of regulations and ATFM delays of the network. **(OK)** Tactical fine-tuned delay measures showed significant delay reduction. **(OK)**	**OK**

<u>Pre-Tactical Planning Scenarios</u>

As discussed in the EX2-OBJ-VLD-03-002 results the confidence in the accuracy of the data is not sufficient at the D-1 Planning stage to propose high fidelity fine-tuned measures, as the implementation cannot ensure the required outcome.

However, all ACM staff involved in this process agreed that if the data fidelity (and therefore confidence) was improved there would be increased situational awareness. The improved assimilation abilities using a collaborative tool affords the opportunity to use more refined measures as part of the D-1 Process. This would ultimately improve efficiency of the network and predictability whilst reducing fuel burn and delays.

Tactical Targeted Flow Measures

It was highlighted by the FMP at the time that if these targeted measures were available today, this solution could be used regularly and this level of delay saved on a regular basis throughout the network.

Although there is a slight additional workload in simulating targeted sub-flows, the benefit far outweighs the additional workload. Exercises showed that implementation of the targeted sub-flow measure would, in some cases, have reduced traffic demand for the area adequately and spread the traffic more evenly.

As for the preparation of the STAM, it was also detected a positive result since it allowed the FMPs to test different options. This helped and guided them in the decision-making process to finally implement the best possible measure possible, knowing beforehand the expected consequences.

Tactical Level-Capping Measures

Thanks to CAP measures applied during 15 out of 17 days of the French CAP Live trial, the ATM network avoided at least 4111 min of regulation delays and their impact elsewhere besides the average delay per flight decreased 2,29 min after AU FPL refiling.

While the analysis above focuses on the impact of CAP on global ATFCM delays, for all AUs, another key parameter is the ratio for each individual company between the efforts required and the benefits that can be expected, which needs to remain positive to meet their business needs.

Tactical Fine-Tuned Delay Measures

Over 5000 flights in MUAC regulations were improved with an overall delay avoidance of over 150.000 minutes of departure delay in the 2018 exercise iteration. Integration into the NM system led to significant NM operators workload reduction compared to 2018 iteration and consequently approx. 90% requests accommodated so far (June 2019). However, no results regarding delay reduction are available at the time of writing of the demonstration report.

Tactical support tools for FMPs in the FABCE area showed improvement of sector load management and capacity performance. Most sectors in EU have a defined buffer on capacity to mitigate unintended flight entering their AoR. With having more efficient tools and better last minute options, these buffers can be reduced, which is exactly what happened with the implementation of STAM processes on FABCE arena.

Very often, the same result can be achieved by rearranging flights in sector in coordination with neighboring FMP, in which case there is no delay involved. It is a simple short operational agreement put in place instead of a regulation. The demonstration showed an increase of opportunities of impacting sector loads by avoiding regulations. Below shows an example of a situation where delay could be avoided through tactical agreements between FMPs.

In case of the Spanish ground delay fine-tuned measures (MCP's), the reduction of delay per flight was not measured due to the lack of a Reference Scenario to compare with. Therefore, for this objective there will be no results on this matter.

Overall, the demonstrations showed that a few but smartly coordinated and well-chosen cherry picked flights can enhance the entire network situation. The better the flights are chosen, the greater the effect on the network will be.

4.2.17OBJ-VLD-05-003 Results

Identifier	OBJ-VLD-05-003	KPA category: Capacity	
Title	Increase the use of available Airport capacity.		
Objective	Reduction of airport delay resulting from DCB issues by using enhanced DCB and TT mechanism.		
Success Criterion	Identifier: CRT-VLD-05-003	The usage of enhanced DCB and TT reduces airport delay compared to airport regulations.	
Results	Application of TTA measures to optimise delivery of arrivals showed a significant reduction of average delay per flight compared to global arrival regulations at Heathrow and a slight increase in average delay at Spanish airports (but with a reduction of reactionary and max delay). **(OK)** Results seem very depending on local arrival optimisation calculations and simulation limitations. **(Partially OK)**		**OK**

Major results from the demonstration exercises show that, in general, as part of ATFCM planning processes the network is capable of supporting Airport operations with targeted measures when required. The demonstration procedures to optimise airport planning as part of network planning were designed not to measure flights that already received earlier network measures. Although this concept of multiple measures has to be still further studied, the demonstration showed significant numbers of arriving flights to the airport that were eligible for airport measures. This allowed having a significant impact on airport operations as aimed for.

The exercise successfully demonstrated the feasibility of the TTA Management process in an extremely busy network period and highlighted where improvements can be made. The concept of airport stakeholders operating in a paradigm that looks at optimising runway utilisation for the benefit of the wider airport performance is proven. The demonstration also showed full operational CDM processes with all stakeholders and more communication and/or study is required to clarify the concept and to clarify next steps of operational implementation of TTA measures.

In the Heathrow demonstrations, there were distinct advantages for participants in the VLD through a reduction in delay compared to CASA regulations, a more definite Airport Plan through adherence to CTOTs at outstations, and a semi-automated TTA process. A reduction in AFTM of between 26-41%, depending on the simulation tool, was measured when applying a TTA rule compared with conventional regulation.

Spanish exercises observed for LEBL we observe a reduction in delay dispersion, with much lower perc90 and maximum delays although slightly higher minimum and perc10 delays. Indeed, the maximum delay in the TTA solution is 12,86 minutes, whereas in the Reference scenario is 24,28 minutes. Same for the 90th percentile, where we have 9,08 minutes with TTA compared to 14,32min in the Reference. This means TTA provides a much more balanced and concentrated range of delay repartition, reduce considerably the high delays.

Regarding the ratio reactionary delay to total delay, a reduction in the ratio at all delay levels was observed. E.g 17,73% in TTA vs. 26,65% in reference for perc10 meaning small delays and 37,58 % in TTA vs. 51,10% in reference for perc90 meaning high delays.

For LEPA the reactionary delay statistics has not been calculated as the sample was not representative enough.

The Spanish exercise has also demonstrated that the TTA regulations provide a reduction of the reactionary delay dispersion and the ratio reactionary delay to total delay and contribute to the efficiency of Airspace Users and ANSPs processes to solve DCB issues, increasing situation awareness for all actors and AU regarding local/network DCB. However, the TTA exercise has also identified a number of faults (both technical and procedural) which would require to be rectified before the phase of industrialisation.

Additionally to the main TTA objective of reactionary delay, other metrics i.e. the TTA regulation maximum delay, average and maximum flight delay have been calculated to have a wider view in the comparison with classic regulations. The observations indicated that the TTA regulation maximum delay is lower than the classic regulation one by 37% delay difference for LEBL and by 18% delay difference for LEPA. However, the observations indicate that the TTA regulation average delay is slightly higher than the classic regulation one with 7% delay difference for LEBL and much higher due to the 6th of June at 44 % for LEPA. The confidence in the results of comparing the classic regulation versus TTA regulation is medium, as some well know limitations apply to the shadow OPS platform used/required for running in parallel the classic regulation.

There were several observations from staff at NMOC that they felt frustrated at not being able to intervene to amend a delay to a TTA flight they felt was excessive, or to assist a departure airport in a tactical response to a last-minute issue at the location. The process created to support VLD operations was specifically designed to allow for minimal workload should there be a requirement to revert to normal ATFCM demand resolution. This understandable decision did create a scenario where NMOC team members highlighted the ease of reversion when compared to the time they had to invest in e-desk or manual calls from airline operators requesting slot improvements which the VLD parameters precluded them from offering.

Even if AIMA algorithm is designed to accommodate individual flight priority/ criticality, due to prototype limitations, the airlines could not easily provide these values nor monitor the results. In conclusion, this feature could not be properly demonstrated. Another element not covered in the exercise and not clear how it would be incorporated in AIMA is the airline swaps ; the presence at an airports of several aircrafts of the same operator (presence of a "base") gives the possibility to the airline to decide aircraft swaps as a way to avoid reactionary delay from a delayed inbound. Different specialized models of "AIMA rules" will need to exist; these rules should be discussed locally, within the A-CDM community.

Participating airlines are supportive of the concept of TTA derived CTOTs as demonstrated. If applicable to the local and/or needs, advanced concepts of TTA operations, such as implementing TTA in executive operations, would require further development work, also to reinforce airline requirements regarding workload and costs, where more participation of Airspace Users is expected to operationally implement the TTA. To avoid possible negative effects of this concept and to be able to validate, a collaboration framework is strongly suggested. In this sense, we also suggest to keep refining the operational procedures in close coordination with EUROCONTROL Network Manager, airports and ANSPs before going to the advanced steps of TTA.

4.2.18 OBJ-VLD-05-004 Results

Identifier	OBJ-VLD-05-004	KPA category: Capacity	
Title	Increase the use of available multi-Airport capacity.		
Objective	Reduce delay resulting from better ATFM measures definition through improved coordination by means of multi-airport planning.		
Success Criterion	Identifier: CRT-VLD-05-004	Overall delay reduction for group of airports compared to baseline scenario	
Results	n/a (recommended to analyse, however dropped from the demonstration activities because of lack of resources).		**n/a**

Unfortunately, because of lack of resources, the analysis of multi-airport delay performance has not been performed during the demonstration activities. As demonstration participants expected positive results, further demonstration activities outside NCM project is recommended.

4.2.19 OBJ-VLD-05-005 Results

Identifier	OBJ-VLD-05-005	KPA category: Capacity	
Title	Increase the use of available FIR capacity in adverse weather.		
Objective	Mitigate the capacity reduction of a FIR, due to adverse weather.		
Success Criterion	Identifier: CRT-VLD-05-005	The degradation of FIR or sector capacity, during adverse weather events reducing the available capacity compared to plan, is mitigated by 5 to 15 %, depending on the ANSP	
Results	n/a (recommended to analyse, however dropped from the demonstration activities because of lack of resources).		**n/a**

No measurements were performed as part of Exercise 5 due to late availability of the demonstration platform. However, it is necessary to analyse required capacity reduction in bad weather. Better informed decision improves efficiency and reduces overall delay (not measured by how much).

The demonstration tool displays meteo information in addition to sector load and sector complexity. It will provide functionality to perform a detailed analysis of the impact of meteo events on traffic and complexity. Further demonstrations or pilot-implementation activities are recommended to confirm the reduction of capacity degradation because of meteo events.

4.2.20OBJ-VLD-06-001 Results

Identifier	OBJ-VLD-06-001	KPA category: Flexibility	
Title	Accommodation of airlines preferences*.		
Objective	Increase the possibility for airlines to provide their preferences as part of the network coordination process.		
Success Criterion	Identifier: CRT-VLD-06-001	Reduction in operating costs resulting from network issues creating airline resource problems , connection of priority flights, better alignment of airline processes (ground/airborne), etc.	
Results	Evaluation for Flexibility: Apart from the collaborative decision making procedures, two mechanisms of AU flexibility were to be tested: "Priority flights" in Exe 2A and "AU input into AIMA in Exe 3A" (the latter not applied during the exercise because of implementation limitations). The airlines of the ATEAM could not measure any indicator associated with this objective.		**n/a**

*Objective OBJ-VLD-06-001 is labelled "Fleet delay" in some locations in the Demo Plan or Demo Report: this refers to the fact that the purpose of AU flexibility is to drive the constraints to affect those flights where their impact is minimum; in theory, one of the sought optimizations could be to reduce total delay on a day of operations. The NCM trials did not put in place this approach as such, after all.

Unfortunately, due to missing time because of late involvement of the airline to the demonstrations and due to summer season preparation, no airline was able to develop a 'decision making support tool (allowing a tactical enhanced decision for the flights to be picked up daily) on time. The idea was to gather all relevant data, such as: passenger connections, crew duty limitations, maintenance events due in a given time at a given airport, curfew constraints, and other constraints and limitations available internally in the airlines system. All this would have been computed including the schedule to allow a quick and efficient decision making from the AU Network Operations Controllers to identify the most critical flights on a day to day basis. The list would have been adapted on a daily basis to optimally fit the operational needs of the airline.

Before exact and reliable fairness mechanisms are included a-priori in the preference/prioritisation processes (a difficult design task) it can be acceptable to monitor in detail their usage of such processes by different airlines, so that post-ops reconciliations can be performed if necessary.

Few results are fully reliable. The general feeling is in favour of the expected results, watch for confirmation base.

4.3 Confidence in Results of Demonstration Exercises

4.3.1 Limitations and impact on the level of Significance

The demonstration exercises were performed in the existing European ATM Operational context. Some of the current development in operations may have an impact on the ATFCM solutions applied in the exercises:

- In collaboration with all operational stakeholders, the Summer 2019 operational network has been strictly managed with additional route RAD restrictions. This could reduce the possibility to find reroute options, limiting the added value of targeted level-cap measures.
- Free Route Airspace developments possibly require different ATFCM solutions. Demonstration exercises focused on fixed route network operations.

The demonstration exercises of NCM were designed with operational applicability as main driver. Most of the demonstrated improved functionality has been implemented in operations for the purpose of the exercises and some of the functionality will even continue to be used. This is the case for Tactical Fine-Tuned Delay measures.

As is normally the case in ATM implementations, the implemented demonstrated functionalities require continuous assessment and, where required, procedural and technical updates. The first implementations have been performed to support demonstration exercises. Wider deployment requires assessment of scalability of the functionality that may result in additional requirements (e.g. training, safety assessments, etc.) for full operational implementation.

In some cases, the technical implementation, due to technical development staff availability, was only performed at a basic level to support the operational demonstrations. This was for instance the case for flight improvement measures that can currently only accept messages from a single ANSP. Further development is necessary before it can be deployed over a wider application area.

The exercises that were performed in shadow operations, normally used local prototype ATFCM tools and/or PLANTA (a EUROCONTROL prototype ATFCM tool). Demonstration result delivered requirements for the operational tools that are currently under development.

Some limitations were related to operational staff availability. For instance, the targeted measures require ATFCM Scenario preparation and maintenance, which is a collaborative activity between AUs, FMP and NMOC staff following Scenario Management CDM processes. NCM demonstrated the maturity of the concept, but in the current implementation, Europe wide application requires more NMOC staff. Deployment needs to be limited according to staff availabilities until more automatic solutions are developed.

In some exercises, dedicated operational staff was made available during the execution of the demonstrations. For full operational implementation, additional requirements from a wider group of operational staff could emerge.

4.3.1.1 Quality of Demonstration Exercises Results

The measurement of performance in ATM is very difficult. Especially for measuring traffic management and coordination techniques, which depend to a large extent on soft skills and organisational workflow efficiencies, and is not always directly measurable in executive operations.

The comparison between the reference and solution situation, with improved coordination and measure definition relies on available simulation techniques. However, European ATM operations are very dynamic. The results of a simulation of a measure on network performance could significantly change if started only 10 seconds later and depend very much on the workflow. In addition, the number of variables interacting is very large and current simulation results can not take all into account. This is why questionnaires with expert judgement by by all operational staff, being from NMOC, ANSPs, AUs or airports provide very useful information as the human-in-the-loop is capable to assess the overall operational situation.

Where possible the exercises provide quantitative performance results. All exercises provided qualitative performance results. The number of respondents were in some exercises limited, impacting negatively the confidence of the published results. However, overall, the quality and confidence of the results have been assessed and positively validated at program level.

5 Conclusions and recommendations

5.1 Conclusions

The NCM concept builds on connecting local (including airports) and network operations and improved coordination processes, enabling the application of flight-specific targeted and fine-tuned ATFCM measures. Main objective of Network Collaborative Management project was to demonstrate the maturity of DCB elements validated in the SESAR1 projects and to verify network performance benefits.

NCM has demonstrated network performance benefits as a result of better information exchange between operational actors (including Airline Operators) supported by local tools connected to the network, enabling the application of targeted flow measures and enabling improved cooperation at a European ATM network level. Where in current operations, areas of collaboration and cooperation are not always clear to the different participants, NCM demonstrations contributed to clarification of roles and responsibilities. Operational staff had a better awareness of planning and execution in the network, avoiding operational actors to work in isolation, from the strategic phase to the tactical phase. This clarification contributes to definition of improved (legal) framework where cooperation between stakeholders with different business models is key.

NCM participants concluded that the cooperative approach to find solutions to network inefficiencies, through system-wide collaboration and improved transparency, was the main contributor to the success of the NCM demonstration activities. Wherever possible it must be aimed for an integrated and seamless toolset to Airspace Users to prevent multiple tools and adverse effects where concepts are not aligned. Unfortunately, due to the VLD program organisation, Airspace Users were only involved in the project after 1 year of the start, minimizing opportunities to include active AU involvement in demonstration exercises.

<u>**Pre-Tactical Planning Scenarios**</u>

There is great potential to be able to improve network predictability, optimisation, reduce flight delays and fuel burn through more effective pre-tactical planning. With collaborative toolsets more effective measures can be proposed and workload can be reduced or maintained but bring greater overall network benefit.

Users agreed that a collaborative toolset (including procedures) improves network visibility, reduces workload and has great potential to bring significant efficiencies to the network. However, this requires a significant improvement in planning data accuracy this is difficult to achieve.

Tactical Targeted Flow Measures

Having the ability to regulate flows rather than traffic volumes led, in some areas, to the observation of significant benefits, whilst respecting a fair distribution of delay to impacted flows.

Targeted flow measures are essentially a “happy medium” between global regulation and cherry pick regulation. The advantage of targeted flow measures is that the workload increase is small, but the overall benefit over global regulation is large. Implementing targeted flow measures is also quite straightforward, as existing systems and processes need very little change as the fine-tuned scenarios can be added to the existing scenario repository, similar to re-route and flight level cap scenarios.

The FMP users were very positive and confident of the overall benefit of using fine-tuned measures and their ability to reduce delays and fuel burn (if used instead of re-route and flight level cap scenarios to balance capacity).

Tactical Fine-Tuned Delay Measures

The application of ground delays with MCP showed the potential to improve the situation experienced in some TVs, mainly during the summer season, by decreasing the number of affected flights by a regulation as well as the total number of minutes of delay.

The Regulation Proposal Mechanism has introduced significant operational benefits. The flight improvements procedures and the system-supported coordination has proven its value. The Regulation What-if Mechanism has introduced significant operational benefits.

Improved sector complexity monitoring resulted in identification of more tactical trajectory improvements in coordination with neighbouring ACC’s. This improves the effectiveness of the impact of an FMP (more tactical STAM measures) and leads to reduced ATFCM regulations (less buffer required for sector capacity). Sector complexity was monitored in combination with MET support tools that further increased the confidence of FMP’s to implement tactical measures at short notice.

The application of flight improvements messages through system-coordination workflow processes showed significant delay reductions. In addition, integration into the NM system led to significant NM operators workload reduction compared to 2018 iteration and consequently approx. 90% requests accommodated so far (June 2019). However, no results regarding delay reduction are available at the time of writing of the demonstration report

Participating airlines perceived ATM Portal of MUAC as a very good and valuable initiative. It allowed airlines to pick the most important flights on Network and Fleet Level. If extended to the entire European ATM Network, airlines could cover all flights in their schedules as this will help to enlarge the positive effects for the Airline AND the Network, provided more integrated system-support is available.

Tactical Level-Capping Measures

From the obtained results, it was concluded that CAP has a positive impact on the reduction of regulations and ATFM delays of the network and it helps to better distribute the traffic among sectors. It improves the situational awareness beyond the ACC boundaries and encourages communication and team working between ACCs and airlines that leads to an increase of the transparency and trust between FMPs and Flight Dispatchers.

During the trials, fuel efficiency of impacted flights receiving reroute proposals dropped. Overall, it was estimated that several dozens of kg, sometimes well above 100kg **of additional fuel per flight** were required to fly at lower altitudes or re-routing to avoid ATFCM regulations. However, applying targeted measures and avoiding regulation could result in fuel savings to other flights.

Better Network Measures exercise proved that linking local Cap tool with the network system (the NCAP tool) was technically feasible. This provides opportunities for further network performance benefits. NCAP workflow process enhances NM's awareness of AUs refiling reasons and FMPs problematic areas and NM impact assessment. With N-CAP, NM retrieves a central role in the process: with full visibility of partners constraints and needs, NM supports standardized exchange between partners and provides global Network view.

Target Times Measures and earlier departure planning

The exercise successfully demonstrated the feasibility of the TTA Management process in an extremely busy network period and highlighted where improvements can be made. The concept of airport stakeholders operating in a paradigm that looks at optimising runway utilisation for the benefit of the wider airport community is proved.

End to end messaging to deliver TTAs has been proved to generally work (except for when messaging limits were exceeded, which resulted in some TTAs pending in the system – but this should be rectified prior to go-live);

There were distinct advantages for participants in the VLD through a reduction in delay compared to CASA regulations, a more definite Airport Plan through adherence to CTOTs at outstations, and a semi-automated TTA process. At London Heathrow, a reduction in AFTM delay of between 26-41% was measures when applying a TTA rule compared with conventional regulation.

The Spanish TTA exercises have measured significant reductions in reactionary delays and maximum delays to flights. However, a slight increase of average delay per flight was measured.

From qualitative assessments, ANSP and Airport staff confirmed benefits to operations performance and recommended further optimisation and implementation of TTA operations.

The results measured by the exercise team in terms of increased predictability show quite clearly that the estimated times of arrival are more accurate when integrating API and DPI messages long in advance of the airport-CDM processes. However, it is not clear how this improvement benefited airlines operations in terms of increased capacity (for example with less margins taken by ATC in case of capacity constraints or demand peaks) or reduced delay.

Main conclusions:

- Cooperative approach of NCM involving all stakeholders is main contributor to reduce current network inefficiencies.
- Flight-specific Delay and Reroute measures contributed to significant reductions in delay and to improved operations coordination processes.
- Using airport arrival times in network operations (through TTA induced CTOTs) contributed to significant delay reductions compared to classical regulations.
- System-supported network coordination workflows (linking local and network tools) spectacularly improved efficiency of operational coordination processes.
- There is great potential to be able to improve network predictability, optimisation, reduce flight delays and fuel burn through more effective pre-tactical planning. However, currently predictive input data of NM system is too inaccurate to produce a useful D-1 planning.
- Having the ability to regulate flows rather than traffic volumes led, in some areas, to the observation of significant benefits. Targeted flow measures are essentially a “happy medium” between global regulation and cherry pick regulation.

5.2 Recommendations

5.2.1 Recommendations for industrialization and deployment

Most of the demonstrated concept elements are ready for further deployment. However, as is the case for existing functionalities in the ATM system, continuous maintenance and improvements are required. This is also the case for demonstrated concept elements, which means that operational/technical procedures need to be refined in line with stakeholders' views before the deployment phase. Specific attention is needed to communication and training of planned procedures/systems to operational staff to ensure effective operational implementation.

For industrialization and deployment, a step-by-step implementation of DCB functionality is recommended. In many areas initiatives are taken to improve effectiveness of measures and improve network coordination in line with the demonstration exercises in this project. Further deployment will result in the evolution towards full dynamic DCB at network level. In some cases the measure workflows need to be further consolidated in coordination with all operational stakeholders before operational implementation (or larger deployment) is possible. This is, for instance, the case for N-CAP measures that create, in the demonstrated workflow, high workload for Airline Users. Harmonisation of procedures and policies, supported by improved automation to support these new concepts is required.

Close coordination between the stakeholders must be key to ensure that the final solutions are validated and provides benefits to the different participants. For this reason, it is recommended that a high coordination taskforce between AUs, NM, Airports and ANSPs shall be set up with agreed setup and responsibilities as well as goals/KPA/KPI, before deployment and during processes of continuous developing (i.e. creation of scenario/measure repository, ATS structure, procedure planning, etc.)/adaption to DCB → an N-CDM (Network Collaborative Decision Making, all stakeholders) to accommodate for those developments.

Airlines, airports, ANSPs and NM will have to spend/invest a lot of money for updating processes/systems, and this investment cannot be supported by a single stakeholder only. As a consequence, innovative financing models would be welcome to accelerate deployment.

Currently NCM demonstrated functionality is insufficiently part of an airline's value/process chain. NCM needs to involve AUs further into decision-making, this means that AUs will be part of the Network Management, fulfilling at least part of the infrastructure services and therefore might be impacted by additional infrastructure costs, i.e. investment in IT and process design and implementation (also taking into account the principal role that AUs have towards the CFSPs).

Furthermore, applying NCM process will lead to an additional economic impact. The limiting factor, due to the complexity of the requirement profile and the required, 'cost efficiency" of airlines, is the man power in the OCCs and therefore AUs need to be heavily involved into IT and process design from beginning on to prevent unnecessary additional workload. An increase in the workload and new planning, additional IT infrastructure, and flight procedures will directly affect airlines cost-efficiency. In this sense, additional mechanisms could ensure that the economic risk is shared between the different stakeholders and a positive cost-benefit balance is ensured to all stakeholders.

To simplify coordination complexity and reduce costs, tools duplication must be avoided and the number of HMIs that are used by airline dispatchers and network controllers should be reduced. All tool developments across the different SESAR activities should be integrated to simplify the operation. Integrated systems result in less complexity. All requests between ATM stakeholders should be managed through one common "Tool". Whether it is an airline trying to contact a specific FMP or an FMP trying to contact a specific airline, communication should be done via this common platform, managed by NM, and linking local tools to network systems.

Due to the increasing complexity of the exchange of flight-specific DCB proposals between operational stakeholders, adjusting measures on IT and process level with an agreed level of automation are needed within operations.

Tactical Targeted Flow Measures

The recommendation from the trial is to industrialize fine-tuned targeted flow measures. If targeted flow scenarios could be added to the existing repository and toolsets, there would be significant opportunity to reduce flight delays over blanket regulation, and also reduce additional fuel burn as a targeted flow scenario could be used instead of a re-route or flight level cap scenario which is likely to unnecessary penalization of flights.

However, targeted flow measures could not work in specific local circumstances. Analysis to the feasibility in local areas is required. Additional requirements to the toolset have been suggested such as appropriate rates and window widths and should be confirmed.

Tactical Fine-Tuned Delay Measures

The Regulation Proposal and MCP mechanism, FORCE CTOT & EXCLUDE mechanism via B2B, and Regulation What-If mechanisms have already been industrialised and are ready for further deployment. Regarding ground delay measures to specific flights, exercise participants suggested some algorithm improvements to speed up the identification process of both overload period and eligible flights.

The number of flight-specific measure proposals and coordination is expected to grow. Therefore, (semi-)automation of proposal acceptance should be further studied.

Tactical Level-Capping measures

As additional service to Airspace users, the avoided cost of regulations should be better published. The current manual simulation of regulation is too costly. The opportunity to make use of NM B2B Services needs to be further explored to perform semi-automatic SIMEX simulation of regulation by B2B to gather quantitative results from all CAP operations. This needs an increase in available simulation slots at NM level.

Experienced CAP users pointed out the benefits of CAP process in combined use with Scenarios (compared to Scenarios, CAP process targets only a few flights in a TV, and not all flights from a flow). During the debriefing sessions with FMP Managers, the opportunity to launch a global discussion analysis of the ATFCM measures catalogue and their combined use was identified. Pre-agreed rerouting measures can replace regulations in solving residual and isolated traffic demand peaks in tactical operations (provided AUs accept the rerouting proposals). The aim would be to adapt them to current operational needs and performance objectives to best tailor the measure to the nature and granularity of the problem to be solved.

The automation of AUs actions is key to ease and agile their decision making processes in new procedures such as the one demonstrated with NCAP. STAM Phase II and PCP will help to follow this path. NCAP process and workflow should be further consolidated before industrialization, specifically to facilitate automation of the entire workflow.

Target Times Measures

Moving towards an airport where all stakeholders understand how to manage excessive runway demands through the smoothing of excessive air holding facilitated by the application of TTAs, it cannot be over emphasised how ingrained the current CASA regulations are in all areas of airport operations, affecting many stakeholders. Therefore, commencement of TTA should be:

- (pre-)announced and presented in various operational briefings, OCCs, platforms such as AOP, NOP, etc.
- Properly documented in agreements, operational documentation such as AIP, manuals, procedures,
- Allowing sufficient time for end-to-end testing.

In view of the results and some particular anomalies encountered during the trial, FMP considers TTA Regulations shall require a dedicated technical implementation by NM, including the ability for NMOC to intervene in specific cases, and some specific improvements in AOP algorithm that address specifically the drawbacks detected during the trial.

Special care should be taken in order to ensure synchronization between the flight list managed by Airport AOP and CHMI/B2B. In most cases airport and network systems were synchronized. However, in some cases, there was a discrepancy between both counts. The sequence provided by the AOP algorithm was counting more aircraft than present in the CHMI graph (therefore pushing them further, generating stronger delays than needed and leaving unused capacity) and in some cases the other way around. It is critical for the concept to work that these two flight lists (and therefore graphs) are fully synchronized.

In case of removal of CASA regulations (except for emergency and critical events) this provides the opportunity for all stakeholders to review the information that is currently available to them via their ACDM/AOP portal (for those airports that have already adopted these platforms). CASA regulations are often used as a justification for delays, schedule slippage and disruptive Night Jet Movements. The use of TTAs provides an opportunity for a wider airport discussion on how to deliver TTAs in order to minimise airport disruption. This will be a challenging environment as it may lead to the prioritisation of best behaviours and as such support and encouragement may be required which will naturally lead to a call for resource and financial investment into training.

Participating airlines are supportive of the concept of TTA derived CTOTs as demonstrated. If applicable to the local and/or needs, advanced concepts of TTA operations, such as implementing TTA in executive operations, would require further development work, also to reinforce airline requirements regarding workload and costs, where more participation of Airspace Users is expected to operationally implement the TTA. To avoid possible negative effects of this concept and to be able to validate, a collaboration framework to share the risk and economic impact between the different stakeholders is strongly suggested.

(Future) Concepts

The cooperative approach between participants of the NCM demonstration project (including the Airspace Users involvement as part of the ATEAM project) is strongly recommended for future concept development work. Cooperation leads to better understanding of typical decision making by operational staff and better communication and coordination between staff. NCM demonstration cooperation showed improved effectiveness to target current general deficiencies in the ATM System (such as unbalances between traffic and capacity and inefficient use of resources. It is recommended that these resources could be either used to temporarily increase capacity, due to a temporary hotspot or to generate extra capacity in a generally smoothly running system in case of disruption (e.g. strike/weather/ emergencies).

For future developments, it would be interesting to review and align Network and National Airspace Strategies, with a focus of NCM's recommended cooperative approach and network thinking. Rather than the traditional provider-customer focus, the target should be set on a more dynamic, efficient and collaborative use of available resources.

Main recommendations:

- Continuation of cooperative approach with all stakeholders to implement NCM's successfully demonstrated functionalities.
- Ensure through establishment of high-level coordination body that NCM implementations provide a positive business case to all stakeholders, including Airspace Users.
- Invest in system-supported network coordination of delay and level-capping measures and study (semi-)automatic acceptance of measures proposals.
- Urgent need for 'single' interface of network operations, linking local tools to network systems, to provide transparency and coordination efficiency to all stakeholders, in particular airspace users.
- Clarify TTA implementation strategy at local and network level and deploy dedicated TTA implementation (not using MCP mechanisms).
- Communicate and pursue wider operational notion on how to deliver TTAs to minimize airport disruptions.
- Recommendation to review next steps of TTA process (fly to TTA) with a focus on pre-notifications of impacted flights, dynamic and standardized process regarding prioritization of flights, and on integration with existing flight planning processes such as fuel planning, crew planning etc.
- ANSP's to analyse the feasibility of targeted flow measures and to add options to the network ATFCM toolbox.
- Study to improve D-1 traffic predictability to enhance network performance through more effective D-1 pre-tactical planning.

5.2.2 Recommendations on regulation and standardisation initiatives

Not addressed during the NCM demonstrations. NCM is about improved coordination between stakeholders. At this stage, regulation and standardisation discussions do not support the collaborative approach of identification of coordination improvements.

However, with more experience regarding demonstrated concepts & tools and the generated learnings, standardisation of workflows and exchanges of messages need to be addressed. For future implementation those standards can be used to harmonize tool development and usage (We need to learn the lessons from the fragmented local A-CDM implementation), as well as the seamless integration of existing tools such as the AU`s flight planning software systems and the interfaces that allow the necessary high level of automation.

Current systems are widely used and do not have the supporting architecture to enable dynamic coordination at the moment. Also introducing new additional systems is not an option in operations as already very busy AU OCC staff cannot handle additional systems. The functionality has to be integrated in the current systems or new but integrated tools with a high level of automation.

Also the way ATM is run at the moment may have to be re-evaluated. This may even require a regulative approach on European level on how and where the concept(s) must be applied and how to do so. In some cases for example, national state laws prohibit the application of initiatives such as “best collaboratively agreed, best served”.

Airlines shall be involved in the development of this framework to ensure that their operation is aligned with the final conclusions. Moreover, all stakeholders must collaborate to develop standards and guidelines that help to deploy procedures, tools and communication systems compatible and scalable across the network. It should aim for reducing the granularity of tools and procedures and support an smooth and efficient operation. Automation should be also addressed set the proper balance between operational improvements and safety.

The framework should also be aligned with new developments and best practices and allow enough flexibility to incorporate future changes without undermining its original purpose.

5.2.3 Recommendations for updating ATM Master Plan Level 2

Not addressed during the NCM demonstrations.

6 Summary of Communications and Dissemination activities

6.1 Summary of communications and dissemination activities

The communication and dissemination strategy of NCM was to make use of existing stakeholder consultation meetings primarily. In addition, brochures, press releases have been produced.

NCM demonstration activities in numerous presentations have been communicated to:

- Network Director of Operations (NDOP)
- Network Operations Group (NETOPS)
- Airspace Management Sub-Group (ASMSG)
- ATFCM Operations and Development Sub-Group (ODSG)
- Other stakeholder consultation meetings

In addition, websites of all participating partners have published press releases regarding demonstration exercises on their websites.

A brochure for general public has been produced by NCM and Airline-Team project teams, publishing demonstration exercise plans. This brochure was circulated initially at the World ATM Conference 2019 in Madrid and distributed widely afterwards.

Articles have been published in ATM magazines announcing the intentions of demonstration exercises.

At the time of writing of this report, the results of NCM have not yet been published. Several communication activities, including video material of the Spanish AOP/NOP exercises, are planned after writing of this report and even after finalizing the official project to present the outcome of NCM demonstration activities and results.

6.2 Project High Level Messages

- Cooperative approach to identify solutions to network inefficiencies, involving all stakeholders is considered key to realizing acceptable operational improvements.
- Moving towards an AIRPORT where all stakeholders understand how to manage excessive runway demands through the smoothing of excessive air holding facilitated by the application of TTAs.
- Targeted Flow (reroute and delay) Measures reduce ATFCM delay and benefit Airspace Users.
- Target Times of Arrival derived CTOTs can significantly decrease ATFM delay compared to the use of classical regulation.
- Complementarity and mutual enrichment of local (&sub-regional) level and NM level supported by robust SWIM functionalities massively improves coordination efficiency.

7 References

Content Integration

[1] B.04.01 D138 EATMA Guidance Material

[2] EATMA Community pages

[3] SESAR ATM Lexicon

Content Development

[4] B4.2 D106 Transition Concept of Operations SESAR 2020

System and Service Development

[5] 08.01.01 D52: SWIM Foundation v2

[6] 08.01.01 D49: SWIM Compliance Criteria

[7] 08.01.03 D47: AIRM v4.1.0

[8] 08.03.10 D45: ISRM Foundation v00.08.00

[9] B.04.03 D102 SESAR Working Method on Services

[10] B.04.03 D128 ADD SESAR1

[11] B.04.05 Common Service Foundation Method

Performance Management

[12] B.04.01 D108 SESAR 2020 Transition Performance Framework

[13] B.04.01 D42 SESAR2020 Transition Validation

[14] B.05 D86 Guidance on KPIs and Data Collection support to SESAR 2020 transition.

[15] 16.06.06-D68 Part 1 –SESAR Cost Benefit Analysis – Integrated Model

[16] 16.06.06-D51-SESAR_1 Business Case Consolidated_Deliverable-00.01.00 and CBA

[17] Method to assess cost of European ATM improvements and technologies, EUROCONTROL (2014)

[18] ATM Cost Breakdown Structure_ed02_2014

[19]Standard Inputs for EUROCONTROL Cost Benefit Analyses

[20]16.06.06_D26-08 ATM CBA Quality Checklist

[21]16.06.06_D26_04_Guidelines_for_Producing_Benefit_and_Impact_Mechanisms

Validation

[22]03.00 D16 WP3 Engineering methodology

[23]Transition VALS SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects

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

System Engineering

[25]SESAR Requirements and V&V guidelines

Safety

[26]SESAR, Safety Reference Material, Edition 4.0, April 2016

[27]SESAR, Guidance to Apply the Safety Reference Material, Edition 3.0, April 2016

[28]SESAR, Final Guidance Material to Execute Proof of Concept, Ed00.04.00, August 2015

[29]SESAR, Resilience Engineering Guidance, May 2016

Human Performance

[30]16.06.05 D 27 HP Reference Material D27

[31]16.04.02 D04 e-HP Repository - Release note

[32]16.06 Strawman Paper on Case Building in SESAR SWP 16.6

[33]16.04.01 Evolution from the ATM HF case to a HP Case Methodology for SESAR, HP assessment process for projects in V1, V2 or V3. D10-001, 00.01.00

[34]06.09.03 D05.1 Single Remote Tower Validation Plan – Appendix Human Performance Assessment Plan

[35]16.06.05 D27 - 00 01 00 -HP Assessment Process for V1 to V3

Environment Assessment

[36]SESAR, Environment Reference Material, alias, “Environmental impact assessment as part of the global SESAR validation”, Project 16.06.03, Deliverable D26, 2014.

[37]ICAO CAEP – “Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes” document, Doc 10031.

Security

[38]16.06.02 D103 SESAR Security Ref Material Level

[39]16.06.02 D137 Minimum Set of Security Controls (MSSCs).

[40]16.06.02 D131 Security Database Application (CTRL_S)

Communication and dissemination

[41]SESAR 2020 Communication Guidelines 04.00.00, [dd/mm/yyyy]

Programme management

For what concerns the general collaboration between all the members of the programme:

[42] SESAR 2020 Membership Agreement, 06/07/2016

[43] SESAR 2020 Programme Management Plan, edition 01.00.00, TBD

For what concerns the definition of the solutions being addressed by the project, their initial maturity levels and the target maturity dates aimed for:

[44] ATM Master Plan, data set 16, 25/05/2016

For what concerns the specific scope of work covered by this project and the general way of working expected from all projects in the SESAR 2020 programme:

[45] 733021 PJ24 NCM Grant Agreement, 17/10/2017

[46] SESAR 2020 Demonstration Plan (DEMOP) PJ24 NCM, 00.01.06, 07/19

[47] SESAR 2020 Project Handbook, edition 01.00.00, 01/02/2017

7.1 Reference Documents

[48] ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.[6]

[49] COMMISSION IMPLEMENTING REGULATION (EU) No 716/2014 of 27 June 2014 on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan

[50] ATFCM Users Manual, edition 20.1.1, 16/11/2016

[51] Release 5 SESAR Solution ID #18 Calculated take-off time (CTOT) and target time of arrival (TTA)

[52] Release 5 SESAR Solution ID #19 Automated support for traffic complexity detection and resolution

[53] Short Term ATFCM Concept of Operations, EUROCONTROL, NETOPS, September 2015.

6

Appendix A Demonstration Exercise #01 Report - Better Network Measures

A.1 Summary of the Demonstration Exercise #01 Plan

Exercise 1 was performed aiming to comply with two high level objectives:

- The optimisation of measures impacting a flight from AU perspective. It is done by means of:
  - improving their decision making processes when a flight is subject to multiple measures
  - better understanding and complying with FMP constraints while maintaining internal KPI levels,
  - increasing awareness of possible measures (and their impact on the flight) they might be subject to.
- Enable complete transparency of measures throughout the Network and reasons for AUs refiling actions, as in regulation proposals via B2B, exclusions from regulations, regulation cancellations, level cap measures at local level…

1. Optimisation of AUs operations

   Improved and transparent coordination processes at network level were particularly of interest to the AU participants. Currently, AU's are unaware of the context and impact of most ATFCM measures proposed to them. Shared awareness between AUs and local/sub-regional Network management has improved thanks to collaborative initiatives- some of them part of PJ24, like CDM@DSNA Portal, MUAC Customers initiative. Some AU's are in contact with local FMP's, especially at airlines' HUB airports but from a network point of view, basically, AUs are blind if it comes to ATFCM measures, even if coordinated on the day before operations. AUs miss information about Airspace Sectors saturation (which sectors - when - for how long). A new coordination process at network level between concerned Stakeholders could help AUs to prevent or at least minimize negative impact such as penalising slot revision, delays, and flight suspensions.

   The demonstration initially aimed to provide AUs with an opportunity to actively participate in the coordination phase of a network collaborative process. Their mere involvement in this exercise as an observer of the whole workflow already provided better understanding of the overall process and already increased situational awareness in AUs operations.

2. Transparency of measures from Network perspective

The transparent overview of local measures enables network actors to improve awareness of proposed or already implemented measures to solve DCB issues in the network. The Airspace Users are also provided with a transparent impact evaluation of a measure when ANSP´s/NM communicate the what-if scenario; expected minutes of delays for specific flights, numbers of slots assignments, etc… in case of sectors saturation. The AU can integrate such information based on the additional impact due to flights transfer and aircraft rotations.

The demonstration exercise improves the overview of stored (NM Scenario Repository), proposed and implemented measures in the NM systems. This information is available to local users via B2B data exchange or, in some cases, by current B2C interfaces such as CIFLO, CIAO, etc.

The automatic exchange of measure information via B2B could replace phone conversations, email exchanges and automate some manual activities.

This demonstration exercise focuses on ATFCM situation awareness sharing between Network partners, thanks to more efficient data exchange based on pre-coordinated options stored and shared to all via the improved NM Scenario Repository. Here listed the exercises that are using this repository in PJ24:

- flight plan modification proposals across ANSP boundaries (EXE4)
- Regulation proposals (EXE2a/EXE5/EXE6)
- Mandatory Cherry Picking (MCP) proposals (EXE6)
- What-If (measures) Simulation (EXE2a/EXE2b/EXE2c/EXE6)
- Flight Exclusions from Regulations (EXE2a)
- Force CTOT in Regulations (EXE2a)
- Query / Apply STAM/ATFCM Scenarios resulting in flight reroute proposals (EXE1/EXE2c)

As shown in the list above, Exercise 1 has addressed the last type of data exchange, the query / application of STAM/ATFCM scenarios.

For this purpose, a new tool was developed by the DSNA team in order to be electronically connected to the NM systems. This resulted in the **NCAP** (**Network CAP**) tool. Through the NM B2B services, this tool enabled the local FMP users (DFS) to query/apply the pre-agreed rerouting measures/STAM scenarios. This tool is an evolution of the CAP tool, developed by DSNA, used in Exercise 4 (DSNA) and Exercise 6 (Enaire).

3. Network Impact Display

   Increased sharing of local measures and their potential impact with the network required improvements to Network Impact Displays (NID) at the NMOC. The current NID was initially designed for classic regulations and did not fit the need of the foreseen demonstrations, for more targeted measures and dynamic coordination.

   With the increased application of STAM, it is necessary to implement more dynamic network impact assessment on a flight by flight basis. This use case addresses the network coordination for an individual flight with STAMs that may impact several geographical areas of the network.

   A measure to an individual flight could create network issue(s) in another area of the network (including hotspot(s)). The NM needs to identify this impact, find possible optimisation of the measure by means of simulations, and initiate the coordination process between the relevant network stakeholders. Measures that could have such an impact are e.g. Slot extensions, delay improvements, MCP's, etc.

   Changes will be implemented to improve the efficiency of the workflow for ATFCM measures on a flight, including the impact of these measures on the network.

   Exercise 1 tries also to show the need to make all this information available in the AUs OCCs.

Stakeholders' main expectations

NM and DSNA main objective was to test the technical feasibility and full workflow of the NCAP process, from the design of the concept to the implementation. NCAP tool was a prototype and one of the main objectives was to test the interoperability between DSNA portal and NM system.

DFS even they stated that they would have staffing issues and therefore they might not be able to participate to the trial as they would have wanted, they admitted the importance of this tool and trial and therefore they cut some other projects down to take part, which led at the end to the execution of the trial. After the execution, DFS will continue the support of the usage of CAP and also NCAP as an NM integrated tool and asking / convincing frequently our customer for participation.

AU took part in EXE1 with the intention to test and assess a new process developed within NCAP, from a technical and qualitative point of view. This has been realised thanks to a NCAP prototype and the its process also developed with the purpose of providing better information for AU to decide whether the request for level capping proposed by FMP is acceptable (regulation avoided vs. less efficient flight routing). In addition, the quality of the existing rerouting provided by NM via RRP in terms of plan and fly-ability was assessed receiving the message via the NOP Portal.

The following topics were identified to be relevant for testing:

- Proposals from local ANSP (due to specific needs or a better condition available)
- Connection/Exchange via B2B directly to NM platform between ANSP and NM
- Technical feasibility to send the rerouting proposal via RRP (from NM side)
- Quality of the rerouting proposals (RRPs) proposed by the NM from the scenario repository
- Transparency of the new proposal to AU (traffic rate reduction, hotspot, proposal expiry time)
- Sufficient time lead to react to measures proposal (at day0, >x hours before the Aircraft EOBT)
- Impact on Capacity and Delay Situation (prevented or mitigated)
- Coordination with adjacent ATC sectors via NM platform to avoid most penalizing regulation and/or not enter one in case of RRP acceptance
- Late filer/Updater Status (status change must be avoided in case of RRP acceptance)

Airlines not participating in the previous phases of the CAP concept (mainly Lufthansa) were interested also in familiarising with it, and, in a second step, further analysing the benefits of NCAP from Airspace User perspective. For this reason, a post-operations analysis with 9 months data was conducted as a valuable complement to the EXE1 NCAP TRIAL.

A.1.1 Exercise description and scope

Participants and Tools

- **FMP:** DFS
    - **TOOLs:**
        - **DSNA´s NCAP (using NM flow B2B services)**
        - **CHMI**
- **NM:**
    - **TOOL:**
        - **PLANTA**

- **Airspace Users:** RYANAIR, LUFTHANSA, BRITISH AIRWAYS, AIRFRANCE, SWISS
    - **TOOLs:**
        - **DSNA´s NCAP (Chat box only)**
        - **ECTLs AO NOP-STAM portal**
        - **CFSPs flight management tools**
            - **LIDO** PARTNERS
                - RYANAIR
                - LUFTHANSA
                - BRITISH AIRWAYS
                - AIR FRANCE (As observer)
            - **SABRE** PARTNER
                - SWISS

Process diagram

The following diagram shows the different roles, tools that are used by each of the actors and processes that took place in the Exercise.

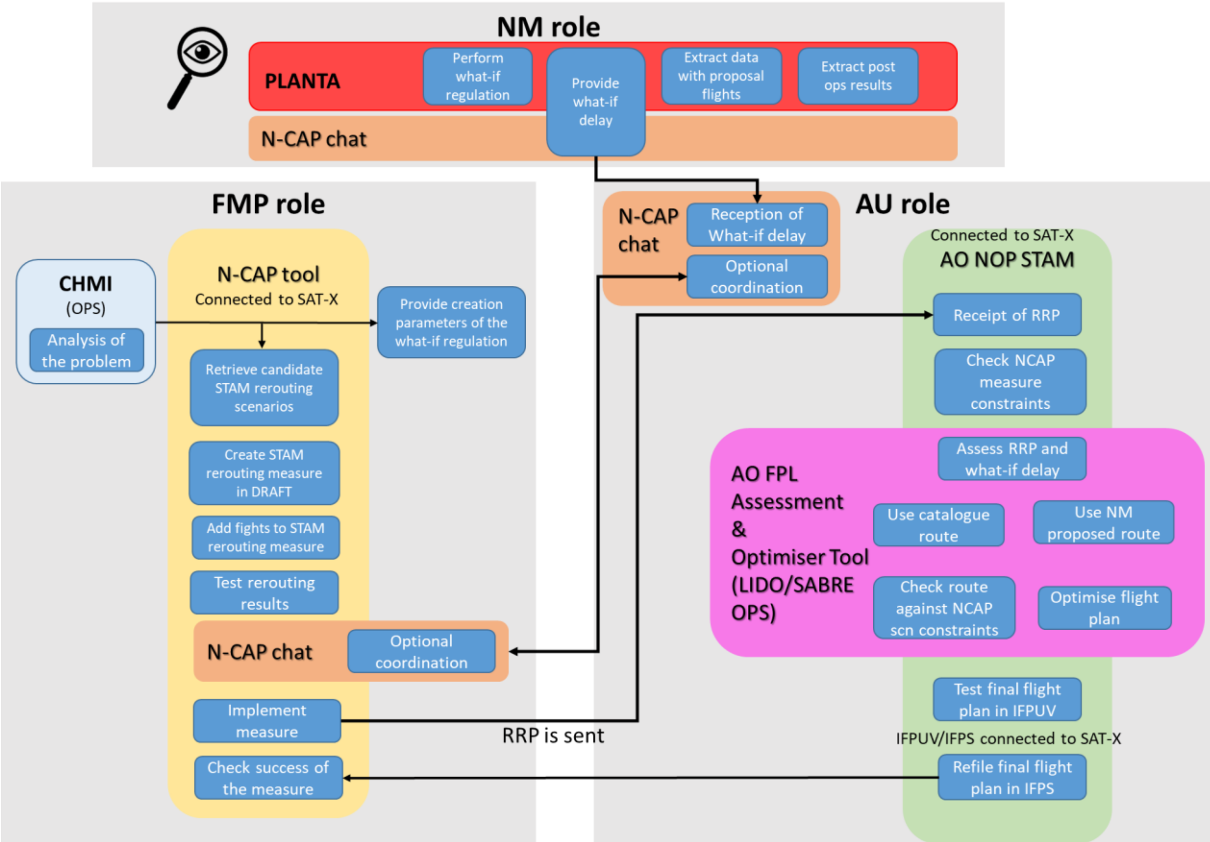


Figure 8: Exe1 Demo tool overview per role

Demonstration Technique and Platform

This exercise was executed in the form of a shadow-mode real-time remote collaboration. It means that the systems and platforms were working as they would do in real operations but in a virtual and safe environment - and all partners were operating from their own European facilities/headquarters. All the systems were connected to one Eurocontrol shadow platform. Following bullets identify the different systems and platforms used in the Demonstration:

- <u>SAT-X</u> is the NM Platform for external testing exercises. It works in shadow-mode. It has all the functionalities that the Operational and the Pre-Operational chains have with the same traffic demand information and same real time messages exchange. All systems used during the exercise (except for the CFSPs flight planning and management tools) were connected to this testing string.

- Systems currently used in real operations:

- **CHMI** – Used in the exercise by DFS FMP to monitor the demand and the capacity of the sectors and identify possible load peaks in the traffic that may require the application of one or some fine-tuned ATFCM measures STAM rerouting measures.
- **AO NOP-STAM Portal**– Based on the current NOP portal Tool with extra fine-tuned ATFCM measures features, which were made available to the Airspace Users participants. In this portal the RRPs and the rerouting measure constraints information was displayed.
- **Airspace User Flight Planning tools** – LIDO and SABRE systems were used during the exercise as well. CFSPs tools served for the off-line analysis of the NM alternative suggested routes and their potential optimisation.

- One operational tool (CAP) including new developments specifically designed for the Exercise: **NCAP Tool. This tool was used by the FMP to create, manage and implement the level capping measures.**
- R&D tool that was used for the regulation simulation activities: ECTL's **PLANTA** tool.
- Teleconference for coordination

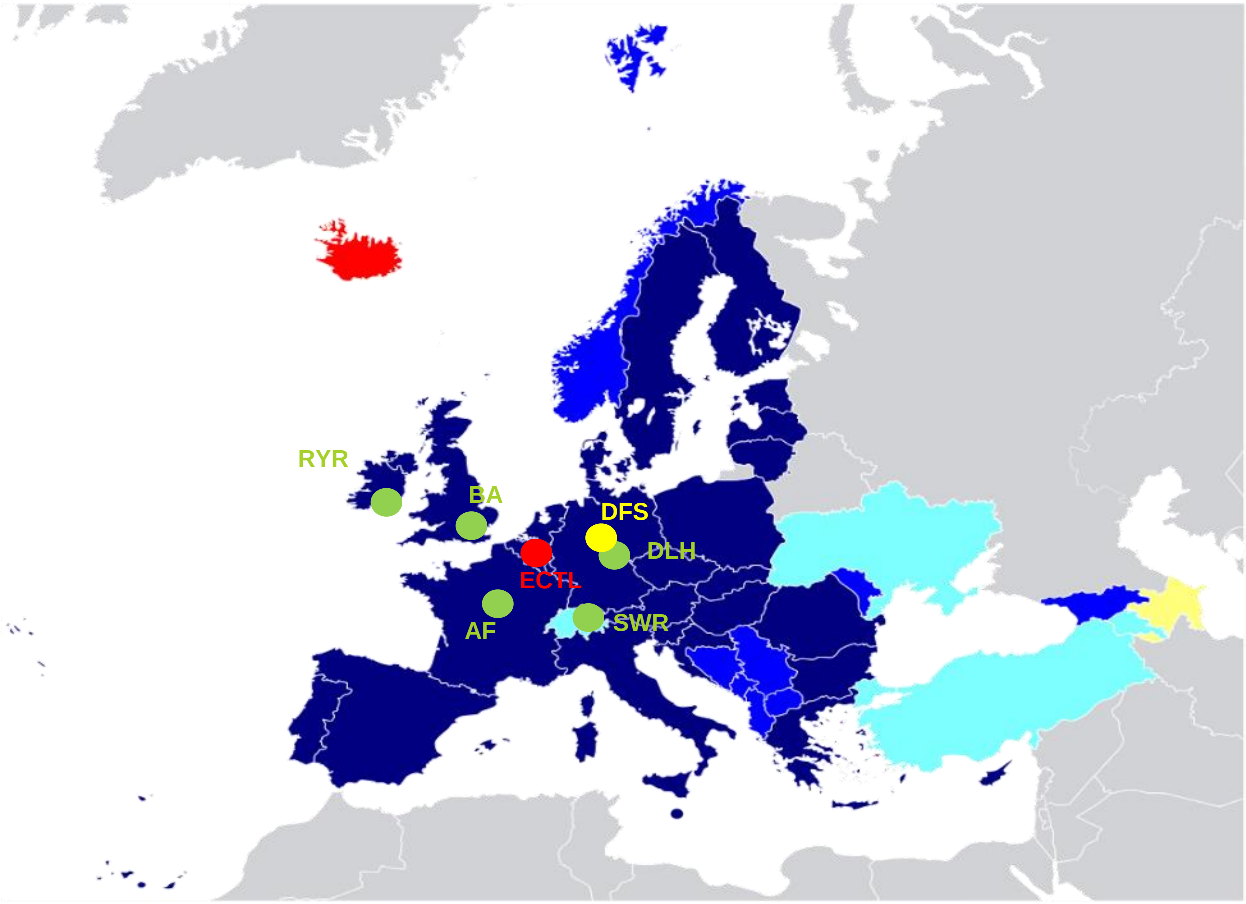


Figure 9: Exe1 partners geographical distribution

Testing Sessions and Dry Run

The evolution of DSNAs CAP tool, i.e. NCAP tool, was developed and tested during the last quarter of 2018 and first quarter 2019. DSNA team and Eurocontrol executed a couple of Technical verification sessions that confirmed NCAP's correct connection to the NM testing platforms.

During the third of week of February, the Exercise Team executed a two-day dry-run with all the participants around the table in Brussels Eurocontrol HQ. The objectives of the dry-run were:

- For the participants to familiarise with FMPs tasks and workflows.
- Training FMP in the NCAP tool and FMP workflow steps to complete the fine-tuned ATFCM measures-RRP process
- Brainstorming on initial ideas for the Demo and the Future deployment activities.

- Testing PLANTA regulation simulations and identify best timing within the fine-tuned ATFCM measures RRP workflow. Additionally, the data extraction was tested.
- For the AUs to familiarise with the AO NOP STAM portal and the AU steps to complete the fine-tuned ATFCM measures RRP workflow.
- Testing new alternative routes in the CFSP Flight Plan tools of the AUs.

Execution Week

The trial was executed during a whole week of March 2019 (18th-22nd). The 1st day was used for the final preparation and coordination, and the other 4 days to execute the Demonstration exercise.

In the 4 days of execution, 10 RUNs were executed (2-3-3-2), with the following characteristics:

- At least 2 Airspace Users targeted in each RUN
- 1 RUN without parallel teleconference coordination (THU afternoon)
- More than 10 Flights rerouted for some of the AUs
- Presence of British Airways for one day

The figure below represents the schedule of the execution-week:

Date	Monday 18-03-2019	Tuesday 19-03-2019	Wednesday 20-03-2019 RYR no FP	Thursday 21-03-2019	Friday 22-03-2019
Time	Preparation Day 1	Execution Day 1	Execution Day 2	Execution Day 3	Execution Day 4
9:00-9:30	Welcome and trial agenda overview	Welcome and briefing for the day	Welcome and briefing (NCAP plan)	Welcome and briefing (NCAP plan)	Welcome and briefing (NCAP plan)
9:30 - 11:00	Review NCAP process (roles, activities and tools). Trial objectives. Coordination strategy set-up.	RUN #1	RUN #3	RUN #6	RUN #9
11:00-11:15		Post exercise debrief	Post exercise debrief	Post exercise debrief	Post exercise debrief
11:15-11:30	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
11:30 - 13:00	Acceptance Test 1 (AU)	RUN #2	RUN #4	RUN #7	RUN #10
13:00-13:15	Post exercise debrief	Post exercise debrief	Post exercise debrief	Post exercise debrief	Post exercise debrief
13:15-14:15	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
14:15-15:45	Acceptance Test 2 (FMP)	Prepare NCAP plan for Day 2	RUN #5	RUN #8	Debrief FULL TRIAL
15:45-16:00	Post exercise debrief		Post exercise debrief	Post exercise debrief	
16:00-16:30	Prepare NCAP plan for Day 1		Prepare NCAP plan for Day 3	Prepare NCAP plan for Day 4	

Figure 10: Exe 1 Demonstration Week Schedule

A.1.2 Summary of Demonstration Exercise #01 Demonstration Objectives and success criteria

The objectives included in this section have been taken from the exercise DEMOPlan, which has experienced a number of changes during the last 2 years thus some of the objectives will appear as 'not addressed' in the objectives result table (Table 19).

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 1 Objectives	Demonstration Exercise 1 Success criteria
OBJ-VLD-01-001	CRT-VLD-01-001	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-01-001 Acceptable increase in workload for network operations planning actors to apply NMOC proposed enhanced DCB and TT measures to optimally use network capacity	EX1-CRT-VLD-01-001 The usage of NMOC proposed enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload
OBJ-VLD-01-004	CRT-VLD-01-004	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-01-004 Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied by sharing NMOC data and actions	EX1-CRT-VLD-01-004 Positive feedback from all actors regarding DCB transparent role of NMOC
OBJ-VLD-02-001	CRT-VLD-02-001	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-02-001 Reduce the margins between planning and actual for flights and loads due to unforeseen changes in the execution of the European Network operations.	EX1-CRT-VLD-02-001 The distribution of early/late arrivals at coordination points or the airport of destination is narrower than current operations. The distribution of difference between estimated and actual

				load is narrower than current operations.
OBJ-VLD-03-001	CRT-VLD-03-001	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-03-001 Reduce the extra fuel consumption in the European Network due to better NMOC proposed measures for network issues or to unforeseen changes in the execution of the European Network operations	EX1-CRT-VLD-03-001 The cumulated additional fuel consumption due to NMOC proposed measures for DCB constraints is reduced.
OBJ-VLD-04-001	CRT-VLD-04-001	Fully covered.	EX1-OBJ-VLD-04-001 Reduction in time for NMOC staff to monitor, analyze, coordinate and implement measures to balance demand–capacity due to NM efficiency improvements	EX1-CRT-VLD-04-001 Positive feedback from NMOC staff to apply measures
OBJ-VLD-04-002	CRT-VLD-04-002	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-04-002 Reduction in time for airline staff to monitor, analyze, coordinate and implement measures to balance demand–capacity due to NM efficiency improvements	EX1-CRT-VLD-04-002 Positive feedback from AU staff to apply measures
OBJ-VLD-04-003	CRT-VLD-04-003	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-04-003 Reduction in time for FMP staff to monitor, analyze, coordinate and implement measures to balance demand – capacity due to NM efficiency improvements	EX1-CRT-VLD-04-003 Positive feedback from FMP staff to apply measures
OBJ-VLD-04-004	CRT-VLD-04-004	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC	EX1-OBJ-VLD-04-004 Reduction in time for APOC/airport planning staff to monitor, analyze, coordinate	EX1-CRT-VLD-04-004 Positive feedback from APOC staff to apply measures

		proposed solutions contribute therefore partially to the objective as described.	and implement measures to balance demand – capacity due to NM efficiency improvements	
OBJ-VLD-05-001	CRT-VLD-05-001	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-05-001 Reduce ATFM delay in the network due to NMOC proposed measures	EX1-CRT-VLD-05-001 The accumulation of ATFM delay due to NMOC proposed measures for DCB issues in the network is reduced due to the application of advanced network collaborative management
OBJ-VLD-05-002	CRT-VLD-05-002	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-05-002 Reduction of sector (arrival, en-route) delay resulting from NMOC proposed measures for DCB issues by using enhanced DCB and mechanism	EX1-CRT-VLD-05-002 The usage of enhanced DCB NMOC proposed measures reduces sector delay compared to regulations
OBJ-VLD-05-003	CRT-VLD-05-003	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-05-003 Reduction of airport delay resulting from NMOC proposed measures for DCB issues by using enhanced DCB and TT mechanism	EX1-CRT-VLD-05-003 The usage of NMOC proposed measures for enhanced DCB and TT reduces airport delay compared to airport regulations
OBJ-VLD-05-004	CRT-VLD-05-004	Partially covered: Exercise 1 activities form part of overall network cooperative processes and NMOC proposed solutions contribute therefore partially to the objective as described.	EX1-OBJ-VLD-05-004 Reduce delay resulting from better ATFM measures definition through improved coordination by means of multi-airport planning and NM system support	EX1-CRT-VLD-05-004 Overall delay reduction for group of airports compared to baseline scenario supported by NM system
OBJ-VLD-06-001	CRT-VLD-06-001	Fully covered:	EX1-OBJ-VLD-06-001 Increase the possibility	EX1-CRT-VLD-06-001 Reduction in airline

			for airlines to provide their preferences through NM system as part of the network coordination process	operating costs through provision of airline preferences by NM system to overcome network issues creating airline resource problems , connection of priority flights, better alignment of airline processes (ground/airborne), etc.

A.1.3 Summary of Validation Exercise #01 Demonstration scenarios

1. Reference Scenario

As mentioned before, the solution scenario of Exe 4 and 6 Iteration 1 and 2 can be considered the reference or baseline scenario of Exe 1. This is, the CAP Tool process that it is operational France nowadays.

It implies the usage of CAP Tool to coordinate measures bilaterally between the ACC and the corresponding Airline, with the NM not acknowledging the nature of the agreements reached by both stakeholders.

Airlines refiling according to the Level Capping measures proposed by the ACC is a non-transparent practice to the Network where there is no awareness of AUs refiling reasons and actions.

Apart from Exercises 4 and 6, under the initiative of DFS in Karlsruhe Upper Airspace Centre (KUAC), and as an activity in parallel to PJ24, Lufthansa Group and DFS have been performing a significant TRIAL involving the operational deployment of DSNA's CAP Tool in this portion of the German airspace. FMPs have been using the tool in the tactical phase, 3h/4h before the traffic peak), to bilaterally coordinate level cappings with the participant airlines (mostly Lufthansa Group) in the same manner as it was done in the aforementioned PJ24 Exercises. A deeper explanation can be found in the coming paragraphs, providing a better understanding of the added value that Exercise 1 has given in the measures coordination context.

Results of the implementation of the CAP procedures by Lufthansa, DFS and DSNA (2018-2019)

As ATEAM did not participate in EXE4 and 6 because they arrived late to PJ24 NCM, an internal analysis before EXE1 was needed to understand the needs, impact and concept behind CAP Tool. These lines above are the result of this research in post ops phase.

The analysis proposed analyses the total amount of the Lufthansa Group flights participating to the extended CAP process in collaboration with the ANSP´s DSNA and DFS in the framework of the Network Collaborative Management System by using CAP tool, here below the results in terms of number of flights collected since October 2018.

The data are here collected until June 2019 (9 months) but the process for CAP tool is still on going in the day-by-day operations in OPS rooms.

LHG	total requested flights	accepted flights	% accepted
Since the start of the initiative (oct 18)	205	133	65%
since 2019 until June	170	118	69%

Table 11: Lufthansa Level Capping Flights 2018-2019

The percentage of acceptances, less than 70%, is due to following reasons:

- the process is not mandatory
- the process rely on manual working from the ops room
- some of the requests are not feasible (due to customized planning setting for instance)
- some of the requests don´t help to avoid restrictions in adjacent sectors
- some of the requests are requiring too high fuel consumption/flight time in comparison with the initial flight plan
- others

Capacity and Delays improvements

CAPACITY

The following table shows the Sectors most affected by capacity issues, in regards of Lufthansa Group Flights.

Top10 ATC Sectors:

ATC SECTORS	Count of city pair
EDUAP22	64
LFEHYR	35

EDUWUR3C	25
EDUERL12	20
EDUFFM3C	12
EDUNTM3C	10
EDUFUL1U	8
EDUDI2C	6
EDUERL22	6
EDUERL1R	4

Table 12: Sectors issuing Level Capping Flights for Lufthansa Flights

The following table shows the most frequent city pairs from Lufthansa Group that have been requested for a refiling proposal.

Top 20 LHG city pairs

City Pair	n. of flights request
EDDM EDDH	14
LSZH EGLL	12
LSGG EGLL	10
LSGG EGLC	9
EDDM EGLL	8
EDDM LFPG	7
EDDM EKCH	6
EDDM EPGD	6
LFPG EDDM	5

LSZH EGLC	5
EDDM ESSA	4
LOWW EDDL	4
LOWW EKCH	4
EDDF LROP	3
EDDK LOWW	3
EDDL EPKK	3
EDDM LEBL	3
EGLL EDDM	3
EPGD EDDM	3
EPWA EDDF	3

Table 13: City pairs of the Lufthansa Flights that were Level Capped

DELAY

The following table shows the accepted flights via CAP tool, by accepting a new vertical flight level and the evaluated numbers of prevented regulation.

The amount of flights are here referred to DLH flights. The period here indicated is only year 2019, from January to June. The table in yellow shows the Estimation of the Regulation impact in terms of minutes of Delay and possible flights affected by such regulation. (Source: Eurocontrol DDR)

The estimation is based on LHG flights data collected in DDR, reference period June 2018, only considering the German DFS airspace, analysed per traffic volume ID and considering Regulation activated only for reason ATC Staffing or ATC Capacity.

The **average minutes of delay per single flight** is calculated by total delay divided total number of LHG flights affected by regulation in the reference period (Tot Delay / Tot regulated flights), only for DFS regulations.

The **average of LHG flights affected by regulation** is calculated based on total number of LHG flights that have been regulated divided the number of occurrences of the regulation, taking into account the reference traffic volume ID in the reference period.

The reference period of June 2018, previous year, is used to obtain an estimation of the benefit that could be reached in the future when implementing the new concept, avoiding the regulation by accepting to refile the proposed lower level.

A similar result is obtained (one/two minutes less in the average) when considering an enlarged time frame (July 2018, June and July 2019) and additional relevant ATC sector such as in Switzerland, Austria and so on.

accepted flights (DLH)	prevented Regulations	total LHG flights affected by regulations	total Delay minutes prevented
56	32	448	5824

13	average minutes of delay per single flight
14	average LHG flights delayed/impacted per Regulation

Table 14: CAP figures

Thanks to the new refiling on 56 flights, 32 regulations have been prevented.

In case of non-acceptances (What if analysis) 32 regulations would have been activated by ATC sectors and 448 flights would have been affected, generating up to around 6.000 minutes total of delay.

Fuel efficiency and performances impact

The following table shows the accepted flights via CAP tool, by accepting a new vertical flight level. It means that for every acceptancy the Dispatchers need to re-calculate a specific city pair, asses the new routing in the planning system applying in a lower level sector and re file the new routing.

In terms of performances, the new routing is not anymore in the optimum profile; it means that an increase of Trip Fuel in terms of kg is possible.

In the table here below, only the DLH (Lufthansa) flights are indicated.

For the delta Trip calculation only a certain amount of flights have been measured due to the specific criteria for the comparison between the two flight Plans (new filed vs optimum).

The following data sample refers to the year 2019, from January to June.

DLH fleet A320, Embraer and CRJ

	accepted flights (DLH)	measured flights	avg delta Trip fuel kg	total additional Trip fuel kg	Total CO2 kg
A320	49	22	69	1528	4813
EMB/CRJ	7	6	27	161	507
TOTAL	**56**	**28**	**60**	**1689**	**5320**

Table 15: CAP measures per a/c type

The minimum value: less than 5 kg of delta trip fuel per flight (i.e. MUC HAM, MUC CPH).

The maximum: up to 280 kg of delta trip fuel per flight (i.e. MUC OSL).

The CO2 conversion factor used for the estimation of the environmental impact, is 3,15 kg_CO2/kg_Fuel (jet A1)

For the benefit analysis on the same data sample, referred to the 28 flights (ref. section Delay), let´s see the data below.

prevented Regulations	total LHG flights affected by Regulations	total Delay minutes prevented
14	196	2548

Table 16: Prevented minutes of delay

Detail of calculation (ref. section Delay):

196 = (14 prevented regulations x 14* LHG flights impacted per single Regulation)

2548 = (196 x 13* average minutes of delay per single flight)

*data estimation (Source: Eurocontrol DDR XXXX)

From Begin of April to Mid of July, 31 flights from SWISS received a request for CAP level rerouting. On an average, a level capping added 35kg Fuel more for the trip fuel planned. The maximum was 222kg (GVA-LHR). In 3 cases over 31, the level capping asked was needing a real rerouting (Due to RAD restrictions, and CDR ...etc.).

Since official beginning of the trial (01APR19), 31 requests have been sent to SWISS, 27 have been accepted.

The flight operation point of view (AU/ Dispatchers Questionnaires)

- AU – Lufthansa Questionnaire provided to Dispatchers for CAP tool.
- Survey period: 15.02.2019 – 15.06.2019 (4 months)
- The questionnaires have filled-in in paper format.
- Total number of questionnaires received: 105
- Questionnaires received containing one or more re-Routing proposal: 14 (13%)

SESAR PJ24 NCM

NCM CAP Tool – Dispatch/SLOCO QUESTIONNAIRE

After finishing the questionnaire, please insert it into the box on the SLOCO Desk. It will be emptied once a week. THANK YOU

Date:	Shift:
OCC(DLH/FRA/MUC/GW/CLH/AUA/SWR):	Role (SLOCO/Dispatch):
Number of requests:	Number of refiles:

SECTION 1 – OPERATIONAL

During your shift today:		YES	NO	N/A	If NO, please detail
1.1	Did the login to CAP Tool/DSNA work and was the service available?	☐	☐	☐	
1.2	Did you get the requests on Time?	☐	☐	☐	
1.3	Did the request from ATC make sense and where they refileable?	☐	☐	☐	
1.4	Was the procedure easy to apply in your normal working environment?	☐	☐	☐	
1.5	Was the regulation finally avoided?	☐	☐	☐	

SECTION 2 – SAFETY

Compared to routine operations:				
2.1	Did you feel that the usage of the CAP tool affected safety?	YES ☐	NO ☐	(if YES, please detail) ☐ weather; Clouds to circumnav. ☐ weather; Turbulence/strong wind ☐ other ....
2.2	Was the deviation from routine working methods acceptable and workable?	YES ☐	NO ☐	(if YES, please detail)

SESAR PJ24 NCM

SECTION 3 – WORKLOAD

During your shift today, compared to routine operations:		Increase	No change	Decrease
3.1	How did the CAP procedure impact your workload level?	☐	☐	☐
3.2	If workload changed, how did CAP procedures influence you?	☐ mental ☐ physical ☐ other (please detail below) ☐ N/A		

SECTION 4 – Quality/Quantity

During your shift today:		1-3min	3-8min	>8	other
4.1	How much time did you need to setup to be ready to work with the tool?	☐	☐	☐	
4.2	How much time did you need to refile CAP related flights (average per flight)?	☐	☐	☐	

		totally agree					not at all
		1	2	3	4	5	6
4.3	If you answered to question 4.1, was CAP Trial operational information, provided before, exhaustive with regards to roles and responsibilities, working methods and operational requirements?	☐	☐	☐	☐	☐	☐
4.4	Was the performance of the website satisfactory?	☐	☐	☐	☐	☐	☐

SECTION 5 – ADDITIONAL REMARKS:

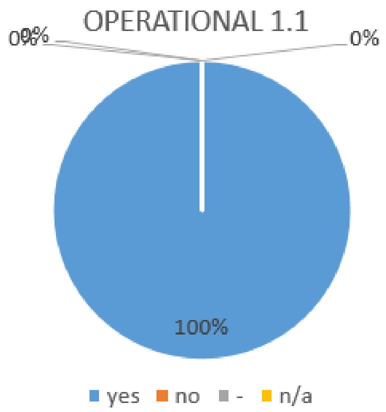
Thanks for your cooperation!

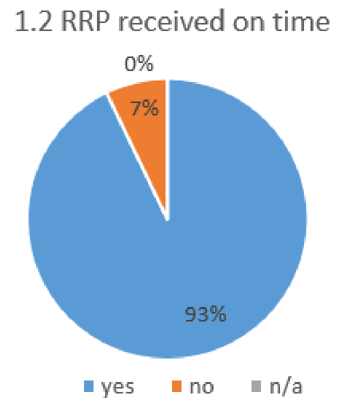
Questionnaires Results:

The following charts are referred only to the 14 questionnaires received containing one or more re-Routing proposal.

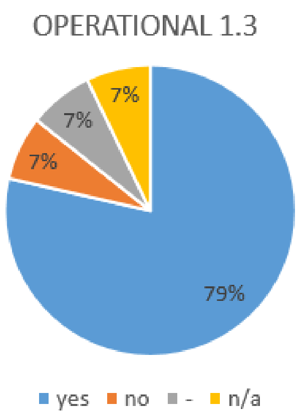
SECTION 1 – OPERATIONAL

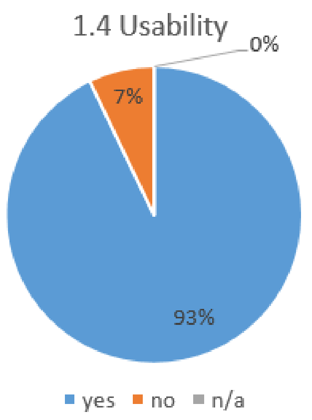
1.1	Did the login to CAP Tool/DSNA work and was the service available?
1.2	Did you get the requests on Time?





1.3	Did the request from ATC make sense and where they refillable?
1.4	Was the procedure easy to apply in your normal working environment?

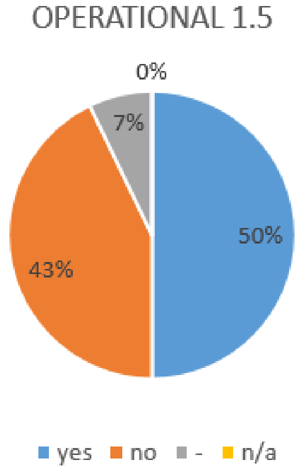




1.3: the 7% of the answers considers the ATC request not refillable.

1.4: the 7% of the answers considers the procedure not easy to apply in his normal working environment.

1.5	Was the regulation finally avoided?



When the regulation has not avoided, it was due to:

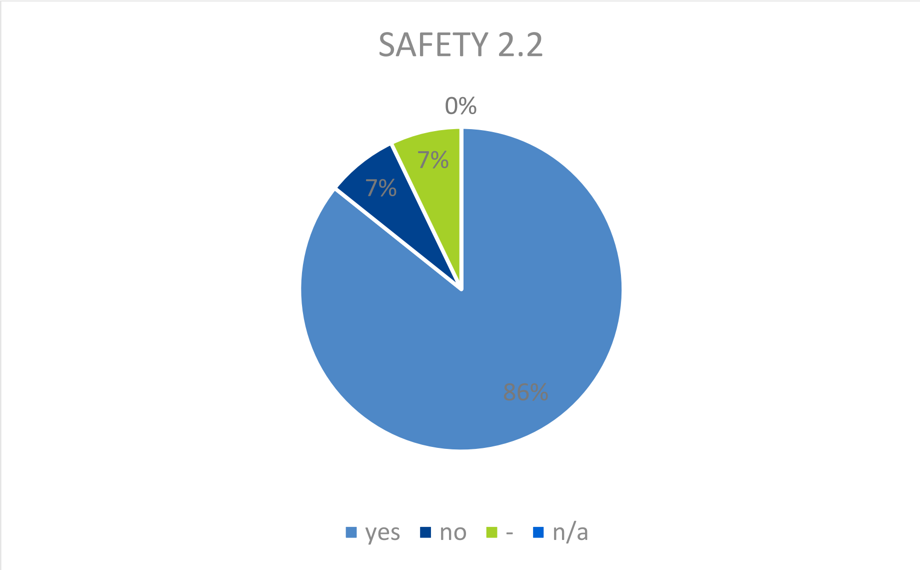
- Not enough flights re-filed to let the ANSP reduce the peak on Traffic Volume exceeding the nominal rate.
- Another regulation occurred in adjacent FMP/ATC sectors

Operational comments:

- Refile unsatisfied (still regulated)
- KER1R01D reg. In force affecting other flights
- DLH5MH - 2 regulations LHCCENHT, LOVVE DLH8HX - 2 regulations LOE1501, LHCCWLM DLH4UC - LOE1501
- both flights received AR regulation
- result of refile: 65min Slot
- but slot improved

SECTION 2 – SAFETY

2.1	Did you feel that the usage of the CAP tool affected safety? → Answer "no" (100%)
2.2	Was the deviation from routine working methods acceptable and workable?



2.1: The usage of CAP tool maintains the current equivalent level of Safety.

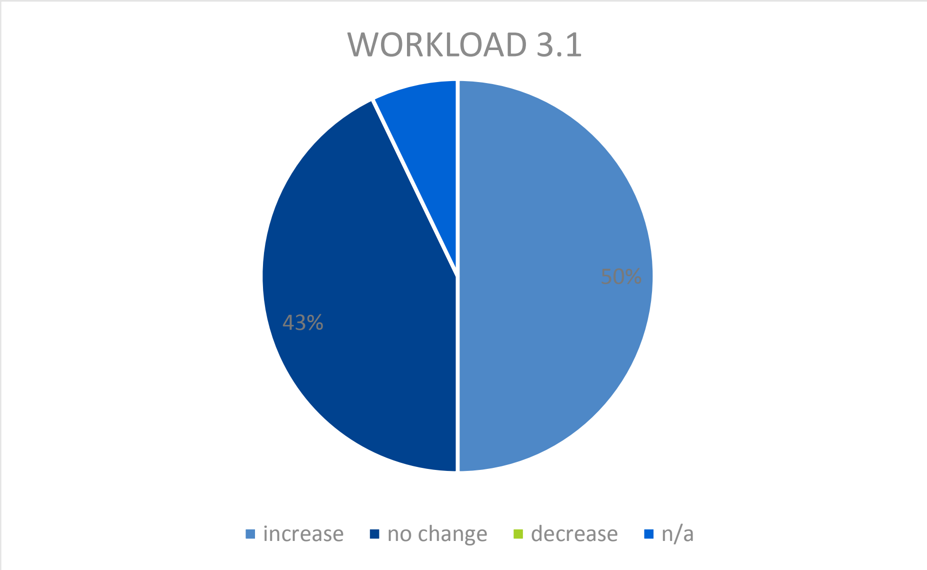
2.1: The deviation from routine nevertheless needs an improvement in terms of procedure and additional staff or computer aid/decision support/integrated elaboration support in Flight planning System.

Safety dispatchers' comments:

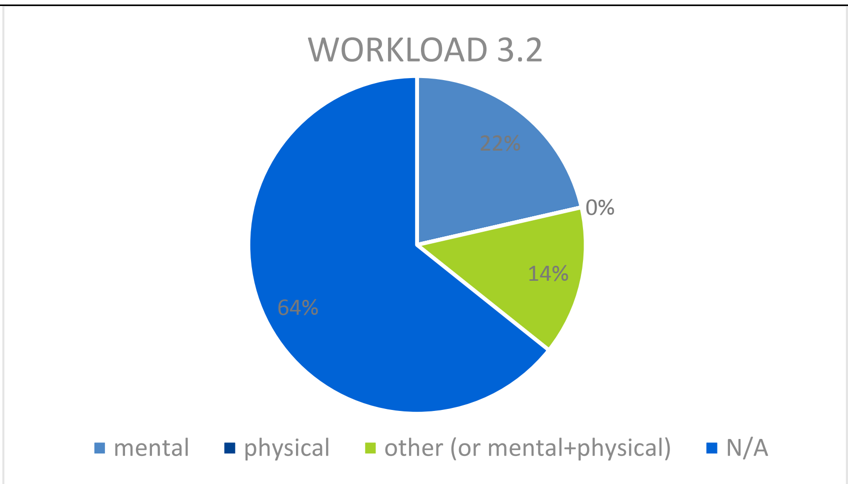
- FL CHG
- additional staff needed
- läuft einfach nebenher (simply runs alongside)

SECTION 3 – WORKLOAD

3.1	How did the CAP procedure impact your workload level?



3.2	If workload changed, how did CAP procedures influence you?

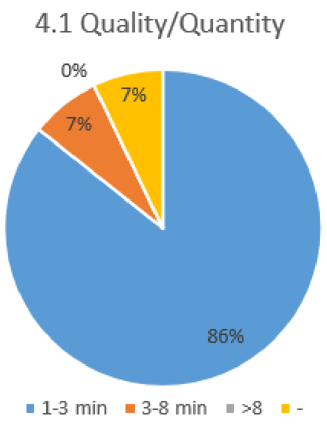


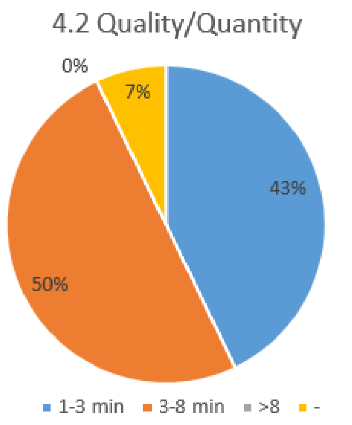
Workload dispatchers' comments:

- "Nobody needs an additional tool. It is just wasting monitoring capacity. Please integrate workflow in CHMI and NM processes and tools! (e.g. RRP)"

SECTION 4 – Quality/Quantity

4.1	How much time did you need to setup to be ready to work with the tool?
4.2	How much time did you need to refile CAP related flights (average per flight)?



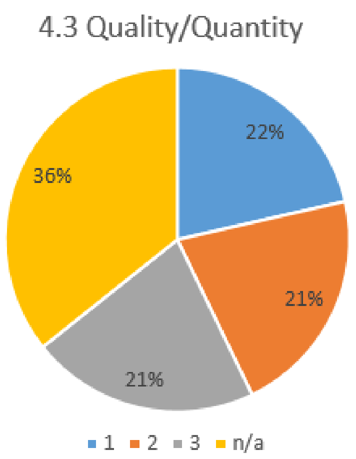


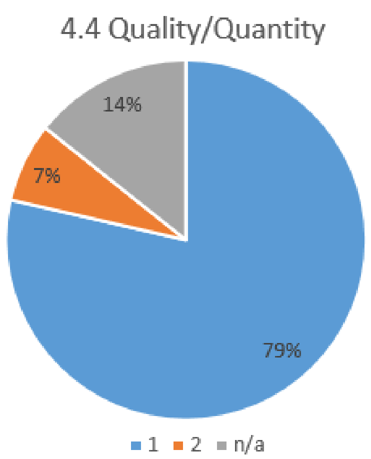
4.1: The 86 % of the answers indicate a set up time in CAP tool not higher than 3 minutes.

4.2: To re-file a single flight, switching the planned flight from AOS to manual, takes no more than 8 minutes. The 43 % answered that it takes no more than 3 minutes.

4.3	If you answered to question 4.1, was CAP Trial operational information, provided before, exhaustive with regards to roles and responsibilities, working methods and operational requirements?
4.4	Was the performance of the website satisfactory?

(1= totally agree; 6= not at all)





4.3: The CAP trial operational information provided, in docSpace and internal communications were quite exhaustive.

4.4: The web site of the CAP tool made by DSNA was satisfactory. (Was also possible to receive the information for the Re-Routing Proposal by e-mail).

Conclusion and recommendations for the Reference Scenario (Lufthansa Group)

Even if CAP is a successful trial, which helps reducing the amount of regulations, it is feasible because airlines do accept to fly non-optimised routes. That leads to additional costs for the airlines, in fuel consumption (i.e. more CO2 emissions) and in dispatcher staff time, as a dispatcher needs to analyse each request from FMP, validate the new route in the flight plan system, modify it manually if necessary, test it and if accepted, submit a new flight plan. Even with the NCAP, which should be developed as quick as possible to reduce the efforts done by the airlines staffs, it is needing less but still additional time from a dispatcher normal work, and still ask the airline to fly another route than its optimised one.

It is important also to have a pre-tactical Phase with FMPs to identify acceptable rerouting for given hotspots/regulations/congested airspaces. In addition, make the CFSPs on-board as soon as possible, to enhance the optimisation possibility, reduce the dispatcher time needed and thus reduce the costs.

However, when a regulation is activated it could mean:

- Additional workload for dispatcher (to find alternate routes with no guidance or support from NM and/or ANSPs, whereas CAP alternate routes are suggested to dispatchers amongst familiar and pre coordinated options)

- Possible delays (for all the affected flights, reactionary flights etc.)
- Possible increase of taxi out fuel (or APU) – but this is difficult to measure

Therefore, and due to the actual conditions of the air traffic management in Europa and the trend for the next three years, ATEAM airlines do agree to participate to the trial and refile accordingly to FMP requests, in order to lower the amount of delay. However, this should not be the final state of the efforts from FMP and NM point of view, and a sustainable solution for European ATM should be developed.

These results are aligned with what was concluded in EXE 4 and 6 regarding CAP process.

2. Solution Scenario

The DSNA's CAP Tool evolution towards a Network Collaborative Advanced Planning tool (NCAP), which includes access to the NM Scenario Repository via B2B, allows the ANSP (in Exercise 1 DFS) to query and apply NM STAM rerouting Scenarios. These scenarios are designed in the Strategic Phase to issue Cherry Pick Level Cappings in order to off-load a specific sector or a traffic volume. Using "fine-tuned ATFCM measures" rerouting scenarios might avoid applying more penalising measures such as a classical regulation.

The FMP is provided with a list of applicable vertical rerouting scenarios (and possibly in the future horizontal too) by the tool to off-load a specific traffic volume. After selecting the vertical rerouting scenario measure, the FMP cherry picks the flights to level cap and an analysis of the alternative routes for each of the flights is automatically triggered. If alternative routes are found for the targeted flights, the FMP is in a position to apply that vertical rerouting measure. After its application, the concerned Airspace User receives a rerouting proposal (RRP/during the Trial only vertical re-routings were tested) message, which includes a valid (IFPS compliant) alternative route that complies with the airspace constraints of that "fine-tuned ATFCM measures" rerouting measure (e.g. avoid airspace XXX, refile via YYYYY point with maximum FL ZZZ).

The Airspace User/flight dispatcher role assesses the RRP received via AO NOP-STAM Portal together with the "fine-tuned ATFCM measures" rerouting measure constraints; the flight dispatcher manually inserts the proposed alternative route into the Flight Planning Tool of its CFSP and starts the new alternative route analysis, comparing it with other company routes calculated by the Flight Planning Tool (namely LIDO and SABRE during the execution of the exercise).

In parallel, the AU also receives the estimated delay that would have been applied in case a classical regulation would have been implemented instead. This classical regulation is performed within a simulation environment in parallel to the "fine-tuned ATFCM measures" RRP process in order to retrieve not only the predicted delay per flight but also the delay per fleet and accumulated delay per Sector in a simulated time period.

Once assessed, the rerouting proposal is accepted, rejected or slightly changed while complying with the constraints.

Consequently, the NM and ANSP systems have both the information whether the Airline has issued or not a new alternative route, the rationale behind it and whether the overload situation has been solved or not (i.e. feedback on the measure efficacy).

Operational goal:

The operational goal of the FMP is to reduce overall delay and number of penalised flights, by avoiding applying a regulation, thanks to the proposal of an alternative route to the initial flight plan of the potentially affected flights.

The set of possible reroutings which shall be compliant with FMP constraints are assessed and pre-agreed by all parties in early stages of the operational planning, they are created and stored in the NM Scenario Repository using the Reference Scenario artefact for later use. In the day of operations, the FMP finds one or more alternative route options to be a solution for an identified overload and sends them as “fine-tuned ATFCM measures” Rerouting Proposals (STAM RRPs) to the concerned AUs more than 2h before the EOBT.

If a sufficient number of flights accepts the RRPs, the FMP can possibly avoid applying a regulation later on, which would exempt all flights initially planned in the overloaded sector from delay penalisation. So the number of flights that are required to avoid the regulation shall be known to AUs to avoid unnecessary replanning/filing.

Technical goal:

In this demonstration exercise, **the technical goal is to connect local user systems to NM systems by using the available NM B2B services in order to enable a transparent and collaborative RRP process.**

3. Detailed workflow

This section aims to provide an overview of the operational steps within Exercise 01 solution scenario performed by the participant roles and the tools at their disposal.

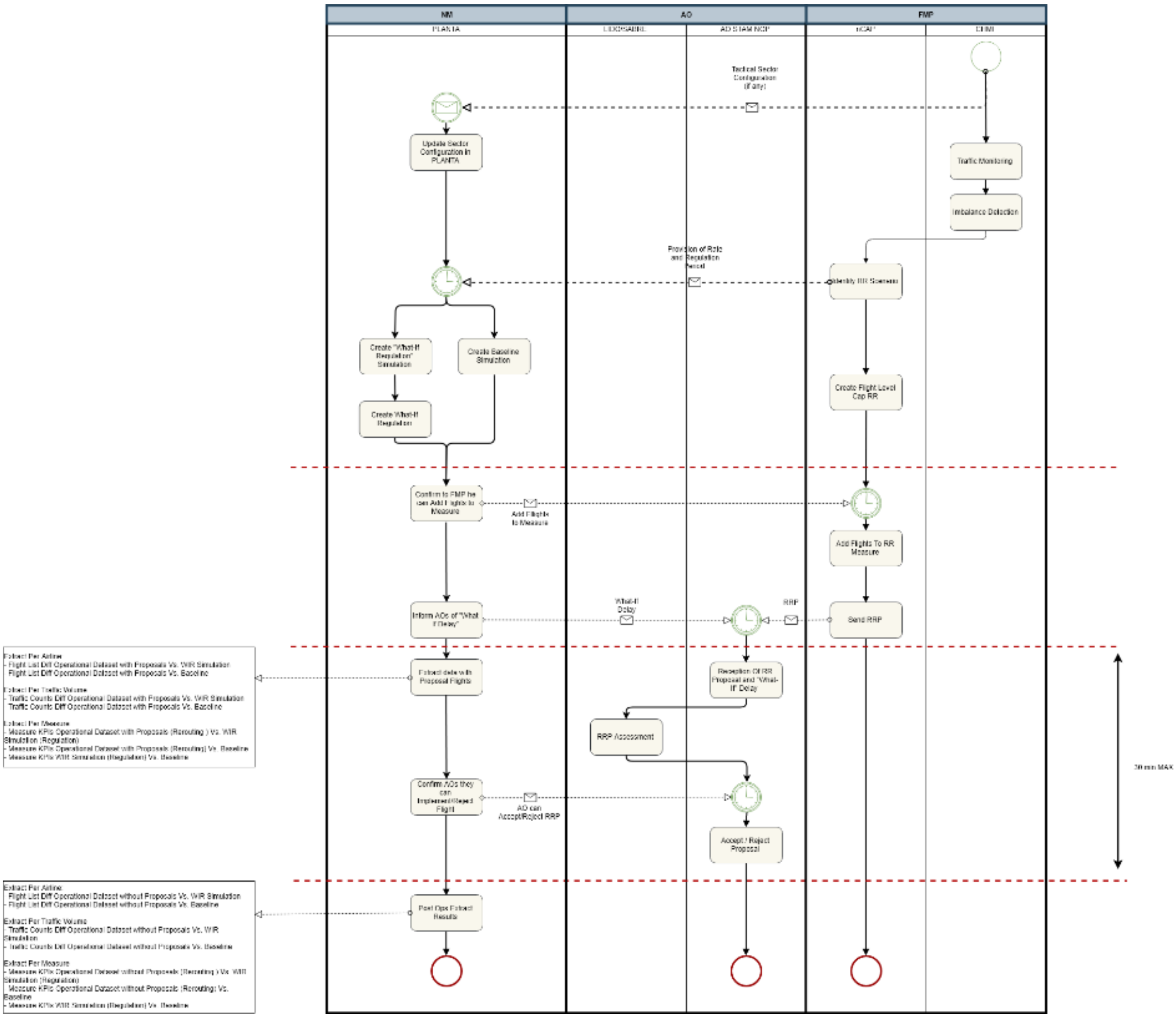


Figure 11: Exe1 Workflow

Demonstration pre-requisites and conditions:

1. NCAP tool to be fully operative within Karlsruhe environment (airspace, traffic volumes…).
2. NCAP tool to link the "fine-tuned ATFCM measures" reroutings measures within a Reference Scenario in the NM systems to the flight level capping solutions of the CAP tool.
3. AU's flight planning tools to be available, accessible and operative during the exercise.
4. The FMP to initiate the NCAP workflow not later than **2 hours before EOBT** of the flight to be rerouted in order to trigger the "fine-tuned ATFCM measures" RRP workflow
5. The FMP to propose reroutings only to those flights which are participating in the exercise. In case of low traffic levels from participant AUs, flights from other airlines could eventually be

considered (drawback: AUs would not be able to assess equally the proposed routes as when managing their own flights).

6. Specific "fine-tuned ATFCM measures" rerouting scenarios (flight level cappings) to be designed, created and stored in the NM Scenario Repository before the execution of the exercise. All stakeholders shall be involved in this process (NMOC, FMPs and AUs).
7. Train AUs in the AO NOP STAM portal and "fine-tuned ATFCM measures" RRP workflow. .
8. Train FMPs in the NCAP tool and the "fine-tuned ATFCM measures" RRP workflow.

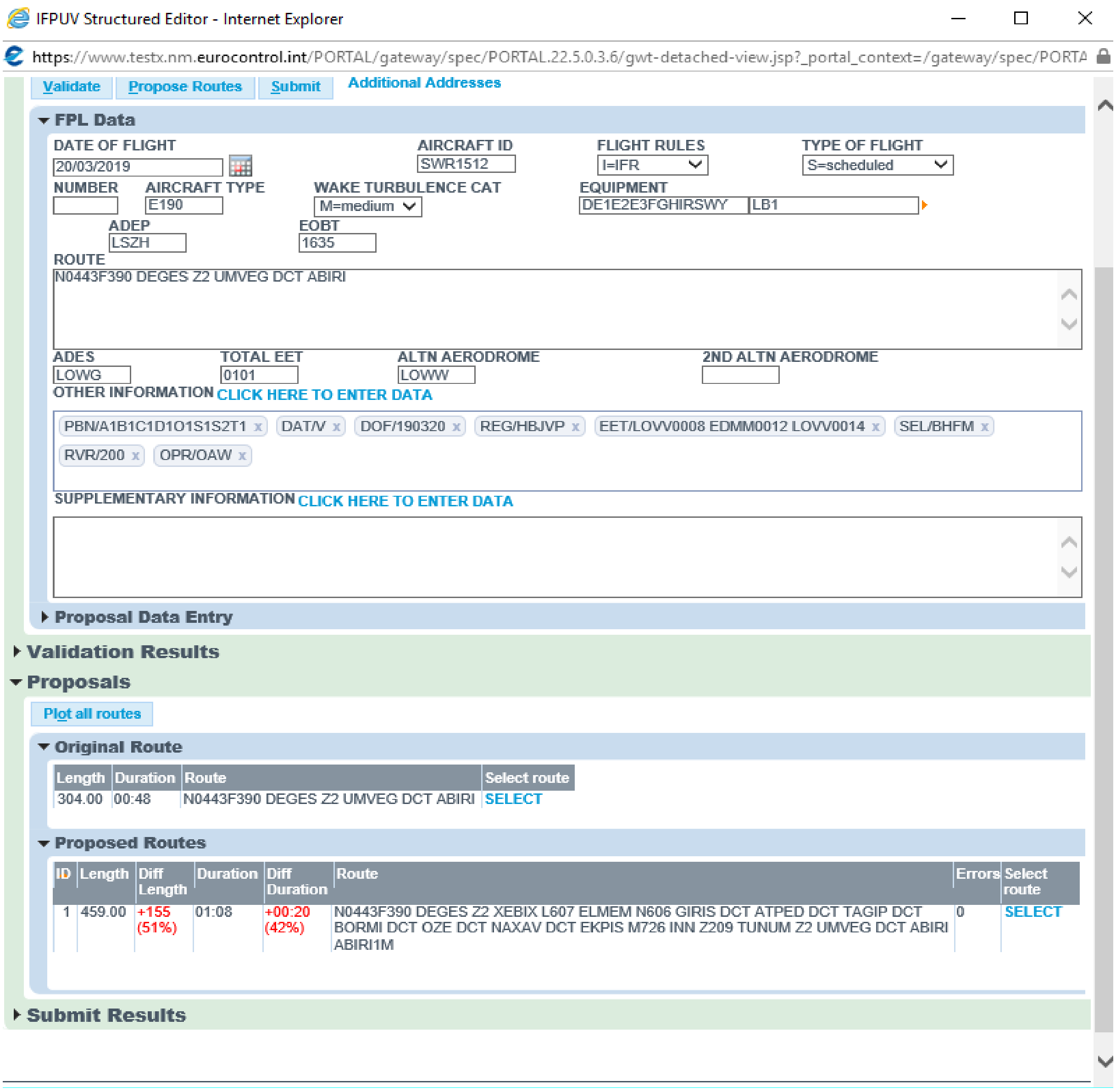


Figure 12: NOP Tool used by AUs

There are three different use cases that might occur within the overall solution scenario and thus they are important to describe. All three use cases are considered nominal, in the following steps of the concept deployment deviations from these three Use cases may have be expected.

USE CASE 1: The FMP applies a "fine-tuned ATFCM measures" rerouting measure and AU accepts RRP and refiles according NM proposed alternative route

FMP ANALYSIS OF THE PROBLEM

1. **FMP:** (CHMI) The FMP identifies a remaining traffic overload[7] during the day of operations (day D, tactical) in one of the traffic volumes for a certain time period
2. **FMP:** (CHMI) The FMP selects the problematic traffic volume and the tool displays the load display with more detailed information
3. **FMP:** (CHMI) The FMP zooms in the overload (or selects the time period where the overload appears and a time buffer)
4. **NM:** (PLANTA) NM updates the sector configuration in the PLANTA tool if necessary to perform the corresponding analysis

FMP ANALYSIS OF THE SOLUTION OPTIONS

5. **FMP:** (phone/mail) The FMP requests NM to simulate a normal regulation and provides date, time period, rate and reason. The delay per flight caused by this regulation is an estimation of the delay the AU would receive in case the overload persists and the FMP needs to apply a regulation to solve it. This what-if delay is an additional information that could serve the AU in their decision making process.
6. **NM:** (PLANTA) NM performs two simulations: a baseline and a what-if regulation with the parameters provided by the FMP.

   THEN EITHER
7. **FMP:** (NCAP) The FMP obtains the flight list that is captured for the selected time period in the problematic traffic volume and filters the flights according to the AU demo participants. The NCAP tool displays the "fine-tuned ATFCM measures" scenarios (which are stored in the NM Scenario Repository) **that are applicable per displayed flight(s)**

   OR

[7] The global DCB analysis of the situation is performed during pre-tactical operations using the CHMI tool. It is important to highlight that the FMP will only use NCAP during tactical operations to cope with **residual and isolated traffic demand peaks**.

7. **FMP:** (NCAP) The FMP obtains the "fine-tuned ATFCM measures" scenarios (which are stored in the NM Scenario Repository) **that are applicable to off-load the problematic traffic volume** for the selected time period. The tool also displays at the same time how many and which flights are captured per "fine-tuned ATFCM measures" scenario (**/!** not per "fine-tuned ATFCM measures" rerouting measure[8]) within that period.

8. **FMP:** (NCAP) The FMP analyses the displayed information and decides which "fine-tuned ATFCM measures" scenario to implement
9. **FMP:** (NCAP) The FMP selects the "fine-tuned ATFCM measures" scenario and retrieves the rerouting measures within
10. **FMP:** (NCAP) The FMP selects the "fine-tuned ATFCM measures" scenario and rerouting measure to implement and creates an instance from it.
11. **NM:** (phone) NM provides green light to the FMP to add the flights to the measure.
12. **FMP:** (NCAP) The FMP adds flights to the "fine-tuned ATFCM measures" rerouting measure and submits. The NCAP tool displays the result of the rerouting (successfully vs. non-successfully rerouted flights, i.e. DRAFT-status flights vs. INTERRUPTED-status flights respectively).

Note: As long as the measure is under DRAFT status, RRPs will not be sent to AUs.

13. **FMP:** (NCAP) The FMP assesses if results of the NCAP measure are satisfactory via the occupancy counts impact assessment. If results are satisfactory, go to step 14. Otherwise,

    EITHER
    The FMP updates the measure by adding/removing flights and submits again
    OR
    The FMP cancels the measure and restart the workflow again

FMP IMPLEMENTATION OF THE SOLUTION

14. **FMP:** (NCAP) The FMP implements the "fine-tuned ATFCM measures" rerouting measure (i.e. the status of the rerouting measure from DRAFT to FOR_IMPLEMENTATION). This action will automatically send the RRP message to the corresponding AUs (only to those AUs whose flights are under FOR_IMPLEMENTATION status)

NM GLOBAL ANALYSIS

15. **NM:** (phone) NM provides the AUs the what-if delay per flight
16. **NM:** (PLANTA) NM extracts relevant data/indicators per airline and per measure right after the rerouting measure has been implemented

[8] One STAM scenario may contain one or more STAM rerouting measures

AU RECEIPT OF THE RRP message

17. **AU:** (AO NOP STAM) The AU accesses the flight list of the AO NOP STAM portal and queries according to its operator ID (e.g. SWR) and relevant time period (e.g. whole day).
18. **AU:** (AO NOP STAM) The AU is continuously monitoring the status of its flights (refreshing the flight list window) in order not to skip any update/RRP message
19. **AU:** (AO NOP STAM) The flight list displays all the flights subject to a flight plan message (e.g. RRP/SAM/SRM amongst others) and corresponding rerouting measure ID (under the MEA+ column) which is typically linked to the Reference Scenario name.
20. **AU:** (AO NOP STAM) The AU clicks on the relevant flight ID to obtain all the flight details including the RRP information with the new proposed route (Details tab of the popping window)

AU ASSESSMENT of RRP proposal

21. **AU:** (LIDO/SABRE/flight management/planning systems) With all the available RRP information displayed in the AO NOP STAM tool, the AU might use its own flight planning/management tools in order to check:
    a. The suitability of rerouting the scheduled flight against rejecting the proposal
    b. Rerouting applicability and eventual trajectory fine tuning with the airline rules.
    c. Possible alternative routes

22. **NM:** (phone) NM provides green light to the AU to refile/reject

AU SUBMITS FLIGHT PLAN UPDATE/CHG (ACCORDING TO NM ALTERNATIVE SUGGESTED ROUTE)

23. **AU:** (LIDO/SABRE/flight management/planning systems) The AU decides **to accept the proposal** to reroute using the NM suggested alternative route.
24. **AU:** (AO NOP STAM) The AU shall remove the EETFIR information to enable a complete match of the STAM matching profile
25. **AU:** (AO NOP STAM) The AU refiles flight plan accordingly

FMP CHECKS RATE SUCCESS OF THE MEASURE

21. **FMP:** (NCAP) The FMP may check the success of the applied “fine-tuned ATFCM measures” rerouting measure by monitoring the traffic load.
22. **NM**: (PLANTA) NM saves the traffic picture after the implementation of the “fine-tuned ATFCM measures” rerouting measure and extract post ops data.

USE CASE 2: The FMP applies a rerouting measure and AU accepts RRP but refiles according to company route/optimised route

Same workflow as in USE CASE 1 from step 1 to 22 (included)

AU CHECKS IFPS COMPLIANCY OF THE ALTERNATIVE COMPANY ROUTE/OPTIMISED ROUTE

23. **AU:** (LIDO/SABRE/flight management/planning systems) The AU decides to **accept the proposal** but refiling an optimised route/company route of their own instead of the NM proposed alternative route.
24. **AU:** (AO NOP STAM): The AU manually copy-pastes the new alternative route proposed by their flight planning/management systems into the AO NOP STAM section and validates the route before actual submission of the flight plan.
    a. If there are no errors, the AU may proceed to flight plan submission.
    b. If there are errors, the AO NOP STAM will display them and the AU shall correct them.

- **Note:** No flight plan should be submitted before previous IFPUV validation.

AU SUBMITS FLIGHT PLAN UPDATE/CHG (ACCORDING TO COMPANY ROUTE/OPTIMISED ROUTE)

25. **AU:** (AO NOP STAM): The AU submits the final flight plan accordingly

FMP CHECKS RATE SUCCESS OF THE MEASURE

26. **FMP:** (NCAP) The FMP may check the success of the applied STAM rerouting measure by monitoring the traffic load.
27. **NM**: (PLANTA) NM saves the traffic picture after the implementation of the STAM rerouting measure and extract post ops data.

USE CASE 3: The FMP applies a rerouting measure and AU rejects RRP

Same workflow as in USE CASE 1 from step 1 to 22 (included)

AU REJECTS RRP PROPOSAL

23. **AU:** (AO NOP STAM): The AU **decides to reject the proposal** and continue operating following the initial filed flight plan
24. **AU:** (AO NOP STAM): The AU shall switch mode from PROPOSAL to NORMAL flight information to reject the “fine-tuned ATFCM measures” RRP
25. **AU:** (AO NOP STAM): The AU submits a rejection message to the proposed “fine-tuned ATFCM measures” RRP

FMP CHECKS RATE SUCCESS OF THE MEASURE

26. **FMP:** (NCAP) The FMP may check the success of the applied “fine-tuned ATFCM measures” rerouting measure by monitoring the traffic load.
27. **NM**: (PLANTA) NM saves the traffic picture after the implementation of the “fine-tuned ATFCM measures” rerouting measure and extract post ops data.

A.1.4 Summary of Demonstration Exercise #01 Demonstration Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
EX1-A1	NM Management support to perform demonstration exercises		NM management reduced support to perform exercises resulted in a slight change of intentions of the Use Cases addressed						NM	
EX1-A2	No major NM system technical evolution required		NCM scenarios were developed within the limitations of the currently available technical infrastructure and tools of NMOC. Baseline version of NM systems is 22.5.						NM	
EX1-A3	Use of prototypes/test platforms in NMOC operations		The demonstration exercises are not considered as full operational implementations requiring integration of demonstration requirements with the current technical/procedural NMOC system. Prototypes may be necessary to perform exercises together with the use of Test Platform.						NM	
EX1-A4	ANSP FMP operational expertise was limited		Due to the lack of resources, DFS operational expertise in FMP operations was limited						ANSPs	

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
EX1-A5	Some of the Airspace Users had limited availability and limited access to the Flight Planning tools		There was a limited Availability of AUs due to the amount of effort in the consortium.						AUs	It was compensated with a stronger collaboration from the other AUs. Both Sabre and LIDO were represented in the execution.

Table 17: Demonstration Exercise Assumptions in EXE #1

A.2 Deviation from the planned activities

Exercise 1 scope differs from what was described in the original DEMOPlan in 2017. The leader of the exercise (NM), decided that Exercise 1 should focus on other defined concepts instead of the original ones:

- Due to the unexpected very busy summer of 2018 in the global network, the availability of NMOC Controllers was dramatically reduced for those activities that were not strictly related to the Operational environment. This stopped the already started and essential consultation meetings for concepts like:
    - Network Optimisation Regulations impacting non-geo related area
    - Post Ops analysis and Best Measure for re-occurring linked regulations patterns
    - Implementation of Best measure for linked regulation
    - Network Optimisation for individual flight impacting non-geo related area
- The second unexpected event during April 2018 was the shortfall in the NM Systems. This unfortunate event led EASA to start closely monitoring every single new development for the subsequent NM Releases. Some of those developments were expected to be the basis for EXE 1, as it was identified in 2017. NM Releases 22.0, 22.5 and 23.0 (and future releases) were downscaled dramatically.
- The Open-Call process for the establishment of the AU consortium in the SESAR2020 Programme in its Wave 1 was launched late, and subsequently the participation of the Airlines in the exercises was not well defined at the beginning of the project. After some consultation months and meetings between PJ24 and ATEAM, an interesting possibility was found in terms of collaboration in the framework of Exercise 1.
- Airspace users were much interested on keep enlarging their knowledge in the local initiatives like CAP Tool and the consequences on their flights and fleets of the new methods of operations. NM, on the other side, was feeling the need of a global approach to the local concepts and the decisions made on bilateral basis (ACC-AU) without its participation. This resulted in a new scope to the Exercise 1. DSNA closed the collaborative loop as the ANSP was interested in connecting their local tool to the NM systems in order to provide more added value to the AUs and open the possibility for NM impact assessment in their CAP process. With this purpose, the CAP Tool was upgraded to a new

version which could connect to the NM systems, access the NM Scenario Repository and make use of the NM B2B services.

- Usage of the reroutings stored within the classical FL (Flight Level) ATFCM scenarios for the exercise, contrary to the initial plan of designing and creating “fine-tuned ATFCM measures” scenarios specifically for this exercise.

Objectives & Success Criteria

As the scope of Exe1 was changed, some of the Objectives (mainly the ones related to airports) will not be covered:

- EX1-OBJ-VLD-01-004
- EX1-OBJ-VLD-03-001
- EX1-OBJ-VLD-04-001
- EX1-OBJ-VLD-04-002
- EX1-OBJ-VLD-04-004
- EX1-OBJ-VLD-05-003
- EX1-OBJ-VLD-05-004

Also, the execution phase after the flights was not investigated, so the following objective related to the reduced margins between planned and actual operations does not apply anymore.

- EX1-OBJ-VLD-02-001

A.3 Demonstration Exercise #01 Results

A.3.1 Summary of Demonstration Exercise #01 Demonstration Results

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Sub-operating environment	Exercise Results	Demonstration Objective Status
EX1-OBJ-VLD-01-001	Acceptable increase in workload for network operations planning actors to apply NMOC proposed enhanced DCB and TT measures to optimally use network capacity	EX1-CRT-VLD-01-001	The usage of NMOC proposed enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload	En-route airspace – Medium Complexity	The workload for NM and FMPs it is envisaged to be decreased or at least to remain the same as nowadays.	OK
EX1-OBJ-VLD-01-004	Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied by sharing NMOC data and actions	EX1-CRT-VLD-01-004	Positive feedback from all actors regarding DCB transparent role of NMOC	En-route airspace – Medium Complexity	The understanding of the other stakeholders work, the coordination of the measures applied and the collaboration between all the actors was the cornerstone of the Exercise	OK
EX1-OBJ-VLD-02-001	Reduce the margins between planning and actual for flights due to unforeseen changes in the execution of the European	EX1-CRT-VLD-02-001	The distribution of early/late arrivals at coordination points or the airport of destination is narrower	N/A		N/A

	Network operations.		than current operations.			
EX1-OBJ-VLD-03-001	Reduce the extra fuel consumption in European Network fleet due to better NMOC proposed measures for network issues or to unforeseen changes in the execution of the European Network operations	EX1-CRT-VLD-03-001	The cumulated additional fuel consumption over an Airline fleet due to NMOC proposed measures for DCB constraints is reduced.	En-route airspace – Medium Complexity	Exercise was focusing mainly on delays avoidance, but some strategies during it like the possibility to counter-propose NM with better company routes, help the AU fleet not to increase dramatically the Fuel consumption.	Partially OK
EX1-OBJ-VLD-04-001	Reduction in time for NMOC staff to monitor, analyse, coordinate and implement measures to balance demand–capacity due to NM efficiency improvements	EX1-CRT-VLD-04-001	Positive feedback from NMOC staff to apply measures.	En-route airspace – Medium Complexity	Although NMOC controllers were not involved, pre-agreed "fine-tuned ATFCM measures" scenarios allows to balance demand and capacity and potentially prevents regulations from being implemented (which implicitly reduces NMOC workload)	Partially OK
EX1-OBJ-VLD-04-002	Reduction in time for airline staff to monitor, analyse, coordinate and implement measures to balance demand–capacity due to NM efficiency improvements	EX1-CRT-VLD-04-002	Positive feedback from airline staff to apply measures.	En-route airspace – Medium Complexity	Small reduction in terms of time to recalculate the new route proposed, assess the consequences and decide whether the flight will be refiled. However, the time used for	Partially OK

					that is still non-negligible	
EX1-OBJ-VLD-04-003	Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity due to NM efficiency improvements	EX1-CRT-VLD-04-003	Positive feedback from FMP staff to apply measures.	En-route airspace – Medium Complexity	New tools like NCAP using the NM B2B services eases the whole process for the FMP-NM communication, and facilitates the identification of applicable pre-agreed Level Capping measures to solve an overload.	OK
EX1-OBJ-VLD-04-004	Reduction in time for APOC/airport planning staff to monitor, analyse, coordinate and implement measures to balance demand – capacity due to NM efficiency improvements	EX1-CRT-VLD-04-004	Positive feedback from APOC staff to apply measures.	N/A	APOC/Airport planning was not subject of study	N/A
EX1-OBJ-VLD-05-001	Reduce ATFM delay in the network due to NMOC proposed measures	EX1-CRT-VLD-05-001	The accumulation of ATFM delay due to NMOC proposed measures for DCB issues in the network is reduced due to the application of advanced network collaborative management	En-route airspace – Medium Complexity	The usage of alternative measures stored in NM systems and automatically proposed to the FMP prevent implementing CASA Regulations and allow to reduce the ATFM delay (provided AUs collaboration)	OK
EX1-OBJ-VLD-05-002	Reduction of sector (arrival, en-route) delay	EX1-CRT-VLD-	The usage of enhanced DCB NMOC proposed	En-route airspace –	The usage of alternative measures stored in NM	OK

	resulting from NMOC proposed measures for DCB issues by using enhanced DCB and mechanism	05-002	measures reduces sector delay compared to regulations	Medium Complexity	systems and automatically proposed to the FMP prevents implementing CASA Regulations and allows to reduce the ATFM delay (provided AUs collaboration)	
EX1-OBJ-VLD-05-003	Reduction of airport delay resulting from NMOC proposed measures for DCB issues by using enhanced DCB and TT mechanism	EX1-CRT-VLD-05-003	The usage of NMOC proposed measures for enhanced DCB and TT reduces airport delay compared to airport regulations	En-route airspace – Medium Complexity	APOC/Airport delay was not subject of study.	N/A
EX1-OBJ-VLD-05-004	Reduce delay resulting from better ATFM measures definition through improved coordination by means of multi-airport planning and NM system support	EX1-CRT-VLD-05-004	Overall delay reduction for group of airports compared to baseline scenario supported by NM system	En-route airspace – Medium Complexity	APOC/Airport delay was not subject of study.	N/A
EX1-OBJ-VLD-06-001	Increase the possibility for airlines to provide their preferences through NM system as part of the network coordination process	EX1-CRT-VLD-06-001	Reduction in airline operating costs through provision of airline preferences by NM system to overcome network issues creating airline resource problems , connection of priority flights, better alignment of airline	En-route airspace – Medium Complexity	Airlines have now an opportunity to contribute with their preferences As part of the "fine-tuned ATFCM measures" Scenario design phase during which the alternative routes are not only defined by NM and	OK

			processes (ground/airborne), etc.		FMPs but also agreed and assessed by the AUs	

Table 18: Exercise 1 Demonstration Results

A.3.2 Airspace Users results

Quantitative results

Lufthansa participation:

Lufthansa was involved the DRY RUN technical test, the training session on 6th March and the final trial, with a total of 23 flights available for re-routings proposals. In order to test the different scenarios, we accepted, rejected and counter-proposed new routings. Using LIDO flight® flight planning software we re-planned the proposed routings and evaluated plan-ability and the effects on time and cost. Additionally, we performed analysis, using LIDO to support our decisions and check operational feasibility. Due to performance issues, only 11 flights could be used to create comparable data sets. Please find below a summary of these flights:

RUN	Flight	ADEP	ADES	Δ Trip Fuel (kg)	Δ Time (Min)	# of affected LH flights in the specific regulated sector	Comments
1	DLH8NJ	EDDF	EPWA	114	1	4	Accepted
1	DLH612	EDDF	UBBB	82	0	-	Unreliable system information in PLANTA
2	DLH2HH	EDDM	EGLL	0	0	-	Rejected
2	DLH9922	EDDM	EGSH	218	3	6	Rejected
4	DLH3PN	EDDF	LBSF	258	3	5	Accepted
4	DLH598	EDDF	HAAB	192	-1	5	Accepted
5	DLH8HH	EDDF	EPWA	0	0	5	Accepted
5	DLH3MP	EDDF	LHBP	0	0	5	Accepted
6	DLH2FR	EDDF	LHBP	71	1	7	Accepted
6	DLH1298	EDDF	LTBA	115	2	7	Accepted
6	DLH600	EDDF	OIIE	186	0	7	Unreliable system information in PLANTA

In General it must be said that the concept of having network evaluated proposals makes sense, especially for obtaining a holistic view on the effect of local solutions and the impact in other parts of the European ATM Network. This view and the quality of the picture is essential for LHG OCC to make proper decisions. This goes along with the importance of generating accurate scenarios. That said: some of the proposals were rejected due to RAD restrictions or because the proposal was not suitable for other reasons (e.g. SID to ATS connection missing).

One big learning from the exercise was that it is absolutely necessary that NM, AOs and FMP work together in ALL phases (from Scenario creation, B2B interface development, distribution of the RRP`s and post OPS analyses.

The second big finding was, that to make most out of the concept, a high rate of automation is crucial. Feedback from dispatch has shown that the slow performance of the flight planning tool and the high amount of "manual interaction from dispatch" that was necessary, led to an inacceptable long time of assessing the RRP and refiling the flights. In some cases it was NOT possible to do the planning in the required time frame and RRP`s needed to be rejected.

Ryanair participation:

Ryanair was involved in the DRY RUN technical test, the training session on 6th March and the final trial, with a total of 15 flights impacted by re-routings proposals. In order to test the different scenarios, Ryanair OCC accepted, rejected and proposed new possibilities checking their compliance with airspace restrictions. Despite an operational analysis was a secondary objective, the flight planners carried out ad-hoc analysis using LIDO flight planning tool to support the decision-making process and assess different parameters like route length, fly time, fuel consumption and overall cost. Please find below a summary of the flights analysed during the trial:

RUN	Flight	ADEP	ADES	Δ Trip Fuel (kg approx.)	Δ Time (Min)	# of affected RYR flights in the specific regulated sector	Comments
3	RYR263M	LIRA	EDDK	100	1	3 (8 min)	Accepted
3	RYR9LP	LIPH	EDDF	160	0	0 (0 min)	Rejected
5	RYR8BH	EDDK	LIME	--	--	--	Not complained
5	RYR58BA	LEMD	EPMO	--	--	7 (12min)	Unreliable system information in PLANTA
6	RYR7BF	EDDF	EPKK	10	0	8 (0min)	Accepted
8	RYR452U	LKPR	EGPH	100	3	8 (79min)	Accepted
9	RYR27GZ	EDDN	LIBD	60	2	8 (10min)	Accepted
10	RYR2936	LIPH	EBBR	40	1	12 (68min)	Response out of time
10	RYR5BB	LIPH	EDDB	15	0	12 (68min)	Response out of time
10	RYR59EH	LIPH	EGSS	35	0	12 (68min)	Response out of time
10	RYR1801	LLOV	EDSB	40	1	12 (68min)	Rejected

Due to the short sample collected, it was not possible to value the benefits of the level capping measures to alleviate congested sectors. In several runs, there were no Ryanair flights impacted by the regulations therefore no action was required.

Preliminary results show that the delay saved (less than 4 min/flight on average including all RYR flights impacted by regulations) does not compensate applying additional actions. The increase in CO2 emissions, extra fuel consumption and the additional workload in the OCC overpasses the potential benefits. It should be also noted that accepting the rerouting proposal does not ensure that the flight is finally not regulated, generating a risk that must be included in the calculations. The FMP can finally apply a regulation if other airlines are not able to evaluate the proposals on time or decide to reject them.

In most cases, our flights were impacted with short delays (0-5 min) in the same regulation, not requiring additional actions, and only 2 Ryanair flights were highly delayed (>15 min in Run 8), requiring attention. Due to the size of Ryanair fleet, we need to prioritize those flights that are severely impacted and could disturb our operation. In this sense, we consider that the sample is not wider enough to determine if this behaviour is recurrent or if it is an exemption. In this sense, we suggest performing more simulations and analyse a wider sample to allow accurate conclusions before deployment phase.

During the exercise, if the re-routing showed an improvement either for Ryanair fleet or the network, it was generally accepted. However, some of the proposals were finally rejected either because there was no delay associated to the flights or because the proposal was affected by RAD restrictions or other reasons (unreliable system information in PLANTA). This last point confirms that the scenarios and alternative routes defined need to be reviewed to increase the rate of acceptance and improve the level of automation. It is important that NM, AOs and FMP work closely to validate these options and reach the maximum benefit of this specific short-term measure. In this sense, we suggest that the current route proposals are refined to allow a quicker validation and avoid manual adjustments (highly time-consuming) when the route is rejected by the flight planning tool.

Another point raised by Ryanair OCC was the resources availability, key to address the analysis and the acceptance/rejection of the re-routings on time. LIDO calculation time is the key limitation to assess the feasibility of the proposal together, followed by the OCC awareness, limiting the number of re-routings that can be addressed at 3-4 every 30 minutes. Due to this restriction, the analysis with LIDO was not possible to be performed on site, being the rerouting processed after the trial only for PJ validation purposes

Furthermore, we also notice that this constraint could be emphasized if the concept is ultimately deployed at network level. The OCC might receive re-routing proposals and other cherry-picking measures from multiple sectors/ACCs, not only from a specific FMP. This situation reinforces the need to automate/standardize the process and refine the scenarios as much as possible. The target implementation of the concept implies a network-wide consolidation of the measures, which will avoid multiple/non-compatible/interfering proposals.

SWISS participation:

SWISS was involved the DRY RUN technical test, the training session on 6th March and the final trial, with 19 flights impacted by re-routings proposals during the final trial. In order to test the different scenarios, we used our flight plan manager from SABRE to calculate the new route with our own aircraft performances. We then accepted, rejected or proposed new possibilities checking their compliance regarding airspace restrictions. We based our decision making on the outputs from SABRE calculation regarding operational feasibility, the additional fuel consumption, additional distance flown, additional flight time and for some cases, in our movement control tool (Netline Ops Classic) checking the maintenance events and passengers connections. Please find below a summary of the flights involved in the exercise

RUN	Flight	Δ Trip Fuel (kg)	Δ Time (Min)	# of affected LHG flights in the specific regulated sector	Comments
Run7	SWR137H	191	3	9 flights from LHG (1BEL, 2 DLH, 1 EWG, 5SWR)	Accepted
Run7	SWR146	0	0	9 flights from LHG (1BEL, 2 DLH, 1 EWG, 5SWR)	Rejected proposition (as A330 ZRH-DEL already having delay due to Pakistan airspace closed). Not suitable candidate.
Run7	SWR242	273	4	9 flights from LHG (1BEL, 2 DLH, 1 EWG, 5SWR)	Accepted
Run7	SWR230L	238	1	9 flights from LHG (1BEL, 2 DLH, 1 EWG, 5SWR)	Accepted
Run7	SWR1578	73	1	9 flights from LHG (1BEL, 2 DLH, 1 EWG, 5SWR)	Accepted
Run8	SWR115Z	196	0	8 Flights from LHG (2AUA, 3 DLH, 1EWG, 2SWR)	Accepted
Run8	SWR133U	445	-1	8 Flights from LHG (2AUA, 3 DLH, 1EWG, 2SWR)	Accepted
Run9	SWR112W	167	3	26 LHG Flights (11 AUA, 1BEL 9DLH, 3 EWG, 2 SWR)	Accepted
Run9	SWR1326	261	5	26 LHG Flights (11 AUA, 1BEL 9DLH, 3 EWG, 2 SWR)	Accepted Because of a lot of pax connection going on this flight, and only 3 PAX with connection in DME. Also

					accepted to help other AUs (RYR)
Run9	SWR139K	-	-	26 LHG Flights (11 AUA, 1BEL 9DLH, 3 EWG, 2 SWR)	NOT operated by SWR, no Flight Plan available (wetlease flight)
Run9	SWR964	187	0	26 LHG Flights (11 AUA, 1BEL 9DLH, 3 EWG, 2 SWR)	Accepted
Run5	SWR1512	-	20	7 LHG flights affected by the regulation (1AUA, 2DLH, 4EWG)	Rejected operated by Helvetics with E190 so no possibilities to recalculate the flight plan with the right performance. However, on AO NOP STAM, Diff Duration of 20min ---> not acceptable at all
Run5	SWR223P	0	0	7 LHG flights affected by the regulation (1AUA, 2DLH, 4EWG)	Accepted
Run3	SWR146	-	-	-	Rejected proposition (as A330 ZRH-DEL already having delay due to Pakistan airspace closed). Not suitable candidate. Even just by relying on estimation from ECTL (+5min flight time more), this is too much for a long haul departing from ZRH with full tank of fuel (too much costs)
Run3	SWR242	184	1	-	Accepted
Run3	SWR137H	204	3	-	Accepted
Run2	SWR2258	212	3	-	Accepted

During the trial, the quality of the RRP has been highlighted as very important criteria. In several cases, manual adaptation have to be done from SWISS staff to enable the flight planning to be accepted in our flight plan system manager. If was in most of the cases relative to active RAD, which were deactivate in NM system to enable the rerouting, but which were not communicated in the Airline system (as it was a shadow mode).

From a general basis, all long-haul picked as rerouting candidates were rejected by SWISS (SWR146 picked twice during the trial week). Indeed, flying lower at the beginning of a long-haul trip means using a lot more additional fuel, which is economically and environmentally not a viable decision. In a more operational environment (CAP Tool) and by bilateral agreement between ANSPs and AUs, long-haul flights are excluded from the de-bunching process.

Another point raised out during the rerouting phase were the difference between the optimal climb profile calculated by the airlines with the exact aircraft performances, and then the climb calculated by Eurocontrol, based on aggregated statistic for the type of aircraft. This leads to two different problems:

1. The climb profile is not optimal and thus uses far more fuel than the optimal one. See below the graphic difference between the original filed flight level by the airline, leading to an optimal climb, and the climb by steps asked by Eurocontrol, leading to much more fuel conception as many levels off are planned (the black area shows the geographical elevation of the overflown area, and the red area represents the current restrictions and constraints that the flight planning system have to take into account).

First example for SWR2258 from LSZH to LHBP, operated by HB-IPX (A319):

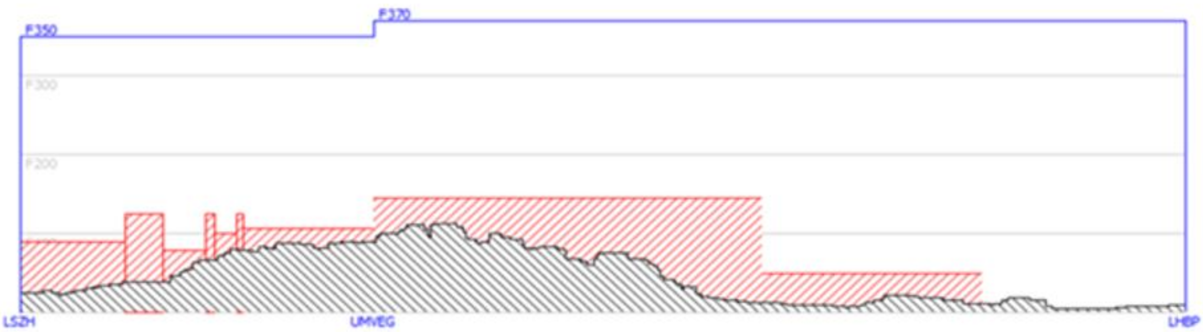


Figure 13: Original planned climb based on the performance of the specific aircraft for SWR2258. From Sabre® AirCentre™ Flight Plan Manager

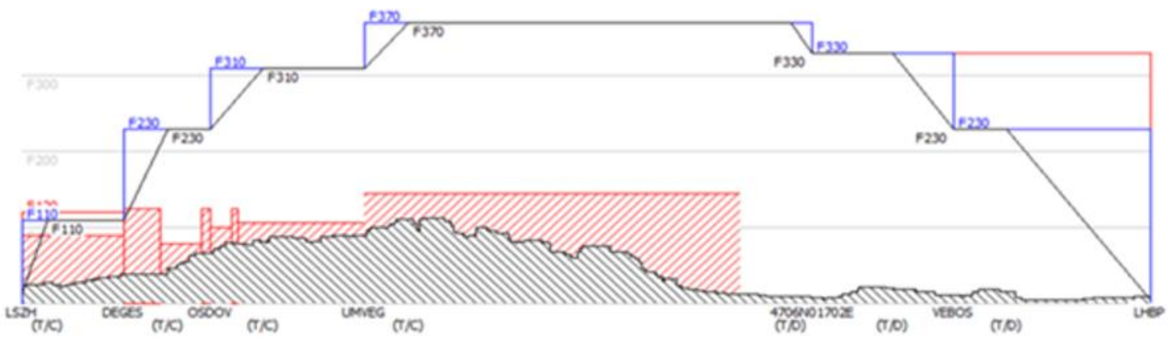


Figure 14: Route proposed by NM with climb by steps calculated accordingly to NM statistic performances of the aircraft type for SWR2258. From Sabre® AirCentre™ Flight Plan Manager

In the first example above, the blue line represents the optimal flight level for HB-IPX, as filed in the initial flight plan. However, NM sent a rerouting proposal, which is represented in the second example above. There, the blue line represents the vertical profile proposed by NM, and the black line represents the planned climb calculated by the flight planning system with the specific aircraft performances.)

Another example with SWR137H from LSZH to LYBE operated by HB-IJN (A320). In the examples below, it can again be observed, that the optimal vertical profile for HB-IJN is to fly directly to FL370 instead of flying from one level to the next one (as proposed by NM) and reach the optimal FL370 a consequent time after the optimal climb. This means a higher fuel consumption.

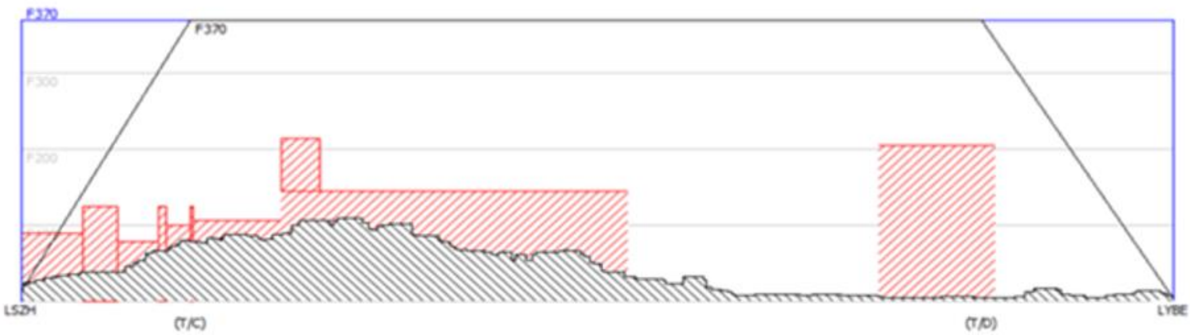


Figure 15: Original planned climb based on the performance of the specific aircraft for SWR137H. From Sabre® AirCentre™ Flight Plan Manager

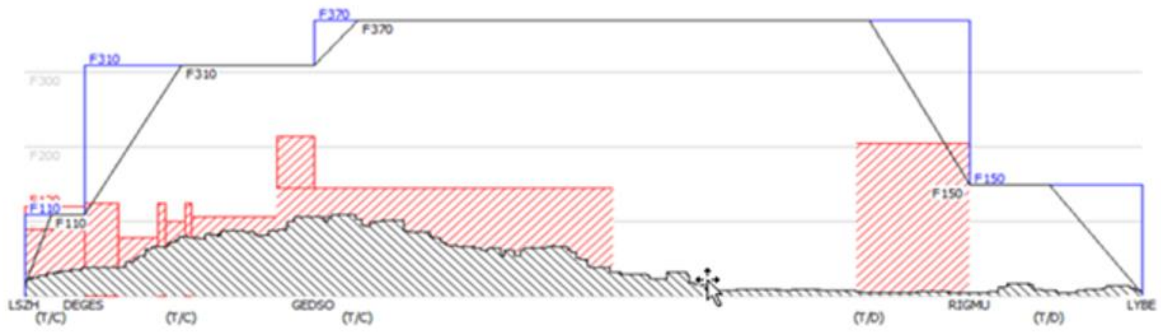


Figure 16: Route proposed by NM with climb by steps calculated accordingly to NM statistic performances of the aircraft type for SWR137H. From Sabre® AirCentre™ Flight Plan Manager

2. This leads also to rejecting by NM system of the refiled flight plan, and therefore the loss by the airline of the frozen CTOT. As matching margins between RRP and refiled flight plan were set based on entry time (max 1min difference),one flight, which have been refiled based on the proposed rerouting sent by NM were automatically rejected by the system. Indeed, the flight (SWR242) were having more than 1 min difference between what NM planned and what SWISS Flight Plan system calculated. This was due to the difference of performance in the calculation, in which SWISS have better data than NM, and thus get a different profile.

The SABRE Flight Plan performances to recalculate the new routes were very satisfying, allowing handling several RRP per 30minutes. The limiting factor to speed up the process was the time needed by Eurocontrol to simulate the situation before accepting the RRP. SWISS were therefore waiting for the finished process to be able to accept, reject or counter propose new routes.

British Airways

We managed to participate in a small way, from our offices at Waterside via the phone. When trying to accept the re-route message within the time window, we encountered some problems with Lido; our CFP service provider, as we had difficulty in copy and pasting the new route into Lido's route parser, required in order to generate a new flight plan. This should be solved next year when we transition to Lido 4D, in which the route parser is much improved.

Air France observer role participation:

As an observer, AFR notices that although the principle of N-CAP and CAP is the same, there are many differences in the way it is implemented, including on the side of the airspace users.

The setup in shadow mode was affected by several limitations.

More validation is recommended before operational deployment, and especially a clarification of the process in several aspects.

Qualitative results

The trial was perceived as an opportunity to test the technical connectivity between the stakeholders and have a first view of the operational feasibility of the concept. In this sense, both topics have been assessed simultaneously to provide the final recommendation.

First, the flight planners who participated in the runs have highlighted that reducing the workload is crucial to the success of this concept. Despite the trial was performed in a period with moderate traffic demand, we detect different areas that must be optimized to address this issue:

→ **OCC awareness**: flight planners cannot be focused on receiving re-routings proposals. In this sense, they suggest refining the process and include notifications that helps to reduce the reaction time.

→ **Calculation time of flight planning tools:** highly dependent on day and the quality of the proposals. We suggest including the "flight planning tools developers" in the scope of the exercise to improve this issue.

→ **Automation:** the process should be as much automated as possible to reduce the time dedicated to the different stages of the process and on that way, be less dependent on resources availability.

→ **Number of re-routing proposed:** number of re-routings should be capped to ensure first that could be addressed properly and second, that all airlines participate equally.

- → **Information provision:** a more detailed description of the RRP will help to speed up the analysis. Some of the fields that could be useful: reason, delay, distance deviation, time deviation, departure time.
- → **Homogenization of tools:** RRP must be received and notified via a unique source.

It was also remarked that in a period with high traffic demand, the above points could de facto be a reason to not being able to apply the procedure accordingly and in this sense, reduce the acceptance rate.

Second, an enhanced analysis of the impact of delays per airspace user and the network should be addressed in both pre-tactical (simulations) and tactical phase. The information provided by Eurocontrol during the trial to simulate the operation was highly appreciated. In some cases, a pre-validated scenario or as mention before, the provision of more detailed information including bottlenecks, other regulations in the adjacent sectors and how the measure will impact in other areas of the network could be useful to propose alternatives in case issues appear.

Finally, transparency of the process is crucial to encourage AUs to accept proposal even when no or minor delays affect to their flights. During the trial, it was not possible to check if other airlines were accepting the proposals too and if the network congestion have been solved thanks to the re-routings. The process needs to be clear and transparent for all stakeholders and provide incentives to accept the re-routings, for instance:

- → Possibility to prioritize other flights in the same or other area
- → Reward participants with “delay credits” to be used in the future.
- → Financial compensation for the extra-cost associated to accept these measures

As currently defined, the process is highly dependent on airlines resources to alleviate bottlenecks and mitigate airspace capacity shortages. To avoid the negative effect of this concept applied to a larger scale, we strongly suggest setting a collaboration framework to share the risk and economic impact between the different stakeholders. In this sense, we suggest to keep refining the concept in coordination with Eurocontrol Network Manager and ANSPs in order to, in the short future, deploy a sustainable and viable concept that satisfies the different network stakeholders’ views.

Capacity and Delays improvements

As the NCAP trial was performed in shadow mode part of the results are based on simulations. The what-if point of view showed that there was an improvement of the delay situation for all AU flights and not only the ones that were actively rerouted. What could not be evaluated is the impact (positive or negative) on other areas of the ATM Network. However, for future implementation such knowledge is of big importance. For example, it would be counterproductive if the improvement in one area would create extra or new delay/capacity issues in another area.

Fuel efficiency and performances impact

Additionally, it must also be stated that the cost for refiling and the huge extra manual work in the OCC`s diminish the positive effect. So the saved cost due to delay minimization were literally used up by a higher fuel consumption (compared to initial optimum Routing) and the cost for extra work, being barely practical or efficient to take additional actions. So again: a higher automation is essential to make full success and benefit of the concept.

However, it has been demonstrated that if rerouting measures are accepted by AUs and successfully implemented, possibilities of applying a regulation instead are reduced, which implies a reduction of the sector delay. Fewer regulations in the network would mean less workload than today in these terms for the OCC.

The flight operation point of view (AU/ Dispatchers)

Depending of the flight planning system, it was more or less time consuming to calculate the performances, fuel consumption, flight time…etc. of the new route proposed by NM. As commented before, a higher amount of traffic and the correspondent higher amount of RRP’s to be addressed could lead to extra manual work. Increase the automation and eventually, a reduction in the number of regulation if the re-routings are accepted and implemented properly by AUs, could help to contain this extra workload. The other (and already mentioned) important topic is the quality of the RRP`s (not only RAD compliant and fillable) in respect to route optimum. In some of the cases, our dispatch staff had other “offload” routings available that would have been more efficient in fuel and mileage. Therefore, the option to place counter proposals should be available if concepts were deployed.

A.3.3 Results per KPA

The KPAs hereafter are identified in the DEMOPlan table that addresses the objectives and its relationship with them. Exercise 1 covers the following performance areas:

Safety

Exercise 01 execution timeframe takes place in the tactical day of operations several hours before the EOBT of the target flight (i.e. flights are not airborne). This leads to a minor impact in the airborne flight phase where the safety of the operations might be easily compromised. Procedures like level cappings and horizontal reroutings are used nowadays in real operations. Moreover, the "fine-tuned ATFCM measures" RRP process is based on a collaborative approach that improves the awareness of the stakeholders and subsequently enhances safety of operations.

Technically speaking, safety was not an issue in the exercise. The Demonstration was executed as a shadow mode demonstration using a NM testing platform for externals (the abovementioned SAT-X platform). Note that all system developments that were implemented and used during the exercise were built on top of already safety-cased tools (i.e. Network connected CAP or NCAP was derived out of the current CAP tool by DSNA and the AO NOP STAM was derived out of the current NOP portal).

Predictability

Exercise 01 helped to increase the predictability in general.

It was based on a very collaborative process where the FMP that faces an overload problem in tactical operations seeks the Airspace User collaboration to refile and avoid the constrained area. Although an IFPS valid alternative route was always proposed to the Airspace User, it was equally important to provide an alternative route they would actually fly (considering their preferences and priorities). This is the point where all stakeholders must find a commonly agreed set of reroutings they can all **adhere** to when a specific "fine-tuned ATFCM measures" rerouting measure is applied in tactical operations.

Provided the output of these discussions are considered in the design and creation phases of the "fine-tuned ATFCM measures" scenarios in strategic/pre-tactical operations and all stakeholders are committed to follow the "fine-tuned ATFCM measures" RRP workflow rules, flight plan adherence is more likely to increase significantly, hence, predictability.

Efficiency (Fuel) - Environmental sustainability

Fuel efficiency was not the main objective of the exercise. Solutions proposed to off-load congested areas are in most cases increasing route length and level-capping flights out of their preferred cruise levels. The efficiency behind this concept is more focused on the reducing delay and global fleet costs of operations rather than fuel consumption. Nonetheless, flight efficiency could be at least maintained within acceptable levels provided that:

- AUs actively participate in the "fine-tuned ATFCM measures" scenario design phase by providing their alternative route preferences
- When accepting the "fine-tuned ATFCM measures" RRP they choose to refile differently from the NM proposed route and consider tactical information from the flight planning tools (winds, payload, performance of the specific aircraft, etc.)

It could be argued that by accepting a "fine-tuned ATFCM measures" rerouting measure, the AU could eventually avoid other ATC measures, which actually create deviations from the originally filed flight plan, thus increase fuel consumption.

Efficiency (Cost)

The cost of the operations of an individual flight may increase, but the global result improves by far the cost efficiency. But this can be acceptable if the overall network stability/performance increases.

From the individual perspective of the Level Capped flight, accepting a "fine-tuned ATFCM measures" RRP might result in a longer/lower route, which means that the flight spends more fuel than initially planned for the same city pair. But, considering that the flight may be eventually captured by a Regulation (in the original congested sector) if it rejects the "fine-tuned ATFCM measures" rerouting proposal, the delay cost may be higher than the rerouting cost in terms of passenger connections, crew shifts, airport curfew...

When considering the full picture, other traffic might benefit thanks to those flights accepting the "fine-tuned ATFCM measures" rerouting proposals, as they might prevent the FMP from applying a regulation. It is important to note that the same Airspace User might have flights with "fine-tuned ATFCM measures" rerouting proposals and flights without, so the overall benefit of the fleet should be assessed during the accept/reject decision making of the process. Moreover, this action may cause a reduction in the global delay figures, which improves the en-route operations of the ACC.

However, Network Manager has demonstrated this year that moving traffic horizontally from one side to another can congest other airspaces. Escalating the concept may incur in creating problems in other airspaces. There is a need of further exploring it.

Capacity

Within the Exercise 01, the sector capacity was more efficiently used. Having the possibility to easily accommodate traffic in lower sectors by proposing level cap reroutings to specific flights allows the FMP to efficiently use the available capacity.

The strategic phase of the work it is also to be considered in terms of improvement of the capacity. Inviting AUs to actively participate from the very beginning of the process helps them to better understand the FMP capacity issues and realise how these local actions might impact the overall network. Additionally, the scenarios and reroutings will be better accepted if they are previously understood and pre-agreed.

Flexibility

Flexibility is clearly improved with the new method:

- Enlarging the DCB toolkit options with other measure types such as “fine-tuned ATFCM measures” rerouting measures increases FMP’s flexibility in solving residual traffic demand peaks.
- Sharing key information with AUs enhances their decision-making processes. They are able to choose between a slightly penalising route or a potential delay, with the objective of minimising the impact of airspace capacity constraints in their operations.

A.3.4 Results impacting regulation and standardisation initiatives

N/A

A.3.5 Analysis of Exercises Results per Demonstration objective

1. EX1-OBJ-VLD-01-001 Results

Acceptable increase in workload for network operations planning actors to apply NMOC proposed enhanced DCB and TT measures to optimally use network capacity

NMOC controllers did not participate in Exercise 1. The current “fine-tuned ATFCM measures” RRP process demonstrated in EXE01 only included vertical rerouting measures which did not involve NMOC staff as an active participant but who could actually act as a mere observer. NMOC participation is expected to have an active role in the overall process when the reroutings may have a significant impact on the network (e.g. with horizontal reroutings). In this case, the digital coordination and information sharing via B2B services supported by the corresponding procedures is expected to reduce the workload related to the traditional phone/emailing exchanges between local actors and NMOC.

2. EX1-OBJ-VLD-01-004 Results

Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied by sharing NMOC data and actions

The main objective of this exercise was to improve the situational awareness of all the involved actors when a measure is proposed to an AU. Before this exercise, there was only a bilateral coordination between the Airspace User and the FMP. The solution proposed by this exercise leads to a significant improvement in terms of information sharing and local situation for all the actors thanks to the NM B2B services, namely:

- For FMPs – The fact of going fully transparent and easily sharing all available information via B2B could impact FMPs procedures when applying rerouting proposals. For example, we could expect that a flight that has already been captured by another measure (e.g. a regulation) would most probably not be targeted by a rerouting proposal unless any benefit could be ensured.

  Additionally, using MCDM elements enables FMPs to quickly assess if the rerouting measures resulted in the expected outcome (through the proposal acceptance rate number).

- For NM – Having local actors digitally connected to the network increases awareness and understanding of the rationale behind a significant number of AU refile actions. It also enhances NMOC's awareness of problematic areas (typically, where FMPs are drafting/implementing measures) and whether those problems persist or not.

- AU – Providing access to rerouting measure information (e.g. avoid airspace XXX, refile via ZZZ with maximum FL YYY), increases AUs awareness and better compliance with FMPs specific constraints while still pursuing their own performance goals, which also leads to a potential rate increase in accepting FMP's proposals.

3. EX1-OBJ-VLD-02-001 Results

Reduce the margins between planning and actual for flights due to unforeseen changes in the execution of the European Network operations.

N/A

4. EX1-OBJ-VLD-03-001 Results

Reduce the extra fuel consumption in European Network fleet due to better NMOC proposed measures for network issues or to unforeseen changes in the execution of the European Network operations

Fuel efficiency was not the main objective of the exercise and neither were NMOC proposed measures for network issues. See previous section Appendix A for FUEL EFFICIENCY important notes.

5. EX1-OBJ-VLD-04-001 Results

Reduction in time for NMOC staff to monitor, analyse, coordinate and implement measures to balance demand–capacity due to NM efficiency improvements

NMOC did not participate in this exercise, so this objective could not be assessed, however, great success rate in vertical rerouting proposals implies less regulations proposed by the FMPs for NMOC to implement as the problem could be solved otherwise.

6. EX1-OBJ-VLD-04-002 Results

Reduction in time for airline staff to monitor, analyse, coordinate and implement measures to balance demand–capacity due to NM efficiency improvements

As in other exercises (like Exe2a), it was demonstrated that there was an increase in workload and tasks to be completed by OCC staff to fulfil the required changes to the original flight plan. This can only be dealt with for future implementation by automation (e.g., validated RRPs directly send to AUs flight planning tool/recalculated automatically and dispatcher only selects the optimum route based on flight and network efficiency). Dispatchers work in the future shall just be a decision-making process (accept/decline/counter propose based on all the information available from the network) rather than recalculating flights.

7. EX1-OBJ-VLD-04-003 Results

Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity due to NM efficiency improvements

This objective was not strictly evaluated at an operational level. However, it is the situational awareness of the FMP and a new subset of methods of operations what was evaluated. New tasks for FMPs will appear in the near future, some actions will be done more and more in the pre-tactical phase rather than in the tactical.

Conclusions from the other PJ24 Exercises could eventually provide more significant operational results.

8. EX1-OBJ-VLD-04-004 Results

Reduction in time for APOC/airport planning staff to monitor, analyse, coordinate and implement measures to balance demand – capacity due to NM efficiency improvements

N/A

9. EX1-OBJ-VLD-05-001 Results

Reduce ATFM delay in the network due to NMOC proposed measures

Main aim of the project was to try to reduce the number of regulations applied on a daily basis in Europe, in this Exercise 1 in particular by making use of one functionality currently available as it is the NM scenario repository and pre-agreed “fine-tuned ATFCM measures” measures. It has been already demonstrated in the exercise that Regulations can be avoided by level capping some flights provided AUs collaboration. This means that the delay due to the ATFM measures is very much reduced.

10. EX1-OBJ-VLD-05-002 Results

Reduction of sector (arrival, en-route) delay resulting from NMOC proposed measures for DCB issues by using enhanced DCB mechanisms

As said in the objective above, the ultimate purpose of applying pre-agreed rerouting measures is to avoid applying Classical CASA Regulations. It has been demonstrated that if rerouting measures are welcomed by AUs and successfully implemented, possibilities of applying a regulation instead are reduced, which directly implies a reduction of the sector delay.

11. EX1-OBJ-VLD-05-003 Results

Reduction of airport delay resulting from NMOC proposed measures for DCB issues by using enhanced DCB and TT mechanism

N/A

12. EX1-OBJ-VLD-05-004 Results

Reduce delay resulting from better ATFM measures definition through improved coordination by means of multi-airport planning and NM system support

N/A

13. EX1-OBJ-VLD-06-001 Results

Increase the possibility for airlines to provide their preferences through NM system as part of the network coordination process

This Exercise did not focus on the airlines preferences, but on the airlines accepting to reroute, delay and fly less efficiently the "less important" flights. This objective is therefore neither compliant nor relevant for this exercise.

A.3.6 Unexpected Behaviours/Results

The scope of EXE1 was always to run the whole workflow and assess the technical feasibility first and foremost. Participants had to deal with the already considered limitations but it is fair to note that the demonstration was short of appropriate operational feedback due to:

1) Lack of NMOC participation

2) Lack of operational FMP participation, although the basis of the operational concept behind was already tried in the CAP exercises.

   This was the reason why there was a lack of FMP tactical operations knowledge and specific "fine-tuned ATFCM measures" scenarios for the constrained area of study (Karlsruhe) could not be built. So classical FL ATFCM scenarios (already stored in the NM Scenario Repository), which have a different operational goal, had to be used instead. This resulted in a short number of options to solve the remaining overloads (hence, lack of flexibility).

Additionally, as the testing platforms were continuously fed by real operational data, live updates of the Flight Plans interfered during the demonstration in several occasions, which was particularly troublesome during the RRP AUs assessment.

A.3.7 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

The lack of operational NMOC and FMP experts in the Exercise limited the operational conclusions that the demonstration may have had as an output. On the other hand, the technical feasibility of the concept was completely and successfully proved and demonstrated.

The scalability of the concept is one of the difficult topics to be addressed. What will happen when every single ACC and AU around the network will start implementing rerouting measures using their own B2B tools has to be deeply evaluated. For this purpose, technically proving the concept in the smallest scale was fundamental to start building an operationally viable process in a larger scale.

Results of Exercise 1 are significant enough for the partners to keep on investing towards its deployment.

2. Quality of Demonstration Exercise Results

Evaluation of the demonstration was conducted using a qualitative assessment through a series of debriefing sessions after each run were executed, where all sessions' findings, conclusions and opinions were well noted. They were exposed and shared on a final 3-hour meeting with all the participants around the table, from which the final conclusions were extracted.

As explained before, the quantitative assessment, even extracted for a deeper assessment that has been done by Airspace Users, was not subject of the Demonstrations due to the lack of NMOC and FMP operational feedback.

3. Significance of Demonstration Exercises Results

Results are an aggregation of what happened not only on the week of the Demonstration but also during the months of collaboration between all the participants, including the bilateral meetings, Dry-Runs, technical connectivity sessions, multiple WebEx…

FMPs and other ANSPs engineers, AU managers and Flight dispatchers, NM representatives and technical people had the opportunity to express their opinions and highlight those aspects that were of their interest or detriment.

A.4 Conclusions

From a general point of view, participants (AUs, FMP, NM, and DSNA as the NCAP tool owner) agreed that the exercise coped with their expectations related to the exercise Plan, and the demonstration was a success in terms of learning one from each other procedures, daily problems and limitations.

The technical feasibility of the concept was certainly approved. The concept relies on already operational functionalities as the scenarios, which is the mature part of the process. It shall be considered that the demonstration was performed with the current available tools and functionalities at that time (except for the NCAP tool that was developed for the exercise). However, the involvement of all operational actors, when designing and implementing processes, is important, as well as the automation. This includes the CFSPs or any other technical solution.

Consequent deployment activities will include system and procedure updates which will consider all feedback and results extracted from this exercise.

NM CONCLUSIONS

- If the operational deployment of EXE01 use case in real operations relies on pre-agreed rerouting measures (stored in the NM Scenario Repository by NMOC), new procedures for NMOC will be in place to create scenarios for measures on individual flights collaboratively with FMPs (as it is done today with ATFM scenarios). This means that operators will have to be trained in the new procedures being undetermined the consequent workload they would experience, moreover when considering that the concept can be scalable to whole Europe (i.e. involving more than one FMP). This is also the reason why new means for “fine-tuned ATFCM measures” rerouting measures not relying in the NM Scenario Repository (i.e. not being pre-agreed as “fine-tuned ATFCM measures” scenarios) are starting to be investigated.
- **AUs shall be involved and shall actively participate in the “fine-tuned ATFCM measures” scenario designing process**. Their input to feed the NM systems with their alternative reroute preferences is key for the whole process to succeed.

- Simulated regulations (i.e. applicable regulations if rerouting proposals were not successfully implemented) were not fully operationally realistic as there was no FMP expert from the Karlsruhe area participating in the exercise. However, the concept behind clearly shows that **pre-agreed rerouting measures can replace regulations in solving residual and isolated traffic demand peaks in tactical operations (provided AUs accept the rerouting proposals)**. On the other hand, NM systems are ready to offer what if simulations via B2B to local systems or even airlines systems to enhance current CAP procedure and support AUs in their decision making processes.

- NCAP workflow process enhances **NM's awareness of AUs refiling** reasons and FMPs problematic areas.

- **NM systems will have to be reinforced** in their processing performance to be able to cope with the upcoming amount of B2B connections and simulations as the future scalability of the concept may require so.

- Operational concept behind current CAP Process is operationally deployed nowadays. This technical improvement, which will involve NM henceforth by coordinating via B2B and making use of NM infrastructure, gives the **possibility to AUs to understand the behaviour of the other actors** (FMPs and NM) and better comply with FMPs' restrictions while trying to ensure minimum disruptions to their own operations.

- Although FMPs have an extended knowledge of the traffic flows in their areas, **predicting traffic behaviour in D-1 for the tactical day is still not accurate** enough to completely rely on pre-agreed measures. The pre-agreed scenarios are more likely to be approved on the D of operations.

- **ANSPs (both DFS and DSNA) are willing to have NCAP tool deployed in real operations** in order to coordinate and implement rerouting measures.

- The **Automatization of AUs actions is key** to ease and agile their decision making processes in new procedures such as the one demonstrated in EXE01. "fine-tuned ATFCM measures" Phase II and PCP will help to follow this path.

- **AUs have expressed their willingness to be more involved operationally in all "fine-tuned ATFCM measures" RRP process phases**, from the scenario design to counter proposing rerouting measures, or, in short, to actively participate in FMP and NMOC measures affecting their operations.

- On a more general note, this exercise **has enlightened some of the areas of collaboration and cooperation** that were not very clear to the different participants in current operations.

Stakeholders have a better perception of what is happening in the network, they do not work in isolation anymore, from the strategic phase to the tactical phase. Each actor within Exercise 1, has reported to have a better knowledge of the work done by the others, why the decisions are taken, which are the possible solutions, the importance of the coordination, and the impact of accepting or rejecting determined proposals by the other concerned actors.

AU CONCLUSIONS

Despite the good performance of the tools, please see some proposals and issues encountered during the development of the trial:

1. The rerouting proposition should be sent directly via RRP, to avoid the need of monitoring on an additional system by a dispatcher. (integrated system to the existent system. Therefore, the RRP process as designed should be implemented.)
2. The quality of RRP must be very high, and the validity of RRP needs to be ensured, so that RRPs do not contain any restrictions and are able to be filed (IFSP compliant and CFSPs constraints compliant)
3. The RRP should contain the following information: New route, RESPBY, EOBT, reason of rerouting (which airspace), delay planned with the current flight plan, CTOT frozen for the new route proposed by NM, difference in time/distance between the original routes and the proposal
4. The strict matching profile must be revised, due to performances differences between AUs and NM (in particular for medium haul)
5. Not too much RRP must be sent per day/regulation. In average for all ATEAM dispatcher, 10min per RRP were needed. Once the RRP directly received in the system, it should need a shorter time, but as already pointed out, during high traffic peaks; the already very busy airlines dispatchers cannot handle too much RRP. (very high need to include CFSPs in the further developments / implementation process to ensure an optimal collaborative management)
6. Flight plan providers (CFSPs) must be integrated in the project, in order to push them to adapt their system to enable a semi-automated calculation, as soon as an RRP is received by the system, to reduce and ease the dispatcher work. It should be a European recommendation to all flight plan providers, otherwise it will not be developed or it will be developed too late. In addition, the solution, which could add value to the ATM currently, will never reach its maximum of potential due to system limits.
7. NM should enable, as during the trial, the possibility to deactivate RAD, or coordinate with ANSPs and military activities, in order to reroute efficiently the flights. However, all these changes should be sent to the flight plan system to all airlines, otherwise, the AUs flight plan system will raise errors due to conflict with RAD and military activities. This would lead to no rerouting possibility from a system point of view, even if it is be possible on a NM point of view.

Scenarios in the scenario repository need to be enrich FMP by FMP and with AUs inputs, to get even better possibilities to reroute the flights and solve network bottlenecks (need of a pre-tactical coordination between FMPs, NM and AUs)

In this sense, we are comfortable with the technical feasibility (connectivity) of the trial. There is room for improvement, but most of our recommendations are focused on technical improvements to bring operational benefits, not technical benefits.

On the other hand, we think that further steps are required in order to agree the operational guidelines and the environment in which this solution could succeed and provide benefits to the network, ANSPs and AOs. The operational procedures and frameworks are not mature enough.

A.5 Recommendations

A.5.1 Recommendations for industrialization and deployment

NM Recommendations

The concept is promising and progress can be seen compared to "simple CAP". Concept is almost ready to be deployed in real operations after including the corresponding adjustments based on the participants' feedback.

DSNA has already presented plans to take the future steps towards the operational implementation of NCAP. During 2020, it is very likely that the tool and the procedures will be ready for operations. NCAP and similar tools will have to be safety-cased before they are operationally used.

Network manager procedures and systems are being prepared in Release 23.5 and 24.0.

B2B services used in the exercise are mostly operational from the NM side. All development work and bug fixing for those not completed will be finished during next months. Guidelines for AUs and FMPs to comply with the RRP process demonstrated in EXE01 are being developed at the moment of the release of this document to support their B2B developments of the coming next years.

Airspace Users have taken actions to be more involved in the process of evolution of “fine-tuned ATFCM measures” concepts. A series of meetings between NM and some of the CFSPs have already started at the moment of the release of this document and will continue to drive EXE01 use case into real operations.

AU RECOMMENDATIONS

Concepts are feasible and the impact may deliver the required performance. Several changes need to be implemented.

In general, ATEAM recommends a close collaboration during implementation phase. This shall continue in the STAM Phase2 Deployment Project.

The following points are deemed to be very important and shall be recognized and taken care of:

- The concepts must be deployed according to the PCP requirements following the appropriate guidelines, the question of participation and the equal spread between AU`s must be incorporated. Airlines that help the network to perform better shall be rewarded. Also “best collaborative, best served” shall be taken into account. (A law change may be necessary to do so)
- Knowledge from OCC Personnel shall be used to create a solid and efficient RRP database. Also the quality of the RRP´s must be very high to get the maximum benefit
- If an Airline refiles a flight plan to do good for the network it must be avoided that this flight ends up in the late updater/late filer state and the bad consequences in case of a regulation
- What if/What if not Values must be available in the planning phase, so OCC`s can make appropriate decisions if they accept a RRP or not
- The overall aim must be to keep the amount of tools and manual work to an absolute minimum.

It is very important to “value” and streamline all the different concepts, such as TT with the NCAP process to make sure that they do not contradict or even worsen the benefits!

A.5.2 Recommendations on regulation and standardisation initiatives

Appendix B Demonstration Exercise #02a Report - Local & Network coordination of fine-tuned ATFCM measures (MUAC)

B.1 Summary of the Demonstration Exercise #02a Plan

B.1.1 Exercise description and scope

Today, ATFCM measures are applied on a regular basis in order to balance predicted demand with available capacity. The coordination of these measures has been traditionally conducted via the telephone, which has the disadvantages of being synchronous, time consuming, bilateral, and opaque to those entire not directly involved in the dialogue. This exercise demonstrated that, in an operational environment, an electronic ATFCM measure coordination mechanism brought the following operational benefits:

- A reduction in the ANSP FMP workload required to create, coordinate, modify and cancel ATFCM measures.
- A reduction in delay and the number of constrained flights resulting from more bespoke measures that are more frequently amended to reflect the changing traffic situation.
- A reduction in the number of constrained flights resulting from the replacement of conventional CASA regulations with more targeted measures.
- An increase in network situational awareness resulting from the sharing of ATFCM measure planning across the network.
- A reduction in ATFCM measure disruption resulting from an ANSP FMP ability to take Airspace User preferences into account, when planning ATFCM measures

The exercise involved:

- **Maastricht Upper Area Control Centre** (MUAC) in the role of an ANSP creating ATFCM measures and taking part in CDM.
- The **Network Manager** conducting their network impact assessments on the ATFCM measures and taking part in CDM.
- **Airspace Users** in supplying priority information to MUAC and taking part in ATFCM measure CDM.

B.1.2 Summary of Demonstration Exercise #02a Demonstration Objectives and success criteria

Demonstration Objective (as in section Error! Reference source not found.**)**	**Demonstration Success criteria (as in section** Error! Reference source not found.**)**	**Coverage and comments on the coverage of Demonstration objectives (as in section** Error! Reference source not	**Demonstration Exercise 2 Objectives**	**Demonstration Exercise 2 Success criteria**

		found.)		
OBJ-VLD-01-001	CRT-VLD-01-001	Partially covered: Exercise 2 activities form part of overall network cooperative processes and **MUAC** proposed solutions contribute therefore partially to the objective as described.	EX2-OBJ-VLD-01-001 Acceptable increase in workload for network operations planning actors to apply MUAC proposed enhanced DCB measures to optimally use network capacity	EX2-CRT-VLD-01-001 The usage of MUAC proposed enhanced DCB does not have an negative impact on ATM operational staff (NM and ATC) workload
OBJ-VLD-01-002	CRT-VLD-01-002	Partially covered: Exercise 2 activities form part of overall network cooperative processes and MUAC proposed solutions contribute therefore partially to the objective as described.	EX2-OBJ-VLD-01-002 The implementation of enhanced DCB measures does not create extra workload for MUAC ATC.	EX2-CRT-VLD-01-002 No increase in workload for MUAC ATC because of non-nominal profiles flown by participating airline flights.
OBJ-VLD-01-004	CRT-VLD-01-004	Partially covered: Exercise 2 activities form part of overall network cooperative processes and MUAC proposed solutions contribute therefore partially to the objective as described.	EX2-OBJ-VLD-01-004 Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied by sharing MUAC data and actions	EX2-CRT-VLD-01-004 Positive feedback from MUAC and NM regarding DCB transparent process
OBJ-VLD-02-002	CRT-VLD-02-002	Partially covered: Exercise 2 activities form part of overall network cooperative processes and MUAC proposed solutions contribute therefore partially to the objective as described.	EX2-OBJ-VLD-02-002 Reduce the margins between planning and actual for flight entering the MUAC AoR due to unforeseen changes in the execution of the European Network operations	EX2-CRT-VLD-02-002 The distribution of early/late arrivals at the entry points of the AoR of MUAC is narrower than current operations.
OBJ-VLD-03-002	CRT-VLD-03-002	Partially covered: Exercise 2 activities form part of overall network cooperative processes and MUAC proposed solutions contribute therefore partially to the objective as described.	EX2-OBJ-VLD-03-002 Reduce the extra fuel consumption due to MUAC DCB measures for the whole traffic flow overflying a FIR	EX2-CRT-VLD-03-002 The cumulated additional fuel consumption over the whole traffic flow overflying a FIR, due to MUAC proposed DCB measures, is

				reduced.
OBJ-VLD-04-003	CRT-VLD-04-003	Partially covered: Exercise 2 activities form part of overall network cooperative processes and MUAC proposed solutions contribute therefore partially to the objective as described.	EX2-OBJ-VLD-04-003 Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity due to FMP efficiency improvements	EX2-CRT-VLD-04-003 FMP workload is not increased, and FMP confidence that STAM resolves the DCB imbalance
OBJ-VLD-05-002	CRT-VLD-05-002	Partially covered: Exercise 2 activities form part of overall network cooperative processes and MUAC proposed solutions contribute therefore partially to the objective as described.	EX2-OBJ-VLD-05-002 Reduction of sector (arrival, en-route) delay resulting from MUAC proposed measures for DCB issues by using enhanced DCB measures and coordination mechanisms	EX2-CRT-VLD-05-002 The usage of enhanced DCB measures proposed by MUAC reduces sector delay compared to regulations

B.1.3 Summary of Validation Exercise #02a Demonstration scenarios

This exercise took place in the operational environment, utilising the associated operational traffic, as it developed, on the day in question. Thus, the tightly scripted scenarios used in low fidelity validation activities were not appropriate. Instead, the facilitators of the exercise observed and recorded details of each of the use cases described as they occurred naturally.

During the exercise, some use cases occurred frequently and some were rare, something that is the nature of working in an operational environment in which it is not possible to have full control. Of course, the time slots for the exercise were chosen carefully to ensure that as many use cases as possible occurred during the demonstrations.

This technique was successfully employed in a predecessor project, VP-700, which also involved recording instances of ATFCM measures.

The exercise took the form of three iterations, one per year:

Iteration 1 (2017)

Iteration 1 demonstrated the following PJ24 use cases:

- 2.1.1 Successful Creation, Coordination & Implementation of CASA Regulation
- 2.1.2 No or Unacceptably Delayed Response to CASA Regulation Proposal

- 2.1.3 CASA Regulation Proposal Invalid or Unacceptable to NM
- 2.1.4 ACC Withdrawal of Regulation Proposal
- 2.1.5 NM Cancellation of Active CASA Regulation
- 2.1.6 ACC Cancellation of Active CASA Regulation
- 2.1.7 ACC Request to Update CASA Regulation Parameters
- 2.8.1 Successful Creation, Coordination & Implementation of Flow Specific CASA Regulation

AUs did not take part in this iteration, leaving MUAC, and NM.

The scope for this preparatory activity was divided into two areas:

Regulation Proposal Service (2.1.1-2.1.7)

For many years prior to PJ24 iteration 1, MUAC FMPs had been coordinating CASA regulations with NM via the telephone which had the disadvantages of being synchronous, time consuming, bilateral, and opaque to those entire not directly involved in the dialogue. The regulation proposal service allowed electronic coordination to be integrated into the local tools of both NM and the MUAC FMP.

At the time that the evaluation phase of this iteration was performed, the NM B2B Regulation Proposal Service was delivered and validated for operational use by MUAC and NM. Extensive work was required to integrate these PJ24 use cases into the existing MUAC ATFCM Tool, iFMP. The new service supported PJ24 uses cases 2.1.1-2.1.7. These use cases were be demonstrated, in the PJ24 context, using the operational tools and in the operational environment.

Targeted CASA Regulations (2.8.1)

MUAC FMPs traditionally request regulations from the Network Manager by specifying a traffic volume and an hourly entry limit. The Targeted CASA concept allowed the MUAC FMP to specify a volume, an hourly entry rate and a traffic filter to ensure that the flights caught in the regulation were really those causing the associated complexity peak. The theory was that this would allow traffic complexity peaks to be addressed by regulations whilst reducing the total delay associated to each regulation.

No electronic mechanism for coordinating the Flow Specific CASA Regulations existed at the time of this iteration. It was thus necessary to demonstrate the principles and potential operational benefits in a simulated environment. Demand/capacity imbalances were identified in the operational environment and then solved in the simulated in environment using the new measure type (see DEMOP use case 2.8.1). Data was collected and analysed to assess whether the new measure type functioned as expected.

Iteration 2 (2018)

Iteration 2 demonstrated the following PJ24 use cases:

- 2.1.1 Successful Creation, Coordination & Implementation of CASA Regulation
- 2.1.2 No or Unacceptably Delayed Response to CASA Regulation Proposal
- 2.1.3 CASA Regulation Proposal Invalid or Unacceptable to NM
- 2.1.4 ACC Withdrawal of Regulation Proposal
- 2.1.5 NM Cancellation of Active CASA Regulation
- 2.1.6 ACC Cancelation of Active CASA Regulation
- 2.1.7 ACC Request to Update CASA Regulation Parameters
- 2.1.8 ACC Request to Remove Flights from CASA Regulation*
- 2.1.9 ACC Request to Adjust Allocated Slots*

* employing an email-based coordination mechanism.

This iteration involved MUAC, NM and AUs.

This second preparatory exercise improved on the successes of the first by adding support for two additional use cases (2.1.8 and 2.1.9). This support was achieved via enhancements to MUAC's ATM Portal (ATMP) that was on operational trial over the summer of 2018. The associated B2B services were not available on the NM platform at this time so ATMP made use of an email-based communication mechanism. A further consequence of the technical dependency was that NMOC had to process the MUAC requests from the Deputy Operations Manager's (DOM) position, rather than from the normal Flow Positions. Considerable development effort was required to integrate these PJ24 use cases into the ATMP platform in a way consistent with MUAC operational procedures; on NM side, the investment was limited to enabling access to e-mail at the DOM, who then subsequently utilized existing NM systems for execution of the requests.

The ATMP also allowed AUs to provide flight priority information to the MUAC FMP in order to improve their operational decision-making. Whilst use cases 2.1.1 to 2.1.7 were already implemented in iteration 1, this new priority information allowed MUAC FMP to plan measures with less negative impact on the AUs, so these use cases were reassessed.

In summary, the trial was successful in the sense that MUAC FMP was delivering requests to NM taking into account AU priority input, and NM did process the requests.

The implementation at MUAC enabled efficient working methods, making the workload on FMP affordable; the achieved results justify the additional tasking on FMP. For NMOC, the additional tasking on DOM is unwanted and the efficiency to work via the e-mail mechanism is low, requiring inefficient swivel-chair operations to move from mail to NM systems.

<u>Airspace Users results:</u>

During summer Customer Initiative 2018, MUAC prioritised flights with significant delay, and decreased the amount of minutes of delay in their airspace, compared with the initial situation (i.e. with no action from MUAC side), based on priorities assigned by AUs. This led to a large amount of “delay minutes saved”. In this exercise with a limited group of airlines participating, they perceived the collaborative coordination tool (i.e. ATM Portal) as a very good and valuable initiative. It allowed airlines to pick the most important flights on Network and Fleet Level.

If a unified prioritization mechanism is devised for the entire European ATM Network, airlines could cover all flights in their schedules as this will help to enlarge the positive effects for the Airline and the Network, provided more integrated system-support is available. Without a better system support however, the risk exists that if one flight is prioritised by the FMP with no coordination with the airlines, it may happen that this flight already has a rotational or operational delay and will not be able to take off on time even with the empty slot allocated by ANSP. This might lead to a non-efficient use of the slot, as the slot will then remain empty. Moreover, some flight with very low importance (compared to other highly important flights) could be picked up by ANSP, and the impact in term of delay reduction would then be very limited and the benefit in respect to OPS efficiency (PAX Connections, Crew Duty times Rotations, etc.) would also be limited.

Iteration 3 (2019)

Iteration 3 demonstrated the following PJ24 use cases:

- 2.1.1 Successful Creation, Coordination & Implementation of CASA Regulation
- 2.1.2 No or Unacceptably Delayed Response to CASA Regulation Proposal
- 2.1.3 CASA Regulation Proposal Invalid or Unacceptable to NM
- 2.1.4 ACC Withdrawal of Regulation Proposal
- 2.1.5 NM Cancellation of Active CASA Regulation
- 2.1.6 ACC Cancelation of Active CASA Regulation
- 2.1.7 ACC Request to Update CASA Regulation Parameters
- 2.1.8 ACC Request to Remove Flights from CASA Regulation*
- 2.1.9 ACC Request to Adjust Allocated Slots*

* employing a B2B-based coordination mechanism.

This iteration involved MUAC, NM and AUs.

In this iteration, the ATMP has been adapted to support the above use cases via the new B2B services in NM system release 23.0, rather than via email, in order to comply with the regular NMOC internal organisation and to facilitate acceptable and efficient work by NM standard flow management positions. A further objective was to expand the operation to include other ANSPs, in order to verify proof of roll-out capability; for this, ATMP has been upgraded to support additional, dislocated FMP positions.

This iteration has been started up in a limited setting (MUAC-NM only) end April 2019; the inclusion of Reims, NATS, and Karlsruhe FMP's is expected to start in October 2019. Initial results are that the change from e-mail to B2B is highly satisfactory for NMOC staff.

The MUAC iFMP platform was also enhanced with the so-called Regulation "What-If" functionality that allowed the MUAC FMP to run high fidelity simulations of alternative CASA regulation solutions before any are proposed to NM. The presence of this function was a significant improvement so use cases 2.1.1 to 2.1.7 were reassessed in this iteration.

Airspace Users results:

During summer Customer Initiative 2019, more airlines joined the ATMP community, in particular the Lufthansa Group (Swiss, Lufthansa, Eurowings, Cityline, Austrian, Brussels Airlines and Edelweiss). Brussels airlines joined mid-June. In a similar fashion to 2018, the ATMP tool allowed AUs to:

- Input their priority flights (for a day or a period), max. 15 flights a day
- chat directly with MUAC FMP,
- request for assistance on a particular flight.

Compared to 2018, ATMP was now focusing on the FABEC, UK and IRL areas instead of just the MUAC area of responsibility, was supporting flight improvements via the new B2B services (available in NM23) instead of e-mail, was getting immediate flight plan update information via the NM B2B publish/subscribe mechanism, was granting access to other ANSPs (NATS, RUAC and KUAC) allowing them the exact same functionalities as MUAC FMPs, and was assessing and reporting on potential rotation impact of delays, curfew risks as well as EUC261 possible infringements. Unfortunately, it was eventually not possible to get other ANSPs on the portal during the summer period. That would have offered the opportunity to pick up flights flying through any airspace from the entire European Network, as well as joined coordination for improvement of flights caught by multiple regulations. The chat function was considered valuable, but would be better allowed through a B2B interface between NM eHelpdesk and ATMP so that AUs only have to interact with a single tool.

B.2 Demonstration Exercise #02a Results

B.2.1 Iteration 1 (2017)

The Regulation Proposal Concept

For MUAC TCMs, regulations are considered the last resort only to be applied when local measures, such as sectorisation changes, have been exhausted. It is thus not typically necessary to simulate the application of a regulation, since there is no viable alternative left open. However, when the TCM has to choose between two regulation options they do need to compare the implications.

A mechanism had been in place for some years that allowed the TCM to telephone the Network Manager and request a “simulation”. The results of this would guide the TCM decision but there were design floors in the mechanism. Firstly, conducting this coordination via the telephone was time consuming and synchronous. Secondly, the mechanism only supported one simulation at a time, which made it more time consuming and made comparisons difficult. Lastly, it was hard for the TCM to assimilate the results of the simulation with the contextual picture that they had on their local tool, iFMP.

By the time of PJ24 Exercise 2a, MUAC had already integrated the regulation what-if mechanism into the operational MUAC local tool, iFMP. However, the concept had not been evaluated in the context of the PJ24 use cases.

Now that the PJ24 evaluation of the Regulation Proposal Mechanism is complete, the following results can be reported.

Since the mechanism was implemented before the evaluation took place, there is no baseline data to compare. This means that we are reliant on the operational community for feedback regarding the mechanism:

Situational Awareness

Users report that having official and reliable regulation information integrated into their local tool greatly increases their situational awareness, especially in regards to delay and network performance.

Workload

TCM staff report that the process of creating, modifying and cancelling regulations, using the new mechanism, requires significantly less time than it did via the telephone.

Independence

The new asynchronous electronic coordination mechanism means that TCM staff can for example; send a regulation creation request, without first contacting an NM operator over the telephone. The TCM can perform other tasks whilst they wait for the NM operator to respond. Users report that this is far more convenient and efficient.

Integration

In the new mechanism, the user creates a regulation by selecting the problem period on their HMI. Information about the coordination of the regulation is also displayed alongside the regulation. Active regulations are displayed within the associated traffic volumes. This is much more intuitive and reliable than passing and receiving information over the telephone.

Post-operational Analysis

Coordination exchanges over the new mechanism are fully logged. This allows for far more post-operational analysis than was possible using telephone logs. For example, it is now easy to determine "the number of regulations that were cancelled within 60 minutes of their start time" or "the percentage of regulation requests rejected by the Network Manager".

The Targeted CASA (TCASA) Concept

The evaluation of the TCASA concept took place on the 20th of September 2017. The strategy for the simulation was that an additional MUAC Tactical Capacity Manager (TCM) who would observe the operational TCM. At the point that the operational TCM created a CASA regulation, the additional TCM would try to solve exactly the same issue but using the TCASA mechanism. The network manager would then calculate the implications of the CASA regulation and estimate the implications of the simulated TCASA regulation. The two set of implications were then compared.

On the day, only two suitable regulations were applied in OPS so these were the subjects of the experiment. Unfortunately, the Network Manager were unable to retrieve the data necessary for the second simulation so only one set of results is available.

Simulation 1:

Volume – MASHMNS

Experiment Traffic Monitoring Value – 64 per hour

Experiment Standard Regulation Value – 66 per hour

	CASA	TCASA
Regulation Period	12:20-14:40	12:20-14:20
Rate	66	2
Flights	All	EHAM Departures Only
Delay	237minutes	165 minutes **(69%)**
Flights affected	73	8 **(11%)**
Total Network Delays	200	47 **(23%)**
Total Network Flights affected	482	141 **(29%)**

The TCMs taking part in the exercise both confirmed that both solutions adequately protected the controller.

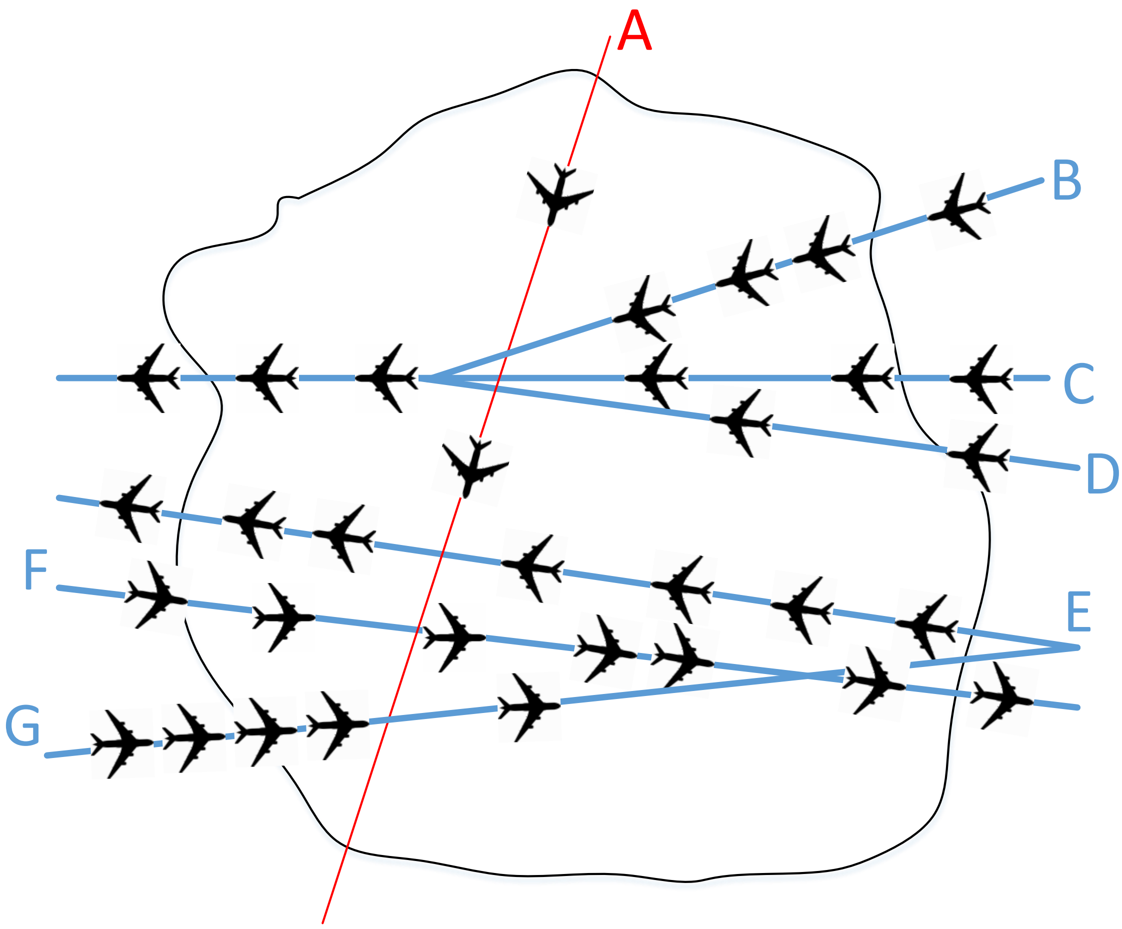
MUAC Observations:

"The TCM felts that the flow causing the complexity within the peak was the EHAM Depts. The targeted CASA measure did not catch a flight until 09:44. Despite this, the TCM felt that removing this flow would make the traffic in the overall hourly entry peak (approx. 09:30-10:30) workable”

NM Observations:

“Target CASA seems an effective measure to reduce hourly peak in sector MASHMNS. The measure reduces the load below the established value. Targeted CASA measure designed for the Scenario 1, reduces the number of flights affected by slot and the total delays. It also reduces the Network Effect that the regulated flights produce – the ‘Snow Ball Effect’. As a consequence, the total Network Delays produced by the Targeted CASA measure is lower than with the application of classic ATFM CASA regulation.”

After analysis of the exercise data and a number of workshops with domain experts, the results of the exercise can be explained as follows.



The diagram above represents a hypothetical complexity peak in a sector. In this scenario we can see flows A-G crossing the sector. In a normal CASA measure, the TCM would limit the rate to a predefined value that they know will result in acceptable complexity, assuming that the flights are delayed near randomly and thus the proportions remain roughly the same. The TCM is trying to reduce complexity by decreasing the overall number of flights. Whilst the delay required to reduce the hourly entry rate is high, all the flights that enter the sector are eligible for delay and so it can be spread over many flights. Of course, the huge disadvantage of this mechanism is that it pays no attention to complexity; in our scenario, placing delay on flow E, a flow of overflights that is nicely spread and does not conflict with other flows, is going to have very little impact on the overall complexity. In summary, the delay is allocated evenly but much of it is unnecessary.

In the case of a TCASA measure, the TCM looks into the make-up of the traffic to identify a flow that creates a disproportionate amount of complexity; in our example, this is flow A. By definition, the chosen flow for TCASA has to be an exception to the overall pattern of traffic in the sector because it is this conflict that gives it the disproportionate amount of complexity. This means that the TCASA flow, being the exception, will always have a very low hourly rate. If you start with a very low rate, then any reduction in that rate will result in a high delay for a small number of flights. Since traffic patterns are highly repetitive, it is likely that TCMs would regularly apply the same TCASA solution to similar problems, resulting in the same flows being targeted.

In summary, TCASA measures result in much lower overall delay but those flights that are delayed receive much higher delays than with CASA measures. TCASA measures would also place a disproportionate amount of delay on complex routes.

When evaluating this concept, it is necessary to ask the following question about network ethics:

Which is more desirable?:

> To create a large amount of inefficient overall delay but share it over all the flights, resulting in a small delay per flight.
>
> OR
>
> To create a smaller amount of overall delay by targeting the complex flights, resulting in those fewer flights having larger delay.

The answer to this question determines whether the TCASA mechanism is beneficial or not.

These results and conclusions were presented to MUAC and PJ24 management teams. The outcome was considered so irrefutable that no further experimentation into the TCASA concept was considered necessary within PJ24 for the MUAC area of responsibility.

B.2.2 Iteration 2 (2018)

FORCE CTOT & EXCLUDE via email - Customer Initiative CI-18

Usage

The amount of flight improvement actions significantly increased (approx. 10x) compared to use of telephones.

Workload

TCM staff report that the process of flight improvement procedures using ATMP was significantly more efficient than using telephone. The workload of NM operator (DOM) was perceived to be too high due to use of email mechanism.

Independence

The new mechanism means that the MUAC TCM can perform flight improvement actions whenever they like, without having to ask for Network Manager for support over the telephone. This is far more convenient and efficient.

Integration

Because the mechanism is integrated in the MUAC local toolset (ATMP and iFMP) the results are displayed alongside the problem and thus are far easier to interpret.

Lack of integration on the NM side led to unacceptable NM operators' workload and consequently approximately 40% of requests could not be accommodated.

Reduction in Delay

Over 5000 flights in MUAC regulations were improved with an overall delay avoidance of over 150.000 minutes of departure delay.

B.2.3 Iteration 3 (2019)

FORCE CTOT & EXCLUDE via B2B - Customer Initiative CI-19

Usage

Early feedback shows increased usage of the mechanism on the NM side.

Workload

Early feedback shows the workload of NM operator (flow position) to be significantly lower due to use of B2B mechanism and consequent integration with ETFMS.

Independence

The new mechanism means that the MUAC TCM can perform flight improvement actions whenever they like, without having to ask for Network Manager for support over the telephone. This is far more convenient and efficient.

Integration

Because the mechanism is further integrated in the MUAC local toolset (ATMP and iFMP) the results are displayed alongside the problem and thus are far easier to interpret.

Integration into the NM system led to significant NM operators workload reduction compared to 2018 iteration and consequently approx. 90% requests accommodated so far.

The Regulation What-if Concept

Now that the PJ24 evaluation of the Regulation What-if Mechanism is complete, the following results can be reported.

Since the mechanism was implemented before the evaluation took place, there is no baseline data to compare. This means that we are reliant on the operational community for feedback regarding the mechanism:

Usage

The users report that the new regulation what-if mechanism has resulted in a dramatic increase in the number of simulations performed. The increase can be explained by the factors below.

Workload

TCM staff report that the process of running simulations using the new mechanism requires significantly less time.

Independence

The new mechanism means that the MUAC TCM can perform simulations whenever they like, without having to ask for Network Manager for support over the telephone. This is far more convenient and efficient.

Integration

The users creates the simulated regulation by selecting the problem period on their HMI. This is much more intuitive than passing details over the telephone.

Because the mechanism is integrated in the MUAC local toolset (iFMP), the results are displayed alongside the problem and thus are far easier to interpret.

Multiple Simulations

The new mechanism allows the TCM to experiment with different regulations within one simulation, rather than closing the existing simulation and starting another. This is much quicker and less frustrating for the user.

Operational Decision Making

Since we know that far more simulations are being performed than before the introduction of this new mechanism, it can be inferred that the results are being used by operational staff to improve their decisions.

Reduction in Delay

The new mechanism is used to show the user the implications, primarily delay, of alternative measures. Since the mechanism is being used much more frequently and each time it is accurately estimating the delay implications of the measure options, it can be assumed that operational staff are considering this information and selecting the option with less delay. That, after all is the reason they are running the simulation. Unfortunately, it is not possible to quantify this reduction.

B.2.4 Airspace Users

SWISS and all other LHG airlines:

Due to missing time and summer season preparation, no airline was able to develop a decision-making support tool (allowing a tactical enhanced decision for the flights to be picked up daily) on time.

The idea was to gather all relevant data, such as passenger connections, crew duty limitations, maintenance events due in a given time at a given airport, curfew constraints, and other constraints and limitations available internally in the airlines system. All this data would have been computed including the schedule, to allow a quick and efficient decision making from the AU Network Operations Controllers, to identify the most critical flights on a day-to-day basis. The list would have been adapted on a daily basis to optimally fit the operational needs of the airline.

It was planned to analyse the impact of MUAC CI-19 based on MUAC data, but unfortunately, the reporting requirements were captured late by MUAC, which then did not allow for timely provision of data supporting a proper quantitative analysis. On top of that, it is worth noting the limited amount of regulations at MUAC in summer 2019 and the fact of other ANSPs not allowed to participate in the trial.

Qualitatively, MUAC CI-19 have had a positive impact on the Network. Indeed, reducing the delay on the appropriate flight, identified by the concerned airline, can only help the network. A better use of the capacity, by filling the empty slot with important flights, is also a very valuable approach, which also has positive effects on a network level. If a flight with critical passenger connections at destination does have a reduced delay, it is obvious to say that this reduced delay will positively affect all the outbound flights, waiting for connecting passengers. This will create an enhanced reduction of delay across the entire network including airports. Moreover, from a company point of view, if a maintenance event is due at a given time, or that a delayed flight is approaching crew's duty time limitation or curfew, the reduced delay thanks to MUAC manual action can have a huge positive financial impact for the company and for the network. No additional ferry flight will be conducted some other time and no other unplanned flights for e.g. positioning will be planned.

On MUAC side, few cases have been observed where one flight was improved by the MUAC FMP and at the exact same time re-filed by the AU. This by chance did not lead to a non-efficient use of the slot, but would require a better coordination UAC <-> NM <-> AU, only possible if NM B2B services get enriched with necessary information.

All these examples prove that a few but smartly coordinated and well-chosen cherry picked flights can enhance the entire network situation. The better the flights chosen, the greater the effect on the network will be.

B.2.5 Summary of Demonstration Exercise #02a Demonstration Results

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Sub-operating environment	Exercise Results	Demonstration Objective Status
OBJ-VLD-01-001	Impacts of using enhanced DCB measures and TTs on ATMC workload (NM, ATC and Airport)	CRT-VLD-01-001	The usage of enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload.			OK

OBJ-VLD-01-002	Assess the impact of using enhanced DCB measures and TT on speed changes in ACCs	CRT-VLD-01-002	No increase in workload for ATC because of non-nominal speed profiles flown by participating airline flights.			n/a
OBJ-VLD-01-004	Transparent coordination processes	CRT-VLD-01-004	Positive feedback from all actors regarding DCB overall processes.			OK
OBJ-VLD-02-002	Improve predictability of flights for an ANSP	CRT-VLD-02-002	The distribution of early/late arrivals at the entry points of the AoR of ANSPs is narrower than current operations.			n/a
OBJ-VLD-03-002	Reduce extra fuel burn over an ANSP traffic flow	CRT-VLD-03-002	The cumulated additional fuel consumption over the whole traffic flow overflying a FIR, due to DCB measures, is reduced.			n/a
OBJ-VLD-04-003	Increased cost-efficiency from more efficient processes for	CRT-VLD-04-003	Positive feedback from FMP staff to apply			OK

	ANSPs		measures Reduced time to achieve the DCB cycle			
OBJ-VLD-05-002	Increase the use of available airspace capacity for an ANSP	CRT-VLD-05-002	The usage of enhanced DCB reduces sector delay compared to regulations.			OK

Table 19: Exercise 1 Demonstration Results

B.3 Conclusions

ANSP & NM Conclusions

Regulation Proposal Mechanism

This report concludes that the Regulation Proposal Mechanism has introduced significant operational benefits (see section B.2.1) and thus it should continue to be used in the MUAC operational environment.

Targeted CASA Mechanism

The TCASA mechanism performed as expected during the exercise. TCASA measures typically reduce the overall delay dramatically but allocate greater delay to a small number of flights and often on the same routes. What remains is for the ATM community to determine whether this behaviour is desirable or not.

ATM Portal Mechanism

The mechanism has proven its value and it will be further developed by MUAC in cooperation with NM, AUs and other ANSPs.

Regulation What-if Mechanism

This report concludes that the Regulation What-if Mechanism has introduced significant operational benefits (see section B.2.3) and thus it should continue to be used in the MUAC operational environment.

Airlines Conclusions (SWISS and all other LHG airlines)

Integrated System

From airline perspective, the ATM Portal (ATMP) has been perceived as a very good and valuable initiative. However, it is one more platform to connect to, to be trained on, and to monitor, in order to get the benefits of it.

This is why the ATEAM is recommending integrating the tool into existing systems. The airlines operational staff cannot continuously connect to different web portals and facilities for each FMP and ATC within Europe. Whether it is a B2B services, through which the airlines could automatically send their priority flights (option preferred by the airlines) or an integrated service in the existing HMI (CHMI, NOP Portal or AOWIR), it is a mandatory step to integrate the system to existing or automatic facilities. Always aiming for as much automation as possible. The MUAC's ATMP concept & tool and the learnings from the NCM VLD must find its way into "fine-tuned ATFCM measures" implementation and developments.

The chat function is also very appreciated by ATEAM, and it would be highly recommended to extend the idea and get the possibility to be redirected directly to the right FMP/ATC when submitting a problem through the e-helpdesk. ATEAM understands and confirms the need of a unique platform on which all ATC stakeholders can ask for help, but a distributing the requests to the right stakeholder should be enabled, to ensure an efficient, quick and optimal resolution to the issue.

Europe wide extension

ATEAM recommends extending this initiative to the entire European ATM Network, in order to get the most out of the concept/system. Restricting the prioritisation to MUAC airspace only is very limiting, especially for some airlines. That's why the ATEAM would like to pick the most important flights on Network and Fleet Level to cover all flights in their schedules as this will help to enlarge the positive effects for the Airline and the Network.

Expansion of B2B services of NM

ATEAM would also like to support the initiative, which has been running between NMOC and MUAC, to get many actions via B2B services instead of having the traditional phone call or email exchange to coordinate the requests between stakeholders (most of them to allocate flights on empty slots and therefore improve the delay situation). For the ATEAM this is perceived as a big step forward and should be extended to all FMPs and to all other ATM Stakeholders.

B.4 Recommendations

B.4.1 Recommendations for industrialization and deployment

ANSP & NM Recommendations

Regulation Proposal Mechanism

The Regulation Proposal Mechanism has already been industrialised and deployed.

Targeted CASA Mechanism

Since the TCASA exercise in 2017, improvements to the concept have been put forward by both the Network Manager and MUAC. The consistent element of these proposals has been the notion of a hybrid concept involving both TCASA and CASA mechanisms. Whilst there seems to be great promise in these concepts, more work for MUAC is required develop them into demonstrable prototypes.

This report suggests that investigation of the TCASA concept should continue within the context of SESAR 2020. Specifically, a hybrid should be prototyped that maintains the positive attributes of both the CASA and TCASA concepts.

ATM Portal Mechanism

FORCE CTOT & EXCLUDE mechanism via B2B have already been industrialised and deployed.

Regulation What-if Mechanism

The Regulation Proposal Mechanism has already been industrialised and deployed.

Airspace Users Recommendations

From a global point of view, ATEAM recommends to reduce the number of systems that are used by airline dispatchers and network controllers. ATEAM does support all the initiatives from ANSPs and NM in order to test and validate new ideas, processes and concepts, but aims for a quick implementation of the valuable trials in the current system offered by NM. The cycle between the validation of a trials and its integration should be quick, in order get the best out of the new concepts.

All initiatives that proved to bring benefit at an airport, airspace or local level, should be extended Europe wide in order to get benefits for the entire network.

Integrated systems result in less complexity. Therefore, all requests between ATM stakeholders should be managed through one common "Tool". Whether it is an airline trying to contact a specific FMP or an FMP trying to contact a specific airline, communication should be done via this common platform, managed by NM.

Appendix C Demonstration Exercise #02b Report - Local & Network coordination of fine-tuned ATFCM measures (NATS)

C.1 Summary of the Demonstration Exercise #02b Plan

C.1.1 Exercise description and scope

Exercise Description

ATFCM measures are applied on a regular basis today in order to balance predicted demand with available capacity. The necessary coordination with NMOC to implement these measures is conducted via the telephone, which has the disadvantages of being synchronous, time consuming, bilateral and opaque to those entities not directly involved in the dialogue. Multiple tools are also used to create plans and coordinated network information is not readily available. This exercise attempts to demonstrate that, in the operational environment, a coordinated electronic ATFCM measure coordination mechanism brings the following operational benefits:

- A reduction in the FMP workload associated with the creation and coordination of ATFCM measures.
- A reduction in the Pre-Tactical workload associated with the creation and coordination of D-1 Plans.
- A reduction in the number of constrained flights as a result of replacing conventional CASA regulations with more targeted measures.
- An increase in network situational awareness as a result of sharing these measures and the consequent flight planning changes across the network.

The exercise will involve:

- NATS creating ATFCM measures and being able to observe and consider other ATFCM measures from other ANSPs.
- The Network Manager conducting their network impact assessments on the ATFCM measures and taking part in CDM for ATFCM measures.

Exercise Scope

This exercise helps build towards supporting Use Cases UC-2.1, UC-2.2 and UC-2.8 by performing the following exercises:

1. To electronically coordinate fine-tuned measures at the D-1 Pre-Tactical planning stage as part of the D-1 Plan. The aim is to demonstrate through KPI assessment that:

a. There is an improvement in the efficiency of measures applied as part of the D-1 plan.

b. The number of constrained flights is reduced through fine-tune assessment.

c. There is a workload reduction in the Pre-Tactical planning phase.

d. There is improved effectiveness of the submitted D-1 Plan.

2. To conduct network impact assessments on pre-defined fine-tuned scenarios and electronically coordinate appropriate measures in the Tactical environment. The aim is to demonstrate through KPI assessment that:

   a. Pre-defined rerouting scenarios can be used to geographically balance traffic to increase capacity and improve predictability.

   b. Pre-defined targeted flow scenarios can be used to impose measures to specific flows rather than blanket regulation to reduce the number of constrained flights through fine-tuned assessment.

Using pre-defined scenarios allows for rapid simulation capability to choose the most appropriate measure to apply reducing workload over individual MCP.

C.1.2 Summary of Demonstration Exercise #02b Demonstration Objectives and success criteria

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 2b Objectives	Demonstration Exercise 2b Success criteria
OBJ-VLD-01-001	CRT-VLD-01-001	Partially covered: Exercise 2b activities form part of overall network cooperative processes and **NATS** contributes therefore partially to the objective as described.	EX2-OBJ-VLD-01-001 Acceptable increase in workload for network operations planning actors to apply **NATS proposed** enhanced DCB measures to optimally use network capacity	EX2-CRT-VLD-01-001 The usage of **NATS proposed** enhanced DCB does not have an negative impact on ATM operational staff (NM and ATC) workload
OBJ-VLD-01-004	CRT-VLD-01-004	Partially covered: Exercise 2b activities form part of overall network cooperative processes and	EX2-OBJ-VLD-01-004 Improved situational/planning awareness for all actors regarding local/network DCB	EX2-CRT-VLD-01-004 Positive feedback from **NATS** regarding DCB transparent process

		NATS proposed solutions contribute therefore partially to the objective as described.	situation and the measures applied by sharing NATS data and actions	
OBJ-VLD-02-002	CRT-VLD-02-002	Partially covered: Exercise 2b activities form part of overall network cooperative processes and **NATS proposed solutions** contribute therefore partially to the objective as described.	EX2-OBJ-VLD-02-002 Reduce the margins between planning and actual for flight entering the **NATS's** AoR due to unforeseen changes in the execution of the European Network operations	EX2-CRT-VLD-02-002 The distribution of early/late arrivals at the entry points of the AoR of **NATS** is narrower than current operations.
OBJ-VLD-03-002	CRT-VLD-03-002	Partially covered: Exercise 2b activities form part of overall network cooperative processes and NATS proposed solutions contribute therefore partially to the objective as described.	EX2-OBJ-VLD-03-002 Reduce the extra fuel consumption due to NATS proposed DCB measures for the whole traffic flow overflying a FIR	EX2-CRT-VLD-03-002 The cumulated additional fuel consumption over the whole traffic flow overflying a FIR, due to NATS proposed DCB measures, is reduced.
OBJ-VLD-04-003	CRT-VLD-04-003	Partially covered: Exercise 2b activities form part of overall network cooperative processes and **NATS proposed solutions contribute** therefore partially to the objective as described.	EX2-OBJ-VLD-04-003 Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity due to FMP efficiency improvements	EX2-CRT-VLD-04-003 FMP workload is not increased, and increased FMP confidence that STAM resolves the DCB imbalance
OBJ-VLD-05-002	CRT-VLD-05-002	Partially covered: Exercise 2b activities form part of overall network	EX2-OBJ-VLD-05-002 Reduction of sector (arrival, en-route) delay resulting from NATS proposed measures for	EX2-CRT-VLD-05-002 The usage of enhanced DCB measures proposed

		cooperative processes and NATS proposed solutions contribute therefore partially to the objective as described.	DCB issues by using enhanced DCB measures and coordination mechanisms	**by NATS** reduces sector delay compared to regulations

C.1.3 Summary of Validation Exercise #02b Demonstration scenarios

This exercise will take place in the operational environment but on a non-operational tool. The data used in the tool will be operational quality and exercises will be run in parallel to operation to enable analysis and KPI reporting. Any decisions made during the exercise will not be implemented in the operational environment.

Scenarios will be pre-defined in the tool and the user will run simulations to determine the most appropriate scenario to implement. The facilitator will record details of each scenario and perform impact assessments to see if improvements have been gained against KPIs.

As the exercise will be run in a live environment utilising the associated operational traffic, as it develops, on the day in question the sort of tightly scripted scenarios used in validation activities are not appropriate here.

It should be clear that some use cases will occur frequently, and some may not be witnessed at all, this is the nature of working with an operational environment of which we have little control. Of course, the time slots for the exercise will be chosen carefully to ensure that as many use cases as possible are likely to occur.

This technique has been successfully employed in a predecessor project, VP-700, which also involved recording instances of ATFCM measures.

7.1.1.1 Reference Scenario(s)

The exercise aims:

1. To demonstrate workflow benefits of collaborative tools in a DCB environment at the Pre-Tactical and Tactical stages.

2. To demonstrate network improvements, reduction in constrained flights and efficiencies at the Pre-Tactical and Tactical stages.

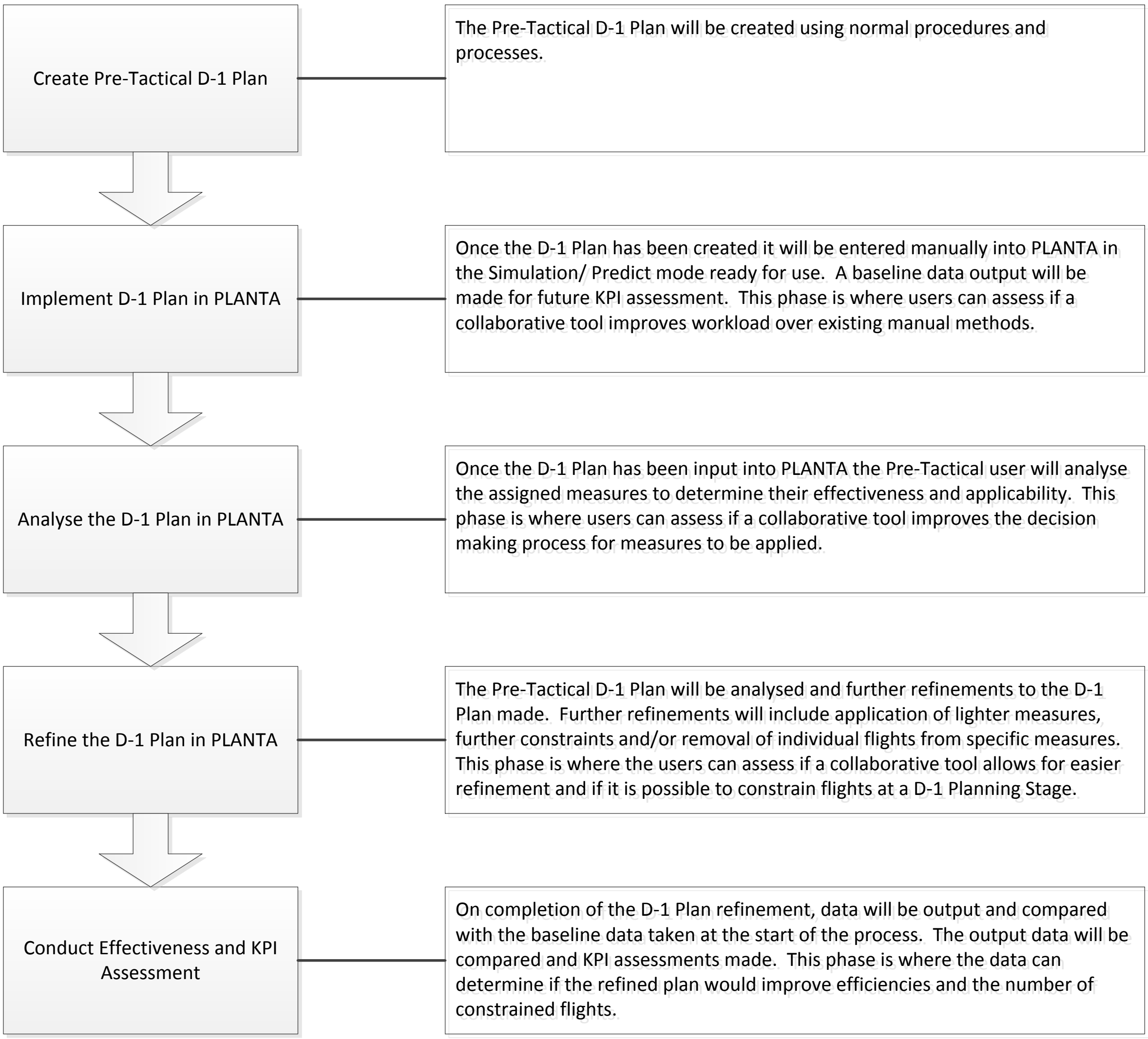
The exercise will demonstrate these by using the NM PLANTA tool in a parallel shadow-mode environment. The are no reference scenarios to compare with. KPI assessments will be made through comparison of the network impact prior to the measures being applied and the network impact post measure being applied through the PLANTA tool.

7.1.1.2 Solution Scenario(s)

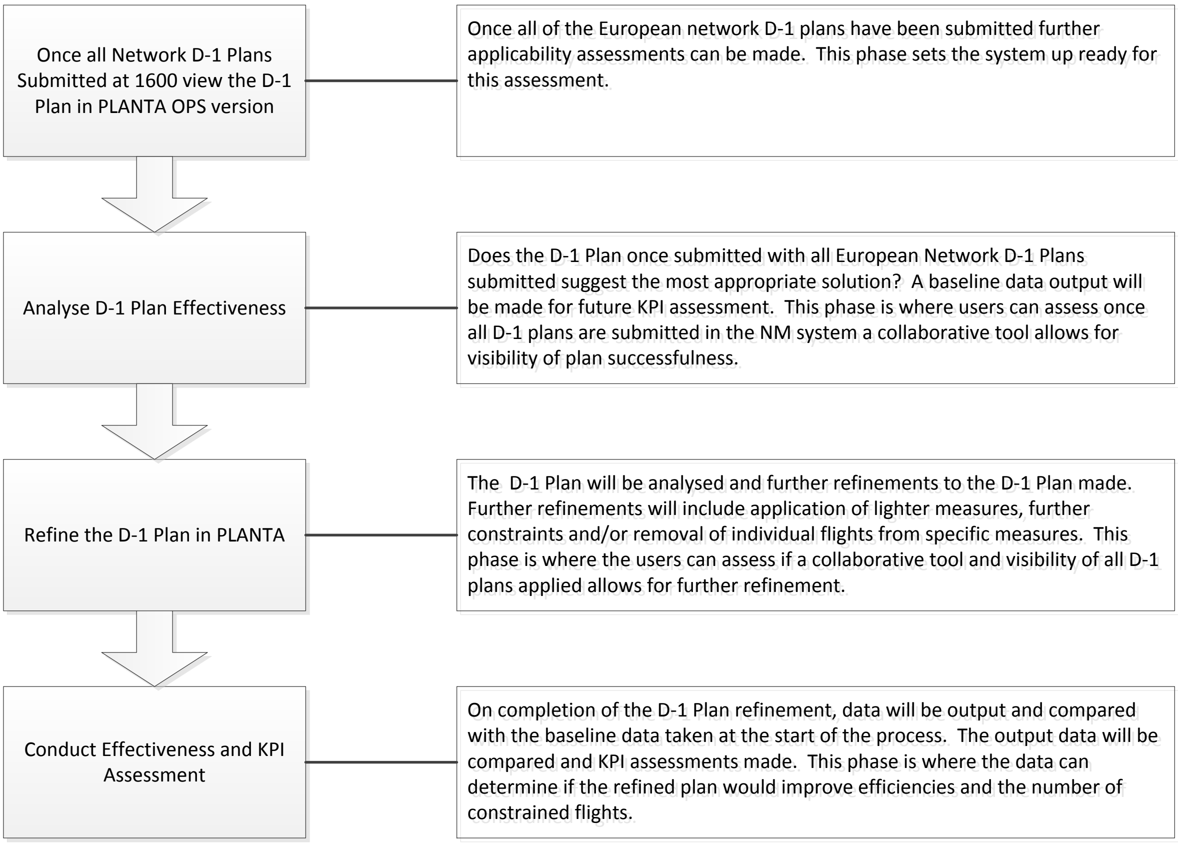
7.1.1.2.1 Pre-Tactical Planning

Currently the creation of the D-1 Plan is a very manual and time consuming process with measures often applied pessimistically. PLANTA will be used in a shadow mode to operation to assess the D-1 Plan in two phases:

Scenario 1.1 D-1 Plan Creation

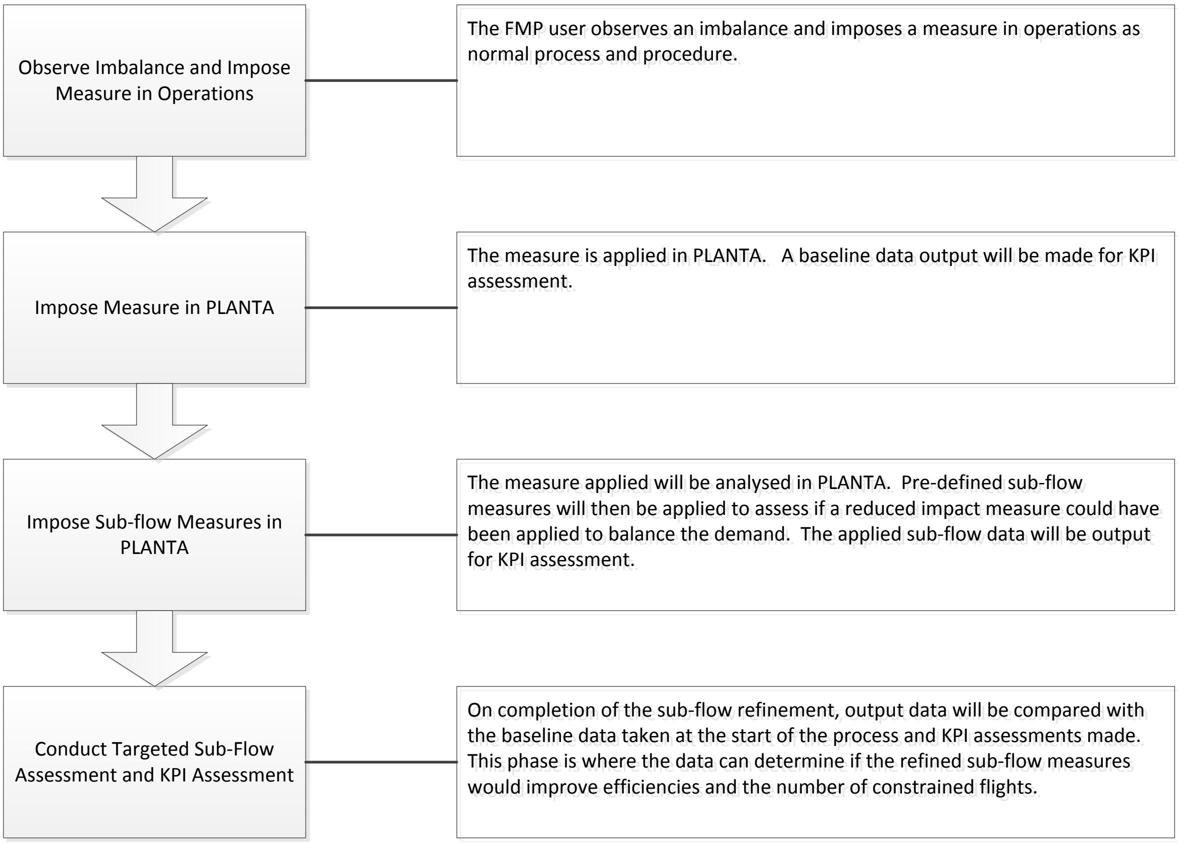


Scenario 1.2 D-1 Plan Assessment and Refinement



7.1.1.2.2 Tactical Fine-Tuned Measures

Imposition of measures today can result in aircraft being impacted with delay, re-routing or level restrictions where this could be avoided. MCP concepts have shown that this could be avoided by selecting only specific aircraft to be imposed by the restriction. However, in the tactical operational environment this is foreseen to be too time consuming and restrictive. A pragmatic approach is to have pre-defined sub-flow measures within the system that only impose measures on aircraft for a particular flow.



C.1.4 Summary of Demonstration Exercise #02b Demonstration Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
EX2b-A1	Use of Prototype		There is no tool in operation suitable to demonstrate the exercises. A prototype (PLANTA) is necessary to be used run in parallel to the operation to demonstrate the exercises.		NA				NM NATS	

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
EX2b-A2	Tool Support		It is only possible for NATS to participate in this exercise if the PLANTA tool has been suitably developed, verified and validated for the exercise scenarios.		NA				NM NATS	
Ex2b-A3	Traffic Characteristics		Operationally representative data for the exercise days will be used. Suitability for the traffic flows for that day against the pre-defined scenarios may not provide sufficient evidence to demonstrate the exercise objectives.		NA				NM NATS	

Table 20: Demonstration Assumptions overview

C.2 Deviation from the planned activities

The exercise was completed as planned. However, it is worth highlighting the following items observed during the trial:

Network Manager conducting Impact Assessments

During the trial, it was proposed to involve the Network Manager when proposing ATFCM measures so that a global network level assessment could be made. However, this did not specifically take place during the trial. An explanation for this is included within the following paragraphs

Pre-Tactical Planning Scenarios

It quickly became apparent that the data required to perform targeted measures at the D-1 Planning phase needs to be of a higher accuracy than it is today. When imposing measures at the D-1 Planning phase today the measures can be applied pessimistically, or a decision made to wait to tactically apply a measure as the data is very much on the acceptable limit. To apply targeted measures at the planning stage the tolerance thresholds reduce as the impact of the measure reduces, which means the user has to apply the measure optimistically with a confidence the data is accurate. Although we were able to observe benefit in using a collaborative tool at the D-1 Planning stage we were unable to observe benefit in applying more targeted measures at the D-1 Planning stage.

As no further targeted measures were proposed, the Network Manager was not included beyond their usual processes to perform specific impact assessments specifically for this trial.

Tactical Targeted Fine-Tuned Measures

We were able during the trial dates to demonstrate the advantage of having more targeted and refined measures available to use in the tactical environment. However, the nature of the traffic levels during the trial dates meant that we were unable to demonstrate all scenarios such as a Re-Route or Flight Level Cap scenario. Even though these were not demonstrated, the result achieved from other scenarios clearly demonstrates the advantage refined measures have in the tactical arena.

It was not possible during the tactical trial to propose the measure and then request the Network Manager impact assesses the measure before implementation as part of the CDM goals. This was because the pressure to apply a solution to resolve the imbalance in operation did not allow for sufficient time to coordinate this process. Although the trial was run in parallel, we were using operational data which meant the operational solution overwrote the picture the Network Manager would have been requested to assess. However, if the tactical measures were applied to the operational arena, the Network Manager would be able to assess as part of their normal procedures and practices when accepting measures.

C.3 Demonstration Exercise #02b Results

C.3.1 Summary of Demonstration Exercise #02b Demonstration Results

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Demonstration Objective Status
OBJ-VLD-01-001	Acceptable increase in workload for network operations planning actors to apply NATS proposed enhanced DCB measures to optimally use network capacity	CRT-VLD-01-001	The usage of NATS proposed enhanced DCB does not have an negative impact on ATM operational staff (NM and ATC)	There is a small workload increase but the benefits far outweigh any additional workload.	OK

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Demonstration Objective Status
			workload		
OBJ-VLD-01-004	Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied by sharing NATS data and actions	CRT-VLD-01-004	Positive feedback from NATS regarding DCB transparent process	There was an improvement in the visibility of the entire network and ability to assimilate the impact of measure proposals more efficiently.	OK
OBJ-VLD-02-002	Reduce the margins between planning and actual for flight entering the NATS's AoR due to unforeseen changes in the execution of the European Network operations	CRT-VLD-02-002	The distribution of early/late arrivals at the entry points of the AoR of NATS is narrower than current operations.	Pre-Tactical D-1 planning requires a higher level of planned data accuracy to achieve this objective to its full capability. Tactical targeted fine-tuned measures demonstrated great potential to reduce flight impact and delays.	Partially OK
OBJ-VLD-03-002	Reduce the extra fuel consumption due to NATS proposed DCB measures for the whole traffic flow overflying a FIR	CRT-VLD-03-002	The cumulated additional fuel consumption over the whole traffic flow overflying a FIR, due to NATS proposed DCB measures, is reduced.	Pre-Tactical D-1 planning requires a higher level of planned data accuracy to achieve more refined Flight Level Cap or Re-route proposals for the D-1 Plan. Although no Flight Level Cap or Re-route measures were made during the trial (the live traffic demand did not require	Partially OK

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Demonstration Objective Status
				this type of interaction), results from OBJ-VLD-05-002 showed great potential to improve fuel efficiencies by better use of the airspace using targeted measures rather than Flight Level Cap or Re-route scenarios. Flight Level Cap and Re-route scenarios are inefficient measures with regard to aircraft fuel burn. Targeted measures impose delay to selected flights rather than forcing flights to fly extra miles or operate at a sub optimum cruising level.	
OBJ-VLD-04-003	Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity due to FMP efficiency improvements	CRT-VLD-04-003	FMP workload is not increased, and there is increased FMP confidence that STAM resolves the DCB imbalance	There is a small workload increase at assessment level but this is negated by reduced workload modifying and monitoring once the measure is in force. The benefits for more refined measures far	Partially OK

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Demonstration Objective Status
				outweigh any additional workloads incurred. NMOC workload was not assessed during the pre-tactical trial.	
OBJ-VLD-05-002	Reduction of sector (arrival, en-route) delay resulting from NATS proposed measures for DCB issues by using enhanced DCB measures and coordination mechanisms	CRT-VLD-05-002	The usage of enhanced DCB measures proposed by NATS reduces sector delay compared to regulations.	Targeted fine-tuned measures shows great potential to reduce network impact and delays over traditional blanket regulation.	OK

Table 21: Exercise 2b Demonstration Results

1. Results per KPA

Stakeholder	Involvement	Why it matters to stakeholder	Key Performance Areas	Exercise Outcome
NATS	Creating fine-tuned ATFCM measures.	Using this mechanism should result in: • A reduction in the FMP workload associated with the creation and implementation of targeted ATFCM measures. • A reduction in the number of constrained flights as a result of replacing conventional	FMP Workload Number of constrained flights.	There is a small workload increase at assessment level but this is negated by reduced workload modifying and monitoring once the measure is in force. The benefits for more refined measures far outweigh any additional workloads incurred. Targeted fine-tuned measures shows great potential to reduce network impact and delays

Stakeholder	Involvement	Why it matters to stakeholder	Key Performance Areas	Exercise Outcome
		CASA regulations with more targeted MCP measures.		over traditional blanket regulation.
NATS	Creating Pre-Tactical D-1 Plans using a collaborative and coordinated toolset.	Using this mechanism should result in: • A reduction in the Pre-Tactical workload associated with the creation and coordination of ATFCM measures. • A reduction in the number of constrained flights as a result of replacing conventional CASA regulations with more targeted measures. • A more dynamic planning capability by simulation of scenarios using coordinated datasets.	Pre-Tactical Workload Number of constrained flights. Efficiency	The workload is comparable to today. There was an improvement in the visibility of the entire network and ability to assimilate the impact of measure proposals more efficiently. However, to be able to confidently propose more refined and targeted measures as part of the D-1 Plan the planned data needs to have a higher level of accuracy.
NMOC	Conducting network impact assessments on the ATFCM measures	Visibility of and involvement in these ATFCM measures should provide NMOC with better network situational awareness, which should in turn result in better network management.	Network capacity Efficiency (Costs)	The NMOC did not perform network impact assessments as discussed in Section C.2. NATS FMP and Planning Managers confirmed a collaborative tool provides greater visibility of the measure proposals and measures

Stakeholder	Involvement	Why it matters to stakeholder	Key Performance Areas	Exercise Outcome
				enforced across the entire network.

C.3.2 Results impacting regulation and standardisation initiatives

The results have shown no immediate requirement for regulation and/or standardisation changes to support deployment.

However, the results have highlighted the following considerations:

1. Pre-Tactical Planning Scenarios – To be able to use a collaborative tool for fine-tuned assessment and proposal the accuracy of the data being used needs to be high. High data accuracy is a complex issue to resolve due to the significant number of variables and changes that can take place in the network between submission of the D-1 Plan and live operation.
2. Tactical Targeted Fine-Tuned Measures – The results show that implementation of fine-tuned measures over traditional regulation has the ability to significantly improve network delays and efficiencies. However, targeted measures by their very nature target specific flows rather than blanket regulation. Targeting a flow can be seen as detrimental to the Airspace User or Airport Operator if they are having the measure placed upon them to resolve a global issue and can be argued as being unfair. However, results have shown that the AU or AO being affected by the measure can be affected less severely in a targeted measure than a traditional global measure. It is important that this is addressed before deployment of this method.

C.3.3 Analysis of Exercises Results per Demonstration objective

1. EX2-OBJ-VLD-01-001 Results

Objective

Acceptable increase in workload for network operations planning actors to apply NATS proposed enhanced DCB measures to optimally use network capacity.

Pre-Tactical Planning Scenarios

The workload experienced to assess and propose DCB measures at the Pre-Tactical stage using a collaborative tool is comparable to existing methods employed today. However, the ability to have greater visibility of the entire network, rapid prototyping and a single system data source to be used as a 'single point of truth' far outweighs any workload increases incurred.

The optimisations that a collaborative tool can provide essentially reduces workload, allowing for more time to be spent trialling options and refining the plan.

Tactical Targeted Fine-Tuned Measures

In the operational environment, time is of the essence, and when tactical measures are being considered it is often to resolve a workload issue in the network in the very near future. The concern with future concepts of individually cherry picking flights for inclusion in a measure is that this is a too time consuming and workload intensive process. *Note: It must be noted that this is based on current methodology. Future concepts of automatic cherry picking through B2B may reduce time in application of cherry pick measures.*

The concept of this exercise was to define more specific measures to be employed for more targeted flights over a traditional regulation. This avoids the need of the FMP to choose individual flights for inclusion in the measure, but also allows to quickly simulate a number of refined scenarios capturing fewer flights than the global regulation for the best overall performance.

During the trial period there were two days where there was a rapid need to impose regulation on the North Sea area. As part of the trial, targeted refined measures were assessed by the FMP prior to the global regulation being enforced. The workload level was observed whilst the FMP performed these processes.

The outcome concluded that assessing the targeted refined measures using PLANTA took less than a couple of minutes. When the FMP was questioned, whether this additional workload increase was acceptable the response was strongly agreed. The reasons being:

1. The assessment allows for rapid visibility of the impact of the global and / or targeted regulation before its imposition.
2. Although there is a small workload increase before the measure is applied, the delay savings that can be made greatly outweigh the small amount of work required by the FMP.
3. The overall workload for the entire measure timeline was perceived to be lower. At the assessment stage, before the measure is applied there is a workload increase. However, the traditional method using a global measure is to pessimistically apply a rate and then improve the rate as confidence grows that the capacity imbalance has been balanced. This method requires constant overview and multiple communications with NM for rate refinement. The targeted method led to a confidence increase and lower delay which if operational would have resulted in less monitoring and refinement with NM resulting in a workload decrease.

2. EX2-OBJ-VLD-01-004 Results

Objective

Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied by sharing NATS data and actions.

Pre-Tactical Planning Scenarios

It was observed during the Pre-Tactical Planning phase that having situational awareness of the entire network for planning assessments and being able to visualise the measures imposed by other actors was advantageous.

The Planning Manager expressed that it was easier to assimilate loadings across the network and understand the impact of the measures applied locally and globally. There was also a noted advantage at the planning stage to be able to visualise the impact other measures applied externally to NATS had on local traffic volumes.

Visibility of other measures was considered very important by the Planning Manager. Often within the operational world, measures are applied by users as late as reasonably practicable to allow for other users to implement measures in advance allowing for the user to implement a smaller or less restrictive measure resulting in less penalising severity. For effective pre-tactical planning and stability, it is advantageous for all users to propose and implement measures as early as reasonably practicable.

Tactical Targeted Fine-Tuned Measures

The FMP after completing targeted fine-tune assessment was asked how strongly they agreed with the following statements:

1. The situational awareness and implication of measures applied across the network are improved over traditional tool sets and processes.
2. A collaborative tool allows for visualisation of applied measures across the network allowing for more efficient planning of local measures to apply.

The FMP agreed with these statements and believed the process was simple, efficient and that confidence was high in the accuracy of the measures if they were applied and would reduce deviations from the plan.

3. EX2-OBJ-VLD-02-002 Results

Objective

Reduce the margins between planning and actual for flight entering the NATS's AoR due to unforeseen changes in the execution of the European Network operations.

Pre-Tactical Planning Scenarios

As with EX1-OBJ-VLD-01-004, there is an increase in situational awareness and it was easier to assimilate loadings across the network. Having a global view of the network and rapid prototyping opportunities allows for more effective planning and assessment due to changing conditions across the network and wider than the specific area of interest.

The main issue experienced at the D-1 Planning stage was the confidence and accuracy of the data to be able to make informed decisions. This is discussed in the EX2-OBJ-VLD-03-002 Results.

Tactical Targeted Fine-Tuned Measures

Implementing regulations today often causes significant impact on the entire network resulting in other measures being imposed downstream. A measure imposed often causes significant disruption and it is often difficult to get back to the original plan once in the execution phase.

As stated in the results for EX1-OBJ-VLD-01-001 the assessment of individual flights to narrow margins is a too time consuming process. Targeted measures allow for a reduction in the network wide impact and also allows assessment of measures to be applied with consideration not only to the local impact but to also the entire network. For example, if there are two potential targeted measures for a traffic volume that have the ability to resolve the imbalance, it is possible with the collaborative tool to assess the global network impact for each and identify the one with least impact for implementation.

During the trial it was observed that the imposition of a targeted measure had the opportunity to save a significant amount of delay to flights, as detailed in EX2-OBJ-VLD-05-002 Results. The application of this measure would also have significantly reduced the margins between the plan and the execution phase and improved overall network performance.

The FMP after completing targeted fine-tune assessment was asked how strongly they agreed with the following statements:

1. The situational awareness and implication of measures applied across the network are improved over traditional tool sets and processes.
2. A collaborative tool allows for visualisation of applied measures across the network allowing for more efficient planning of local measures to apply.

The FMP agreed with these statements and believed the process was simple, efficient and that confidence was high in the accuracy of the measures if they were applied and would reduce deviations from the plan.

4. EX2-OBJ-VLD-03-002 Results

Objective

Reduce the extra fuel consumption due to NATS proposed DCB measures for the whole traffic flow overflying a FIR.

Pre-Tactical Planning Scenarios

During the trial phase, the Pre-Tactical teams were managing predicted demand on the North Sea area and considering the application of a Re-route measure (RR2GNOR) between 0740 and 1100 as part of the pre-tactical D-1 Plan. This decision was based upon operational experience that measures had been required for the previous two days.

As part of the trial, we were able to simulate the measure and see the impact within the collaborative tool. However, it was observed within the tool that the predicted loadings were within peak tolerance levels and in theory a measure need not be applied. Users acknowledged that the application of the Re-route measure will create additional fuel burn for flights affected by the measure and if we were to follow the guidance of the tool this measure would not be required.

Following the above considerations, the Planning Managers made a decision to apply the measure as part of the D-1 Plan. As part of this trial we would compare the predictions against the actuals on the day.

The image below is the predicted demand for the EGNOR traffic volume taken at 1300UTC on the 11th April 2019 as part of the D-1 pre-tactical planning phase within PLANTA. The black line is the predicted demand with no measure applied and the blue bars are the predicted demand with RR2GNOR applied 0740-1100.

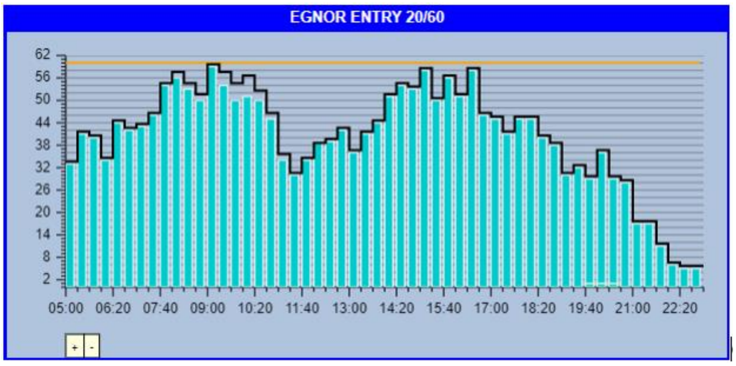


Figure 17:EGNOR TV comparison

A reassessment of the D-1 Plan at 1630UTC showed that the loadings had not changed.

The following morning (12th April) at 0720UTC CHMI was used to observe the EGNOR traffic volume demand with the RR2GNOR applied. As can be observed in the image below the demand is slightly higher than threshold even with the re-route measure applied and that demand was spread for a much longer period than the PLANTA prediction had suggested the day before.

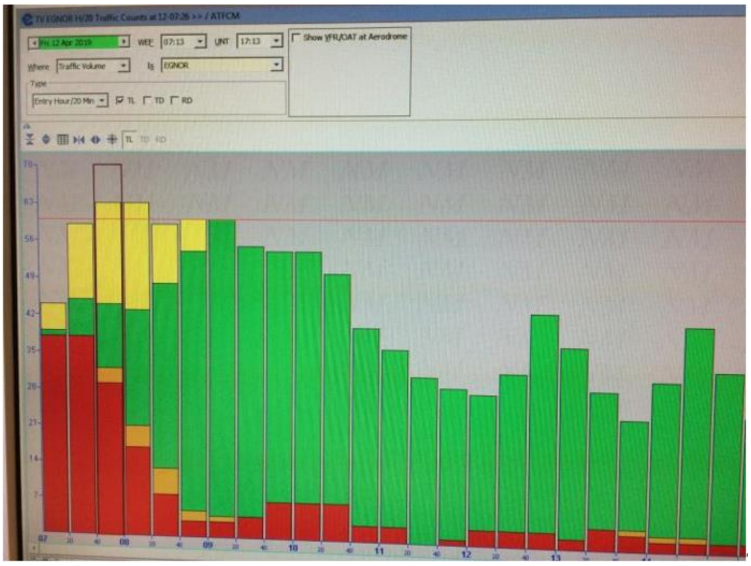


Figure 18: EGNOR TV re-assessment

If the decision had been based solely on the D-1 PLANTA demand, no re-route measure would have been applied. The measures applied by the tactical teams would have resulted in a greater amount of delay to flights with less notice given to airspace users.

The conclusion from the ACM team is that for effective D-1 planning with a collaborative tool the data used for planning needs to be more accurate and trusted.

At peak times when measures are likely to be required, the fidelity of the data is a significant factor in both the requirement and the degree of impact of a measure. At present the level of accuracy of the data does not provide the required fidelity. Hence, any measures applied as part of the D-1 process are implemented pessimistically in an attempt to provide a stable plan.

Although the output of this trial appears negative in this scenario it actually highlights opportunity to improve operational performance at the D-1 Planning stage. All ACM staff involved in this process agreed that if the data fidelity and confidence was improved and with the increased situational awareness and assimilation abilities a collaborative tool gives, more refined measures could be applied as part of the D-1 Plan. This would ultimately improve efficiency of the network and predictability whilst reducing fuel burn and delays.

In addition, improved planning has a secondary benefit of improving the consistency and predictability of the plan during the operational phase. This ultimately reduces reactive measures, delays and a more consistent experience of the airspace users.

<u>Tactical Targeted Fine-Tuned Measures</u>

During the trial, there was no operational situation that required an imposition of a re-route measure at the tactical phase, so this objective was not achieved. However, the imposition of targeted re-route measures is the same principle as objective EX2-OBJ-VLD-05-002 and rapid simulation of targeted re-route measures in the operational environment with delay assessment over a global measure provides significant opportunity for network efficiencies.

5. EX2-OBJ-VLD-04-003 Results

Objective

Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity due to FMP efficiency improvements.

Pre-Tactical Planning Scenarios

As discussed in previous objective results the workload experienced to assess and propose DCB measures at the Pre-Tactical stage using a collaborative tool is comparable to existing methods employed today as the overall user process has not changed. However, the ability to have greater visibility of the entire network, rapid prototyping and a single system data source to be used as a 'single point of truth' far outweighs any workload increases incurred.

The optimisations that a collaborative tool can provide essentially reduces workload, allowing for more time to be spent trialling options and refining the plan.

However, results during the trial have also confirmed that the confidence in the accuracy of data is low at the D-1 Planning stage. The imposition of refined measures is difficult to determine as the data fidelity is not sufficient to support this capability. This is explained in EX2-OBJ-VLD-03-002 Results for the EGNOR scenario.

Tactical Targeted Fine-Tuned Measures

The results for this objective are as described in EX2-OBJ-VLD-01-001 Results. The conclusion from the users was that although there is a small workload increase due to having an increased number of measures to assess and simulate the network benefits far outweigh increased workload. In some situations, the workload for the measure lifecycle would be reduced, as the user may not be required to continuously refine the applied measure.

The confidence in the data during the trial for the tactical scenarios was high, due to the data presentation in PLANTA being the same data as used in CHMI (currently used in the operations room today).

6. EX2-OBJ-VLD-05-002 Results

Objective

Reduction of sector (arrival, en-route) delay resulting from NATS proposed measures for DCB issues by using enhanced DCB measures and coordination mechanisms

Pre-Tactical Planning Scenarios

As discussed in the EX2-OBJ-VLD-03-002 results the confidence in the accuracy of the data is not sufficient at the D-1 Planning stage to propose high fidelity fine tuned measures, as the implementation cannot ensure the required outcome.

However, all ACM staff involved in this process agreed that if the data fidelity (and therefore confidence) was improved there would be increased situational awareness. The improved assimilation abilities using a collaborative tool affords the opportunity to use more refined measures as part of the D-1 Process. This would ultimately improve efficiency of the network and predictability whilst reducing fuel burn and delays.

Tactical Targeted Fine-Tuned Measures

During the trial, on the 10th April 2019 traffic volume EGNOR (S10/S11) was showing a significant over demand between 0900 and 1100 and discussions between the FMP and Group Supervisor led to the need to regulate the area as tactical level capping would not have provided the reductions required.

Using the PLANTA targeted regulation tool the global regulation was entered and compared against the EHAM departures targeted regulation setup in PLANTA (STEG10EH). The FMP had observed that a number of the flights in the traffic spike were Amsterdam departures.

Running the simulation showed that the global regulation would incur approximately 1864 minutes of delay to resolve the over demand. If the targeted regulation was imposed there would only be approximately 48 minutes of delay imposed, as shown below.

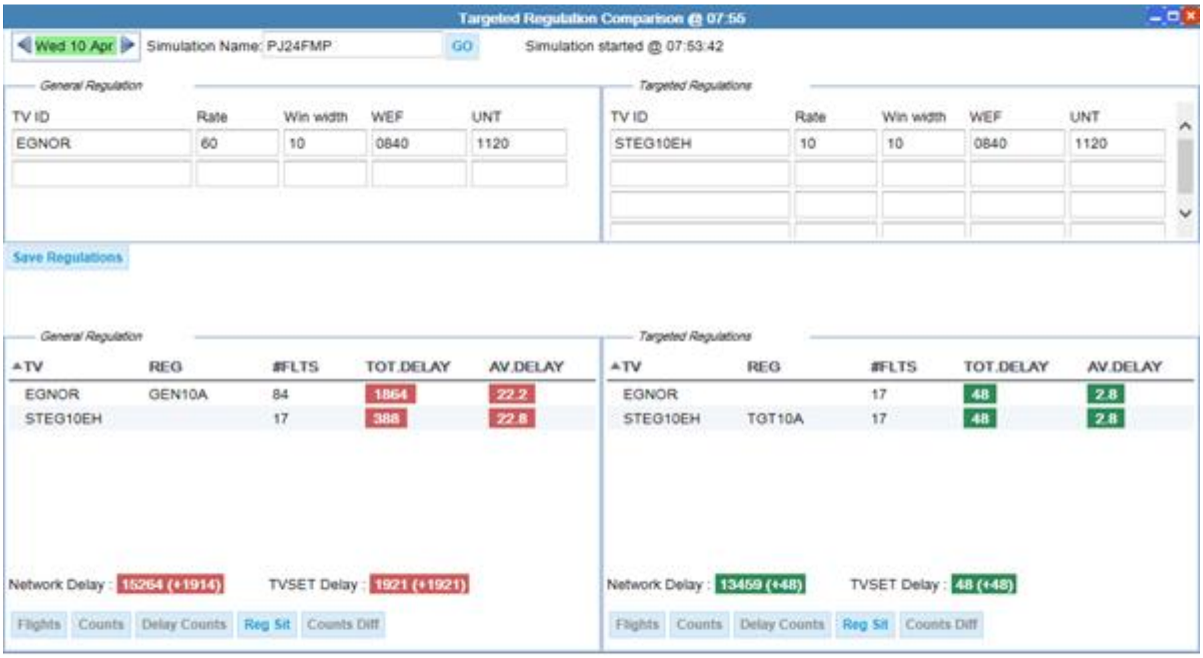


Figure 19: Global Regulation Vs Targeted Regulation. Delay reduction

It was also noted that the global regulation would generate 388 minutes of delay to the Amsterdam departing flights due to the overall spread required. This means that although the targeted regulation only targets Amsterdam departures the overall impact of the global versus targeted regulation on the Amsterdam departures would have been 340 minutes less delay.

On observation of the loadings, the application of the sub-flow measure resolved the over demand adequately and if implemented in today's operation would have been the desired solution. The loadings are shown below:

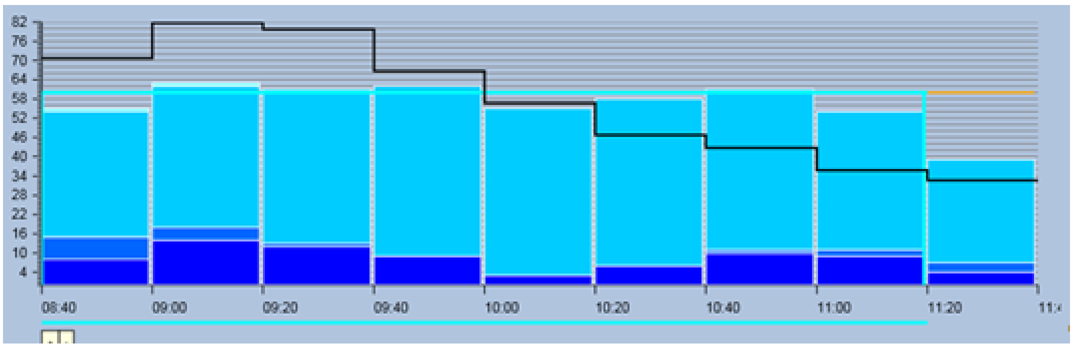


Figure 20: Histogram of the solved over-demand

The EGNOR output shows that implementation of the targeted sub-flow measure would have reduced traffic demand for the area adequately and spread the traffic more evenly (black line pre-regulation demand, blue bars implemented sub-flow measure demand).

In this instance, the FMP stated that due to network pressures and timeliness to deliver a suitable resolution it would not have been possible to cherry pick sufficient flights. Although there is a slight additional workload in simulating targeted sub-flows, the benefit far outweighs the additional workload. In this instance significant reduction in ATFCM delay (over 1800 minutes).

It was highlighted by the FMP at the time that if these targeted measures were available today, this solution could be used regularly and this level of delay saved on a regular basis throughout the network.

C.3.4 Unexpected Behaviours/Results

During the trial, we were unable during one run to load the Targeted Regulation Comparison tool in PLANTA due to error messages. This was investigated and rectified by Eurocontrol and the trial continued without issue.

C.3.5 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

The main limiting factors to the trial were that due to availability of staff and the PLANTA tool there was only opportunity to run the trial for five consecutive days. The trial was also dependent on the correct demand and environmental conditions being in place to perform measure assessment.

However, from the trial we were able to run the trial scenarios using operational data and assessment by operational staff. We believe our results are sufficiently representative to be used for representation.

2. Quality of Demonstration Exercise Results

Pre-Tactical Planning Scenarios

The data used during the trial was the same data as used in operation and the toolsets used required no specific development for this trial. The pre-tactical scenarios were run in parallel with operation and comparisons were being made at all times with existing operational procedures. The quality of the trial was therefore considered to be realistic and accurate.

Tactical Targeted Fine-Tuned Measures

The data used during the trial was the same data as used in operation. The PLANTA toolset required a specific HMI to be developed, but the targeted measures to be used were specified scenarios entered into the existing NM Systems before the trial. Therefore, processing and algorithmic calculation was processed in the same way as existing scenarios.

During the trial, on execution of a measure in operation, the PLANTA toolset was used and compared with operational CHMI to ensure the display was consistent. The PLANTA scenarios were then run, recorded and analysed in parallel to operation. At this point, the operational measure was imposed.

Although the trial was run in parallel to operation, the operational user was in charge of comparing and manipulating the operational systems and trial system in tandem, and as the trial system was also using a live copy of the operational data the trial can be considered realistic.

The limiting factor that affects the confidence of the results is that the targeted measure was not physically applied in operation, and although we have delay saving results at the time of imposition of the measures, we do not have results to show that after the measure was executed completely it was accurate to its forecast.

3. Significance of Demonstration Exercises Results

Pre-Tactical Planning Scenarios

Pre-tactical scenarios were run in parallel to operation using operational data. The trial was run over five consecutive days and by two pre-tactical Planning Managers. As discussed in the conclusion and objective results sections, it was apparent that the quality of the data requires a greater accuracy to be able to perform fine-tuned measure assessment at the D-1 Planning stage.

Although the trial was only run over five days and by two members of staff, the results gained were significant in determining that it is currently not possible to perform fine-tuned measure assessment at the D-1 Planning stage with the current levels of confidence in pre-tactical data accuracy.

Tactical Targeted Fine-Tuned Measures

The tactical targeted fine-tuned measure trial was run over five consecutive days. The opportunity to perform fine-tuned measure assessment in the operational environment only occurs when the demand is of a significance to require measures to be enforced. During the trial dates, there were two opportunities to perform a full assessment. As detailed in EX2-OBJ-VLD-05-002 Results one occasion allowed us to demonstrate the potential for delay savings to be made using fine-tuned measures. Although the trial only showed one result, the result is significant and was detailed and accurate enough to conclude the benefits of fine-tuned measure implementation.

C.4 Conclusions

Pre-Tactical Planning Scenarios

There is great potential to be able to improve network predictability, optimisation, reduce flight delays and fuel burn through more effective pre-tactical planning. With collaborative toolsets more effective measures can be proposed and workload can be reduced or maintained but bring greater overall network benefit.

The issue that exists today is data held in repositories and used for planning purposes is not always accurate as it is a predictive data set. There are many variables that can influence demand at given points and times in the network that are difficult to predict or too onerous to simulate using existing toolsets.

The trial highlighted that as the network (UK FIR) operates continually at peak demand, trying to fine tune or impose more constrained measures at the pre-tactical D-1 planning stage is difficult, as the level of fidelity of planning data needs to be improved. The consequence is that a small variance in demand could result in a traffic volume overload or under demand and inefficiency.

Users agreed that a collaborative toolset improves network visibility, aids, simplifies workload, and has great potential to bring significant efficiencies to the network. However, without an improvement in planning data accuracy this is difficult to achieve.

Tactical Targeted Fine-Tuned Measures

Having the ability to regulate flows rather than traffic volumes led to the observation of significant benefits. As discussed in EX2-OBJ-VLD-05-002 Results, a global regulation imposed for 2hrs 40mins incurred 1864 minutes of delay. Imposing a targeted fine-tuned measure on Amsterdam departures only for this traffic volume incurred only 48 minutes of delay and resolved the imbalance, thus saving 1816 minutes of delay in one regulation period of 2hrs 40mins.

It can be argued that targeted fine-tuned measures could be considered unfair as the regulation is not apportioned to all users of the traffic volume. However, it should also be considered that for the global regulation discussed above Amsterdam departures were subject to 388 minutes of the 1864 minutes of delay. Even though the targeted measure only imposed constraints on Amsterdam departures, delays to Amsterdam were only 48 minutes and a higher proportion of the network was able to operate to plan.

Targeted fine-tuned measures are essentially a “happy medium” between global regulation and cherry pick regulation. The advantage of targeted fine-tuned measures is that the workload increase is small, but the overall benefit over global regulation is large. Implementing targeted fine-tuned measures is also quite straightforward, as existing systems and processes need very little change as the fine-tuned scenarios can be added to the existing scenario repository, similar to re-route and flight level cap scenarios.

The FMP users were very positive and confident of the overall benefit of using fine-tuned measures and their ability to reduce delays and also fuel burn (if used instead of re-route and flight level cap scenarios to balance capacity).

C.5 Recommendations

C.5.1 Recommendations for industrialization and deployment

Tactical Targeted Fine-Tuned Measures

The recommendation from the trial is that fine-tuned targeted flow measures are industrialised. Currently in operation there is the option to perform re-route or flight level cap scenarios as a fine-tuned method rather than blanket regulation. If targeted flow scenarios could be added to the existing repository and toolsets, there would be significant opportunity to reduce flight delays over blanket regulation, and also reduce additional fuel burn as a targeted flow scenario could be used instead of a re-route or flight level cap scenario which is likely to induce increased fuel burn.

C.5.2 Recommendations on regulation and standardisation initiatives

No regulation or standardisation initiatives identified.

Appendix D Demonstration Exercise #02c Report - Local & Network coordination of fine-tuned ATFCM measures (DFS)

D.1 Summary of the Demonstration Exercise #02c Plan

D.1.1 Exercise description and scope

ATFCM measures, such as CASA regulations, re-routeing scenarios, flight level capping etc., are applied on a regular basis today in order to balance predicted demand with available capacity. The coordination of these measures is conducted via the telephone, which has the disadvantages of being synchronous, time consuming, bilateral and opaque to those not directly involved in the dialogue.

This exercise attempts to demonstrate that, in the operational environment, the creation of pre-tactical re-routeing measures via a supporting tool (PLANTA), as part of the D-1 plan, brings the following operational benefits:

- A reduction in the FMP workload associated with the creation of pre-tactical re-routeing measures.
- A reduction in the number of constrained flights, as a result of partially replacing conventional CASA regulations with pre-tactical re-routeing measures.

The exercise involves:

- DFS in the role of an ANSP creating pre-tactical re-routeing measures.
- The Network Manager as a B2B service provider for the use of the B2C prototype tool PLANTA, allowing impact assessment on the traffic counts.

D.1.2 Summary of Demonstration Exercise #02c Demonstration Objectives and success criteria

Demonstration Objective (as in section Error! Reference source not found.)	Demonstration Success criteria (as in section Error! Reference source not found.)	Coverage and comments on the coverage of Demonstration objectives (as in section Error! Reference source not found.)	Demonstration Exercise 1 Objectives	Demonstration Exercise 1 Success criteria
OBJ-VLD-01-001	CRT-VLD-01-001	Partially covered:	EX2-OBJ-VLD-01-001 Acceptable increase in	EX2-CRT-VLD-01-001

		Exercise 2c activities form part of overall network cooperative processes and **DFS** contribute therefore partially to the objective as described.	workload for network operations planning actors to apply **DFS proposed** enhanced DCB measures to optimally use network capacity	The usage of **DFS proposed** enhanced DCB does not have a negative impact on ATM operational staff (NM and ATC) workload
OBJ-VLD-01-002	CRT-VLD-01-002	Partially covered: Exercise 2c activities form part of overall network cooperative processes and **DFS proposed solutions** contribute therefore partially to the objective as described.	EX2-OBJ-VLD-01-002 The implementation of enhanced DCB measures does not create extra workload for **DFS** ATC.	EX2-CRT-VLD-01-002 No increase in workload for **DFS** ATC because of non-nominal profiles flown by participating airline flights.
OBJ-VLD-01-004	CRT-VLD-01-004	Partially covered: Exercise 2c activities form part of overall network cooperative processes and **DFS proposed solutions** contribute therefore partially to the objective as described.	EX2-OBJ-VLD-01-004 Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied **by sharing DFS data and actions**	EX2-CRT-VLD-01-004 Positive feedback from **DFS** regarding DCB transparent process
OBJ-VLD-02-002	CRT-VLD-02-002	Partially covered: Exercise 2c activities form part of overall network cooperative processes and **DFS proposed solutions** contribute therefore partially to the objective as described.	EX2-OBJ-VLD-02-002 Reduce the margins between planning and actual for flight entering the **DFS's** AoR due to unforeseen changes in the execution of the European Network operations	EX2-CRT-VLD-02-002 The distribution of early/late arrivals at the entry points of the AoR of **DFS** is narrower than current operations.
OBJ-VLD-03-002	CRT-VLD-03-002	Partially covered: Exercise 2c activities form part of overall network cooperative processes and **DFS proposed solutions** contribute therefore partially to the objective as described.	EX2-OBJ-VLD-03-002 Reduce the extra fuel consumption due to **DFS proposed** DCB measures for the whole traffic flow overflying a FIR	EX2-CRT-VLD-03-002 The cumulated additional fuel consumption over the whole traffic flow overflying a FIR, due to **DFS proposed** DCB measures, is reduced.

OBJ-VLD-04-003	CRT-VLD-04-003	Partially covered: Exercise 2c activities form part of overall network cooperative processes and **DFS proposed solutions** contribute therefore partially to the objective as described.	EX2-OBJ-VLD-04-003 Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity **due to FMP efficiency improvements**	EX2-CRT-VLD-04-003 FMP workload is not increased, and FMP confidence that STAM resolves the DCB imbalance
OBJ-VLD-05-002	CRT-VLD-05-002	Partially covered: Exercise 2c activities form part of overall network cooperative processes and **DFS proposed solutions** contribute therefore partially to the objective as described.	EX2-OBJ-VLD-05-002 Reduction of sector (arrival, en-route) delay resulting from **DFS proposed measures for** DCB issues by using enhanced DCB measures and coordination mechanisms	EX2-CRT-VLD-05-002 The usage of enhanced DCB measures **proposed by DFS** reduces sector delay compared to regulations

Demonstration Objectives applicable to Exercise 2c

D.1.3 Summary of Validation Exercise #02c Demonstration scenarios

The exercise took place on a non-operational tool and was executed in shadow mode to enable analysis and KPI reporting. Any decisions made during the exercise were not implemented in the operational environment.

Re-routeing measures were designed and pre-defined in the corresponding repository of the NM systems and the user ran simulations to determine the most appropriate re-routeing measure to implement comparing it also with possible CASA regulations to be applied in the sector. The facilitator recorded details of each scenario and performed impact assessments to see if improvements had been achieved on certain KPIs.

Since the exercise was executed on the basis of operational traffic, some re-routeing measures were often possible to be applied and some were not required at all; this is the nature of working in an operational environment of which we have little control. Of course, the time slots for the exercise were chosen carefully to ensure that as many use cases as possible were likely to occur.

The reference scenario corresponds to the operational environment, since any decisions made during the exercise were not implemented.

The solution scenario corresponds to the application of pre-tactical re-routeing measures in the frame of the demonstration.

D.1.4 Summary of Demonstration Exercise #02c Demonstration Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
EX2b -A1	Use of Prototype		There is no tool in operation suitable to demonstrate the exercises. A prototype (PLANTA) is necessary to be used in parallel to the operation to demonstrate the exercises.		N A				NM DFS	
EX2b -A2	Tool Support		It is only possible for DFS to participate in this exercise if the PLANTA tool has been suitably developed, verified and validated for the exercise scenarios.		N A				NM DFS	
Ex2b-A3	Traffic Characteristics		Operationally representative data for the exercise days will be used. Suitability for the traffic flows for that day against the pre-defined scenarios may not provide sufficient evidence to demonstrate the exercise objectives.		N A				NM DFS	

D.2 Deviation from the planned activities

The following demonstration objectives were not assessed:

- OBJ-VLD-01-002
- OBJ-VLD-01-004
- OBJ-VLD-02-002

The following demonstration objectives were only partially assessed:

- OBJ-VLD-01-001

D.3 Demonstration Exercise #02c Results

The results are based on qualitative assessments and expert judgement.

D.3.1 Summary of Demonstration Exercise #02c Demonstration Results

Demons-tration Objective ID	Demons-tration Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Demons-tration Objective Status
OBJ-VLD-01-001	Impacts of using enhanced DCB measures and TTs on ATFCM workload (NM, ATC and Airport)	CRT-VLD-01-001	The usage of enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload.	The usage of enhanced DCB on D-1 (pre-tactically) does not have a negative impact on operational staff (FMP) workload. The impact of TTs on operational staff workload was not assessed. Tactical DCB was not assessed (only D-1, pre-tactical was assessed). NM, ATCO and airport workload were not assessed (only FMP workload was assessed).	OK
OBJ-VLD-01-002	Assess the impact of using enhanced DCB measures and TT on speed changes in ACCs	CRT-VLD-01-002	No increase in workload for ATC because of non-nominal speed profiles flown by participating airline flights.	Not assessed.	Not OK
OBJ-VLD-01-004	Transparent coordination processes	CRT-VLD-01-004	Positive feedback from all actors regarding DCB overall processes.	Not assessed due to the fact that the measures were not coordinated with other partners.	Not OK
OBJ-VLD-02-002	Improve predictability of flights for an ANSP	CRT-VLD-02-002	The distribution of early/late arrivals at	Not assessed due to the fact that TTs were not demonstrated.	Not OK

			the entry points of the AoR of ANSPs is narrower than current operations.		
OBJ-VLD-03-002	Reduce extra fuel burn over an ANSP traffic flow	CRT-VLD-03-002	The cumulated additional fuel consumption over the whole traffic flow overflying a FIR, due to DCB measures, is reduced.	No, the demonstrated DCB measures do not necessarily reduce fuel burn over an ANSP traffic flow. For those flights captured by the DCB measures, the average fuel burn was not reduced in all cases.	Not OK
OBJ-VLD-04-003	Increased cost-efficiency from more efficient processes for ANSPs	CRT-VLD-04-003	Positive feedback from FMP staff to apply measures Reduced time to achieve the DCB cycle	Yes, the demonstrated system functionalities are efficient and support FMP decision-making.	OK Remark: a direct relationship between ANSP cost-efficiency and efficient DCB processes could not be established.
OBJ-VLD-05-002	Increase the use of available airspace capacity for an ANSP	CRT-VLD-05-002	The usage of enhanced DCB reduces sector delay compared to regulations.	Yes.	OK

Table 22: Exercise 2c Demonstration Results

1. Results per KPA

The creation of pre-tactical re-routeing measures via a supporting tool (PLANTA), as part of the D-1 plan, results in a reduction of the FMP workload associated with the creation of such measures and a reduction in the number of constrained flights.

The results per KPA can be summarised as follows:

- **Safety**: no issues with safety on D-1 preparation.

- **Predictability**: Traffic predictability was not assessed, since the demonstration focused on the D-1 plan.

- **Fuel Efficiency**: Depending on the use of the different re-routeing measures; some re-routeing measures decreased the fuel efficiency, others did not. Further factors have an influence on fuel efficiency (weather, mileage, weight).

- **Environmental sustainability**: An increase of arrival punctuality through the reduction of ATFM delay could increase the environmental sustainability through a reduction of the reactionary delay of a flight rotation.

- **Cost Efficiency**: Depending on the use of the different re-routeing measures, as in the case of fuel efficiency. Further factors have an influence on cost efficiency (weather, unit rates, mileage, weight).

- **Capacity**: The use of pre-tactical re-routeing measures leads to a reduction in ATFM delay and in the number of constrained flights, thus allowing for a more efficient use of the available capacity.

D.3.2 Results impacting regulation and standardisation initiatives

Not applicable.

D.3.3 Analysis of Exercises Results per Demonstration objective

1. EX1-OBJ-VLD-01-001 Results

Objective Title: **Impacts of using enhanced DCB measures and TTs on ATFCM workload (NM, ATC and Airport)**

The demonstrated re-routeing measures in the pre-tactical period (D-1) may contribute to reduce the FMP workload in the tactical period (day of operations), provided that the PREDICT data in CHMI and PLANTA is reliable.

Workload on D-1 preparation with PLANTA is increased due to too many steps whilst creating a measure; on the other hand, the result provided by PLANTA offers an added value for FMP decision-making, since it increases the overall situational awareness on all traffic counts.

2. EX1-OBJ-VLD-01-002 Results

Objective Title**: Assess the impact of using enhanced DCB measures and TT on speed changes in ACCs**

Not assessed.

3. EX1-OBJ-VLD-01-004 Results

Objective Title: **Transparent coordination processes**

Not assessed due to the fact that the measures were not coordinated with other partners.

4. EX1-OBJ-VLD-02-002 Results

Objective Title: **Improve predictability of flights for an ANSP**

Not assessed due to the fact that TTs were not demonstrated.

5. EX1-OBJ-VLD-03-002 Results

Objective Title: **Reduce extra fuel burn over an ANSP traffic flow**

The demonstrated re-routeing measures aim at optimizing tactical capacity and avoiding overloads whilst minimizing the usage of CASA regulations, not at reducing average fuel burn.

A reduction of the average fuel burn was not observed; nevertheless, in particular cases the re-routeing might lead to a reduction of fuel burn.

6. EX1-OBJ-VLD-04-003 Results

Objective Title: **Increased cost-efficiency from more efficient processes for ANSPs**

The usage of PLANTA increases the efficiency and effectiveness of the FMP decision-making process due to the comparison between the impact of CASA regulations and DCB measures (pre-defined re-routeing measures).

7. EX1-OBJ-VLD-05-002 Results

Objective Title: **Increase the use of available airspace capacity for an ANSP**

The usage of PLANTA and the demonstrated re-routeing measures allowed for a reduction of the number of regulated flights and/or the number of CASA regulations – and therefore of ATFM delay.

D.3.4 Unexpected Behaviours/Results

- The content of error messages is not always precise enough to identify the problem (e.g. error reason "other").
- Some flights for re-routeing in the DCB measure disappeared from the list of candidate flights whilst implementing the measure.

The following unexpected results observed in isolated cases:

- Traffic counts after implementation of regulation were still above the regulation rate (in the collapsed sector Roding + Eggenfelden):

- Simulation results showed +2 min (Delta EET) and -8 NM (Delta Route) for DLH756 on 15 May 2019.

- In the case of two flights on the same city pair and flight plan route (EJU606D and EWG8006 on 16 May, from EDDT to EDDS), a significantly higher fuel consumption and estimated elapsed time was calculated for one of them after the implementation of the re-routeing measure than for the other one.

D.3.5 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

The following factors limit the representativeness of the exercise results:

- Short execution period (4 days), with two simulations per day.

- Only one participant (FMP) available.

- No live trial.

- Moderate traffic level, with less hotspots (due to the execution period: 13-16 May 2019).

2. Quality of Demonstration Exercise Results

The results are based on expert judgement by the participating FMP. Quantitative data have been retrieved and qualitatively assessed, and are available if required (refer to D.3.4).

No specific questionnaire was used; instead, the demonstration objectives have been globally assessed in the course of the exercise.

3. Significance of Demonstration Exercises Results

Statistical significance is limited by the number of exercise, runs and the short execution period (refer to D.3.51).

Operational significance is limited by the fact that the exercise was not carried out under live conditions.

D.4 Conclusions

The use of pre-tactical re-routeing measures allows for a reduction of the number of regulated flights and/or the number of CASA regulations – and therefore of ATFM delay. Furthermore, they may contribute to reduce the FMP workload in the tactical period (day of operations).

As far as the tool used in this exercise – PLANTA – is concerned, it provides an added value with regard to the FMP decision-making process in the D-1 period (pre-tactical process), since it improves the situational awareness through a rapid identification and visualization of candidate flights in the traffic counts for re-routeing measures. Furthermore, it allows for a quick comparison between the impact of CASA regulations and re-routeing measures.

A further quality increase can be reached by:

- More accurate data in PREDICT
- Further development of user-friendlier HMI (e.g. workflow optimization through reduction of simulation steps)
- More flexibility through the implementation of ad-hoc scenarios (in addition to the pre-defined ones); in case the pre-defined scenario does not solve the hotspot, an ad-hoc and tailored scenario is needed. PLANTA shall provide possible re-routeings and a what-if analysis for all new sectors concerned in order to avoid additional overload situations.

D.5 Recommendations

D.5.1 Recommendations for industrialization and deployment

The following further developments are recommended:

- Further development of traffic complexity assessment (for the sake of fulfilment of (EU) No 716/2014 - PCP).
- Possibility to create ad-hoc scenarios for more precise DCB measures (refer to D.4).
- HMI improvements for workflow optimization (e.g. reduction of simulation steps, multi-editor for easy access to the measures).

- Each FMP shall be able to simulate the impact of any pre-defined measure, independently of the owner of such measure. A coordination shall be only required for the implementation of the measure.

D.5.2 Recommendations on regulation and standardisation initiatives

As mentioned in the previous section (D.5.1), a further development of complexity assessment is recommendable in order to fulfil the EU regulation No 716/2014 (PCP).

Appendix E Demonstration Exercise #03a AOP-NOP integration and Arrivals Management

E.1 Summary of the Demonstration Exercise #03a Plan

E.1.1 Exercise description and scope

Within this demonstration, there were two clearly differentiated objectives:

- To demonstrate the increase in the accuracy and predictability of the traffic demand in the ATM network through a full integration of the airports into the ATM network exchanging information beyond the current A-CDM (**via AOP-NOP exchange of data**).
- To demonstrate the improvement of the airport and network performance through the integration of airports and airlines solving airport arrivals DCB imbalances during the Planning phase and the monitoring during the Execution phase of the applied measure **(via TTA measure instead of traditional CASA regulation).**

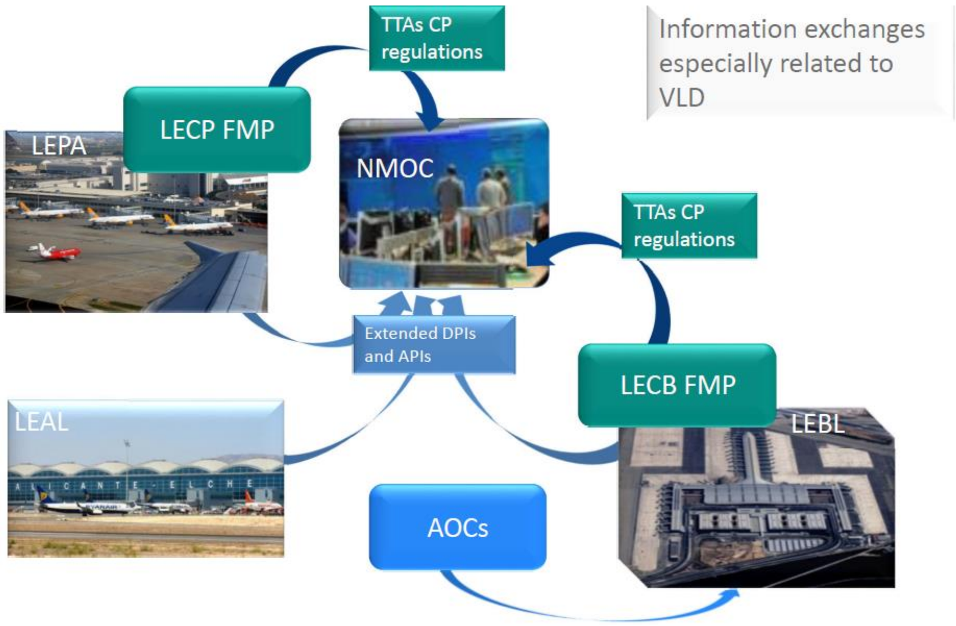


Figure 21: Demonstration Sites

Specifically, the VLD PJ24 WP6 has endeavoured to achieve integration between multiple airports and the network through AOP-NOP data exchange and airport arrival management when an airport arrival DCB imbalance is detected by TTAs instead of the traditional ATFCM CASA regulation. The objective was also to demonstrate the benefits of moving from the current system to a new one taking into account the both airports and airline business rules with the aim to minimize the reactionary delays, which has been detected in several CODA studies as the biggest cause of delay in the European ATM network.

The following stakeholders were needed to conduct the demonstration:

- Air Navigation Service Provider (ANSP)
- Airport Operators (AO)
- Network Manager (NM)
- Airspace Users (AU)

Airspace Users participation

Air France AF (3a) and British Airways BA (3b) took the lead from AU side in EXE3 with participation of RYR and VLG. LHG only participated in the observer status. The OCC was informed and Dispatch provided the flight plans at least six hours before the flight. NOTAMS to inform Pilots about the trial were issued during the period.

Generally, it was expected that better AOP-NOP integration and the usage of Target Times would lead to an improvement of predictability for ANSPs and a reduction in delays for AUs.

TTAs issued during the EXE were expected to help improve predictability and therefore have a positive impact on punctuality.

The possibility of cherry picking was enabled for the EXE, but AUs required input was changed to simplify the process and the execution was too complicated to be carried out with limited resources.

Generally speaking we must assure that TT`s are coordinated with the CDM Airports and linked and calculated after take-off to realistically state DPI. We, for DLH-airline, cannot support our crews on short notice with SAM/SRM TTO information, since we have no technical ability to do so and not yet introduced Trial Target Time Over (TTO) for dedicated airports.

However, the crews were advised of the trial and expected to follow CTOT's.

The following active contribution was requested to airlines in the exercise:

- Early filing of Flight Plans.
- Disseminate the TTAs to the flight crew and recommend to fly as close as possible to the TTAs.
- Inform the airport about connecting passengers (optional).

More information can be found in the AU's Contribution section in this document.

AOP-NOP integration

AOP-NOP integration is the concept that fulfils the need of integrating the airport operations into the ATM network manager, with the aim of enhancing the accuracy and the predictability of the network operation in order to have a better usage of the current network capacity.

AOP-NOP integration concept is an extension of flight information exchange that is deployed through A-CDM procedures, where not only information from an outbound flight is exchanged between the airport and the network through the DPI messages, but also inbound flight information is exchanged through the API messages. The information exchange between the AOP and the NOP is achieved through SWIM-based services.

The objective of this exercise is to demonstrate the benefits for the ATM network of the integration of several airports beyond the current 3 hours of A-CDM airports.

The information exchange includes airport arrival and departure information covering from the planning phase to the execution phase.

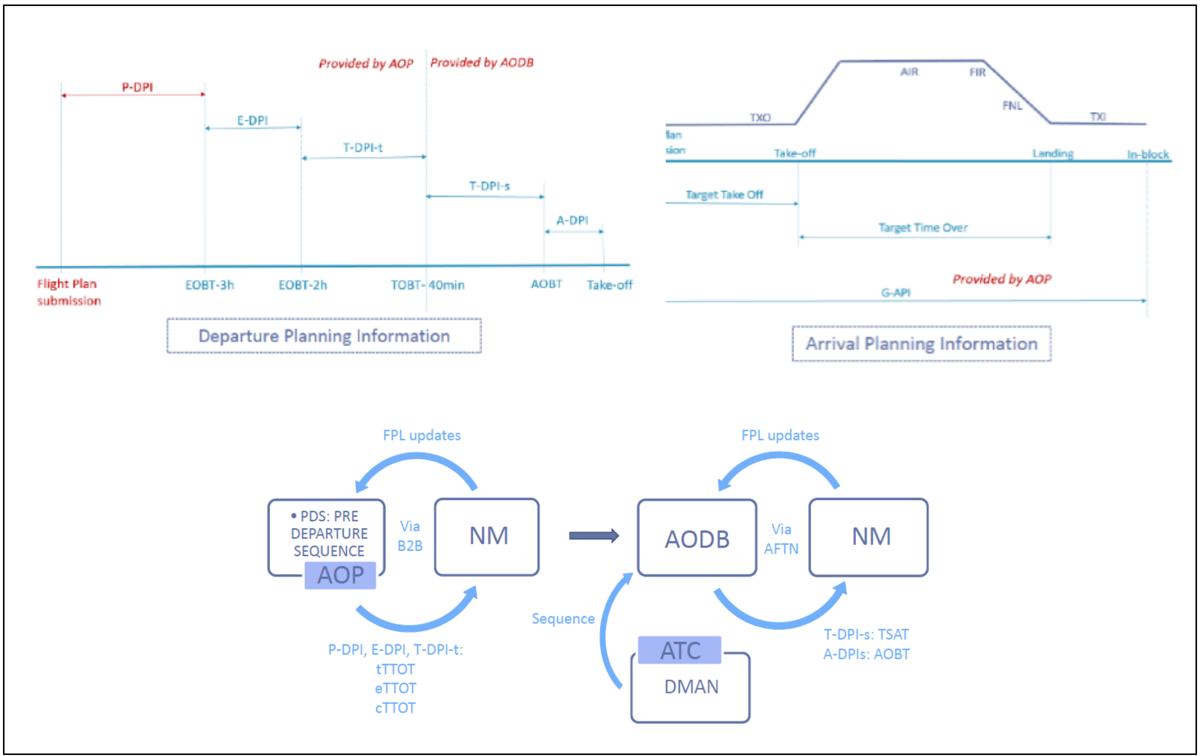


Figure 22: Information exchange AOP-NOP integration in LEBL & LEPA Airports

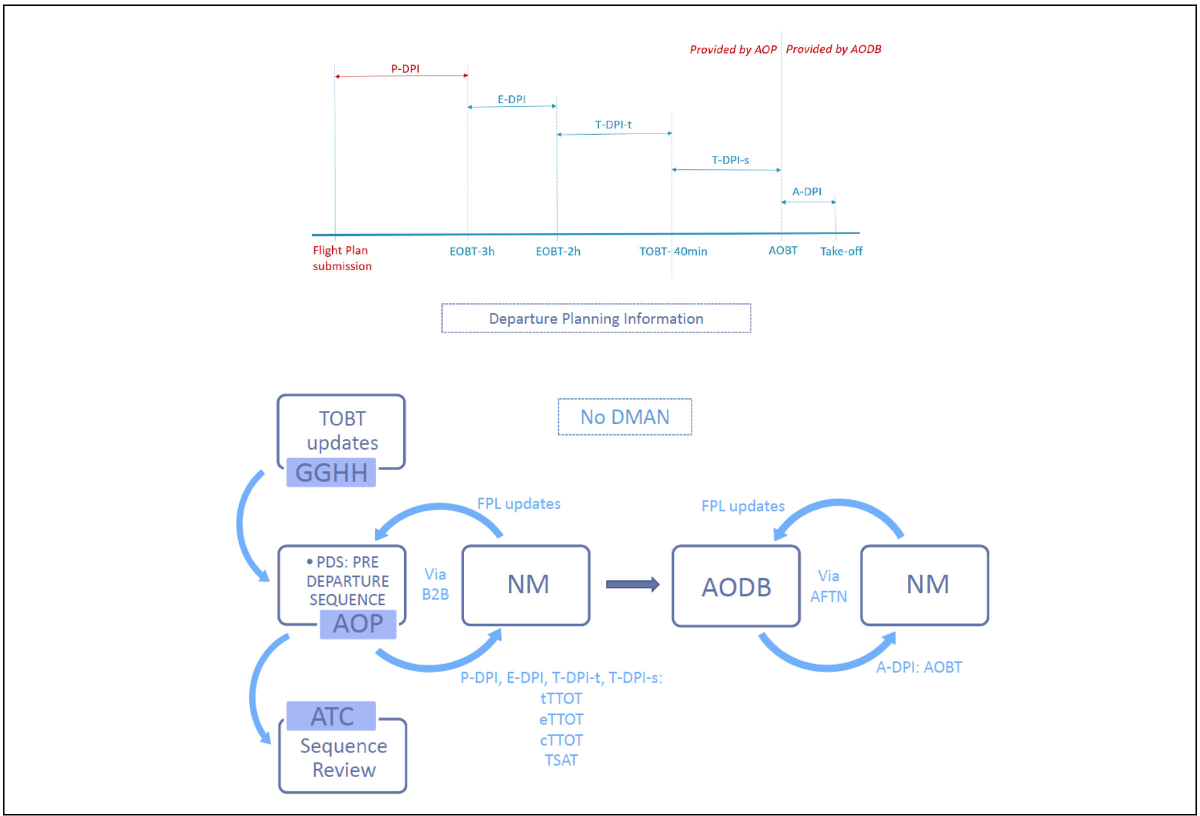


Figure 23: Information exchange AOP-NOP integration in LEAL Airports

The AOP/NOP Integration aspect of the exercise has given us the opportunity to demonstrate that a full integration NOP/AOP can improve the network predictability and accuracy.

The NOP has a dynamic and rolling lifecycle starting in the long-term planning phase and progressively updated up to and including the execution and post-flight phases. It supports and reflects the results of the collaborative ATM planning process.

The NOP facilitates and supports all ATM stakeholders' decision-making process providing a more accurate and predictable traffic demand forecast.

Gains in predictability were assessed focusing on two main predictability drivers: Improved accuracy of predictions of Departure Times via TTOT assessment compared to current operations and expanded Time horizon of predictions, from the current 3 Hours before EOBT to 9 hours before EOBT.

The predictability provided by AOP-NOP Integration was significantly better than the one obtained with flight plan data and in heavy traffic days, the predictability gain was even higher. The higher the traffic demand, the better the gain. The increase of predictability was clearly explained by the rolling exchange of DPI that provides the most up-to-date take-off times according to the (heavy) traffic situation.

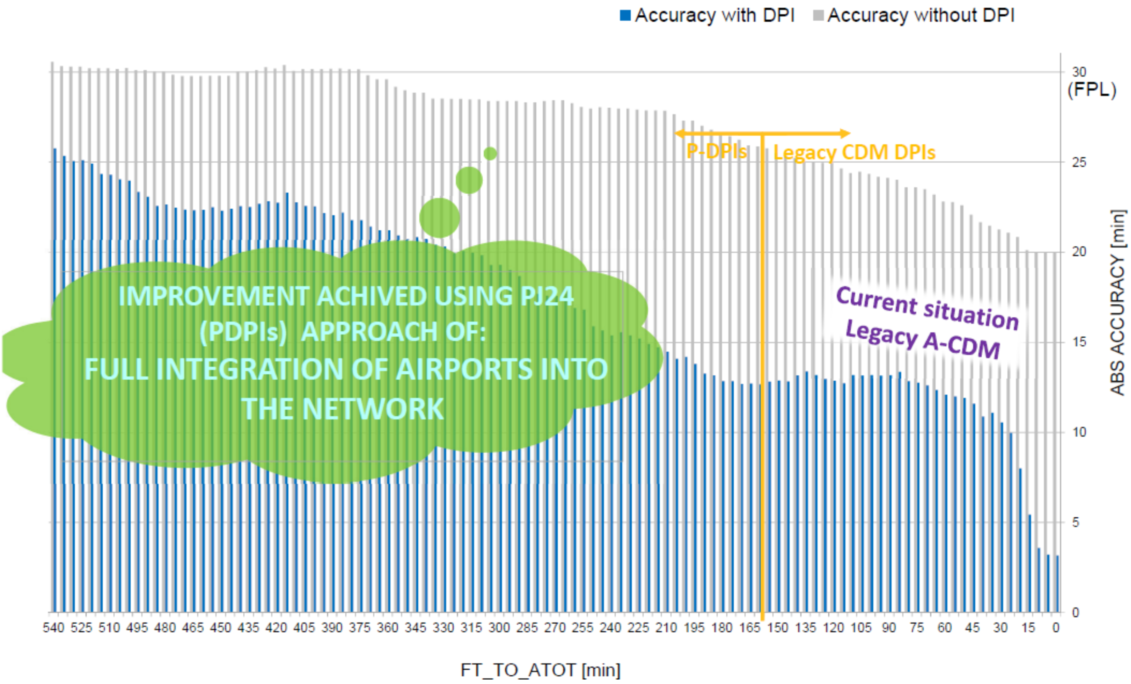


Figure 24: Predictability ALL TTOT→ATOT

TTA Management process

The TTA Management concept is a new collaborative procedure to optimize any demand capacity imbalance at the airport arrival sector. When an imbalance is detected, the Airport and FMP will coordinate a resolution process with the airport launching the AIMA to solve it during the Planning phase. Specifically, instead of using flow rate ATFCM measures, hotspot resolution is based on Target Times of Arrival (TTA) proposed by a local DCB tool using local business rules. TTA are pre-departure constraints provided by the destination airport to NMOC during defined periods of 'hotspot' or Demand-Capacity Imbalance.

Under congested situations, the integration of the airports in the arrivals management process, can improve airports arrival predictability and punctuality and reduce the next aircraft leg departure delay (knock-on effect) at the congested airport.

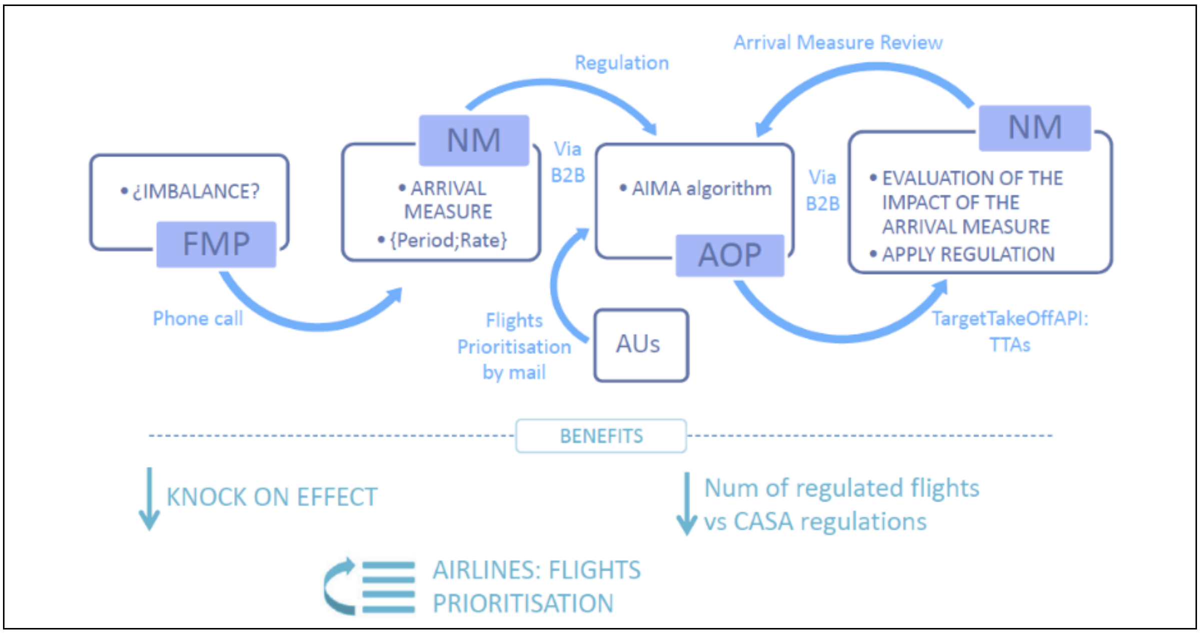


Figure 25: TTA Management flow in LEBL & LEPA Airports

Use Cases detail

The use cases related to Airport – Network integration focus on integrating airport arrival requirements into network planning processes and identifying resulting target time measures.

The use cases for Airport - Network integration focus on bringing airport proposed measures (target times mainly) in the network coordination processes and on the monitoring of the delivery of arriving flights according to the requested target times.

These were the finally carried out use cases:

- UC 3.1: Detect Arrival Demand & Capacity imbalance during the planning phase.
- UC 3.2: Analysis and Coordination of the A-DCB management proposals during the planning phase.
- UC 3.3: NM acceptance of the A-DCB management proposals during the planning phase.
- UC 3.4: Detect and Resolve Arrival and Departure Demand & Capacity imbalance between multiple airports during the Short Term planning and Execution phases. Depart to CTOT and FLY to TTA.
- UC 3.5: Dynamic Exchange of arrival and departure information from airport to network as from FPL reception.

Plan

The exercise has been organized in two parts:

1. AOP-NOP integration, which has been established and kept on during the whole VLD.
2. TTA Management process has been organized in certain time-periods where a thorough monitoring of the exercise has been present.

The exercise has run in 4 weeks' time. First week has been dedicated to review the demonstration infrastructure and configuration, to hold a Demonstration Kick-Off Meeting, and to start running the AOP-NOP integration of the three Spanish airports (ALC, BCN, PMI). From the second week until the exercise end, it has been dedicated to demonstrate the airport arrival management using TTA.

- The AOP-NOP Integration has started 1 week prior to TTA VLD. The three Spanish participating airports were connected the same date, with some delay between each other so that basic checks were performed by EUROCONTROL, Aena and INDRA, and it has run seamlessly during 4 weeks.
- The TTA Management process has been built upon the AOP-NOP integrations, first starting with BCN airport, then PMI one week later.

Platform used

The demonstration infrastructure has been formed by five main system components (NMOC, FOC, AICRAFT, APOC, ANSP (ACC/TMA/TWR/SACTA)) together with two main communication channels (B2B (SWIM), AFTN).

Systems and Operational Actors

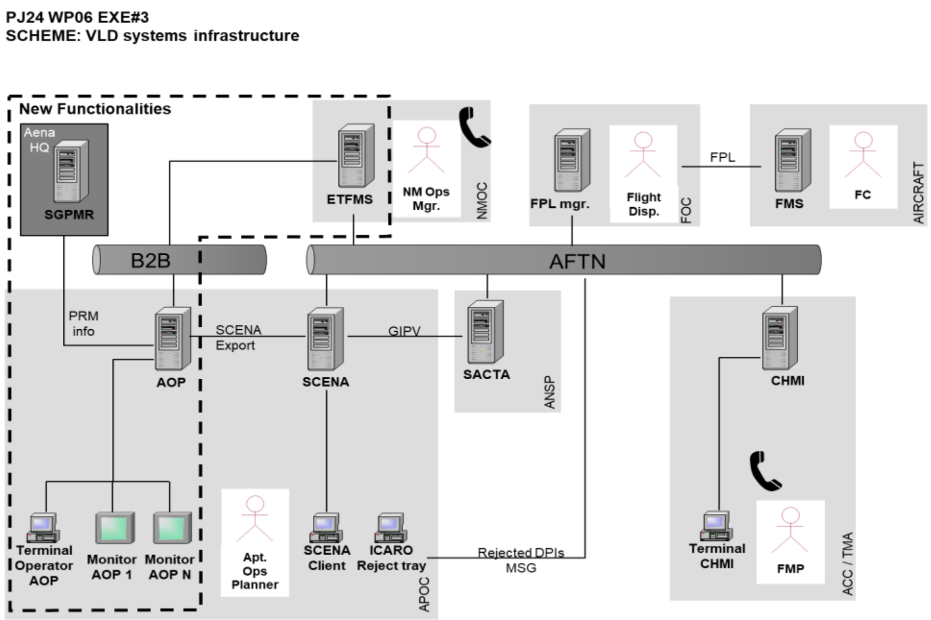


Figure 26: Platform used

The scheme above depicts the systems providing **the new functionalities** used in the EXE#3a (left hand side) as described below:

- ETFMS is the main system provided by NMOC. The Traffic Demand, the API and the extended DPI services provided by NMOC through B2B (SWIM) are essential technological enablers for this exercise. This exercise has been carried out under NM 23.0 Release, although the B2B release will be 22.5.
- AOP is the main system provided by the APOC. The AOP consumes 'traffic demand data' and provides 'airport arrival and departure planning information' through B2B (SWIM) services provided by NMOC. The AOP is fed by the Airport Operational Database (SCENA) and with flight plan information from the ANSP (SACTA-GIPV). It will also receive PRM information from Aena's SGPMR system, and connecting passengers' information directly from the AUs to enhance the traffic predictions.)

Furthermore, a set of legacy systems provided key functionalities that are also necessary to run EXE#3a but are not considered as new elements brought about by the SESAR solution. Such systems are listed below:

- Flight Plan Manager system by the FOC (AUs' Flight Operations Centres)
- FMS by the AIRCRAFT
- EUROCONTROL CHMI by the ACC.
- SACTA System (including GIPV and DMAN subsystems)

- SCENA: Aena´s AODB and A-CDM Platform.
- ICARO System: Enaire´s FPL , AIS and AFTN COM system.
- SGPMR: Aena's system for the management of PRM information.

AU contribution

The ATEAM AU Consortium, in particular Air France and Ryanair, have participated in PJ24 Exe3A providing expertise in the area of flight planning/dispatching, analysing the concept, scope and results of the exercise as well as future implications and next steps.

The concrete actions that were requested to Airspace Users in the context of NCM Exe 3A were the following:

Early filing of FPL

This action is necessary so that API and DPI messages can be handled by the systems many hours in advance. In later stages, the notions of SBT/RBT are expected to replace this temporary workaround.

Ideally, airlines were requested to submit the flight plans at least 12 hours before the departure time. This requirement was followed by the different members according to their internal procedures.

AU Consortium member	FPL Filing
Air France	6 hours before departure
Ryanair	7 hours before departure
Lufthansa Group	6 hours before departure
Easyjet	7 hours before departure

Statistics provided by Eurocontrol

For most major operators, Medium Haul flights flight plans are generated and filed automatically by the CFPS (the dispatchers only handle specific flights in exception mode, if particular circumstances apply to those flights). In principle, the airlines are available to adjust this configuration of the CFPS, but flight plans calculated too much in advance are unreliable because of the incomplete knowledge of all circumstances (g. weather) and will therefore be modified; as said, better solutions around the notion of "trajectory" are being developed in SESAR to allow the support of early predictions and information exchanges.

TTA Dissemination

The TTA/TTOs were communicated via SAM message to the airlines' OCC.

Airlines were requested to communicate the TTAs to the flight crew, when a TTA regulation was applied to a flight, with the purpose to adhere to it if possible (see "Fly TTA" below).

On this requirement, every AU has followed its internal procedure.

At Ryanair, to be aware of this notification, flight planners and ops controllers should review each of the SAM messages received in order to get the details regarding TTA regulation. Due to the size of Ryanair's fleet, the action was not practical to carry out and therefore, flight crew didn't receive the information on time. However, the OCC monitored and analysed the flights during the whole exercise.

Air France and Swiss use Acars to notify to the crew on the aircraft the latest information about regulations. As part of this information, the point of the route where the regulation applied is given, with the Target Time Over this point, besides the CTOT and/or TSAT resulting from the regulation.

The lack of a standardized way to recognize "TTA" regulations from "traditional" regulations was recognized as a shortcoming of the current implementation, because it does not facilitate specialized treatment of those regulations.

In any case, all airlines put in place internal communication in various forms, to remind to the pilots how to interpret the TTA information.

Fly TTA

The exercise did not expect adherence to TTAs within a specified tolerance. On the contrary, the assumption is made that adherence to the assigned departure time (CTOT, with its tolerance) and to the filed flight plan will reflect in adherence to the times-over calculated based on those timings. As it is known, circumstances happening during flight execution may cause a difference, and the pilot can control those circumstances only to a limited extent.

Nevertheless, a recommendation was made to pilots to take in consideration the TTAs distributed together with the departure constraints (TSAT/CTOT) and try to fly accordingly. NOTAMs about the exercises where TTAs were applied had been distributed as well.

Surveys were put in place to collect direct input from the flight crews. Air France put in place a survey on the mobile application accessible to all medium-haul pilots where it was asked whether TTAs had been assigned to their flight and how this impacted flight execution. In fact, very few crews returned the survey, and none for the NCM Exe 3A flights. Similarly, Ryanair set an online survey to be transmitted via EFB to the pilots. However, the survey was finally not distributed because of the impossibility to notify the TTA, as explained earlier.

Connecting Passengers Information (flights prioritization)

The Airport Impact Assessment Model ("AIMA", as described in the OSED document for Solution #21) gives the possibility to airlines to indicate the "severity" (in the AIMA sense of this term) of specific flights from the AU point of view.

This parameter, called “Airline Contribution”, allows to reflect the impact of delay according to the airline's own business rules. Depending on the circumstances of the day, the same "amount" (minutes) of delay causes more or less problems on different flights, because of for example, different rebooking possibilities for passenger mis-connections; end-of-day curfew issues on the aircraft rotation; or regulatory service times limits for crew; usually multiple of these or other aspects apply.

The implementation of this process by Exercise 3A went through different phases. It was at first specified only as a daily e-mail containing the number of passengers connecting on inbound-and-departing flight pairs. Later it was generalized to indicate just "severity" for specific arrival flights. To ensure a fair process, the number of flights that a single AU could prioritize in this way was limited to 10% of the scheduled flights for one operator.

The ATEAM airlines barely use this mechanism, which was considered difficult to drive (limited application windows) and with little expected effect (priorities defined at D-1).

The "AU severity" mechanism was implemented by Barcelona airport only. Palma de Mallorca airport decided not to use any.

Demonstration technique

To evaluate the demonstration exercise objectives, two types of assessment were defined: a quantitative assessment and a qualitative assessment.

Qualitative assessment

To assess qualitatively the impact of AOP-NOP integration and TTA management, the following mean has been used:

- Questionnaires → Three different online questionnaires, one for the FMPs/ATCO, one for the NM, and the other one for the AU.

Quantitative analysis

During the exercise, the following types of data have been collected:

- Information coming from the NM.
- Flight Plans already filled and implemented in the system.
- Flights affected by TTAs if a hotspot or an imbalance is detected.
- KPI production based on situation awareness.
- Data collected by SCENA, AOP (AIMA), CODA, OPS (CASA)

The collection of data have been assessed in alignment with the Demonstration Objectives, defined in the sections E.1.2. Based on these objectives, the KPAs addressed have been the following:

- Safety

  The aim of this KPA is to evaluate the impacts of using enhanced DCB measures and TTA measures.

- Predictability

  Working with similar DCB imbalance scenario used as reference will be the way to assess the higher percentage of flights arrived as planned in the solution scenario. It is expected collecting several data, amongst others: AIBT, SIBT, AOBT, and SOBT.

- Efficiency (Costs)

  The improvement can be measured by assessment of the reduction of knock-on effects, due to the correct selection of flights to be delayed by the AIMA algorithm. It is expected collecting several data, amongst others: AOBT, SOBT, ARDT, ASAT, TOBT, EXOT, CTOT, AIBT, XTTT, SIBT and reason of delay (CODA codes or other sources).

- Capacity

  The nature of the DCB Imbalance is at the aerodrome so to assess that the number of aircraft managed per hour per volume of airspace is increased compared to baseline need to be deeply study in order to find the correct metric to measure it and to obtain conclusive results. Nevertheless, within this exercise, what can be measured is the fact the there is a relevant resilience improvement due to the concept; specifically, it is expected that with new concept addressed there will be a reduction in the wasted slots because an arrival regulation. Explained in a different manner, from all the regulated flights affected by an arrival capacity regulation, there will be less of them losing their slot. For measuring it, the following data at least will be collected: ATOT, CTOT, EOBT, and TTOT.

Static Variable	Sources				All Airports
	SCENA	AOP	CODA	EUROCONTROL	
CTOT				X	X
TTOT	X	X			X

ETOT	X	X			X
AOBT	X	X			X
SOBT	X	X			X
ARDT	X	X			X
ASAT	X	X			
TOBT	X	X			X
EXOT	X	X			X
AIBT	X	X			X
XTTT	X	X			X
SIBT	X	X			X
MPR (Flag The Most Penalizing Regulation)				X	
EIBT	X	X			X
ELDT				X	X
COBT				X	X
EOBT				X	X
ASRT	X	X			
ATOT	X	X			X
TTA		X			
EXIT	X	X			X
IATA Delay Codes			X		X
ALDT	X	X			X

Dynamic Variable	Snapshots	Sources		
	Reference moment to capture	SCENA	AOP	EUROCONTROL
CTOT	* In origin * 2 hours before the regulation starts * when the regulation starts * 1 hour after the end of the regulation period			x
ETOT	* In origin * 2 hours before the regulation starts * when the regulation starts * 1 hour after the end of the regulation period	x	x	
EIBT	* Latest EIBT before departing from outstation	x	x	
ELDT	* Latest ELDT before arriving			x
TTOT	* Beyond 3h * Values that cover the evolution in flights with second or third jumped airports	x	x	

E.1.2 Summary of Exercise #03a Demonstration Objectives and Success Criteria

The table below provides a summary of the Demonstration objectives and the success criteria addressed by the exercise.

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 3 Objectives	Demonstration Exercise 3 Success criteria

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 3 Objectives	Demonstration Exercise 3 Success criteria
OBJ-VLD-01-001	**CRT-VLD-01-001**	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solution contribute therefore partially to the objective as described.	**EX3-OBJ- VLD-01-001** Acceptable increase in workload for network operations planning actors to apply the proposed solution enhanced DCB and TT measures to optimally use network capacity (TTA EXE)	**EX3- CRT-VLD-01-001** The usage of the proposed solution enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload
OBJ-VLD-01-003	**CRT-VLD-01-003**	Fully Covered.	**EX3-OBJ- VLD-01-003** Reduction of necessary ATC interventions to de-bunch and optimally sequence traffic entering departure and arrival sectors (TTA EXE)	**EX3- CRT-VLD-01-003** The usage of the proposed enhanced DCB and TTs does not have a negative impact on ATC TWR/APP operational staff workload
OBJ-VLD-01-004	**CRT-VLD-01-004**	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solutions contribute therefore partially to the objective as described.	**EX3-OBJ-VLD-01-004** Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied (TTA EXE)	**EX3-CRT-VLD-01-004** Positive feedback from operational staff regarding a clearly defined DCB coordination process.
OBJ-VLD-02-001	**CRT-VLD-02-001**	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solutions contribute therefore partially to the objective as described.	**EX3-OBJ-VLD-02-001** Assess the improved network predictability due to the earlier, beyond the current A-CDM, departure and arrival data and estimates exchanges	**EX3-CRT-VLD-02-001A** Network traffic demand accuracy. The distribution of predicted-actual flights in NM platform is narrower than current operations. EX3-CRT-VLD-02-001B More actual (compared to airport

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 3 Objectives	Demonstration Exercise 3 Success criteria
				data and/or actuals) flight departure and arrival time estimates, other airport related data and profiles
OBJ-VLD-02-002	**CRT-VLD-02-002**	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solutions contribute therefore partially to the objective as described.	**EX3-OBJ-VLD-02-002** Reduce the margins between planning and actual for flight entering the actors AoR due to unforeseen changes in the execution of the European Network operations (TTA EXE)	**EX3-CRT-VLD-02-002** The distribution of early/late arrivals at the entry points of the AoR of actors is narrower than current operations.
OBJ-VLD-02-003	**CRT-VLD-02-003**	Fully covered	**EX3-OBJ-VLD-02-003** Reduce the margins between planning and actual for flight landing on the runway for the airports involved in the exercises due to unforeseen changes in the execution of the European Network Operations. (TTA EXE)	**EX3-CRT-VLD-02-003** The distribution of early/late arrivals at the runway of the airports involved in the exercise is narrower than current operations.
OBJ-VLD-04-001	**CRT-VLD-04-001**	Partially covered: Exercise activities form part of overall network cooperative processes and this proposed solutions contribute therefore partially to the objective as described.	**EX3-OBJ-VLD-04-001** Reduction in time for NMOC staff to monitor, analyse, coordinate and implement measures to balance demand–capacity (TTA EXE & AOP-NOP EXE)	**EX3-CRT-VLD-04-001** NMOC workload is not increased, and NMOC confidence that TTA measure resolves DCB

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 3 Objectives	Demonstration Exercise 3 Success criteria
OBJ-VLD-04-002	**CRT-VLD-04-002**	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solutions contribute therefore partially to the objective as described.	**EX3-OBJ-VLD-04-002** Reduction in time for AU staff to monitor, analyse, coordinate and implement measures to balance demand–capacity (TTA EXE & AOP-NOP EXE)	**EX3-CRT-VLD-04-002** AU workload is not increased, and AU confidence that TTA measure resolves DCB
OBJ-VLD-04-003	**CRT-VLD-04-003**	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solutions contribute therefore partially to the objective as described.	**EX3-OBJ-VLD-04-003** Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity (TTA EXE)	**EX3-CRT-VLD-04-003** FMP workload is not increased, and FMP confidence that TTA measure resolves DCB
OBJ-VLD-05-004	**CRT-VLD-05-004**	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solutions contribute therefore partially to the objective as described.	**EX3-OBJ-VLD-05-004** Reduce delay resulting from better ATFM measures definition through improved coordination by means of multi-airport planning (TTA EXE & AOP-NOP EXE)	**EX3-CRT-VLD-05-004** Overall delay reduction for group of airports compared to baseline scenario

E.1.3 Summary of Demo Exercise #03a Demonstration Scenarios

SCN-EX3a	
Scope of the Demonstration Exercise	The Scope of the Demonstration Exercise is to achieve the integration between multiple airports and the network through AOP-NOP data exchange and airport arrival management, when an airport arrival DCB imbalance is detected, using TTAs instead of the traditional ATFCM CASA regulation. The VLD is performed at the airports of Barcelona, Alicante and Palma de Mallorca (AOPs). It will include the corresponding Enaire ACC (FMPs), the Network Manager (NOP) EUROCONTROL in NMOC, and airlines AU.
Demonstration Objectives	EXE3-OBJ-VLD-01-001 EXE3-OBJ-VLD-01-003 EXE3-OBJ-VLD-01-004

	EXE3-OBJ-VLD-02-001 EXE3-OBJ-VLD-02-002 EXE3-OBJ-VLD-02-003 EXE3-OBJ-VLD-04-001 EXE3-OBJ-VLD-04-002 EXE3-OBJ-VLD-04-003 EXE3-OBJ-VLD-05-004
Operational Context	As described before this exercise will take place in the operational environment, utilising the associated operational traffic, as it develops, on the day in question. Thus, some scenarios will occur frequently and some may not be witnessed at all, this is the nature of working in an operational environment of which we have little control. Of course, the time slots for the exercise will be chosen carefully to ensure that as many scenarios as possible are likely to occur.
Initial condition	AOP-NOP Integration No initial condition is needed; this scenario can be performed in any circumstance however to measure the real advantage of this tool it is desirable to have some busy days of operations TTA Management. An imbalance is detected at an airport for arrivals
Key Roles	AOP-NOP Integration • NOP to integrate API and DPIs messages from participating AOPs together with today's A-CDM DPIs. • NOP to update and publish traffic demand data. • Airport to monitor SCENA • Airlines to submit FPLs at least 12 hrs before SOBT. • AOP to send the extended departure planning information over NM B2B web services (SWIM). • AOP to send the arrival planning information (API) over NM B2B web services (SWIM). • SCENA to send the departure planning information over AFTN. TTA Management • NOP to activate and monitor Network Cherry Pick Measures when requested by the FMPs to solve a local hotspot. • Airport to monitor TTA regulations and interfaces with TWR and airspace users. • Airlines to provide in advance their priority. • Airlines to fly the TTAs (it is optional, but if desired to provide feedback). • AOP to publish airport data (TTO-API) as soon as the Cherry Pick regulation is created and to share them with NOP. • FMP to follow the procedure for TTA implementation.
Assumptions	Same as in section E1.4

Reference Scenario(s)

As this exercise has two different objectives, there would be two different reference scenarios:

- AOP-NOP integration reference scenario will be the flight plans since this information is the current base upon which the stakeholders take their decisions nowadays.
- TTM reference scenarios will be current operations (not using the TTM) in days similar to the ones used to perform the solution scenarios.

Solution Scenario(s)

There are different solution scenarios depending on the objectives addressed in the demonstration. These scenarios can be grouped depending on these objectives. AOP-NOP integration scenario and TTM scenario will be demonstrated separately to avoid results crossed effects.

- AOP-NOP integration scenario will cover form EOBT-24h until aircraft departure, visiting all aircraft flight steps from schedule to execution and through its intermediate stages as FPL filling, A-CDM monitoring and so on.
- TTM scenario will address the resolution of an airport arrival DCB imbalance during the pre-tactical phase of operations covering the monitoring of the applied DCB measures during the execution phase.

E.1.4 Summary of Exercise #03a Demonstration Assumptions

The following assumptions were considered.

Title	Description	Justification	Flight Phase	Source	Impact on Assessment
Fight profile	Flight trajectories will be used by NM to back-calculate CTOTs	When TTAs are sent to NM, NM will back-calculate CTOTs in line with the trajectories in their system (which is taken from flights plans). We assume that these are accurate.	Planning Phase	Expert opinion	Medium

OPVAL	limitations of the OPVAL when simulating the classical regulations	The simulation reflects the duration of the TTA regulation even if extended.	Planning Phase		

Table 23: Demonstration Assumptions – EXE3a

E.2 Deviation from the planned activities

There were the following deviations from the planned activities identified with respect to the DEMO Plan PJ24 NCM EXE#03a:

1. AOP-NOP Scenario with PFD, in this demonstration there was not PFD, as this service was not implemented; the solution scenario performed was only the one of AOP-NOP without PFD. This affected the Use cases 3.6 and 3.7.
2. All solution scenarios for TTM as stated in the DEMOP:
   - TTM Scenario due to an Over Demand
   - TTM Scenario due to Capacity Shortfall
   - TTM Scenario with Multi Constrains
   - TTM Scenario monitoring in the Execution phase

   They were grouped in a single one named "TTM scenario".
3. LEMD did not take part in the execution.
4. LEAL executed the VLD within the timeframe but in other dates.

E.3 Demonstration Exercise #03a Results

E.3.1 Summary of Exercise #03a Demonstration Results

The following table summarizes the demonstration results by objective.

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Demonstration Objective Status
EX3-OBJ- VLD-01-001	Acceptable increase in workload for	**EX3- CRT-VLD-01-001**	The usage of the	The workload to apply a TTA	OK

	network operations planning actors to apply the proposed solution enhanced DCB and TT measures to optimally use network capacity (TTA EXE)		proposed solution enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload	measure was acceptable in the Network Operation Planning task. (FMP 76% agree or strongly agree) (NM 50% agree or strongly agree, 17% Neither agree nor disagree)	
EX3-OBJ- VLD-01-003	Reduction of necessary ATC interventions to de-bunch and optimally sequence traffic entering departure and arrival sectors (TTA EXE)	**EX3- CRT-VLD-01-003**	The usage of the proposed enhanced DCB and TTs does not have a negative impact on ATC TWR/APP operational staff workload	The workload to de-bunch and sequence the traffic was acceptable. (ATCO 60% agree or strongly agree, 20% Neither agree nor disagree)	OK
EX3-OBJ-VLD-01-004	Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied (TTA EXE)	**EX3-CRT-VLD-01-004**	Positive feedback from operational staff regarding a clearly defined DCB coordination process.	Operational staff is able to maintain situational awareness in the coordination task with NM put in place to implement TTA measure. (FMP 90% agree or strongly agree) (NM 42% agree or strongly agree, 8% Neither agree	OK

				nor disagree) Operational staff is able to coordinate the implementation of TTA measure with NM in a timely manner. (FMP 80% agree or strongly agree) (NM 50% agree or strongly agree)	
EX3-OBJ-VLD-02-001	Assess the improved network predictability due to the earlier, beyond the current A-CDM, departure and arrival data and estimates exchanges	**EX3-CRT-VLD-02-001A** **EX3-CRT-VLD-02-001B**	Network traffic demand accuracy. The distribution of predicted-actual flights in NM platform is narrower than current operations. More actual (compared to airport data and/or actuals) flight departure and arrival time estimates, other airport related data and profiles	#PI-21 Departure predictability improvement in the TTOT information provided by EDPIs (extended DPIs) when using “business trajectory” concept and XTTT #PI-20 Accuracy improvement in the TTOT information provided by EDPIs (extended DPIs) when using XTTT	OK
EX3-OBJ-VLD-02-002	Reduce the margins between planning and actual for flight	**EX3-CRT-VLD-02-002**	The distribution of early/late	#PI-29 Estimated Landing time of	OK

	entering the actors AoR due to unforeseen changes in the execution of the European Network operations (TTA EXE)		arrivals at the entry points of the AoR of actors is narrower than current operations.	the TTA flights vs Actual Landing Time	
EX3-OBJ-VLD-02-003	Reduce the margins between planning and actual for flight landing on the runway for the airports involved in the exercises due to unforeseen changes in the execution of the European Network Operations. (TTA EXE)	**EX3-CRT-VLD-02-003**	The distribution of early/late arrivals at the runway of the airports involved in the exercise is narrower than current operations.	#PI-29 Estimated Landing time of the TTA flights vs Actual Landing Time	OK
EX3-OBJ-VLD-04-001	Reduction in time for NMOC staff to monitor, analyse, coordinate and implement measures to balance demand–capacity (TTA EXE & AOP-NOP EXE)	**EX3-CRT-VLD-04-001**	NMOC workload is not increased, and NMOC confidence that TTA measure resolves DCB	The time to design and implement a TTA measure was not increased in the Network Operation Centre. The workflow impact of applying the rate calculation (FMP rate x3) to the Network Cherry Pick arrival measure was acceptable (NM 75% agree or strongly agree) NMOC staff is able to monitor for traffic surges (bunching)	OK

				using the slot list influenced regulations tool in the slot list. (NM 42% agree or strongly agree, 33% Neither agree nor disagree) NMOC staff is able to recognize that the regulation was a Network Cherry Pick arrival measure when dealing with AU calls/e-help requests. (NM 75% agree or strongly agree)	
EX3-OBJ-VLD-04-002	Reduction in time for AU staff to monitor, analyse, coordinate and implement measures to balance demand–capacity (TTA EXE & AOP-NOP EXE)	**EX3-CRT-VLD-04-002**	AU workload is not increased, and AU confidence that TTA measure resolves DCB.	#PI-4 Recovery and Mitigation of Reactionary Delay PI4 above 95% and reference scenario above 97%	Partially OK
EX3-OBJ-VLD-04-003	Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity (TTA EXE)	**EX3-CRT-VLD-04-003**	FMP workload is not increased, and FMP confidence that TTA measure resolves DCB	FMP is moderately confident that the implemented TTA measure will resolve the Demand and Capacity imbalance. (FMP 43% agree or strongly agree,	Partially OK

				34% neither agree nor disagree)	
EX3-OBJ-VLD-05-004	Reduce delay resulting from better ATFM measures definition through improved coordination by means of multi-airport planning (TTA EXE & AOP-NOP EXE)	**EX3-CRT-VLD-05-004**	Overall delay reduction for group of airports compared to baseline scenario	#PI- 28 Measure the predictability (AOP-NOP exercise part) i.e. the evolution of the EIBT of the second or third airport from hours ago.	Not measured due to lack of data

Table 24: Exercise 3 Demonstration Results

1. Results per KPA

KPA	Objective ID	KPA result
Safety	EX3-OBJ-VLD-01-001 EX3-OBJ-VLD-01-003 EX3-OBJ-VLD-01-004	As explained in E.3.31, E.3.32 and E.3.33, FMP, ATCO and NM think that safety is not compromised when applying TTA measures.
Predictability	EX3-OBJ-VLD-02-001 EX3-OBJ-VLD-02-002 EX3-OBJ-VLD-02-003	As elaborated in E.3.34, E.3.35 and E.3.36, results show that AOP-NOP integration and TTA process is perceived as an improvement of predictability of traffic for an ANSP.
Efficiency (Cost)	EX3-OBJ-VLD-04-001 EX3-OBJ-VLD-04-002 EX3-OBJ-VLD-04-003	As explained, E.3.37 and E.3.38, the AOP-NOP integration and TTA process are perceived as feasible and can work in an operational environment, with expected benefits to reduce knock-on effects and it contributes to the efficiency of Airspace Users and ANSPs processes to solve DCB issues.
Capacity	EX3-OBJ-VLD-05-004	Not measured due to lack of data.

Rationale of each KPI

ID	KPA	KPI	
#PI-1	Capacity	CAP4 Un-accommodated traffic reduction (wasted slots)	From those flights with a CTOT (in other airports different from the one validated) due to an aerodrome regulation in destination, calculate for those flights that do not comply with the tolerance window (ATOT out of -5+10 newCTOT (in this case in our airport) or +- 5min TTOT if flight is going to an A-CDM airport and has not been regulated, or +-15min (EOBT+TT) if flight goes to a non-A-CDM airport and is not regulated) and also calculate the value of that deviation. All---- Regulated----- CTOT - 5min +10min A-CDM Non regulated TTOT ± 5min No A-CDM Non regulated (EOBT+TT) ± 15min

#PI-2	Punctuality	PUN3 % Departures < +/- 3 mins vs. schedule due to Airport ATM Factors	Two metrics: 1) % Departures (AOBT-SOBT)< +/- 3 mins when ARDT < ASAT-2min 2) New additional: Departures punctuality among all those flights scheduled turnaround time is achievable--- % Departures (ARDT-SOBT)< +/- 3 mins when ARDT < ASAT-2min) We have used all the flights on the trial period (not only the TTA affected ones). Comparison between the estimated airport punctuality (SCENA) and the predicted by the AOP AOBT, SOBT, ARDT, ASAT
#PI-3	Behavioural	Behavioural KPI: % of flights in airport flight list with Most Penalising regulation due to a TTA reg vs those which is another en-route or exempted	% Departures (AOBT-SOBT)< +/- 3 mins when TOBT+EXOT < CTOT (to detect only the flights that are ready in origin (when the CTOT comes) and the CTOT is due to a regulation that is not our regulation). New things to measure: Most penalising field, total number of flights Closed with the new changes
#PI-4	Punctuality	PUN6% Departures < +/- 3 mins vs. schedule due to Recovery and Mitigation of Reactionary Delay	% Departures (AOBT-SOBT)< +/- 3 mins when AOBT<AIBT+XTTT Source Airport Tools or CODA or both of them.
#PI-5	Predictability	PRD1 Variance of Difference in actual & Flight Plan or RBT durations	PRD1: Comparison between the Actual In/Off Block Times and the coordinated airport slots. PRDA-1 Variance of Difference in (AIBT-SIBT) PRDA-2 Variance of Difference in (AOBT-SOBT)

#PI-6		Average delay improvement AIMA vs CASA ((ad-hoc) For Severity 2 flights)	Only for severity 2 flights We have agreed to compare the following snapshots: - 2 hours before the regulation starts - when the regulation starts - 1 hour after the end of the regulation period ATFM Delay will be calculated for severity 2 flights as the difference between CTOT and ETOT in origin (Maximum, Average and Total). AOP can provide this data 2 average will be calculated: - From the total of flights of the regulation - Only from the flights whose MPR is the one of study. To be recorded: CTOT in origin, ETOT in origin, MPR (Most Penalising Regulation), Severity, number of flights of the regulation AIMA (OPVAL) vs CASA (OPS)
#PI-7	**Access & Equity**	EQUI3 Total ATM Delay per AU relative to Baseline ATM delay	Focusing in arrivals delay... to compare the final solution (**latest EIBT before departing from outstation**) against the reference scenario (SIBT)... arrival delay (EIBT-SIBT) with AIMA per Airline. With CASA the same but (latest ELDT+"taxi-in time"-SIBT) per airline. Airports, define a baseline with CASA. Estimates vs schedule
#PI-18		ATFM Delay: API regulation vs Classical (CASA) regulation	Preferred option: to inform Fran Tortosa. Using OPVAL environmment to emulate the CASA regulation and use de OPS environment to emulate AIMA. The last snapshot to compare is before the first regulated flight is reported airborne Recording: CTOT in origin -ETOT in origin-- or -- COBT-EOBT MPR number of flights of the regulation Average delay = average delay for flights from the regulation flight list Total delay Max delay
#PI-19	1	**AOP-NOP Integration**	[ASRT(actual start request time) - TOBTaop vs ASRT - TOBTscena]

		Improve Airport Departure Predictability by increasing turnaround times predictability with the use of expected turnaround times (XTTT)	AOP will record ASRT, TOBTaop and the Airport will record TOBTscena
#PI-20	2	**AOP-NOP Integration** Accuracy (absolute deviation) improvement in the TTOT information provided by EDPIs when using XTTT	Regarding the 2 indicators calculating the average and standard deviation of: a) (TTOT -ATOT) vs (ETOT-ATOT), the idea is to see the evolution of the TTOTs from AOP and Airport throughout the time. In this way, every TTOT sent in the E-DPIs by AOP and Airport shall be recorded. b) (TTOTaop-ATOT) versus (TTOTacdm-ATOT) depending on time anticipation from flight departures (beyond 3h) Comparison with the actual system SCENA AOP will record TTOTaop, ETOT, ATOT and the Airport will record TTOTacdm. To compare the evolution of the results during the whole day of E-DPIs from AOP with E-DPIs from SCENA.
#PI-21	3	**AOP-NOP Integration** Predictability (standard deviation) improvement in the TTOT information provided by EDPIs when using “business trajectory” concept and XTTT	Regarding the 2 indicators calculating the average and standard deviation of: a) (TTOT -ATOT) vs (ETOT-ATOT), the idea is to see the evolution of the TTOTs from AOP and Airport throughout the time. In this way, every TTOT sent in the E-DPIs by AOP and Airport shall be recorded. b) (TTOTaop-ATOT) versus (TTOTacdm-ATOT) depending on time anticipation from flight departures (beyond 3h) Comparison with the actual system SCENA AOP will record TTOTaop, ETOT, ATOT and the Airport will record TTOTacdm. To compare the evolution of the results during the whole day of E-DPIs from AOP with E-DPIs from SCENA.
#PI-22	5	**TTA** Total delay of inbound flights within TTA regulation	Perform in the same way as the previous. Measuring the regulation day, busy day . AOP will record TTA, EXIT, SIBT, and NM will record ELDT, EXIT, SIBT from OPS Real data from OPS. TTA regulation in AOP vs Real

		period *(TTA vs CASA)*	Regulation in CASA Total Delay TTA(AIMA) < Total Delay CASA DelayTTA = TTA+EXIT-SIBT > 0 min DelayCASA = LDT+EXIT-SIBT > 0 min Derived data from the slot lists
#PI-23	6	TTA Mngt - CASA vs AIMA - Knock-on effect reduction: comparison of departure delays due to CASA regulation vs TTA allocation	AOP can provide the necessary data in order to calculate this indicator in OPEVAL (TTA reg). Airport tools will provide this data SIBT, SOBT, ARDT, AIBT in OPS. Real data from OPS. TTA regulation in AOP vs Real Regulation in CASA The link between aicrafts and flights should not be broken. Take out from the measure the ones that have the link broken. Arrival delay = AIBT-SIBT>0 Departure Delay= ARDT-SOBT>0 Airports have the data (and may be checked against CODA if desired ...Code 93)
#PI-29		Estimated Landing time of the TTA flights vs Actual Landing Time	To satisfy OBJ-VLD-02-003 (predictability of arrivals)

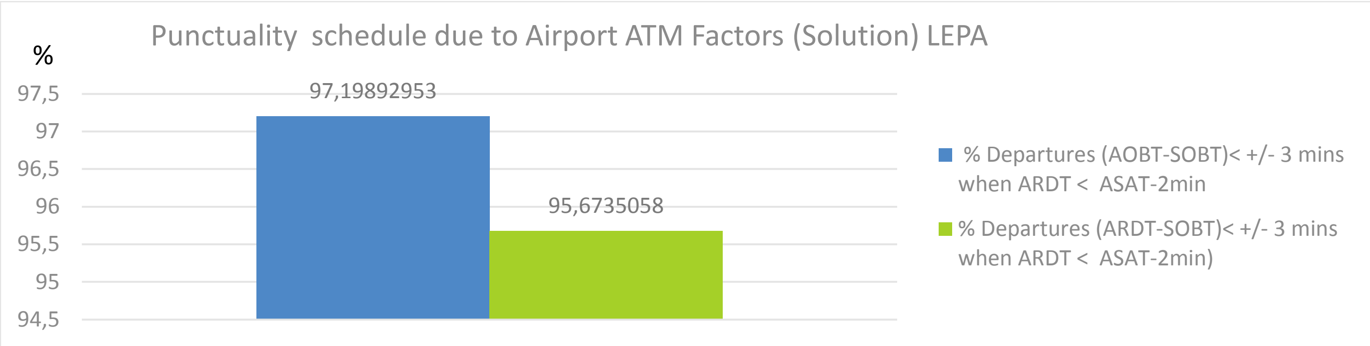
a. AOP/NOP integration

Efficiency (Cost)

#PI-2 Departures punctuality due to Airport ATM Factors

The “Solution” scenario is the EXE3a timeframe execution. The “Reference” scenario corresponds to the same period of last year (2018). Data source is the AODB for both cases. In line with “on-time” definition based on SESAR Performance Framework. As seen in the graphs, for both LEPA and LEBL, the punctuality is slightly better than same period last year.

LEPA



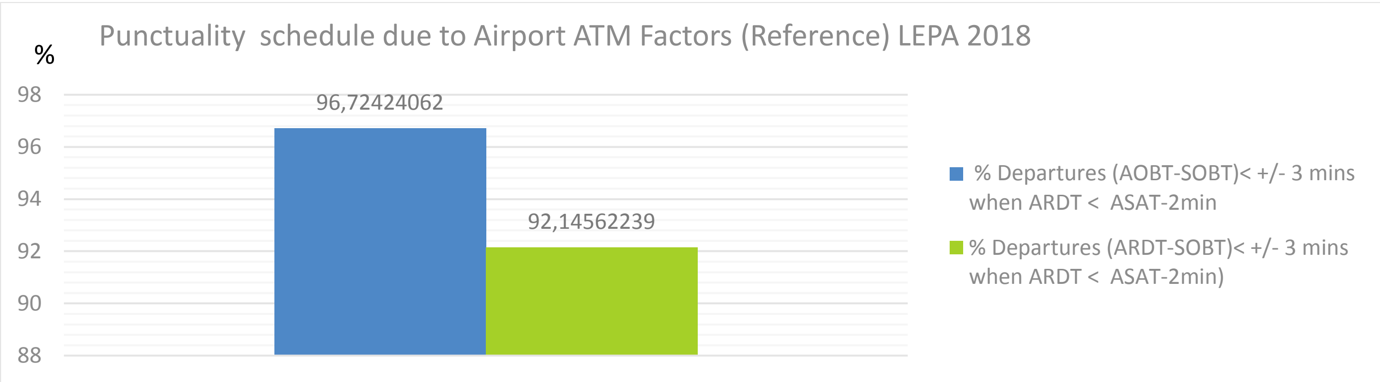
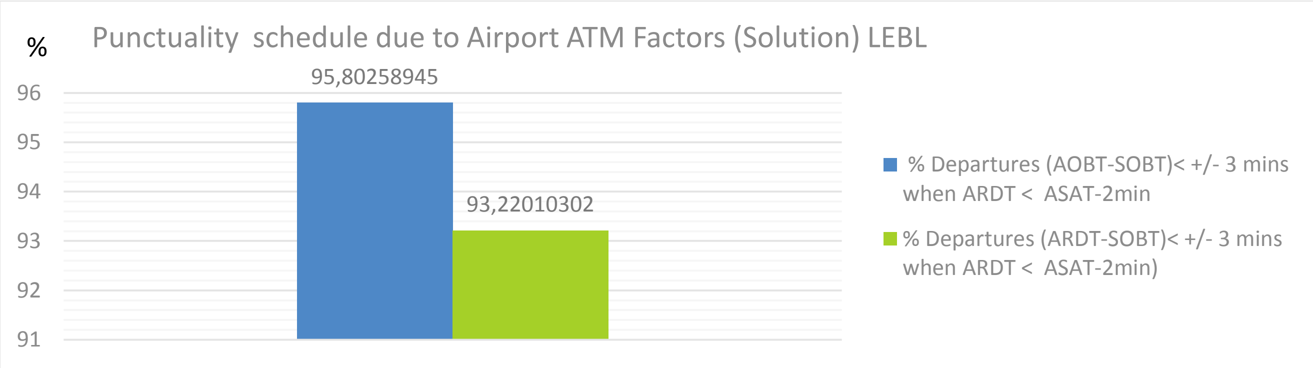


Figure 27: Departures punctuality due to Airport ATM Factors LEPA

LEBL



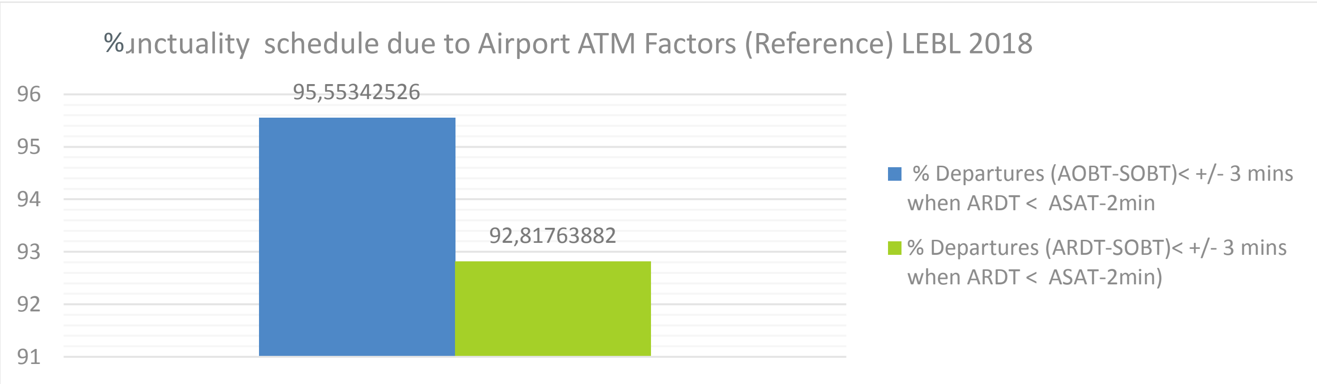


Figure 28: Departures punctuality due to Airport ATM Factors LEBL

LEAL

Not possible to be measured for LEAL

#PI-4 Departures punctuality due to Recovery and Mitigation of Reactionary Delay

See Section E.3.38.

Predictability

#PI-5 Comparison between the Actual In/Off Block Times and the coordinated airport slots

All the following curves are Gaussian distribution, this indicator measures how predictable the airport is (arrivals and departures) with respect to the planned, this means that the narrower the Gaussian bell is, the airport plan is better accomplished.

The “Solution” scenario is the EXE3a timeframe execution. The “Reference” scenario corresponds to the same period of last year (2018).

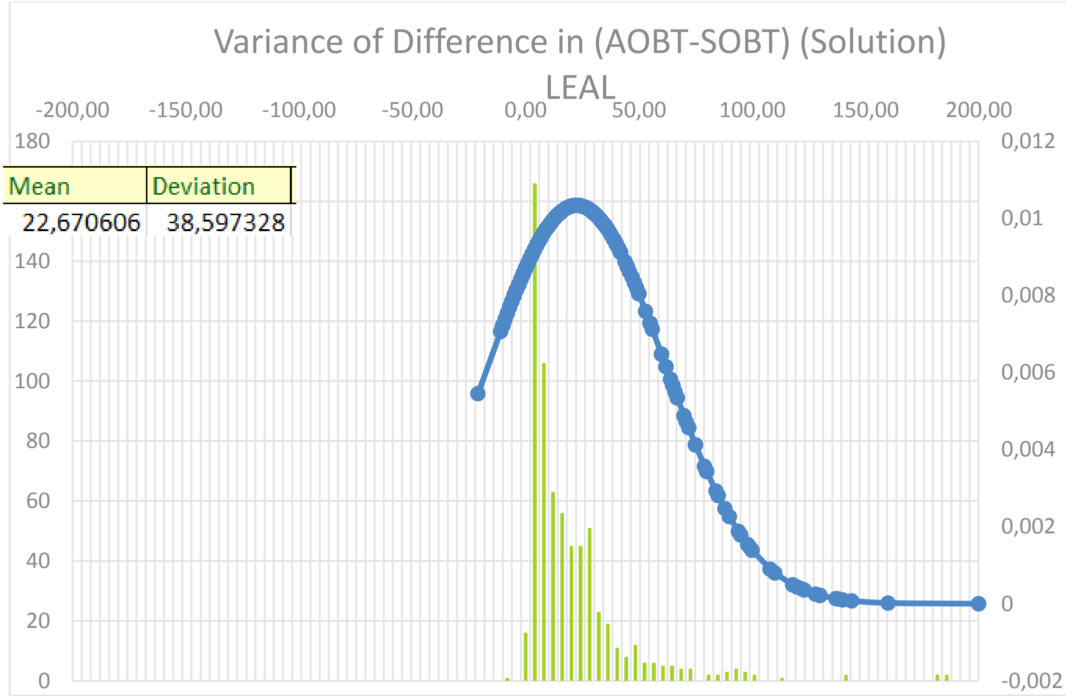


Figure 29: Variance of Difference in (AOBT-SOBT) LEAL

Blue curve must be read with X (difference in minutes) and Right Y axis (probability value).

Green graph must be read X (difference in minutes) and Left Y axis (number of occurrences).

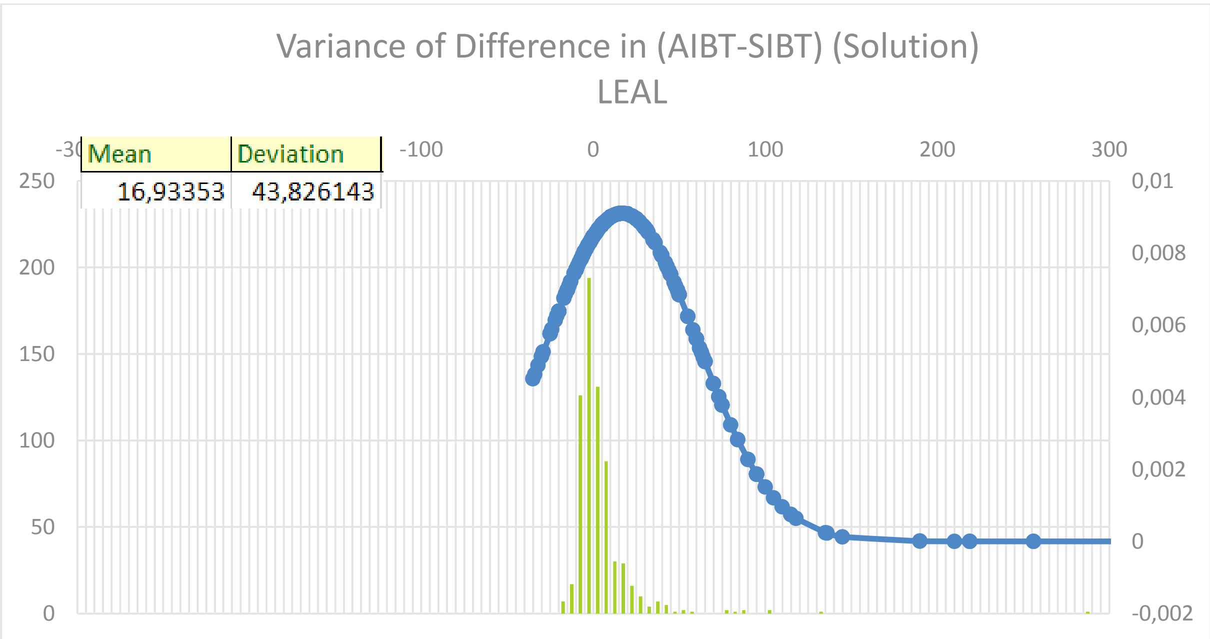


Figure 30: Variance of Difference in (AIBT-SIBT) LEAL

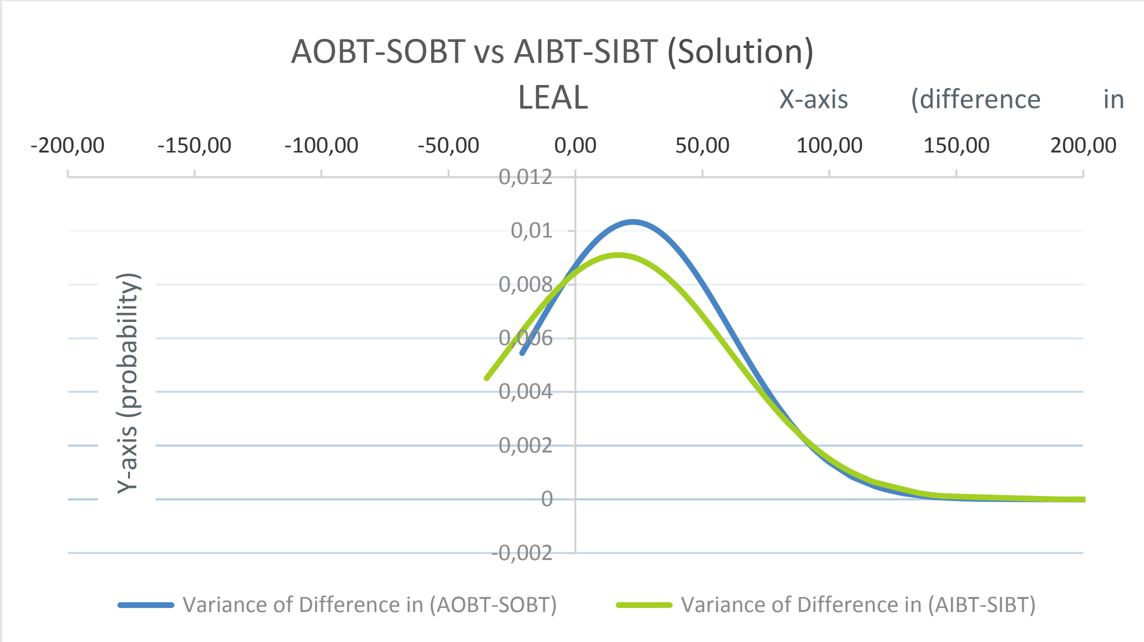


Figure 31: Comparison between (AOBT-SOBT) and (AIBT-SIBT) LEAL

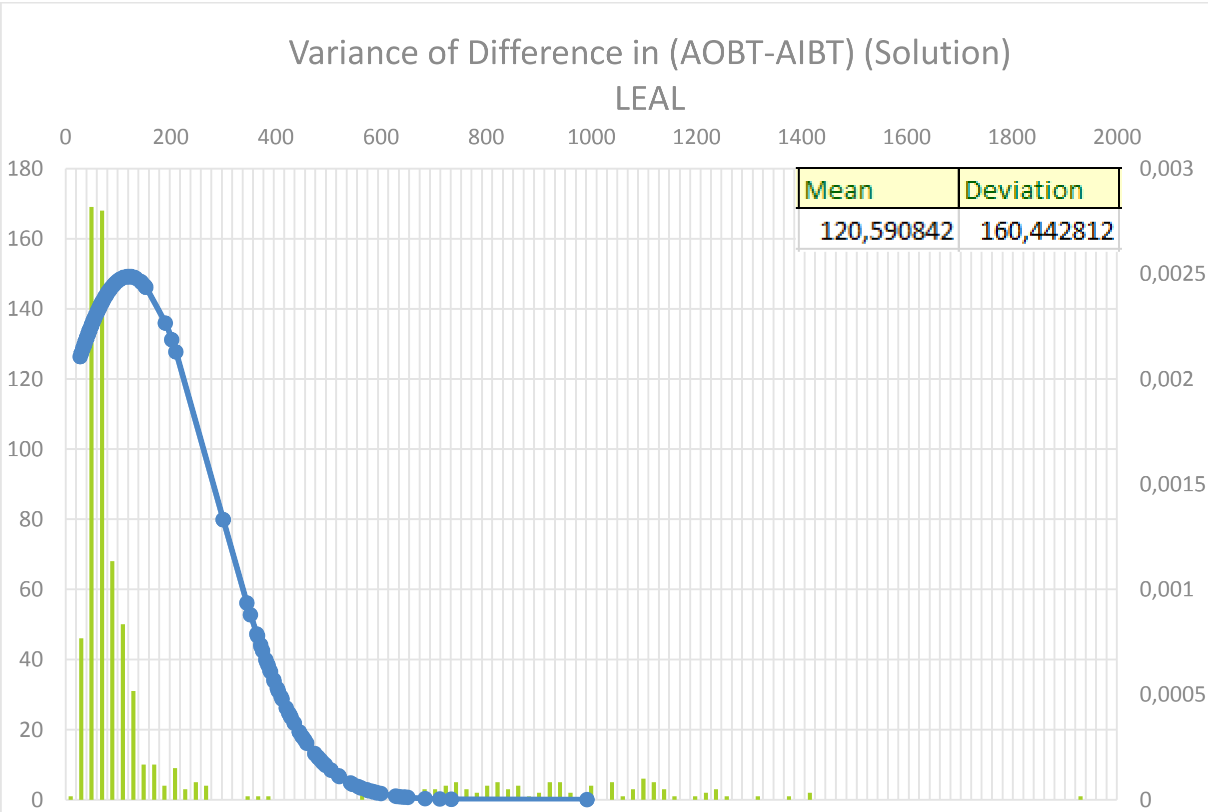


Figure 32: Variance of Difference in (AOBT-AIBT) LEAL

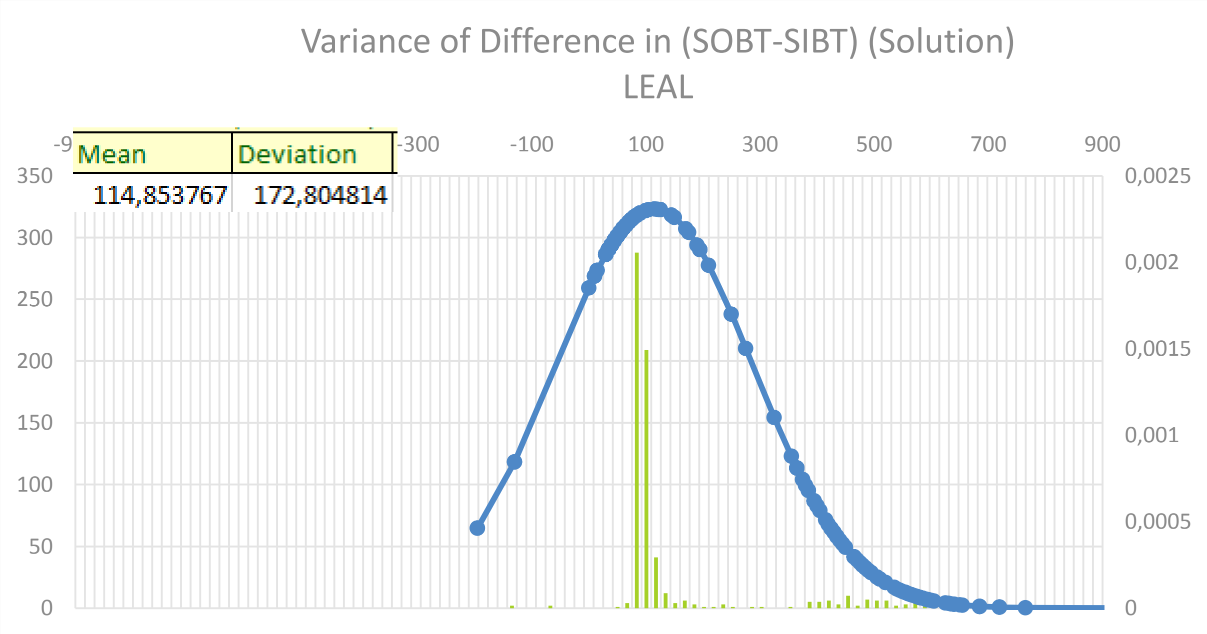


Figure 33: Variance of Difference in (SOBT-SIBT) LEAL

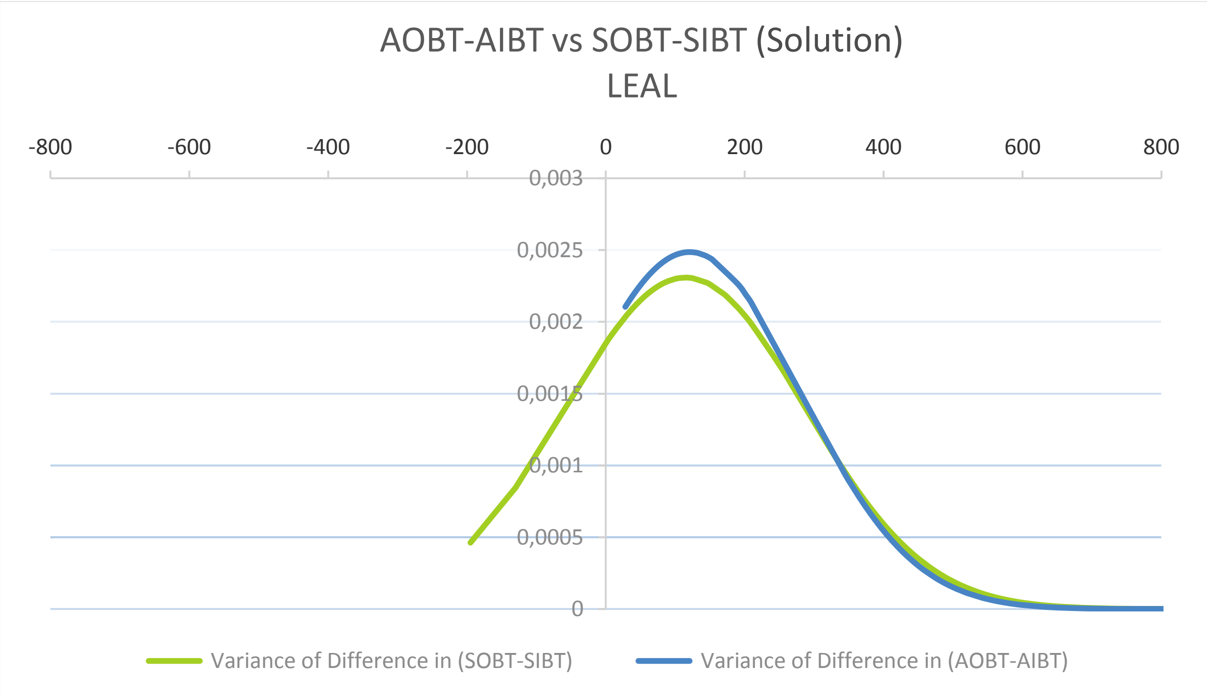
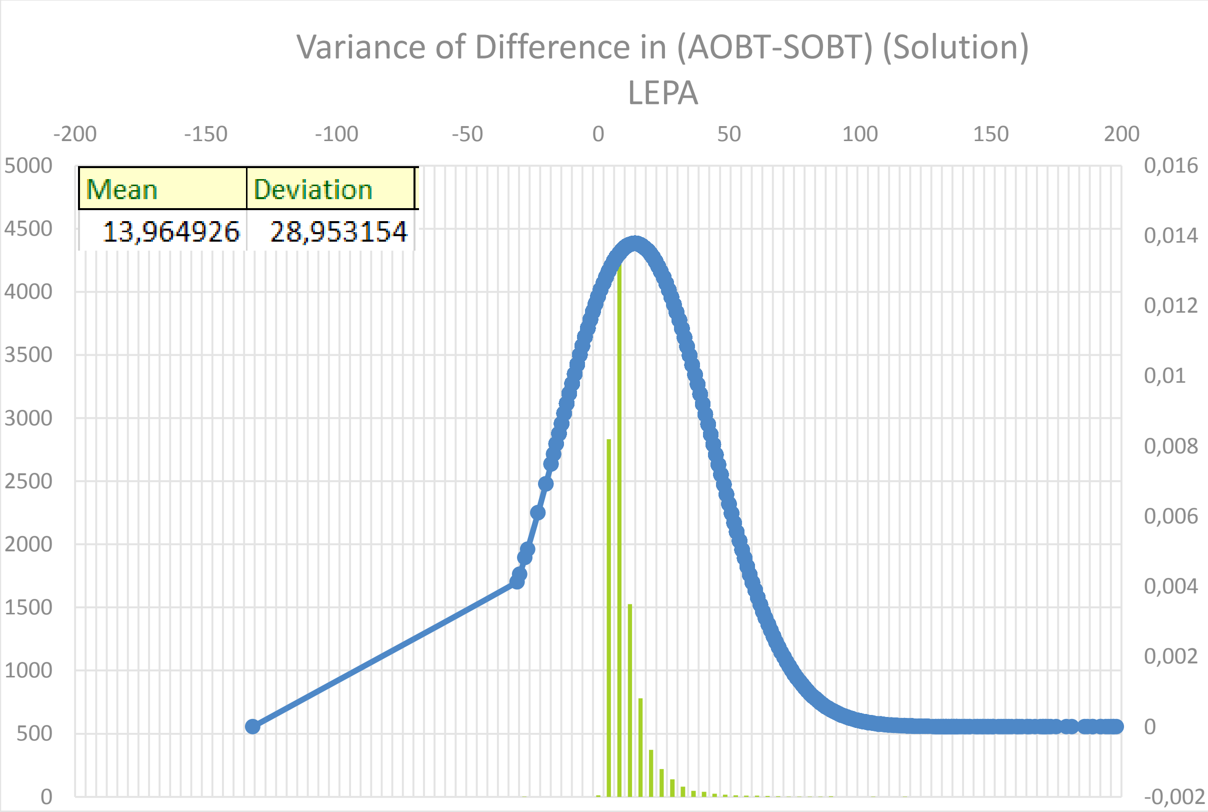


Figure 34: Comparison between (AOBT-SOBT) and (AIBT-SIBT) LEAL


Variance of Difference in (AOBT-SOBT) (Solution)
LEPA
-200 -150 -100 -50 0 50 100 150 200
5000 4500 4000 3500 3000 2500 2000 1500 1000 500 0
0,016 0,014 0,012 0,01 0,008 0,006 0,004 0,002 0 -0,002
Mean
Deviation
13,964926
28,953154

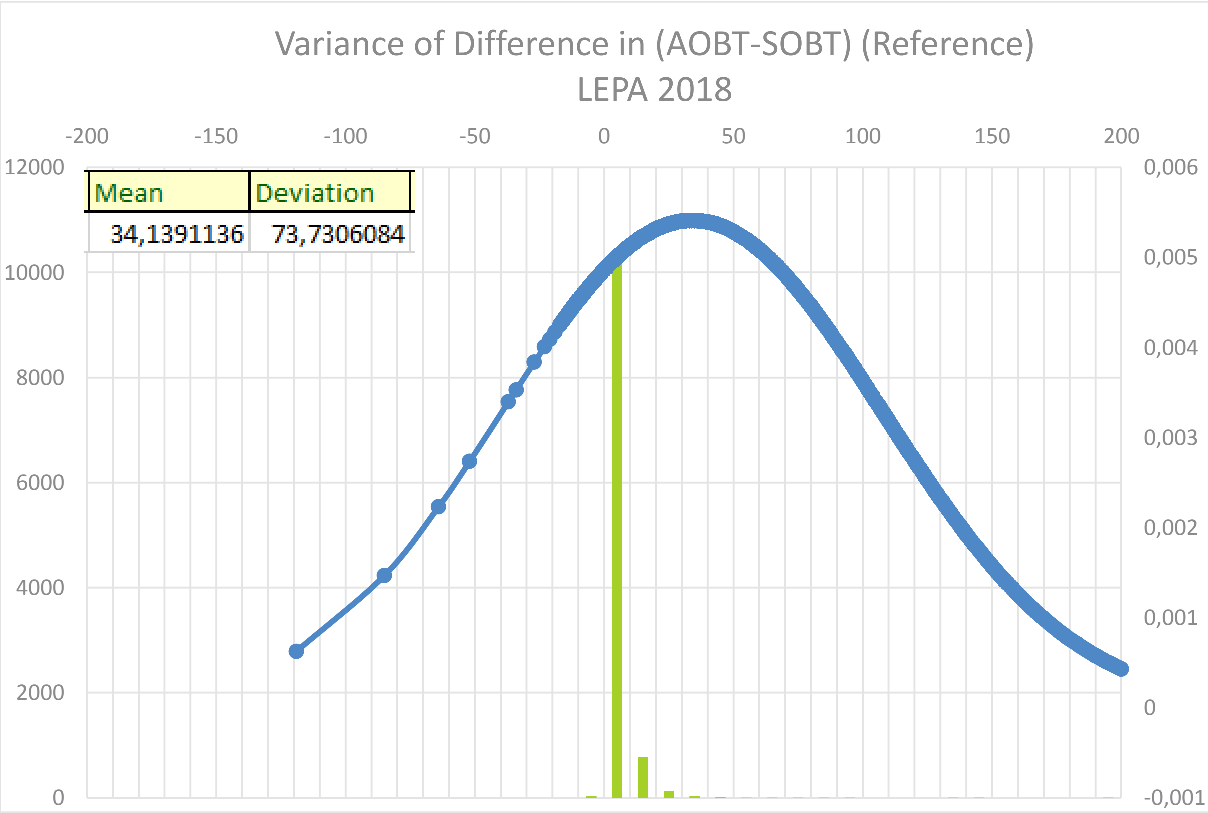
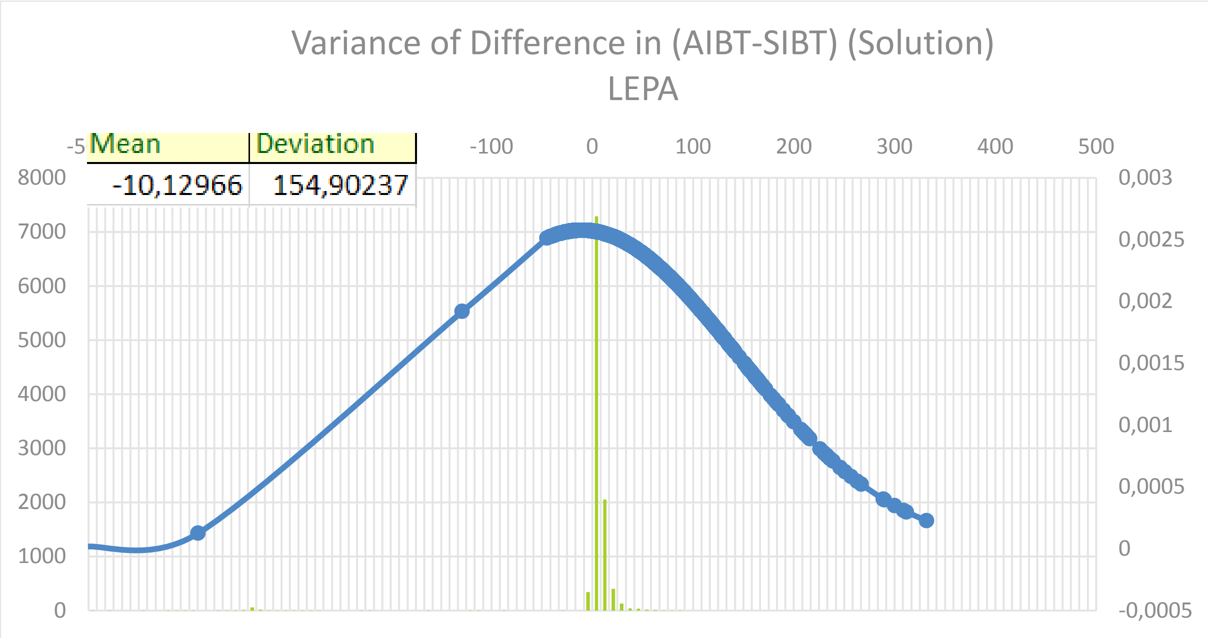

Variance of Difference in (AOBT-SOBT) (Reference)
LEPA 2018
-200 -150 -100 -50 0 50 100 150 200
12000 10000 8000 6000 4000 2000 0
0,006 0,005 0,004 0,003 0,002 0,001 0 -0,001
Mean
Deviation
34,1391136
73,7306084

Figure 35: Variance of Difference in (AOBT-SOBT) LEPA



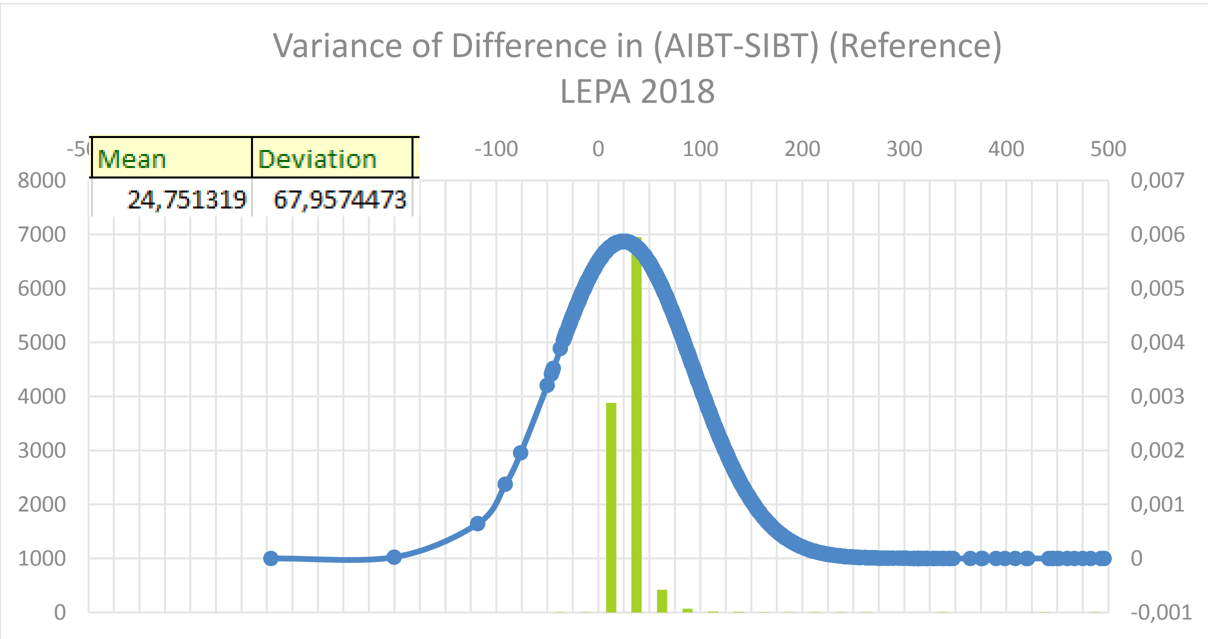


Figure 36: Variance of Difference in (AIBT-SIBT) LEPA

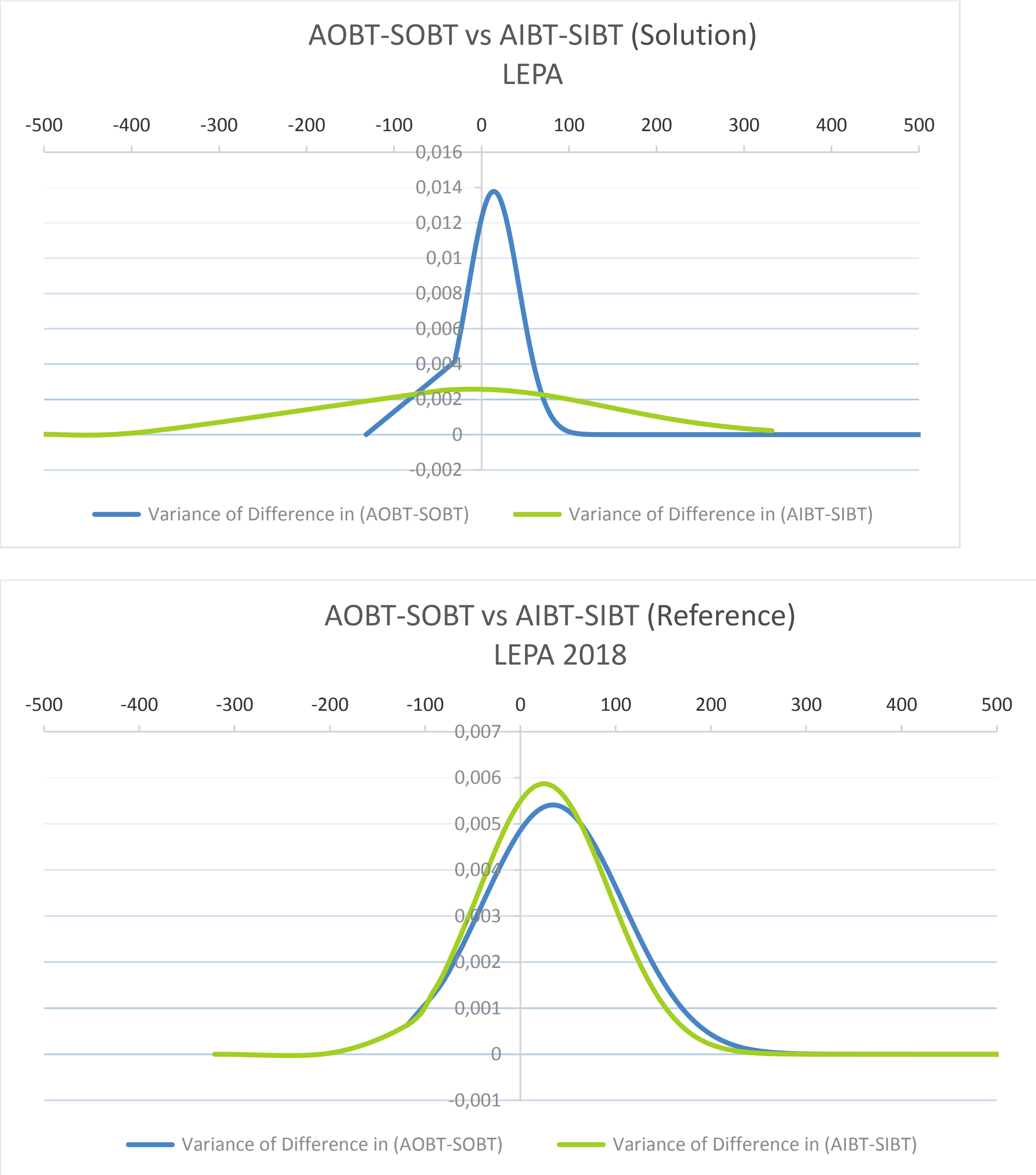
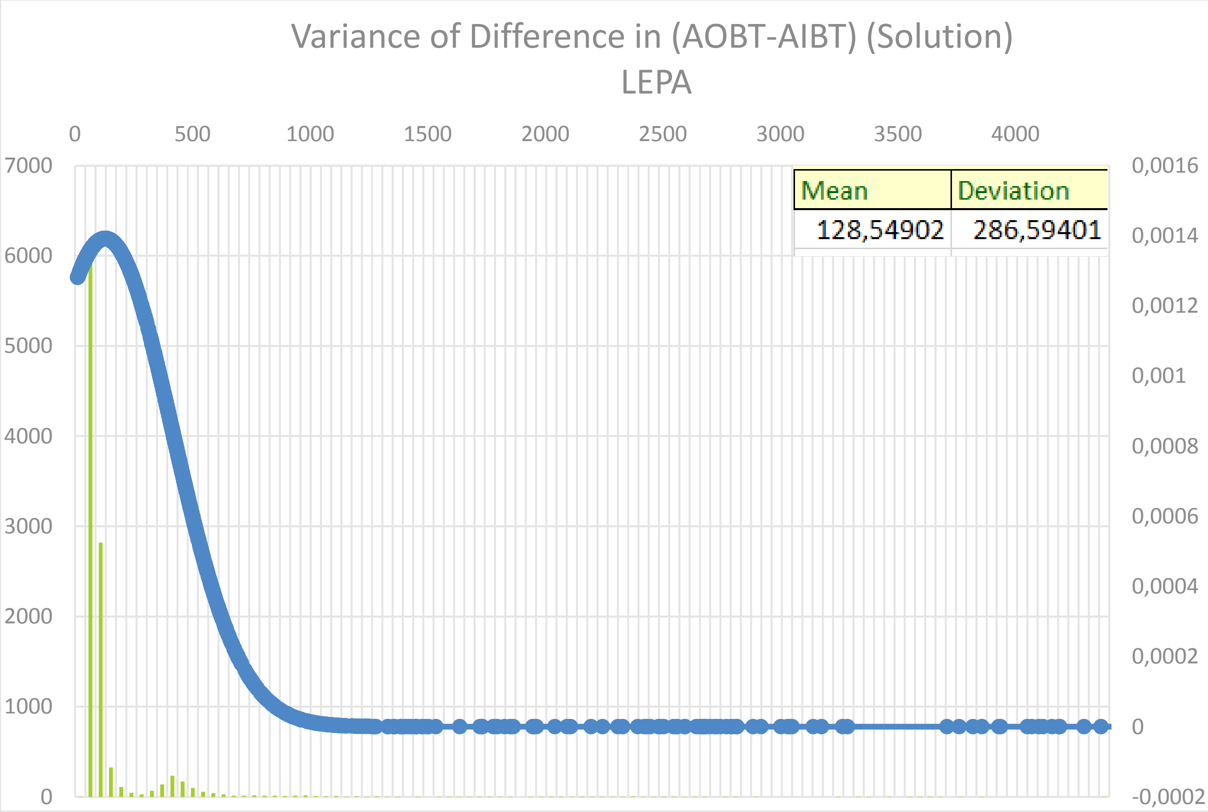


Figure 37: Comparison between (AOBT-SOBT) and (AIBT-SIBT) LEPA


Variance of Difference in (AOBT-AIBT) (Solution)
LEPA
0
500
1000
1500
2000
2500
3000
3500
4000
7000
6000
5000
4000
3000
2000
1000
0
0,0016
0,0014
0,0012
0,001
0,0008
0,0006
0,0004
0,0002
0
-0,0002
Mean
Deviation
128,54902
286,59401

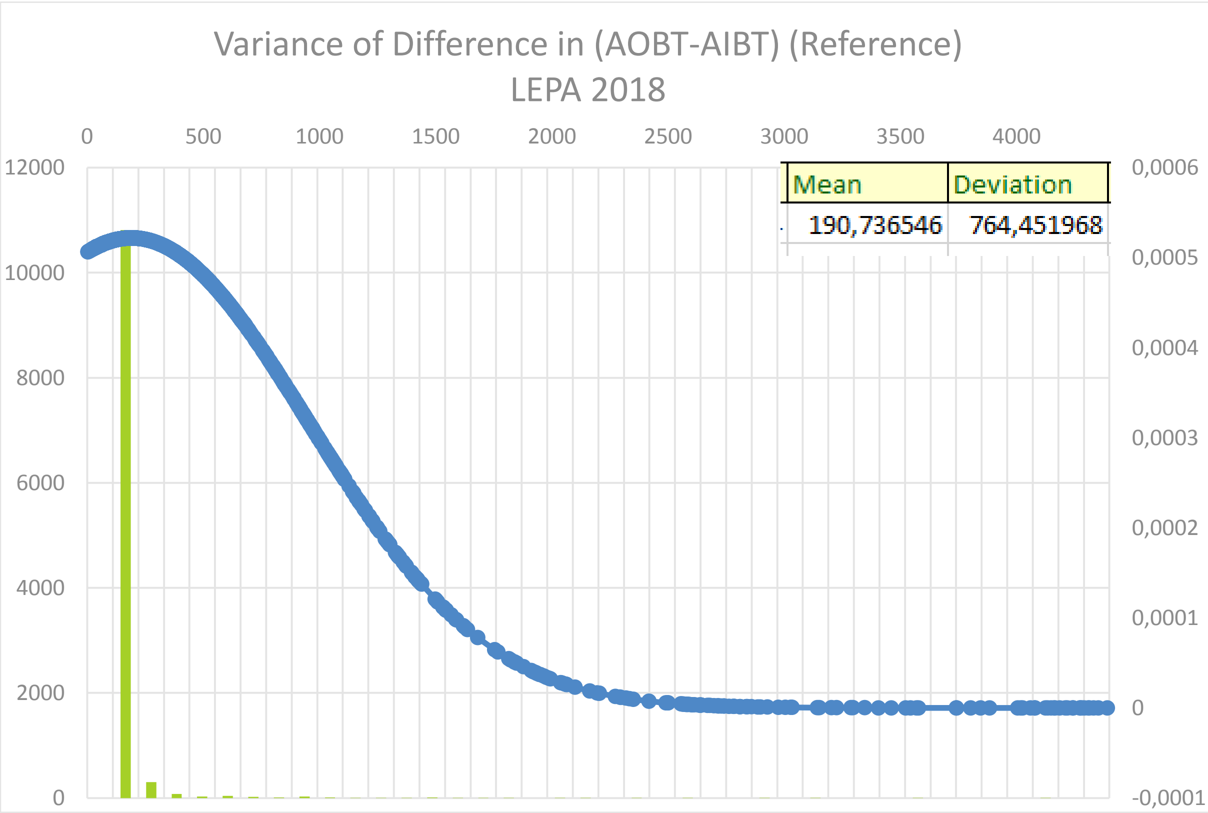
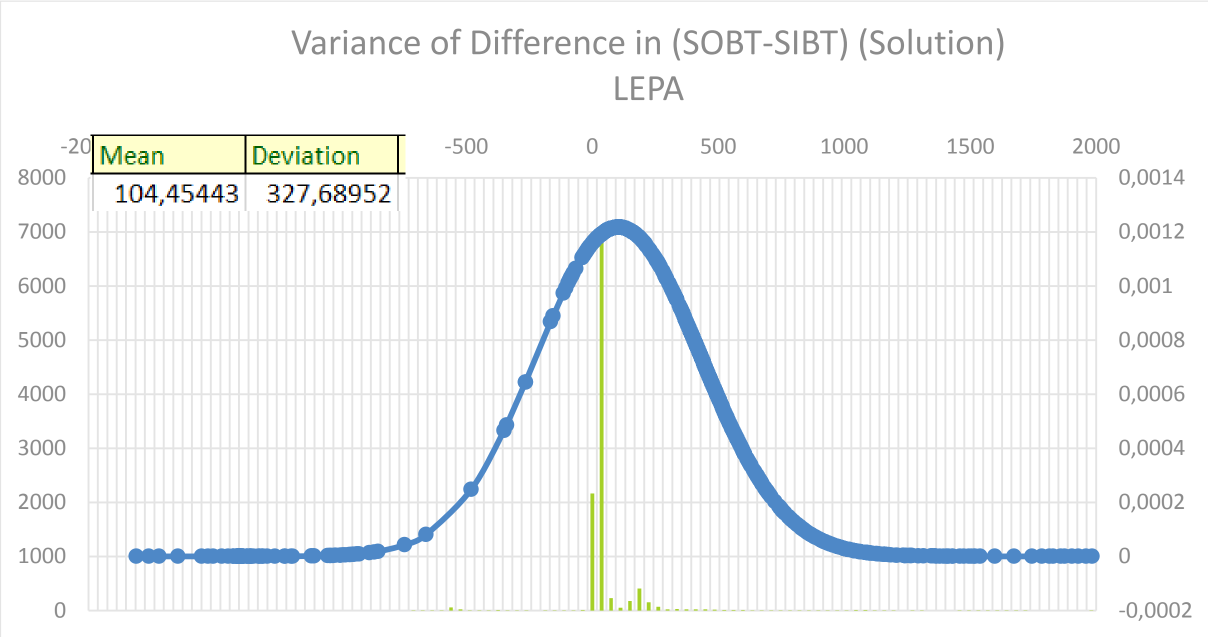

Variance of Difference in (AOBT-AIBT) (Reference)
LEPA 2018
0
500
1000
1500
2000
2500
3000
3500
4000
12000
10000
8000
6000
4000
2000
0
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
-0,0001
Mean
Deviation
190,736546
764,451968

Figure 38: Variance of Difference in (AOBT-AIBT) LEPA



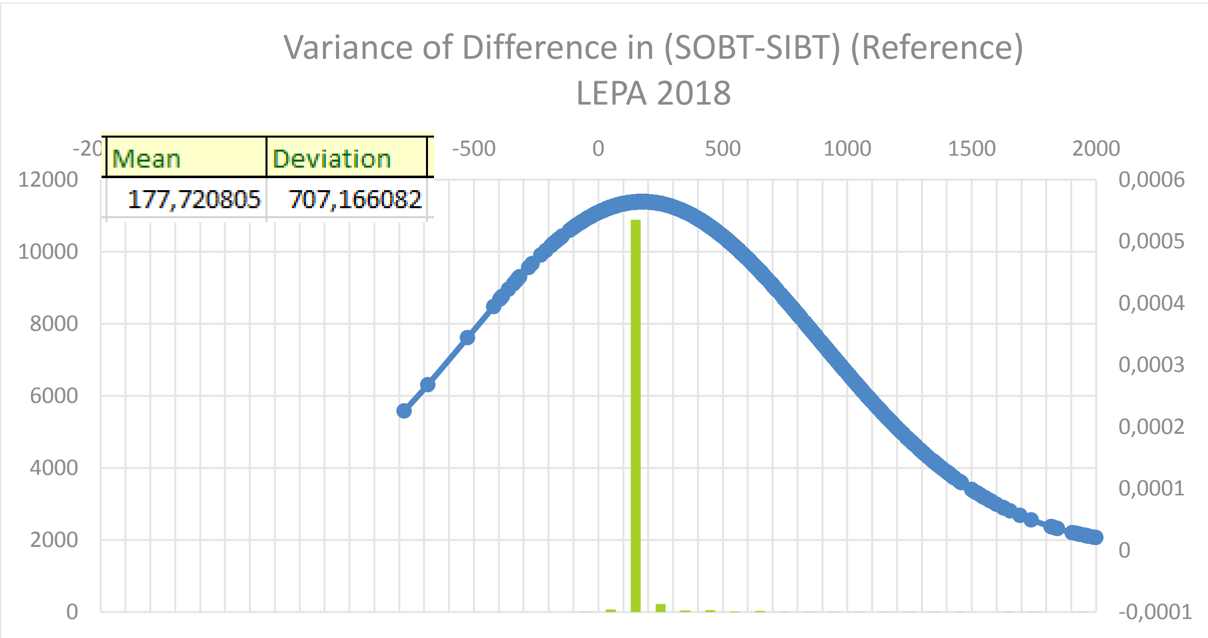
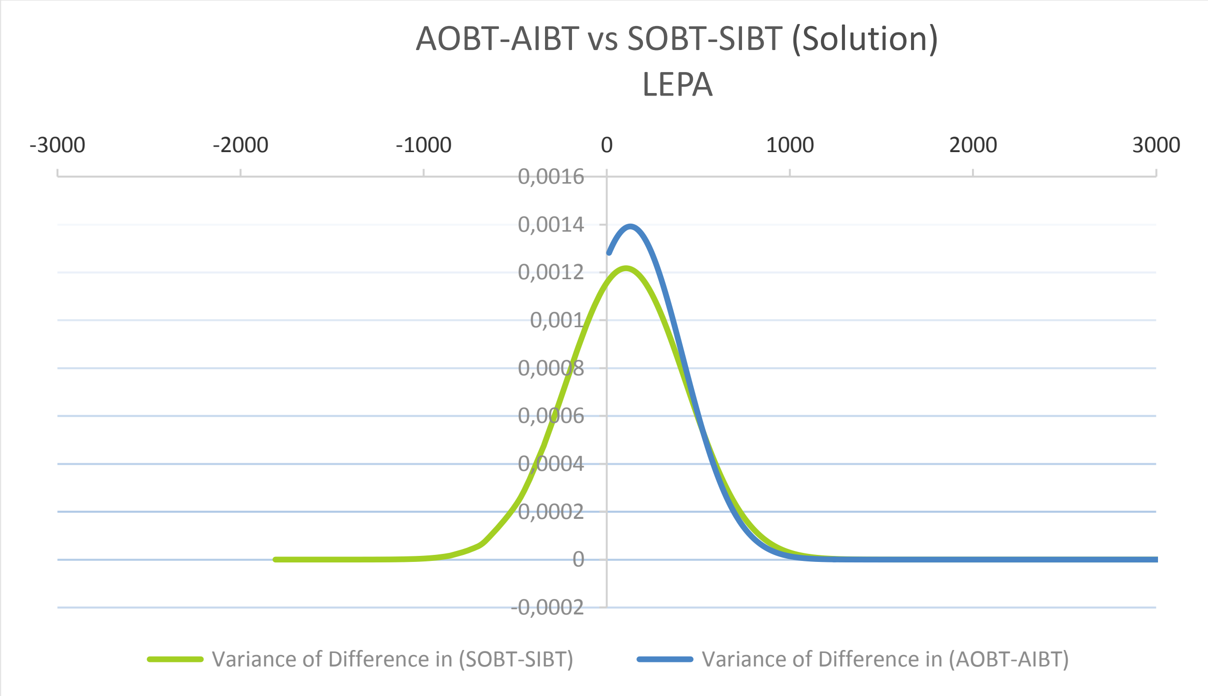


Figure 39: Variance of Difference in (SOBT-SIBT) LEPA



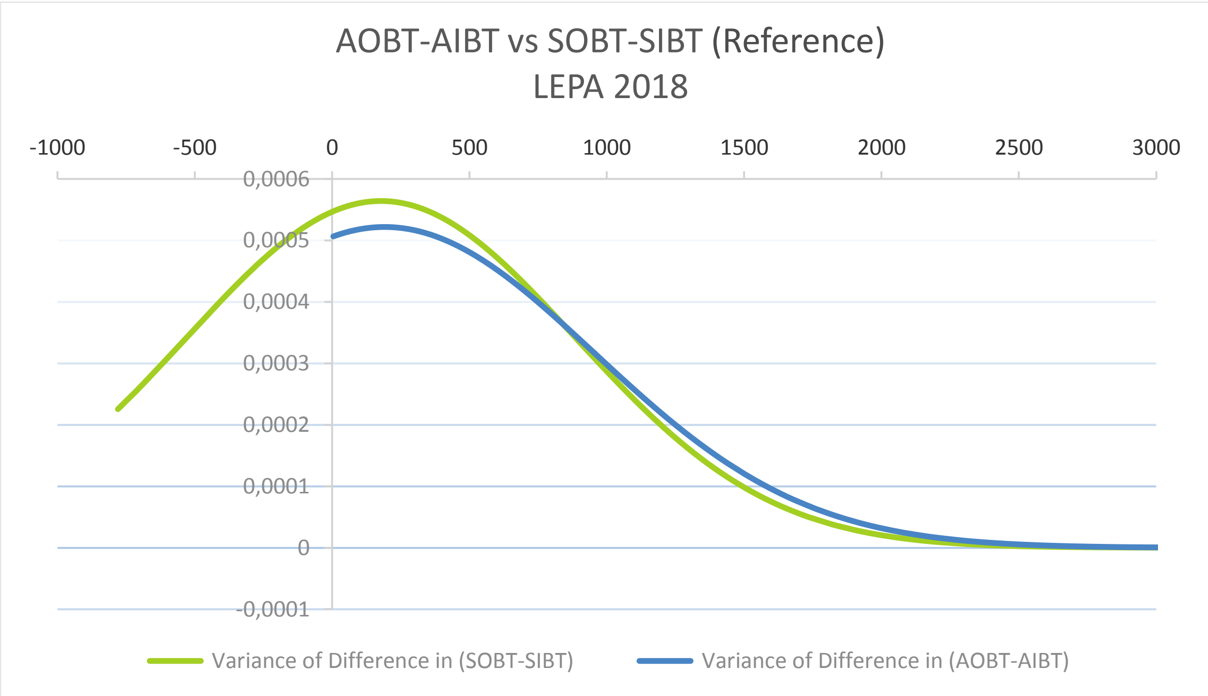
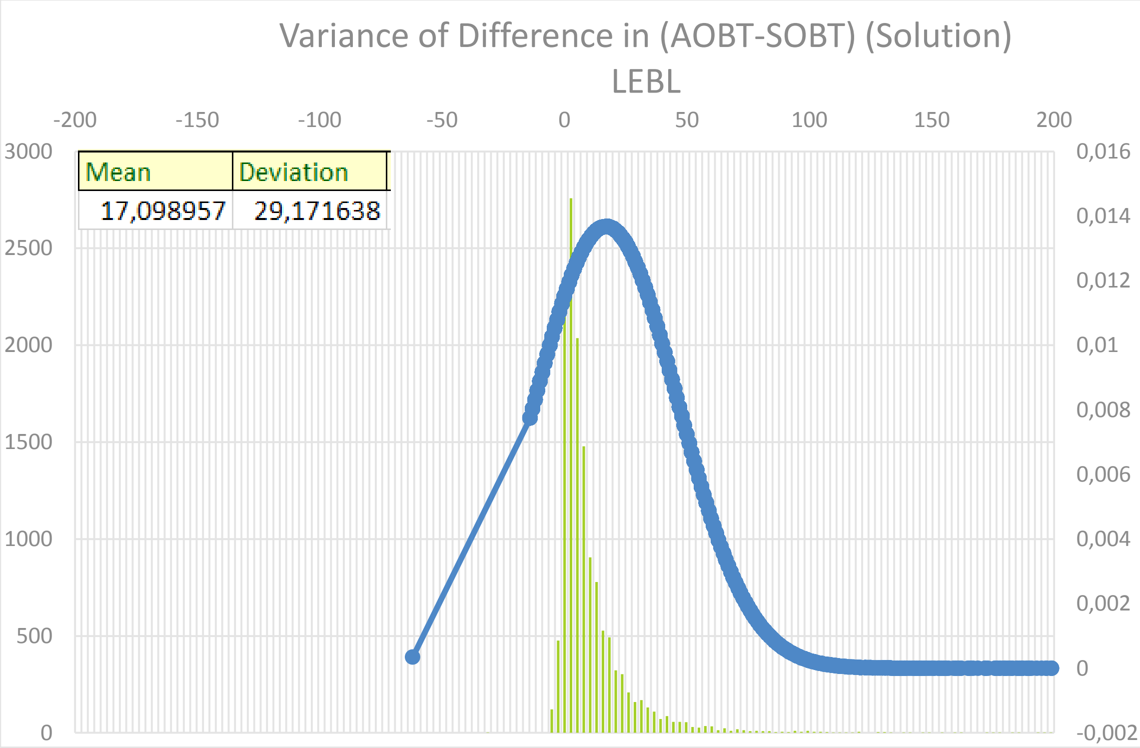


Figure 40: Comparison between (AOBT-AIBT) and (SOBT-SIBT) LEPA



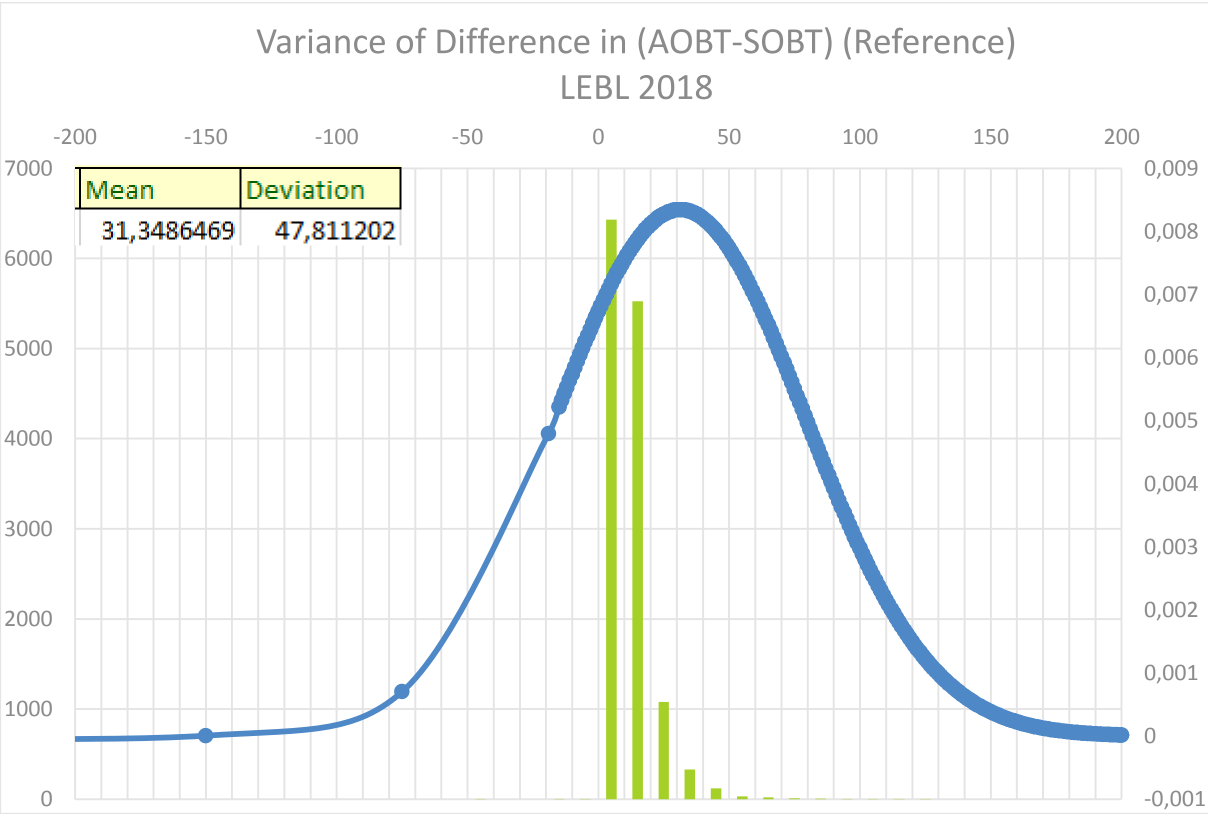
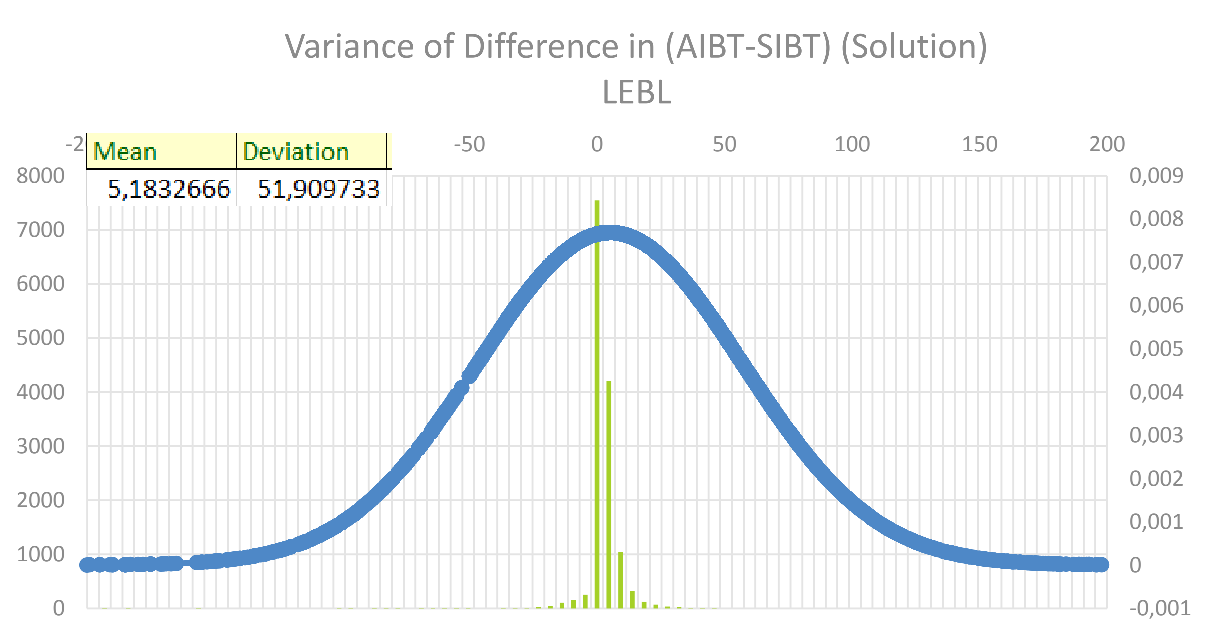


Figure 41: Variance of Difference in (AOBT-SOBT) LEBL



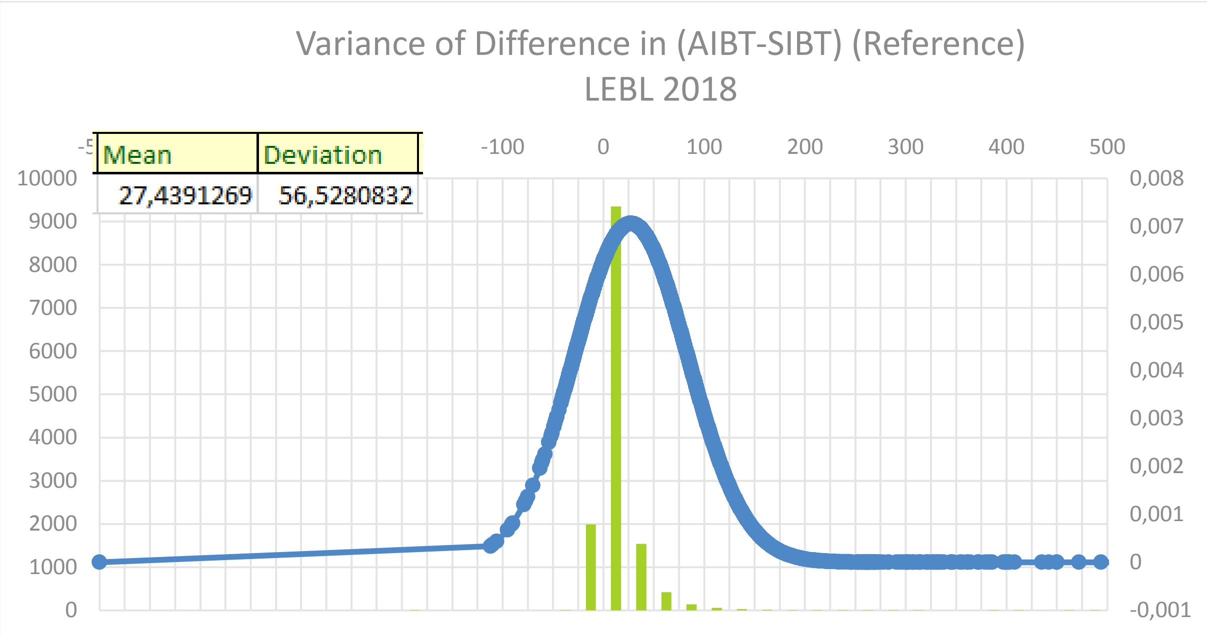
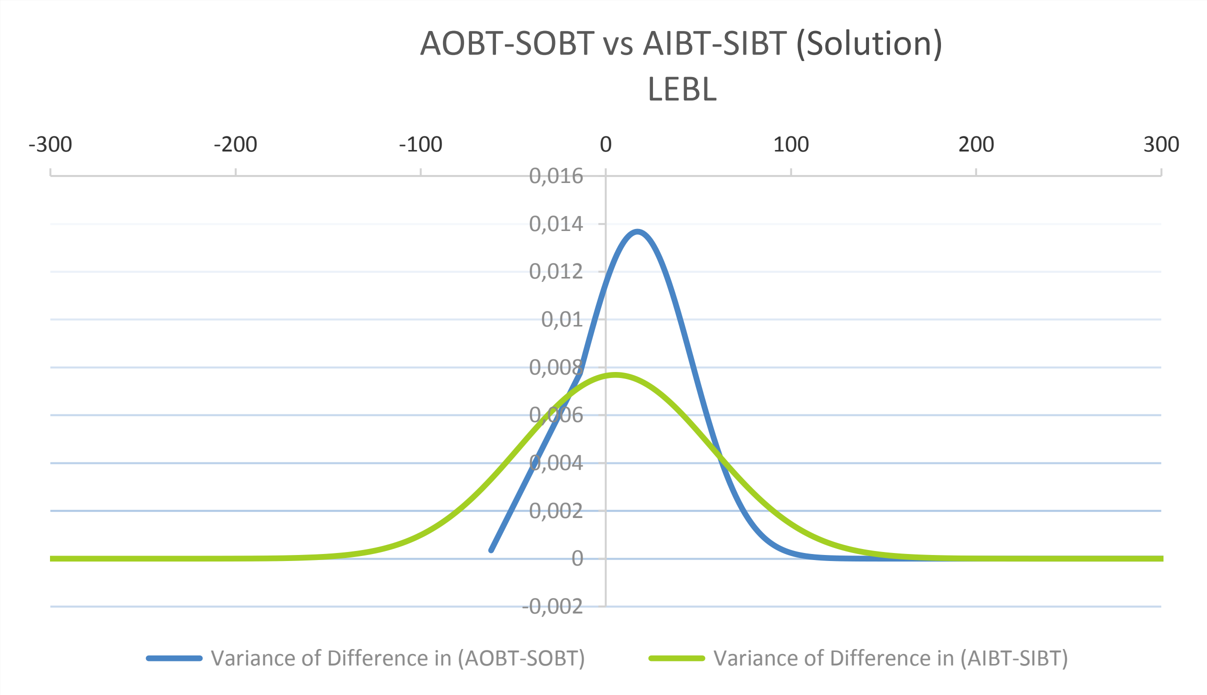


Figure 42: **Variance of Difference in (AIBT-SIBT) LEBL**



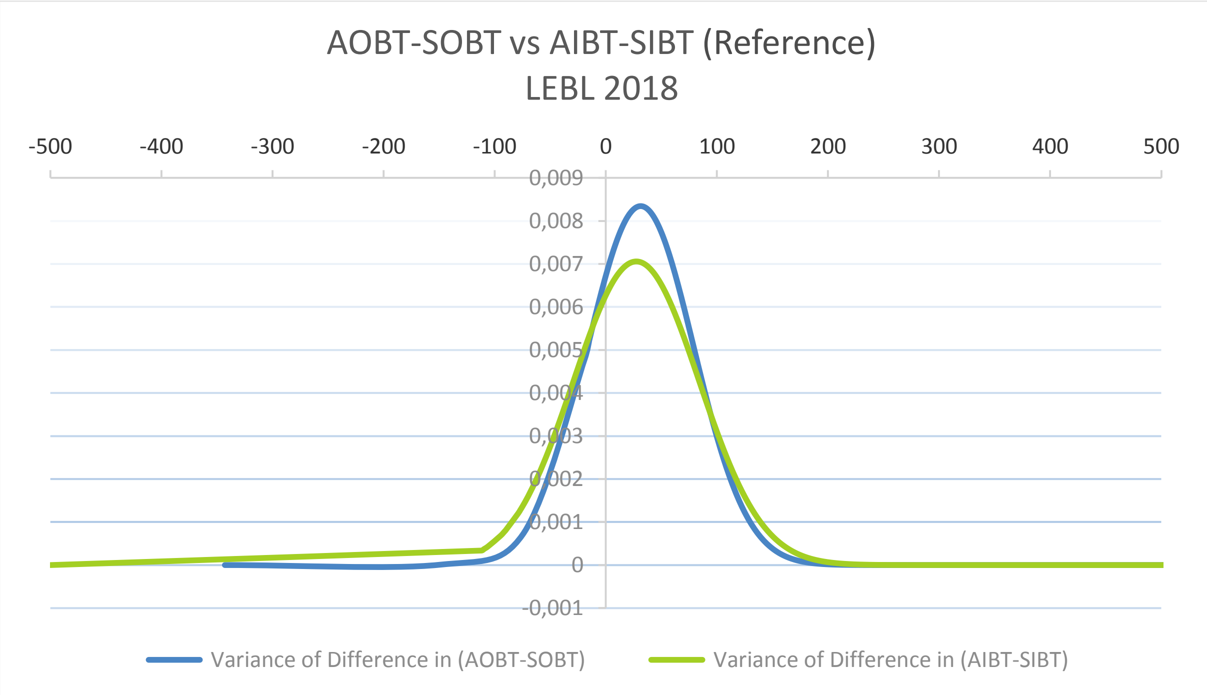
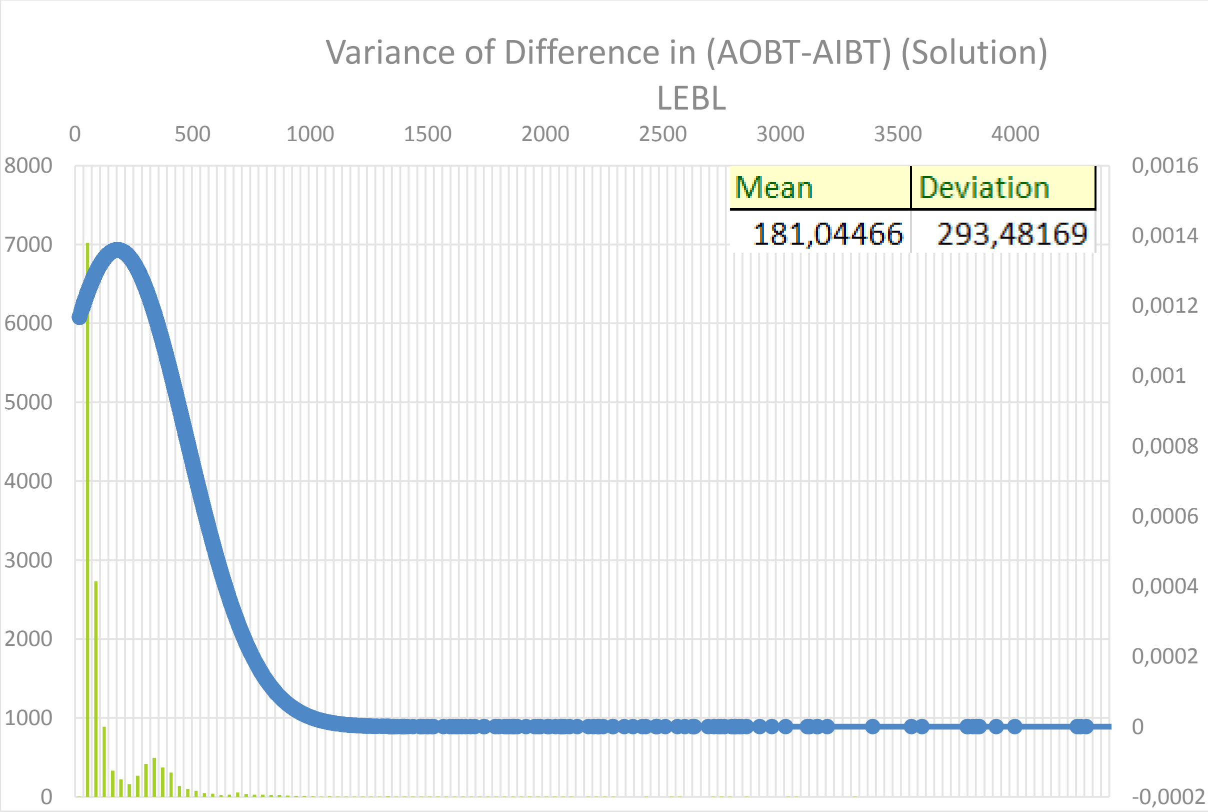


Figure 43: Comparison between (AOBT-SOBT) and (AIBT-SIBT) LEBL


Variance of Difference in (AOBT-AIBT) (Solution)
LEBL
0 500 1000 1500 2000 2500 3000 3500 4000
8000 7000 6000 5000 4000 3000 2000 1000 0
0,0016 0,0014 0,0012 0,001 0,0008 0,0006 0,0004 0,0002 0 -0,0002
Mean
Deviation
181,04466
293,48169

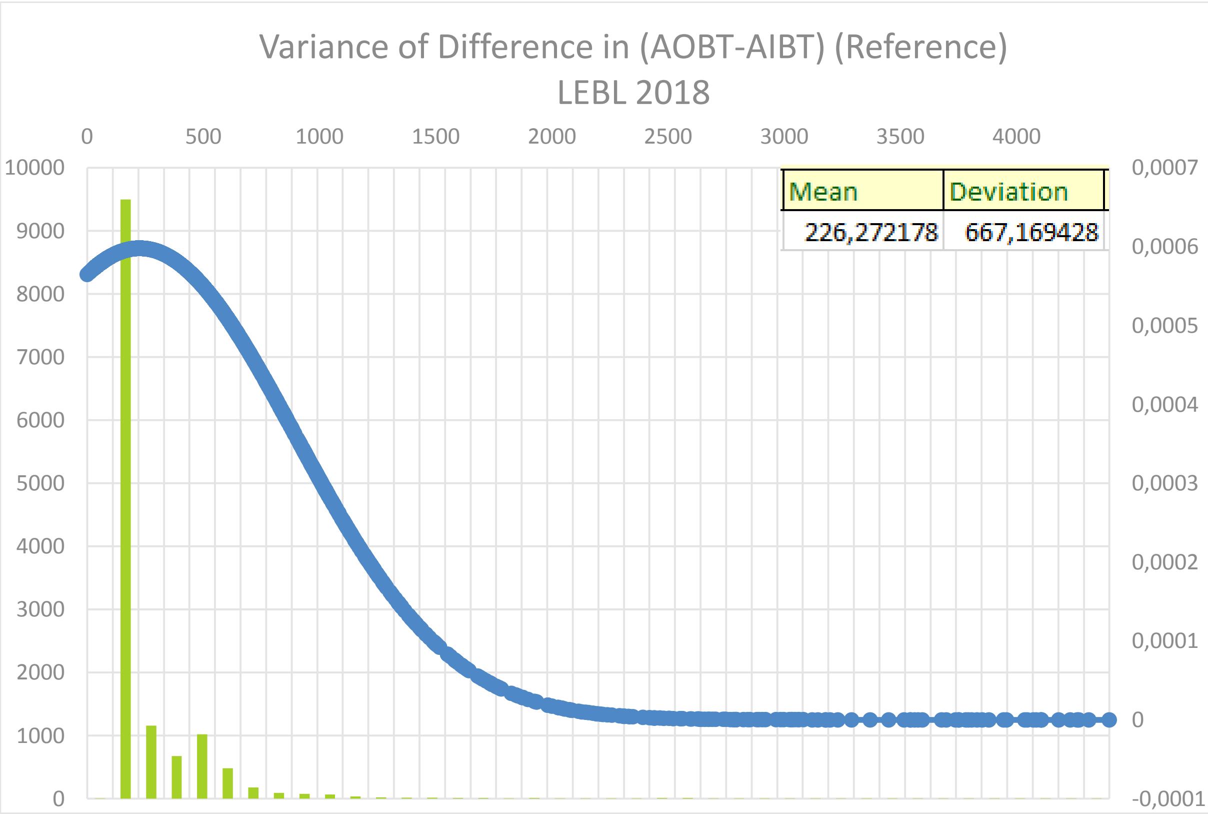

Variance of Difference in (AOBT-AIBT) (Reference)
LEBL 2018
0 500 1000 1500 2000 2500 3000 3500 4000
10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0,0007 0,0006 0,0005 0,0004 0,0003 0,0002 0,0001 0 -0,0001
Mean
Deviation
226,272178
667,169428

Figure 44: Variance of Difference in (AOBT-AIBT) LEBL

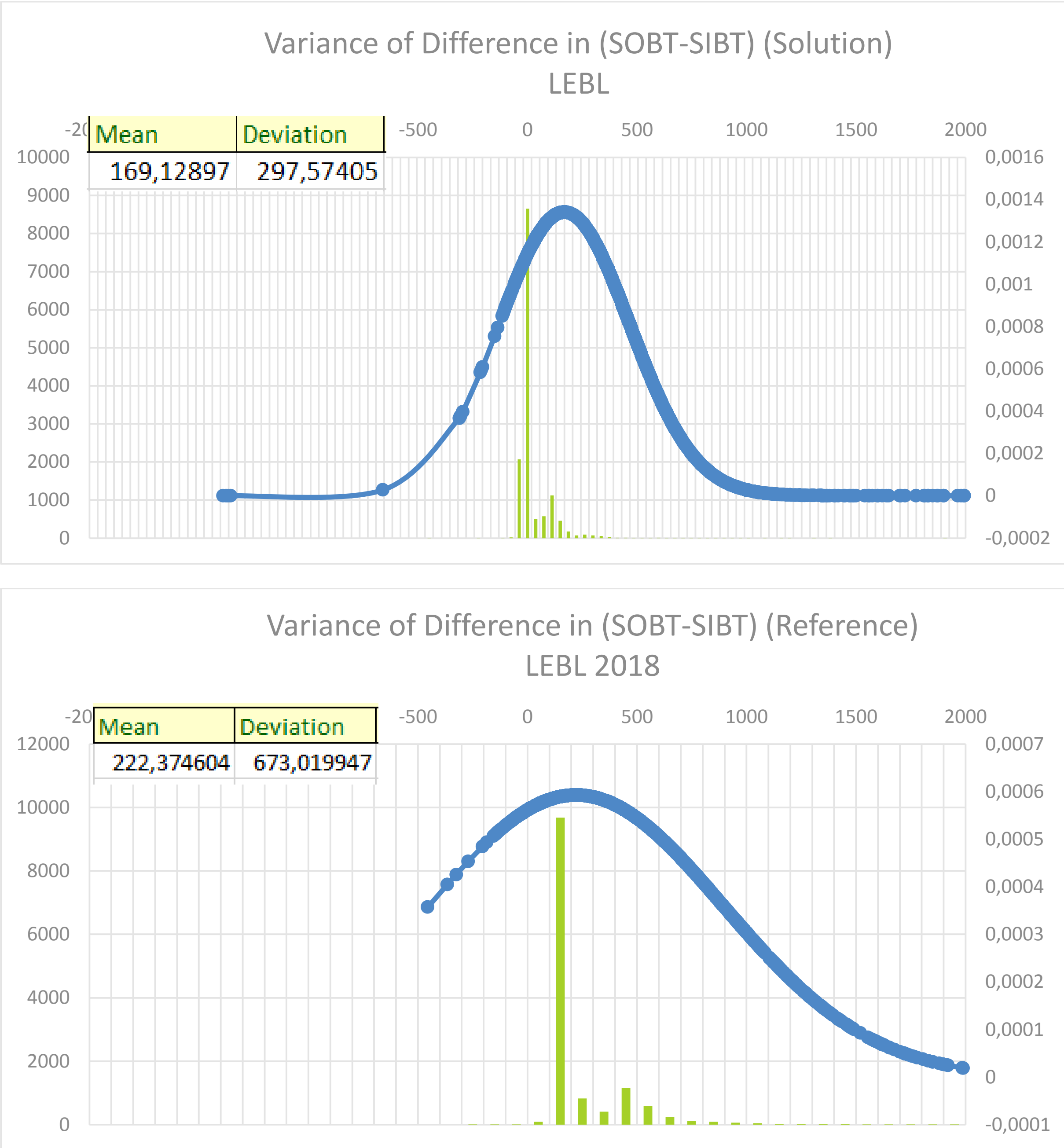
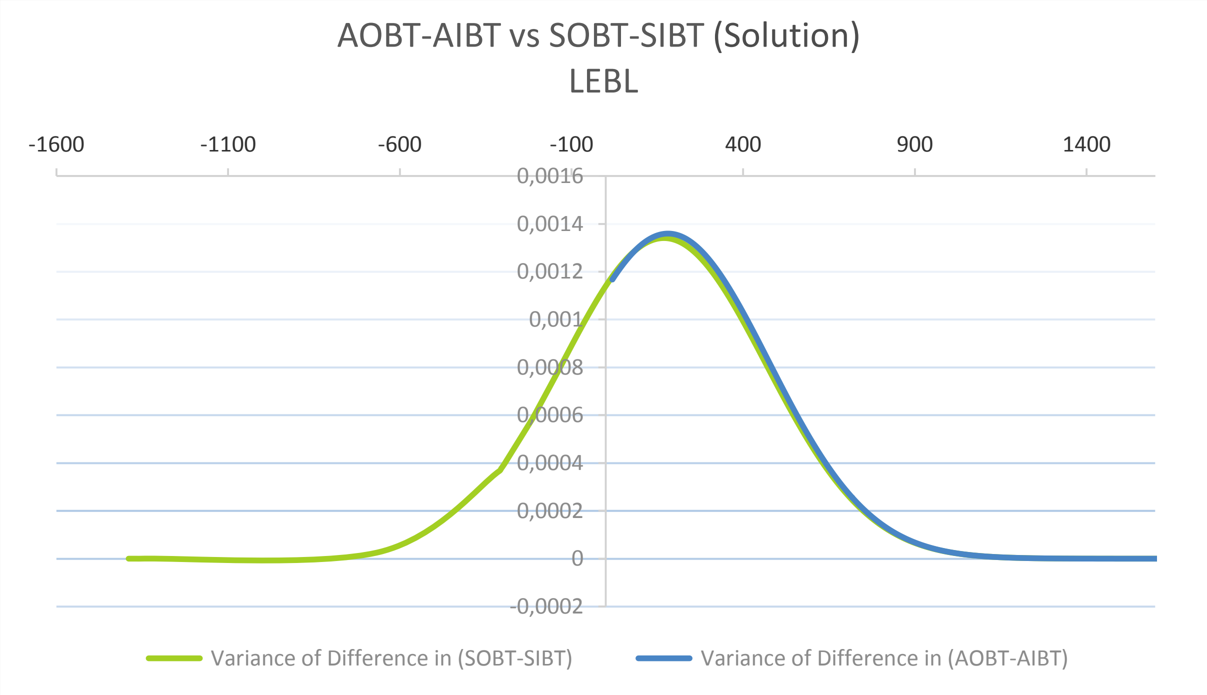


Figure 45: Variance of Difference in (SOBT-SIBT) LEBL



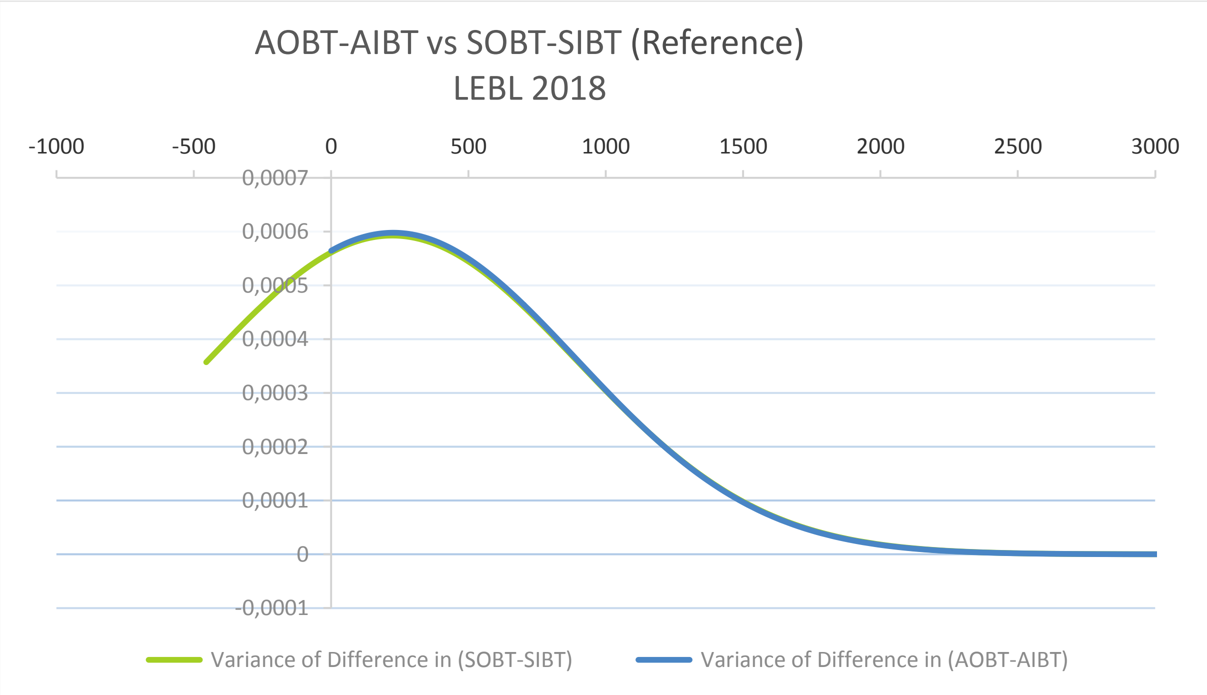


Figure 46: Comparison between (AOBT-AIBT) and (SOBT-SIBT) LEBL

Conclusion:

Airport	Measure	Scenario	Mean	Deviation

LEBL	Variance of AIBT-SIBT	Solution	5,1832666	51,909733
		Reference	27,4391269	56,5280832
	Variance of AOBT-SOBT	Solution	17,098957	29,171638
		Reference	31,3486469	47,811202
	Variance of AOBT-AIBT	Solution	181,04466	293,48169
		Reference	226,272178	667,169428
	Variance of SOBT-SIBT	Solution	169,12897	297,57405
		Reference	222,374604	673,019947
LEPA	Variance of AIBT-SIBT	Solution	-10,12966	154,90237
		Reference	24,751319	67,9574473
	Variance of AOBT-SOBT	Solution	13,964926	28,953154
		Reference	34,1391136	73,7306084
	Variance of AOBT-AIBT	Solution	128,54902	286,59401
		Reference	190,736546	764,451968
	Variance of SOBT-SIBT	Solution	104,45443	327,68952
		Reference	177,720805	707,166082

The Solution scenario shows less dispersion (lower average variance and lower dispersion of the variance) than the Reference scenario for all the following indicators:

- Variance of arrival delay (AIBT-SIBT)

- Variance of departure delay (AOBT-SOBT)

- Variance of actual flight duration delay (AOBT-AIBT)

- (SOBT-SIBT is the scheduled flight duration, that is not affected by the actions of the exercise)

These measures allow to conclude that the predictability of flight timings is increased.

#PI-19 Departure predictability due to increment of turnaround times predictability

LEBL

The TOBT is closer to the Actual Ready Time in the AOP ("solution") than in SCENA ("reference").

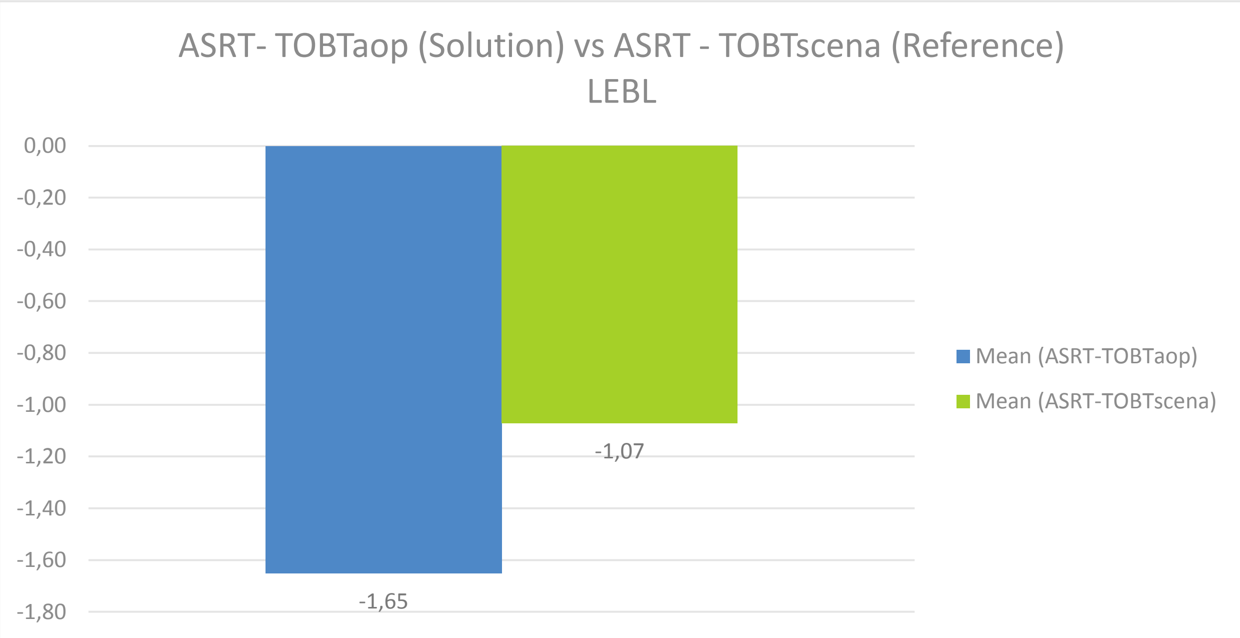


Figure 47: ASRT- TOBTaop vs ASRT - TOBTscena LEBL

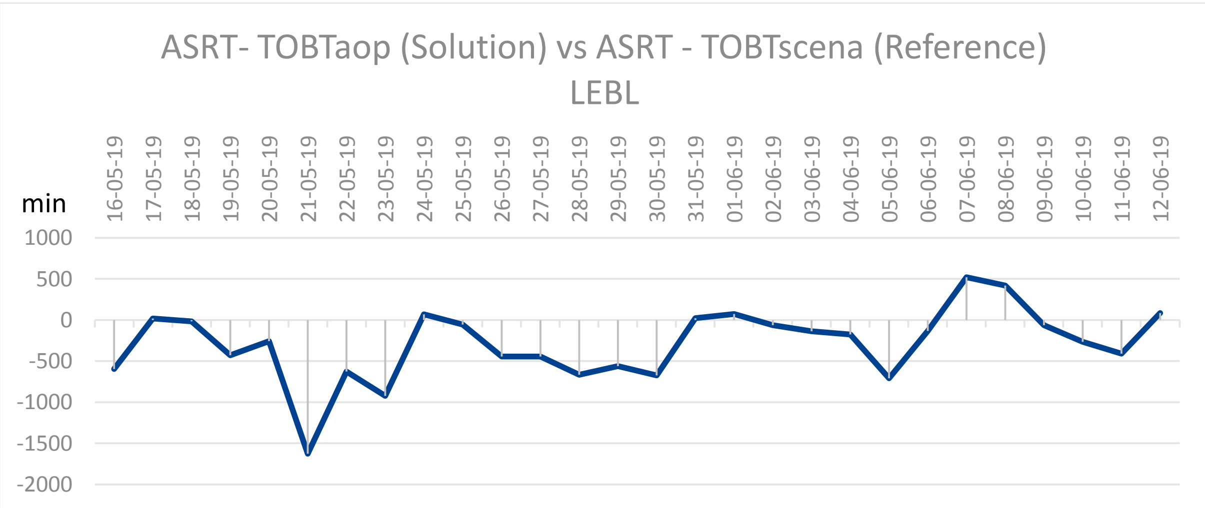


Figure 48: ASRT- TOBTaop vs ASRT – TOBTscena per day LEBL

LEPA

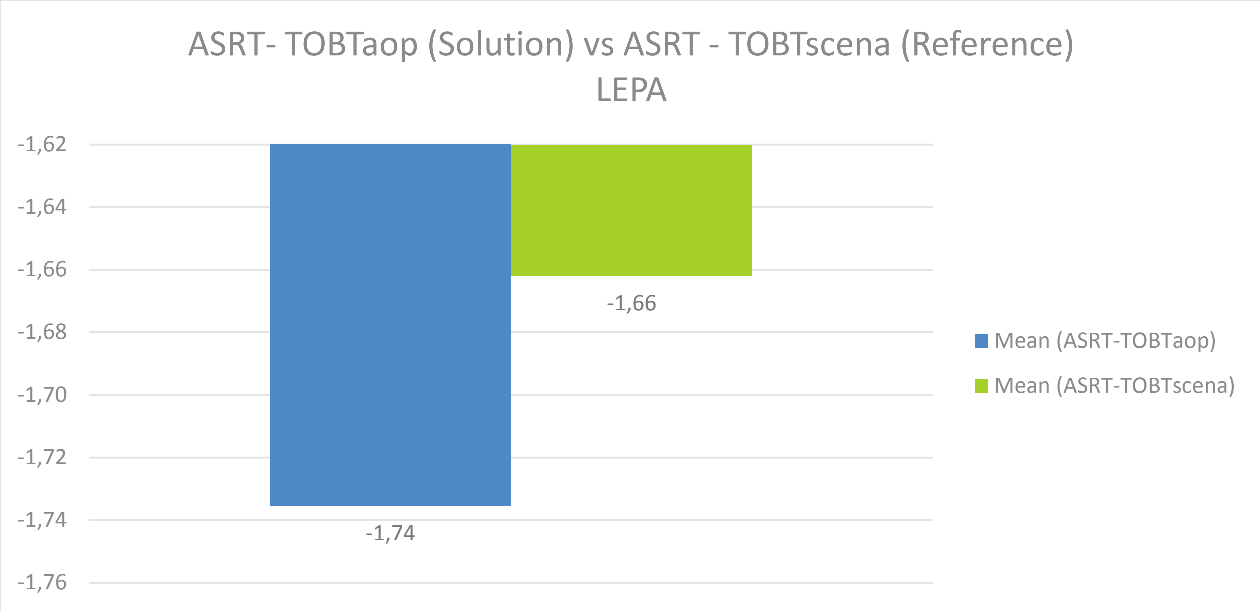


Figure 49: ASRT- TOBTaop vs ASRT - TOBTscena LEPA

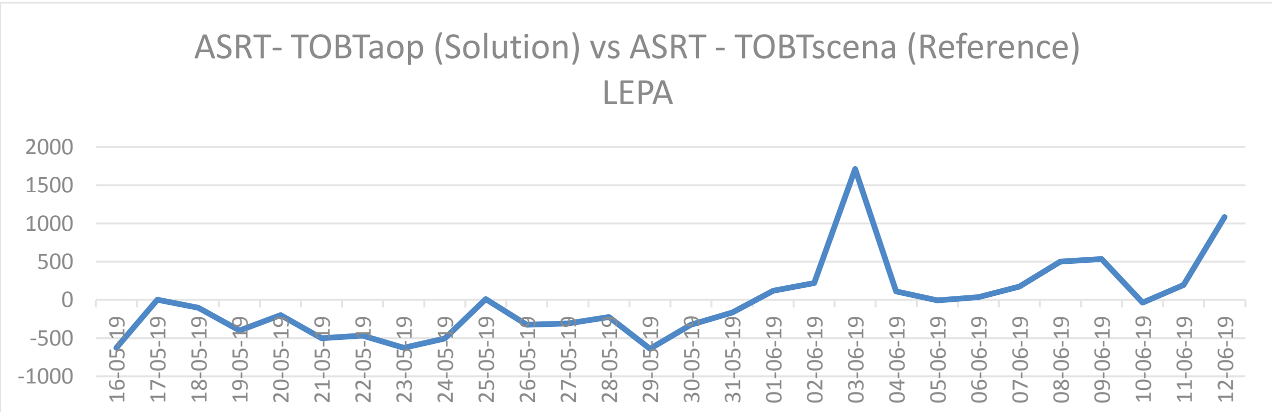


Figure 50: ASRT- TOBTaop vs ASRT – TOBTscena per day LEPA

LEAL

Not possible to Measure for LEAL

#PI-20 Accuracy improvement in the TTOT information provided by Extended–DPIs (P-DPI) when using XTTT (absolute deviation)

See Section E.3.34.

#PI-21 Accuracy improvement in the TTOT information provided by Extended–DPIs (P-DPI) when using XTTT (standard deviation)

See Section E.3.34.

b. TTA Management process

Efficiency (Cost)

#PI-3 Number of flights with Most Penalising regulation due to a TTA

LEBL:

From 20th May until 12th June, there were 965 flights with Most Penalising regulation due to a TTA.

LEPA:

From 27th May until 12th June, there were 87 flights with Most Penalising regulation due to a TTA.

#PI-4 Departures punctuality due to Recovery and Mitigation of Reactionary Delay

See Section E.3.38.

#PI-6 Average delay improvement of using AOP instead CASA for severity 2 flights

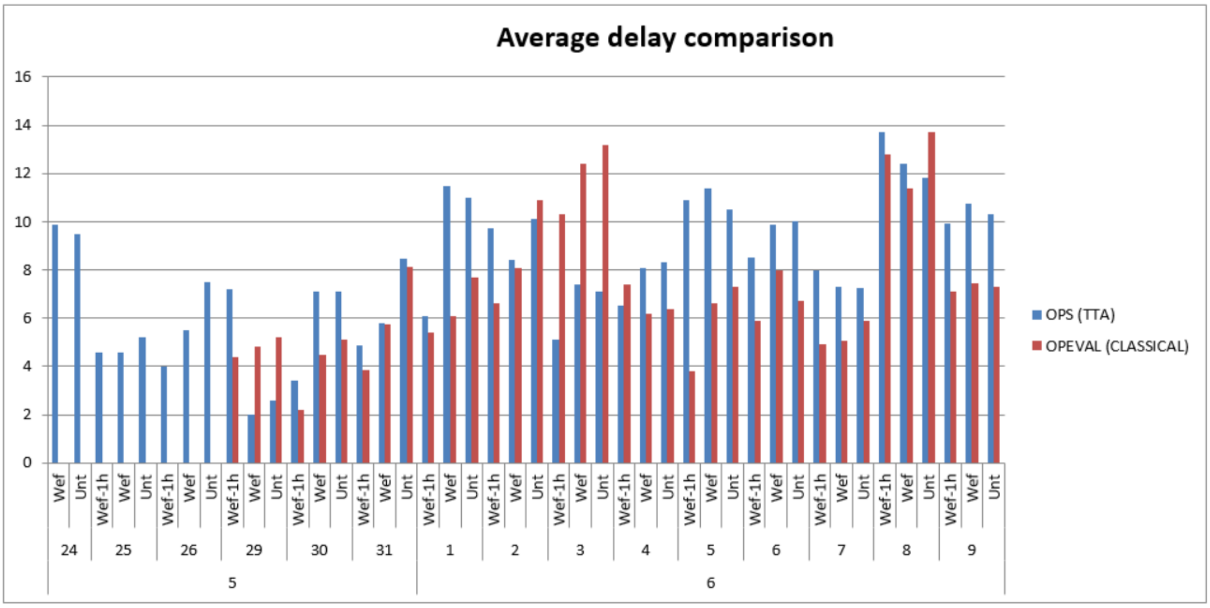


Figure 51: Average Delay LEBL

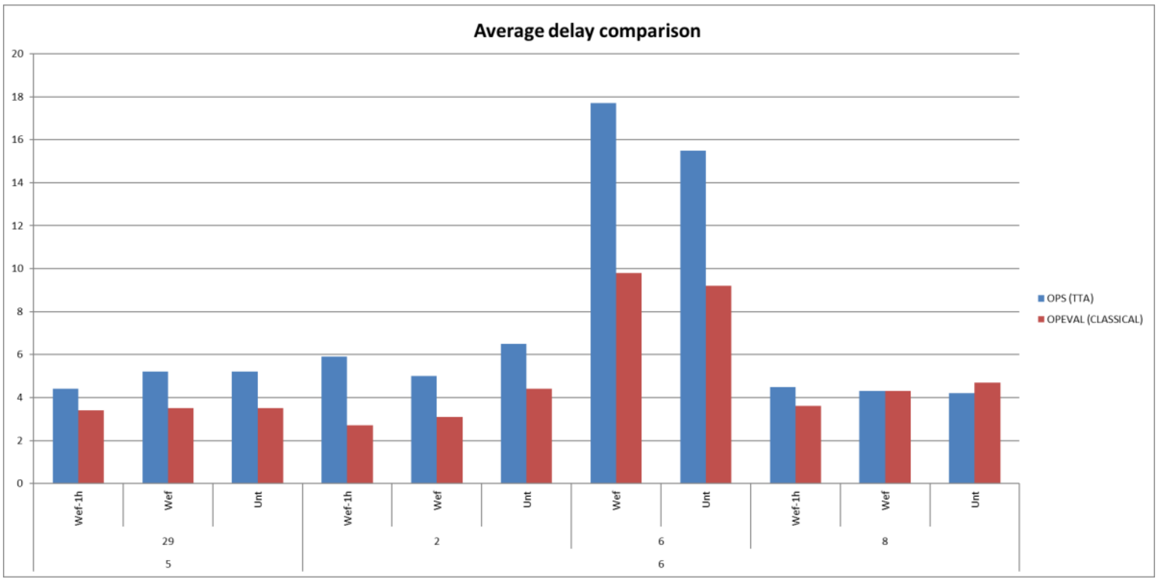


Figure 52: Average Delay LEPA

The observations indicate that overall the TTA regulation average delay is slightly higher than the classic regulation one with 7% delay difference for LEBL and much higher due to the 6th of June at 44 % for LEPA.

#PI-7 Total ATM Delay per AU relative to Baseline ATM delay

The AOP delay is only slightly higher; the higher delay is very evenly distributed over the different airlines

Total ATM Delay per AU relative to Baseline ATM delay LEPA					
AU IATA code	Total ATM Delay of AOP min	Total ATM Delay of CASA min	Difference min	Number of operations	Mean of delay in minutes by operations
0B	26,00	20,00	6,00	3,00	2,00
2L	-32,00	-46,00	14,00	11,00	1,27
3O	34,00	33,00	1,00	3,00	0,33
3Z	45,00	42,00	3,00	4,00	0,75
5O	46,00	42,00	4,00	6,00	0,67
6B	482,00	468,00	14,00	15,00	0,93
7E	0,00	-1,00	1,00	1,00	1,00
7O	28,00	28,00	0,00	1,00	0,00
AD	152,00	142,00	10,00	11,00	0,91
AE	16,00	14,00	2,00	2,00	1,00
AF	194,00	191,00	3,00	8,00	0,38

AH	424,00	410,00	14,00	33,00	0,42
AO	154,00	150,00	4,00	6,00	0,67
AP	267,00	259,00	8,00	34,00	0,24
AR	16,00	15,00	1,00	2,00	0,50
AS	10,00	9,00	1,00	1,00	1,00
AT	85,00	81,00	4,00	13,00	0,31
AX	20,00	18,00	2,00	2,00	1,00
AY	-96,00	-101,00	5,00	6,00	0,83
AZ	64,00	60,00	4,00	9,00	0,44
B2	5,00	1,00	4,00	2,00	2,00
BA	869,00	796,00	73,00	93,00	0,79
BE	152,00	147,00	5,00	32,00	0,16
BF	179,00	179,00	0,00	4,00	0,00
BT	14,00	11,00	3,00	4,00	0,75
BV	12,00	12,00	0,00	2,00	0,00
BY	3775,00	3554,00	221,00	303,00	0,73
BZ	63,00	62,00	1,00	3,00	0,33
CA	-16,00	-17,00	1,00	1,00	1,00
CB	21,00	21,00	0,00	1,00	0,00
CD	358,00	355,00	3,00	11,00	0,27
CJ	250,00	202,00	48,00	42,00	1,14
CL	15,00	13,00	2,00	4,00	0,50
D8	525,00	413,00	112,00	195,00	0,57
DB	3,00	2,00	1,00	1,00	1,00
DC	33,00	32,00	1,00	2,00	0,50
DE	2027,00	1714,00	313,00	370,00	0,85
DF	10,00	8,00	2,00	2,00	1,00
DK	830,00	779,00	51,00	82,00	0,62
DS	-47,00	-50,00	3,00	4,00	0,75
DX	-38,00	-42,00	4,00	6,00	0,67
DY	1168,00	1123,00	45,00	113,00	0,40
E4	85,00	63,00	22,00	30,00	0,73
E9	165,00	153,00	12,00	17,00	0,71
EC	3134,00	2640,00	494,00	581,00	0,85
ED	-31,00	-38,00	7,00	7,00	1,00
EF	58,00	102,00	-44,00	6,00	-7,33
EG	-12,00	-14,00	2,00	3,00	0,67
EI	370,00	334,00	36,00	39,00	0,92

EN	-10,00	-10,00	0,00	1,00	0,00
EW	6600,00	6309,00	291,00	1201,00	0,24
FB	258,00	257,00	1,00	6,00	0,17
FL	51,00	47,00	4,00	6,00	0,67
FR	13432,00	12710,00	722,00	1657,00	0,44
FS	32,00	31,00	1,00	1,00	1,00
FT	71,00	70,00	1,00	1,00	1,00
GA	47,00	40,00	7,00	10,00	0,70
GL	26,00	26,00	0,00	1,00	0,00
GM	481,00	417,00	64,00	20,00	3,20
GN	-1,00	-2,00	1,00	1,00	1,00
GP	141,00	116,00	25,00	4,00	6,25
GW	34,00	101,00	-67,00	4,00	-16,75
HR	83,00	77,00	6,00	6,00	1,00
HT	15,00	13,00	2,00	2,00	1,00
HV	1488,00	1444,00	44,00	111,00	0,40
I2	-469,00	-531,00	62,00	157,00	0,40
IF	49,00	47,00	2,00	2,00	1,00
IJ	8,00	7,00	1,00	1,00	1,00
IT	17,00	15,00	2,00	1,00	2,00
JA	47,00	46,00	1,00	2,00	0,50
JB	51,00	47,00	4,00	5,00	0,80
JC	-46,00	-50,00	4,00	5,00	0,80
JE	19,00	19,00	0,00	2,00	0,00
JF	127,00	121,00	6,00	7,00	0,86
JK	19,00	18,00	1,00	1,00	1,00
JL	15,00	14,00	1,00	1,00	1,00
JM	10,00	9,00	1,00	1,00	1,00
JN	24,00	19,00	5,00	1,00	5,00
JP	33,00	33,00	0,00	3,00	0,00
JT	283,00	265,00	18,00	28,00	0,64
KB	50,00	49,00	1,00	2,00	0,50
LG	161,00	142,00	19,00	47,00	0,40
LH	1686,00	1609,00	77,00	152,00	0,51
LN	36,00	33,00	3,00	2,00	1,50
LR	78,00	77,00	1,00	4,00	0,25
LS	791,00	542,00	249,00	392,00	0,64
LW	71,00	71,00	0,00	2,00	0,00

LX	681,00	690,00	-9,00	92,00	-0,10
MG	0,00	0,00	0,00	1,00	0,00
MH	10,00	9,00	1,00	1,00	1,00
MO	60,00	58,00	2,00	3,00	0,67
MT	267,00	221,00	46,00	132,00	0,35
NJ	350,00	293,00	57,00	66,00	0,86
NO	24,00	16,00	8,00	11,00	0,73
NT	166,00	156,00	10,00	17,00	0,59
OE	4727,00	4584,00	143,00	484,00	0,30
OR	1259,00	1226,00	33,00	32,00	1,03
P6	137,00	133,00	4,00	5,00	0,80
P8	98,00	98,00	0,00	1,00	0,00
PA	166,00	162,00	4,00	5,00	0,80
PE	-23,00	-24,00	1,00	5,00	0,20
PQ	115,00	114,00	1,00	4,00	0,25
PS	23,00	21,00	2,00	3,00	0,67
QA	141,00	134,00	7,00	9,00	0,78
QB	23,00	22,00	1,00	2,00	0,50
QG	163,00	156,00	7,00	6,00	1,17
QS	1101,00	1076,00	25,00	50,00	0,50
RC	12,00	12,00	0,00	1,00	0,00
RR	211,00	206,00	5,00	12,00	0,42
S7	-315,00	-338,00	23,00	27,00	0,85
SA	187,00	182,00	5,00	7,00	0,71
SF	-13,00	-14,00	1,00	1,00	1,00
SI	-10,00	-13,00	3,00	2,00	1,50
SK	346,00	73,00	273,00	88,00	3,10
SL	21,00	20,00	1,00	1,00	1,00
SN	-145,00	-166,00	21,00	31,00	0,68
SP	12,00	9,00	3,00	1,00	3,00
SR	-18,00	-46,00	28,00	22,00	1,27
SS	30,00	29,00	1,00	2,00	0,50
SU	-64,00	-68,00	4,00	10,00	0,40
SV	127,00	124,00	3,00	3,00	1,00
SW	768,00	734,00	34,00	136,00	0,25
SX	-2,00	-2,00	0,00	1,00	0,00
TB	-146,00	-260,00	114,00	100,00	1,14
TI	52,00	49,00	3,00	2,00	1,50

TJ	-11,00	-12,00	1,00	1,00	1,00
TO	109,00	95,00	14,00	25,00	0,56
TY	-128,00	-84,00	-44,00	12,00	-3,67
U2	2340,00	1889,00	451,00	348,00	1,30
U6	218,00	208,00	10,00	11,00	0,91
UG	858,00	759,00	99,00	23,00	4,30
UL	-17,00	-18,00	1,00	1,00	1,00
UX	5231,00	4534,00	697,00	877,00	0,80
V7	381,00	311,00	70,00	117,00	0,60
VB	16,00	15,00	1,00	1,00	1,00
VC	45,00	44,00	1,00	7,00	0,14
VI	-3,00	-5,00	2,00	1,00	2,00
VJ	53,00	51,00	2,00	5,00	0,40
VK	-152,00	-144,00	-8,00	30,00	-0,27
VL	71,00	70,00	1,00	3,00	0,33
VV	56,00	54,00	2,00	2,00	1,00
VX	101,00	101,00	0,00	1,00	0,00
VY	1379,00	875,00	504,00	834,00	0,60
W2	-11,00	-9,00	-2,00	2,00	-1,00
W6	199,00	195,00	4,00	8,00	0,50
WK	369,00	345,00	24,00	31,00	0,77
X3	762,00	540,00	222,00	295,00	0,75
XG	34,00	34,00	0,00	2,00	0,00
XJ	39,00	38,00	1,00	1,00	1,00
XR	37,00	32,00	5,00	9,00	0,56
YW	-3392,00	-3679,00	287,00	500,00	0,57
ZF	150,00	132,00	18,00	13,00	1,39
ZI	-9,00	-9,00	0,00	1,00	0,00
ZZ	2726,00	2646,00	80,00	127,00	0,63

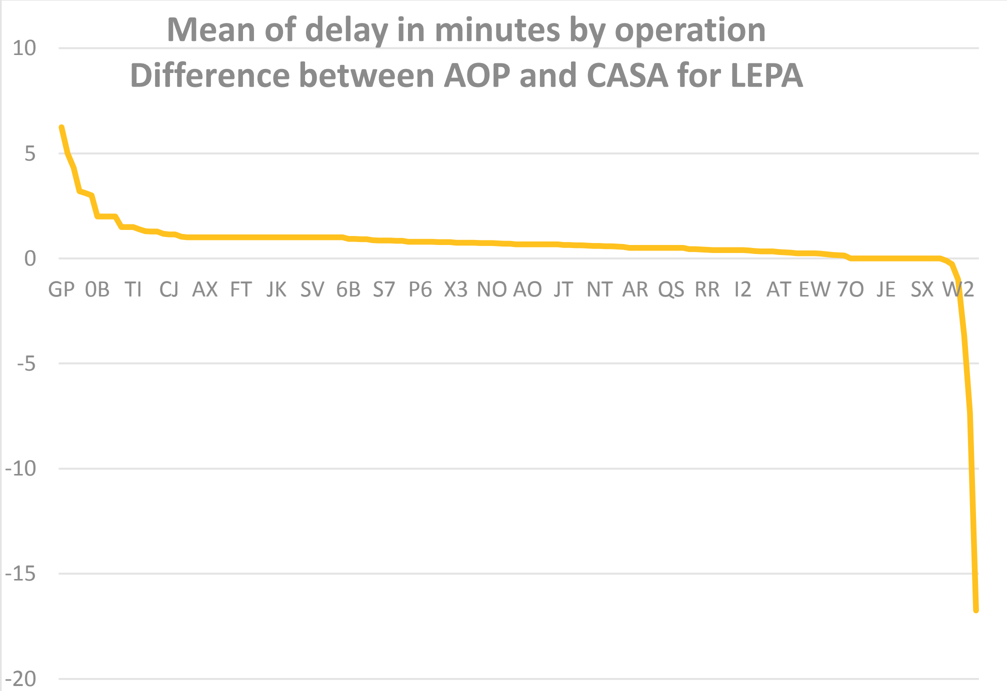


Figure 53: Mean of delay in minutes by operations LEPA

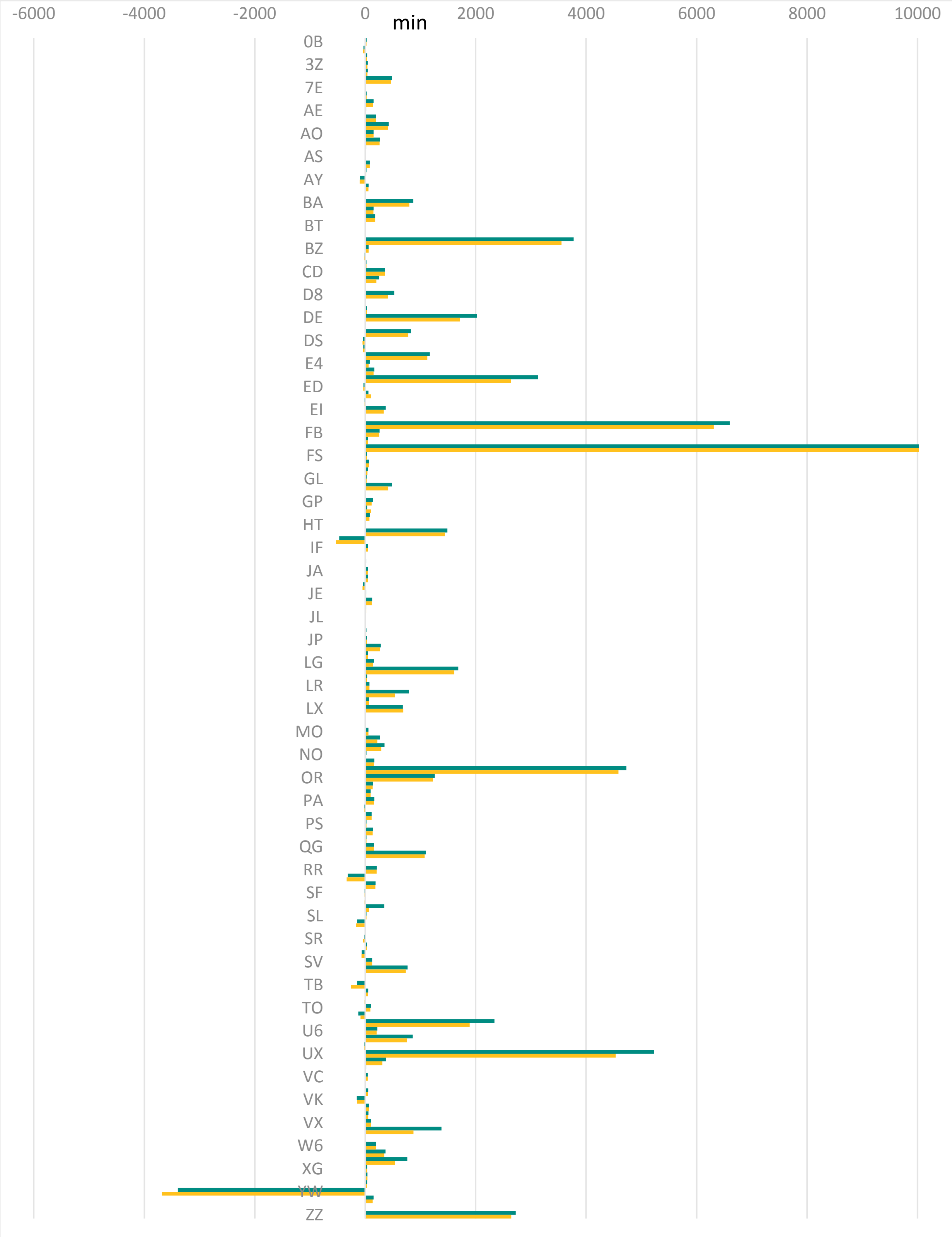


Figure 54: Total ATM Delay per AU relative to Baseline ATM delay LEBL

Total ATM Delay per AU relative to Baseline ATM delay LEBL					
AU IATA code	Total ATM Delay of AOP min	Total ATM Delay of CASA min	Difference min	Number of operations	Mean of delay in minutes by operations
0B	-176,00	-176,00	0,00	24,00	0,00
3O	639,00	334,00	305,00	58,00	5,26
3V	-1,00	-6,00	5,00	20,00	0,25
3Z	167,00	166,00	1,00	4,00	0,25
5O	108,00	120,00	-12,00	5,00	-2,40
5X	232,00	215,00	17,00	36,00	0,47
7E	97,00	97,00	0,00	1,00	0,00
7W	30,00	30,00	0,00	5,00	0,00
9U	573,00	570,00	3,00	13,00	0,23
A3	200,00	200,00	0,00	43,00	0,00
A9	108,00	106,00	2,00	8,00	0,25
AA	2388,00	1572,00	816,00	139,00	5,87
AD	147,00	147,00	0,00	3,00	0,00
AF	942,00	905,00	37,00	168,00	0,22
AH	288,00	166,00	122,00	51,00	2,39
AM	61,00	60,00	1,00	3,00	0,33
AO	87,00	86,00	1,00	4,00	0,25
AP	138,00	137,00	1,00	5,00	0,20
AS	70,00	69,00	1,00	1,00	1,00
AT	812,00	803,00	9,00	35,00	0,26
AV	-504,00	-508,00	4,00	29,00	0,14
AX	-87,00	-87,00	0,00	1,00	0,00
AY	-57,00	-68,00	11,00	56,00	0,20
AZ	295,00	285,00	10,00	83,00	0,12
B2	-130,00	-127,00	-3,00	22,00	-0,14
BA	514,00	476,00	38,00	230,00	0,17
BN	8,00	8,00	0,00	2,00	0,00
BT	11,00	9,00	2,00	26,00	0,08
BY	95,00	95,00	0,00	1,00	0,00
CA	583,00	579,00	4,00	33,00	0,12
CJ	-41,00	-41,00	0,00	3,00	0,00
CX	460,00	461,00	-1,00	16,00	-0,06
D8	3152,00	2988,00	164,00	294,00	0,56

DB	93,00	70,00	23,00	3,00	7,67
DC	89,00	91,00	-2,00	4,00	-0,50
DE	56,00	55,00	1,00	3,00	0,33
DL	144,00	-99,00	243,00	56,00	4,34
DN	3,00	3,00	0,00	1,00	0,00
DS	921,00	913,00	8,00	87,00	0,09
DY	2769,00	2761,00	8,00	118,00	0,07
E4	146,00	146,00	0,00	11,00	0,00
EC	4663,00	4583,00	80,00	627,00	0,13
ED	19,00	18,00	1,00	1,00	1,00
EE	136,00	136,00	0,00	3,00	0,00
EF	120,00	119,00	1,00	4,00	0,25
EG	9,00	9,00	0,00	1,00	0,00
EI	409,00	408,00	1,00	76,00	0,01
EK	-453,00	-459,00	6,00	51,00	0,12
EN	78,00	77,00	1,00	4,00	0,25
EO	53,00	52,00	1,00	2,00	0,50
EW	1414,00	1332,00	82,00	214,00	0,38
EY	-335,00	-343,00	8,00	28,00	0,29
FB	14,00	13,00	1,00	13,00	0,08
FL	71,00	70,00	1,00	5,00	0,20
FR	14712,00	14479,00	233,00	1867,00	0,13
FV	78,00	74,00	4,00	33,00	0,12
FX	121,00	117,00	4,00	12,00	0,33
FY	136,00	135,00	1,00	1,00	1,00
GA	70,00	70,00	0,00	2,00	0,00
GJ	-6,00	-6,00	0,00	1,00	0,00
GP	535,00	593,00	-58,00	29,00	-2,00
GW	-10,00	-9,00	-1,00	4,00	-0,25
HA	16,00	16,00	0,00	2,00	0,00
HR	-8,00	-8,00	0,00	1,00	0,00
HV	1480,00	1472,00	8,00	134,00	0,06
HW	24,00	24,00	0,00	1,00	0,00
IB	902,00	870,00	32,00	408,00	0,08
IF	-10,00	-10,00	0,00	2,00	0,00
IJ	48,00	48,00	0,00	1,00	0,00
IN	10,00	9,00	1,00	1,00	1,00
IO	-57,00	-57,00	0,00	5,00	0,00

IZ	33,00	33,00	0,00	3,00	0,00
JB	57,00	57,00	0,00	2,00	0,00
JC	30,00	30,00	0,00	1,00	0,00
JD	11,00	10,00	1,00	3,00	0,33
JJ	-1,00	0,00	-1,00	28,00	-0,04
JL	53,00	52,00	1,00	2,00	0,50
JN	-5,00	-7,00	2,00	3,00	0,67
JP	-23,00	-23,00	0,00	2,00	0,00
JU	18,00	17,00	1,00	4,00	0,25
KE	249,00	249,00	0,00	17,00	0,00
KF	60,00	60,00	0,00	1,00	0,00
KL	1738,00	1729,00	9,00	140,00	0,06
LD	0,00	-1,00	1,00	1,00	1,00
LG	212,00	278,00	-66,00	35,00	-1,89
LH	5136,00	5109,00	27,00	388,00	0,07
LN	106,00	106,00	0,00	1,00	0,00
LO	433,00	429,00	4,00	28,00	0,14
LP	-21,00	-23,00	2,00	12,00	0,17
LR	167,00	168,00	-1,00	2,00	-0,50
LS	-92,00	-100,00	8,00	48,00	0,17
LW	10,00	10,00	0,00	1,00	0,00
LX	1844,00	1829,00	15,00	136,00	0,11
LY	438,00	432,00	6,00	35,00	0,17
MO	12,00	12,00	0,00	1,00	0,00
MS	54,00	51,00	3,00	21,00	0,14
NI	-6,00	-7,00	1,00	4,00	0,25
NJ	167,00	160,00	7,00	26,00	0,27
NT	7,00	6,00	1,00	1,00	1,00
OE	184,00	181,00	3,00	48,00	0,06
OI	15,00	15,00	0,00	2,00	0,00
OK	439,00	436,00	3,00	29,00	0,10
OR	487,00	492,00	-5,00	23,00	-0,22
OU	156,00	150,00	6,00	16,00	0,38
OZ	-178,00	-182,00	4,00	16,00	0,25
PA	-272,00	199,00	-471,00	11,00	-42,82
PC	-510,00	-524,00	14,00	39,00	0,36
PK	104,00	104,00	0,00	8,00	0,00
PN	36,00	36,00	0,00	1,00	0,00

PP	-20,00	-21,00	1,00	1,00	1,00
PQ	1050,00	1049,00	1,00	30,00	0,03
PS	52,00	52,00	0,00	26,00	0,00
PT	52,00	52,00	0,00	1,00	0,00
QB	-36,00	15,00	-51,00	1,00	-51,00
QE	34,00	32,00	2,00	4,00	0,50
QF	83,00	83,00	0,00	2,00	0,00
QG	14,00	14,00	0,00	1,00	0,00
QK	-5,00	-5,00	0,00	2,00	0,00
QQ	-17,00	-17,00	0,00	1,00	0,00
QR	-600,00	-610,00	10,00	78,00	0,13
QU	603,00	602,00	1,00	9,00	0,11
QY	390,00	357,00	33,00	46,00	0,72
RC	-34,00	-36,00	2,00	3,00	0,67
RE	13,00	13,00	0,00	1,00	0,00
RJ	-227,00	-226,00	-1,00	14,00	-0,07
RL	216,00	201,00	15,00	14,00	1,07
RO	76,00	85,00	-9,00	28,00	-0,32
RR	145,00	144,00	1,00	4,00	0,25
RV	-49,00	-55,00	6,00	47,00	0,13
S7	-675,00	-675,00	0,00	36,00	0,00
SA	23,00	23,00	0,00	1,00	0,00
SI	34,00	34,00	0,00	1,00	0,00
SK	15,00	14,00	1,00	6,00	0,17
SN	437,00	431,00	6,00	84,00	0,07
SQ	550,00	547,00	3,00	20,00	0,15
SR	271,00	271,00	0,00	6,00	0,00
SS	68,00	67,00	1,00	1,00	1,00
SU	-1131,00	-1039,00	-92,00	116,00	-0,79
SV	98,00	97,00	1,00	3,00	0,33
SW	-200,00	-216,00	16,00	53,00	0,30
TE	17,00	17,00	0,00	1,00	0,00
TI	-14,00	-17,00	3,00	1,00	3,00
TK	48,00	18,00	30,00	112,00	0,27
TO	5,00	8,00	-3,00	40,00	-0,08
TP	1945,00	1932,00	13,00	222,00	0,06
TS	-2,00	-25,00	23,00	26,00	0,89
TU	820,00	359,00	461,00	17,00	27,12

TY	-2,00	-2,00	0,00	3,00	0,00
U2	2085,00	2062,00	23,00	313,00	0,07
U6	-81,00	-86,00	5,00	54,00	0,09
UA	1265,00	1265,00	0,00	49,00	0,00
UG	154,00	154,00	0,00	2,00	0,00
UL	-9,00	-9,00	0,00	1,00	0,00
UX	3103,00	3073,00	30,00	247,00	0,12
VB	6,00	6,00	0,00	2,00	0,00
VJ	301,00	299,00	2,00	15,00	0,13
VK	-142,00	-149,00	7,00	28,00	0,25
VL	22,00	21,00	1,00	1,00	1,00
VN	13,00	13,00	0,00	1,00	0,00
VV	-9,00	-9,00	0,00	1,00	0,00
VX	55,00	55,00	0,00	1,00	0,00
VY	72522,00	71738,00	784,00	5564,00	0,14
W2	13,00	13,00	0,00	1,00	0,00
W5	210,00	211,00	-1,00	8,00	-0,13
W6	1563,00	1536,00	27,00	242,00	0,11
WG	-16,00	-16,00	0,00	1,00	0,00
WS	72,00	72,00	0,00	9,00	0,00
X3	52,00	52,00	0,00	9,00	0,00
XR	52,00	52,00	0,00	4,00	0,00
XW	39,00	39,00	0,00	2,00	0,00
XY	-16,00	-16,00	0,00	1,00	0,00
YE	25,00	25,00	0,00	1,00	0,00
YW	16,00	4,00	12,00	101,00	0,12
ZF	-646,00	-654,00	8,00	39,00	0,21
ZZ	355,00	351,00	4,00	14,00	0,29

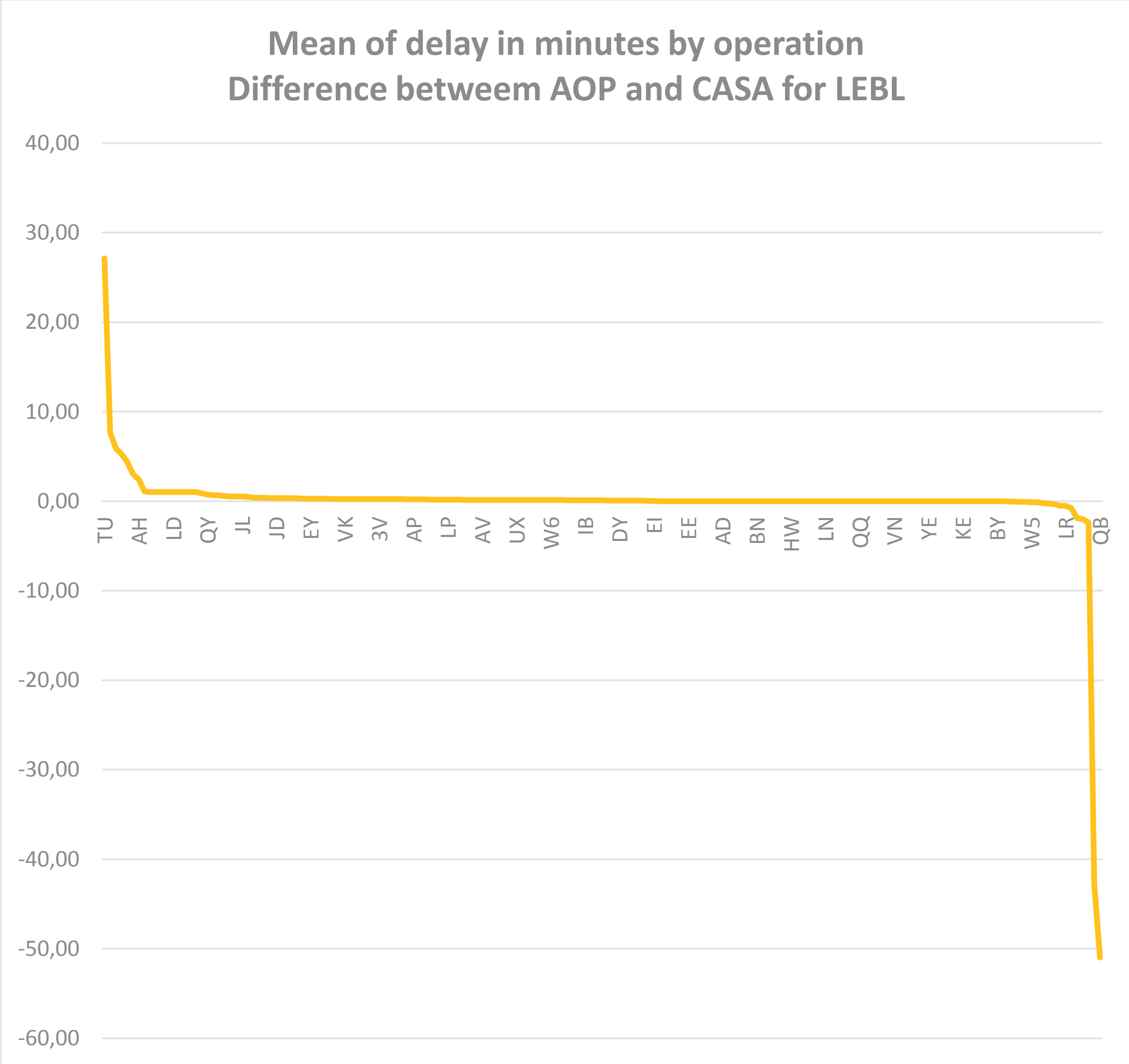


Figure 55: Mean of delay in minutes by operations LEBL

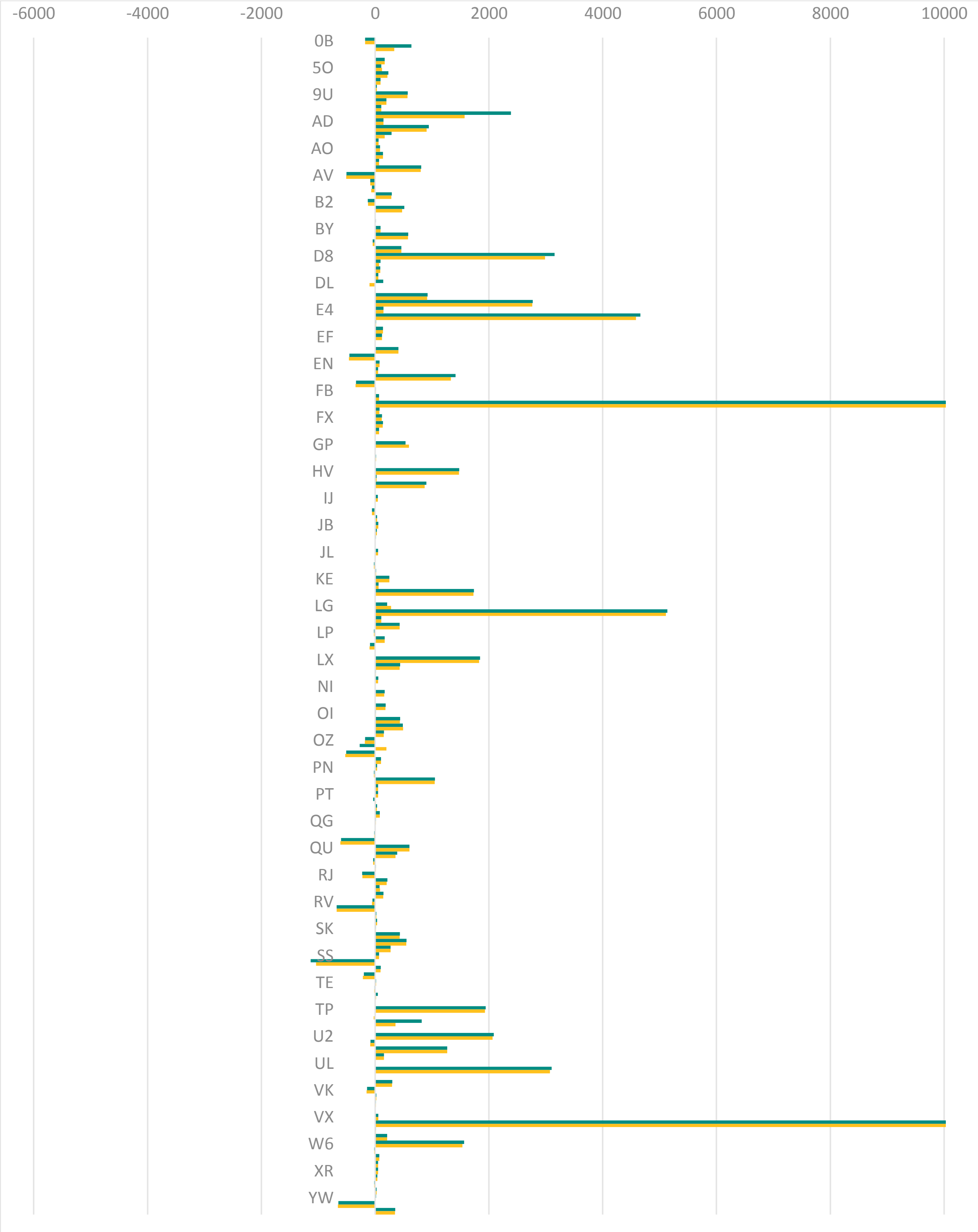


Figure 56: **Total ATM Delay per AU relative to Baseline ATM delay LEBL**

#PI-18 ATFM Delay: TTA regulation vs Classical (CASA) regulation

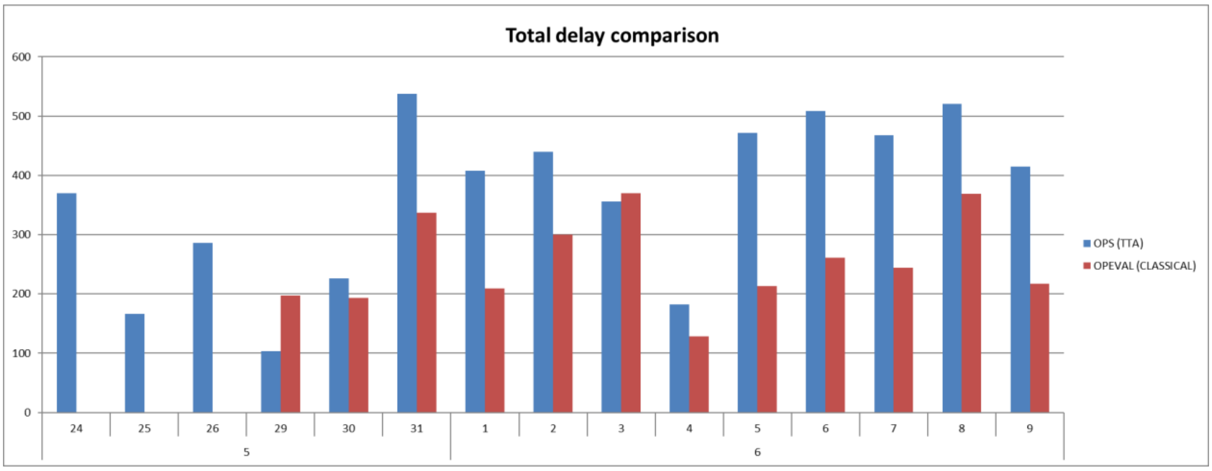


Figure 57: Total Regulation Delay LEBL

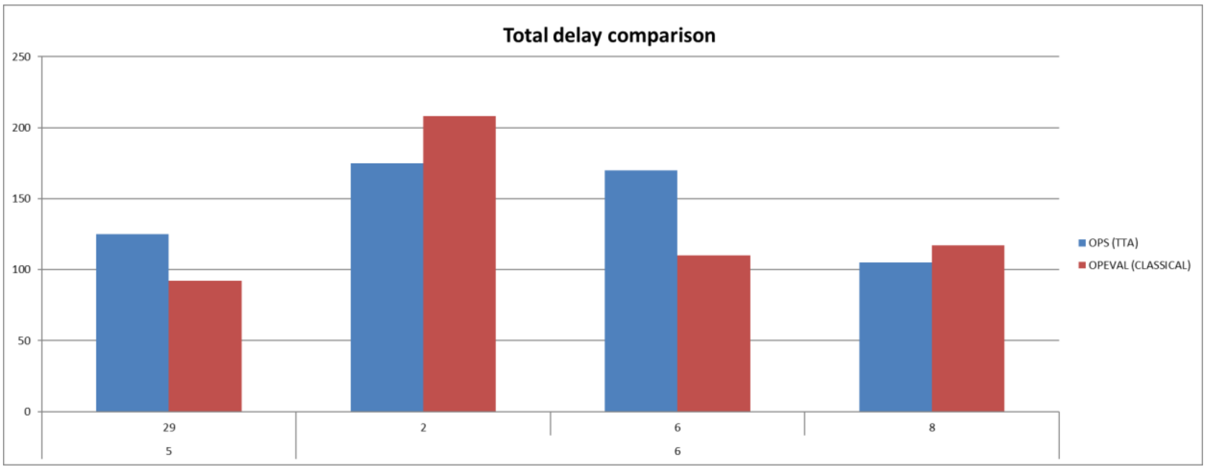


Figure 58: Total Regulation Delay LEPA

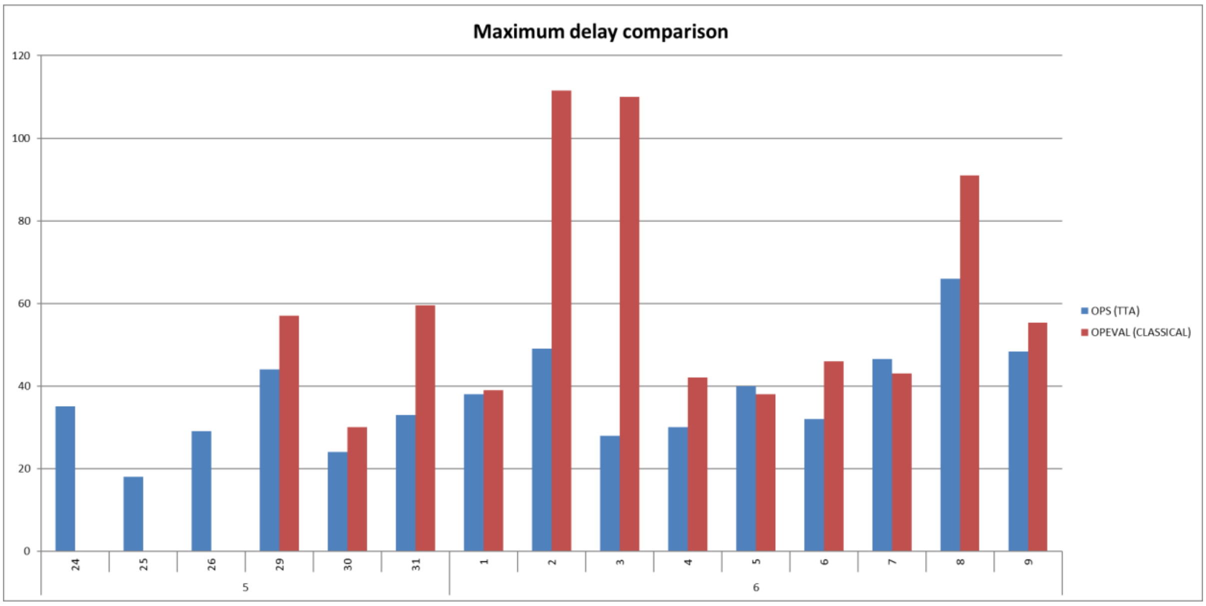


Figure 59: Maximum Regulation Delay LEBL

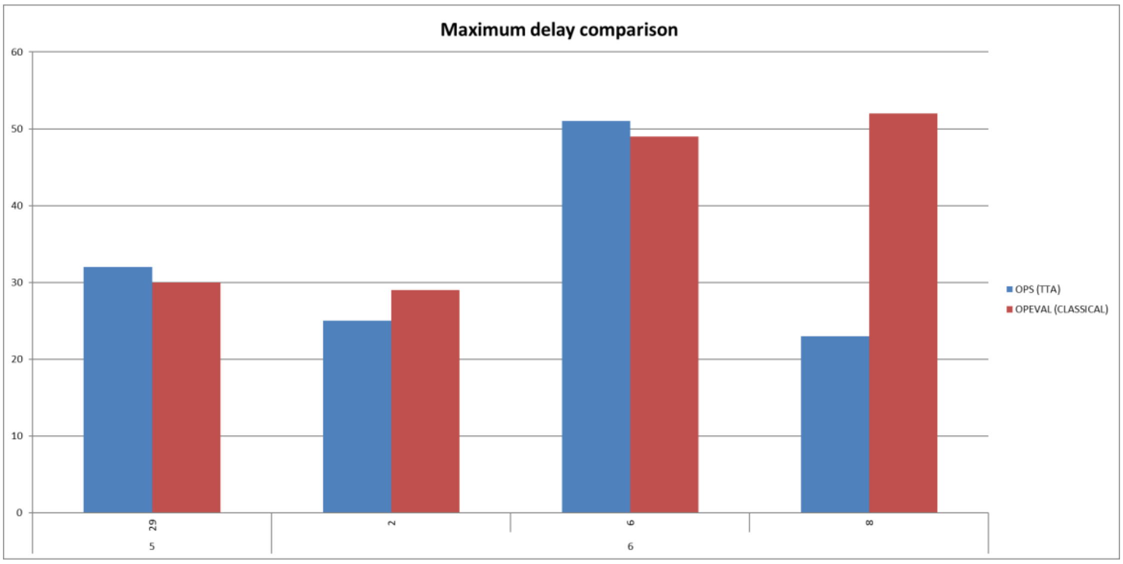


Figure 60: Maximum Regulation Delay LEPA

The observations indicate that overall the TTA regulation maximum delay is lower than the classic regulation one by 37% delay difference for LEBL and by 18% delay difference for LEPA.

#PI-22 Total delay of inbound flights within TTA regulation

LEBL

From 20th May until 12th June, there were 21 API TTA regulations that affected 1162 flights of which 965 received a delay totalling 8101 minutes.

Execution	Date	Regulation	Start Time	End Time	Activation Time	Notice (min)	Regulation Duration (min)	Reg Reason	WW (min)	MP Reg Traffic	Reg Traffic	ATFM Delay (min)	MP Delayed Traffic	AVG Delay per Reg Traffic
Ran fully	24-may	CPEBL24	17:00	19:40	15:31	88	160	C	10	39	44	370	26	8.4
Ran fully	25-may	CPEBL25	8:00	10:00	6:03	117	120	C	10	33	42	178	23	4.2
Ran fully	26-may	CPEBL26X	7:20	10:00	5:35	105	160	C	10	57	62	328	32	5.3
Ran fully	26-may	CPEBL26A	16:40	18:40	13:56	164	120	C	10	38	50	286	26	5.7
Ran fully	29-may	CPEBL29	20:40	22:40	18:22	137	120	V	10	40	43	122	13	2.8
Ran fully	30-may	CPEBL30A	16:20	18:20	14:53	87	120	C	6	32	38	226	25	5.9
Ran fully	31-may	CPEBL31E	8:00	10:40	4:53	186	160	C	6	61	75	471	40	6.3
Ran fully	31-may	CPEBL31A	16:00	19:20	13:21	159	200	C	10	66	82	604	39	7.4
Ran fully	01-jun	CPEBL01	7:40	10:00	5:38	121	140	G	6	37	53	408	26	7.7
Ran fully	02-jun	CPEBL02A	16:20	19:20	14:49	91	180	C	10	43	58	366	29	6.3
Ran fully	02-jun	CPEBL02L	20:54	23:40	18:24	150	166	V	10	44	49	513	27	10.5
Ran fully	03-jun	CPEBL03M	8:00	10:00	5:22	157	120	C	10	50	53	356	36	6.7
Ran fully	04-jun	CPEBL04A	16:40	18:20	15:34	66	100	C	10	22	22	182	16	8.3
Ran fully	05-jun	CPEBL05A	16:20	18:40	14:38	102	140	C	10	46	53	481	36	9.1
Ran fully	06-jun	CPEBL06M	8:00	10:00	4:39	201	120	C	10	51	56	509	38	9.1
Ran fully	07-jun	CPEBL07M	6:00	11:00	4:36	83	300	C	10	103	121	547	61	4.5
Ran fully	07-jun	CPEBL07N	21:00	23:40	17:12	228	160	V	10	42	59	388	22	6.6
Ran fully	08-jun	CPEBL08	8:00	10:20	5:16	164	140	C	10	45	68	521	33	7.7
Ran fully	09-jun	CPEBL09M	8:00	9:40	5:08	171	100	C	10	40	42	319	29	7.6
Ran fully	09-jun	CPEBL09A	16:40	18:20	14:32	128	100	C	10	31	41	226	19	5.5
Ran fully	09-jun	CPEBL09N	21:00	23:00	17:40	200	120	C	10	45	51	700	28	13.7
										965	1162	8101	624	

Where:

V - Environmental Issues

W - Weather

C - ATC Capacity

G - Aerodrome Capacity

LEPA

From 27th May until 12th June, there were four API TTA regulations that affected 122 flights of which 87 received a delay totalling 575 minutes.

Execution	Date	Regulation	Start Time	End Time	Activation Time	Notice (min)	Regulation Duration (min)	Reg Reason	WW (min)	MP Reg Traffic	Reg Traffic	ATFM Delay (min)	MP Delayed Traffic	AVG Delay per Reg Traffic
Ran fully	29-may	CPEPA29A	29-may	29-may	29-may	107	120	C	10	24	37	125	17	3.4
Ran fully	02-jun	CPEPA02M	7:00	10:00	5:33	87	180	C	10	27	37	175	19	4.7
Ran fully	06-jun	CPEPA06	18:20	19:40	17:21	59	80	C	10	11	11	170	8	15.5
Ran fully	08-jun	CPEPA08A	17:40	19:20	14:29	190	100	C	10	25	37	105	14	2.8
										87	122	575	58	

Where:

V - Environmental Issues

W - Weather

C - ATC Capacity

G - Aerodrome Capacity

Predictability

#PI-5 Comparison between the Actual In/Off Block Times and the coordinated airport slots

See Section a (Predictability section)

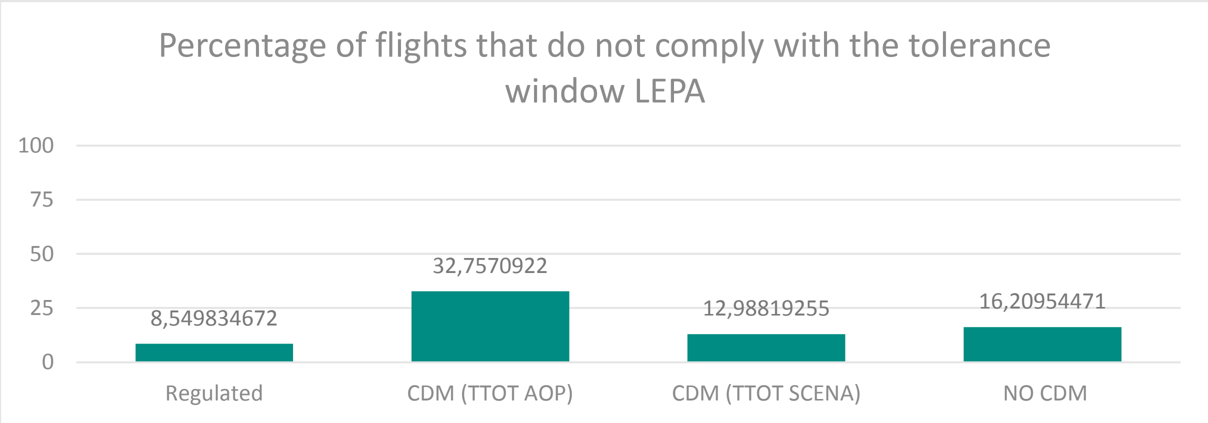
#PI-29 Estimated Landing time improvement of the arrival flights

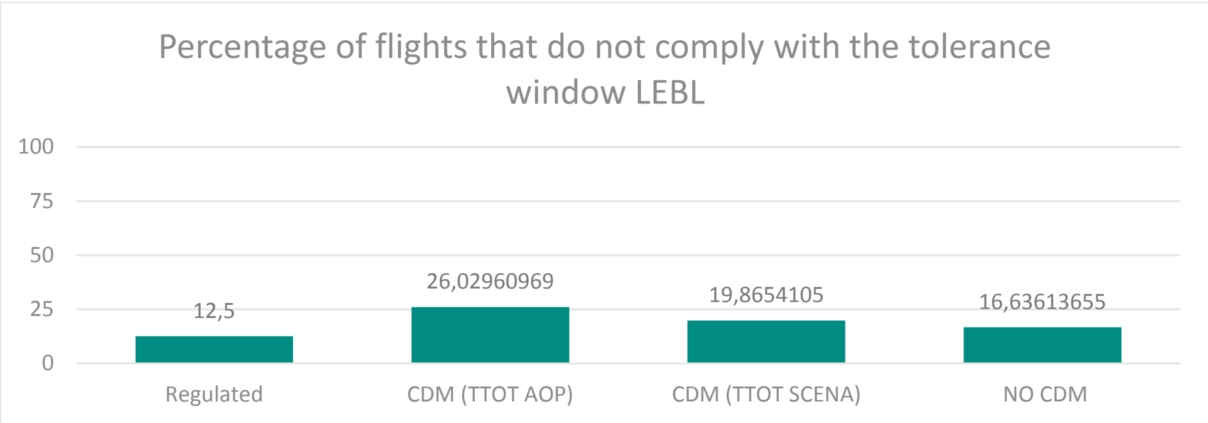
See Section E.3.35.

Capacity

#PI-1 Number of flights that do not comply with the tolerance window

From those flights with a CTOT (in other airports different from the one validated) due to a aerodrome regulation in destination, calculate for those flights that do not comply with the tolerance window (ATOT out of -5+10 newCTOT (in this case in our airport) or +- 5min TTOT if flight is going to an A-CDM airport and has not been regulated, or +-15min (EOBT+TT) if flight goes to a non-A-CDM airport and is not regulated) and also calculate the value of that deviation.





E.3.2 Results impacting regulation and standardisation initiatives

The COMMISSION IMPLEMENTING REGULATION (EU) No 716/2014 of 27 June 2014 states a Pilot Common Project that identifies a first set of ATM functionalities to be deployed in timely, coordinated and synchronised way so as to achieve the essential operational changes stemming from the European ATM Master Plan, in sections 4.1.2 and 4.1.3 mention the AOP-NOP integration and the Target Times, respectively.

E.3.3 Analysis of Exercises Results per Demonstration objective

This section presents the qualitative and quantitative analysis of the results gathered from the Trial. The results are obtained from:

- The questionnaires answered by the FMPs, NM and the AUs
- The data collected during the Trial.

For further information regarding the demonstration technique, see cf. E.1.1 "*Demonstration technique*".

The following table correlates the objectives and associated success criteria with the items addressing them.

Demonstration Exercise 3 Objectives	Demonstration Exercise 3 Success criteria	Items addressing the Objective
EX3-OBJ-VLD-01-001 Acceptable increase in workload for network operations planning actors to apply the proposed solution enhanced DCB and TT measures to optimally use network capacity (TTA EXE)	**EX3-CRT-VLD-01-001** The usage of the proposed solution enhanced DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload	• Queries #1 FMPs/ATCO questionnaire • Queries #1 NM questionnaire
EX3-OBJ-VLD-01-003 Reduction of necessary ATC interventions to de-bunch and optimally sequence traffic entering departure and arrival sectors (TTA EXE)	**EX3-CRT-VLD-01-003** The usage of the proposed enhanced DCB and TTs does not have a negative impact on ATC TWR/APP operational staff workload	• Queries #2 FMPs/ATCO questionnaire
EX3-OBJ-VLD-01-004 Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied (TTA EXE)	**EX3-CRT-VLD-01-004** Positive feedback from operational staff regarding a clearly defined DCB coordination process	• Queries #3 #4 FMPs/ATCO questionnaire • Queries #2 #3 NM questionnaire
EX3-OBJ-VLD-02-001 Assess the improved network predictability due to the earlier, beyond the current A-CDM, departure and arrival data and estimates exchanges (AOP-NOP EXE)	**EX3-CRT-VLD-02-001A** Network traffic demand accuracy. The distribution of predicted-actual flights in NM platform is narrower than current operations **EX3-CRT-VLD-02-001B**	• Performance indicator-21 TTOT predictability • Performance indicator-20 TTOT Accuracy

	More actual (compared to airport data and/or actuals) flight departure and arrival time estimates, other airport related data and profiles	
EX3-OBJ-VLD-02-002 Reduction of the margins between planning and actual for flight entering the ANSP's AoR due to unforeseen changes in the execution of the European Network operations (TTA EXE)	**EX3-CRT-VLD-02-002** The distribution of early/late arrivals at the entry points of the AoR of actors is narrower than current operations	• Performance indicator-29 ELDT of the TTA flights vs ALDT
EX3-OBJ-VLD-02-003 Reduce the margins between planning and actual for flight landing on the runway for the airports involved in the exercises due to unforeseen changes in the execution of the European Network Operations. (TTA EXE)	**EX3-CRT-VLD-02-003** The distribution of early/late arrivals at the runway of the airports involved in the exercise is narrower than current operations	• Performance indicator-29 ELDT of the TTA flights vs ALDT
EX3-OBJ-VLD-04-001 Reduction in time for NMOC staff to monitor, analyse, coordinate and implement measures to balance demand–capacity (TTA EXE)	**EXE3-CRT-VLD-04-001** NMOC workload is not increased, and NMOC confidence that TTA measure resolves DCB	• Queries #4 #5 #6 NM questionnaire
EX3-OBJ-VLD-04-002 Reduction in time for AU staff to monitor, analyse, coordinate and implement measures to balance demand – capacity (TTA EXE)	**EXE3-CRT-VLD-04-002** AU workload is not increased, and AU confidence that TTA measure resolves DCB	• Queries AU questionnaire • Performance indicator-4 Recovery and Mitigation of Reactionary Delay
EX3-OBJ-VLD-04-003 Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity (TTA EXE)	**EX3-CRT-VLD-04-003** FMP workload is not increased, and FMP confidence that TTA measure resolves DCB	• Queries #5 FMPs/ATCO questionnaire
EX3-OBJ-VLD-05-004 Reduce delay resulting from better ATFM measures definition through improved coordination by means of multi-airport planning (TTA EXE & AOP-NOP EXE)	**EXE4-CRT-VLD-05-004** Overall delay reduction for group of airports compared to baseline scenario	• Performance indicator-28 Departure predictability on those flights that have at least an internal "jump"

Table 25: Correlation between the objectives, success criteria and items addressing them

NMOC Questionnaires and feedback

TTA trial had a duration of 4 weeks for LEBL (from 20th May to 12th June) and 3 weeks for LEPA (from 27th May to 12th June), 35 TTA related CP regulations were created for LEBL arrivals, and 9 for LEPA.

During the trial period, 8 questionnaires have been received from NMOC, 6 related to LEBL TTA regulations on 20th, 24th and 26th May and 2 related to LEPA TTA regulations on 1st and 11th June. It should be highlighted that additional positive verbal feedback was received from the NMOC, mainly for the days when no issues occurred. This indicates that most of NMOC operators filled in the questionnaires to indicate problems and abnormal behaviours. Therefore, the results depicted in the figures below and the conclusions are based on the questionnaires received, linked to 7 TTA CP regulations out from the total of 44 regulations, namely 16% of the trial. These figures do not fully reflect NMOC operator's feedback on the trial, but the extracted conclusions also include verbal feedback captured directly from the NMOC operators.

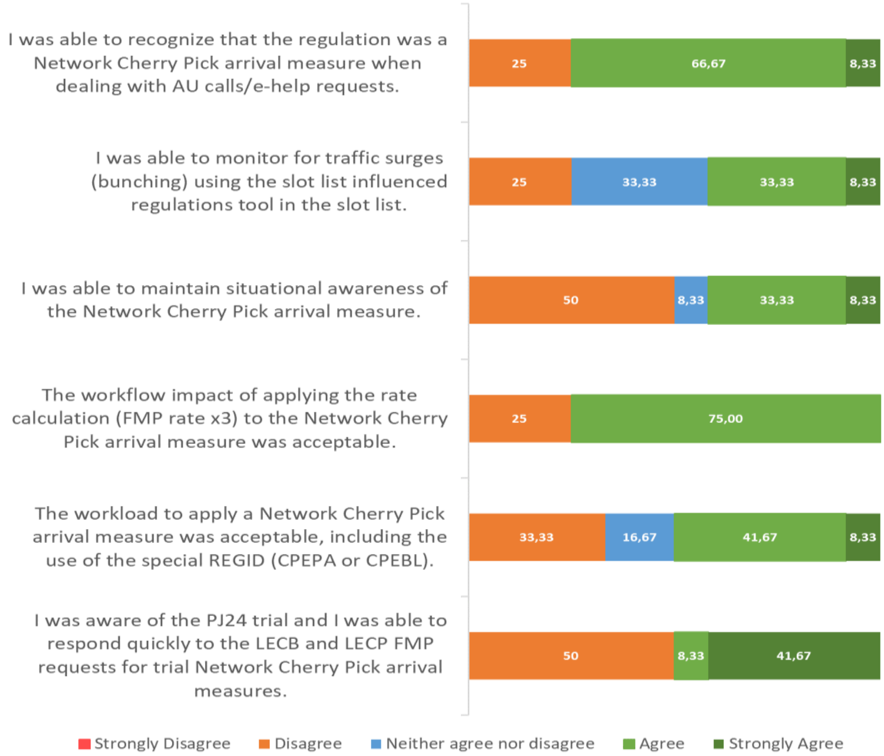


Figure 61: NMOC questionnaires replies

The feedback received from NMOC through the questionnaires indicate operators were prepared and aware of PJ24 trials thanks to the printed out sheets at their position also to the clear requests coming from FMPs in the context of the trial. Few cases were registered with lack of awareness about the trial and the Network Cherry Pick – NCP- regulation principles (TTA regulation).

There were 2 cases with little awareness of the PJ24 trials and the needs of the Network Cherry Pick arrival measure and the regulation parameters required at creation (name and rate). Lack of information from the FMPs, such as the regulation period, slowed down NMOC procedure for creating the Network Cherry Pick Regulation. This was caused by FMPs' little experience on NCP usage, which required a progressive learning curve and demonstrated more confidence after the first week of the trial, according to FMPs' feedback. Also not being familiar with the naming connection made it difficult to recognise the regulation easily when dealing with AU calls/e-help requests. The rest of the operators had no problem. These two operators monitored PMI regulations. A NMOC operator did not understand that the TTA regulation principle. Can it be deep rectify or not, on which principles AOP allocates TTAs.

Moreover, the period of the trial (May – June) played a part in NMOC having to focus on more priority tasks, probably in detriment of being well prepared and aware of PJ24 trial, especially on busiest days. This could explain mostly the 50% replies in disagreement with the measure situational awareness and PJ24 procedure in request to NCP, indicated in Figure **61** above.

There was also mention to the confusion created by the regulation rate (3x rate indicated by FMP) used for technical reasons to avoid artificial delays applied by CASA to the flights with assigned TTA. This created difficulties for regulation monitoring and identification of the regulation effectiveness. However, the solution has already been agreed for implementation along with further improvements for regulation sub-periods rates for NM23.5/NM24.0. The available solution could not be used during the trial due to lack of time for the additional testing required to the AOP/NOP that would have delayed the trial. Another new feature in NM system in support of AOP/NOP integration creating confusion to the operators was seeing the CFTM model created earlier around SIT1 or earlier unlike it was in OPS, some 40 min when receiving the T-DPI-s. The operator was not aware of the new DPI implementation rules used in PJ24.

It was important to double or triple the actual rate of TTA CP regulation, to avoid artificial delays. This is no longer the case. A CR was implemented so that CASA no longer creates more delay than what comes from the TTA and other regulations.

The workload perceived by NMOC operators for NCP application and its corresponding rate was acceptable during the trial, so the described procedure would not have a negative impact on daily operations and workload.

The regulation period extension for an NCP created confusion to a NMOC operator when requested by FMP. TTA regulation needs a longer period from the start to avoid peaks of bunching that do not dissolve with period extension.

PJ24 does not want to promote the behaviour of AO requesting the extension, get it accepted and disregard the TTA. However, PJ24 understand that the extension should be granted when really needed. TBD the conditions on which the extension should be accepted. Note that during the trial, the extensions were not allowed to respect as much as possible the TTA that was the main goal.

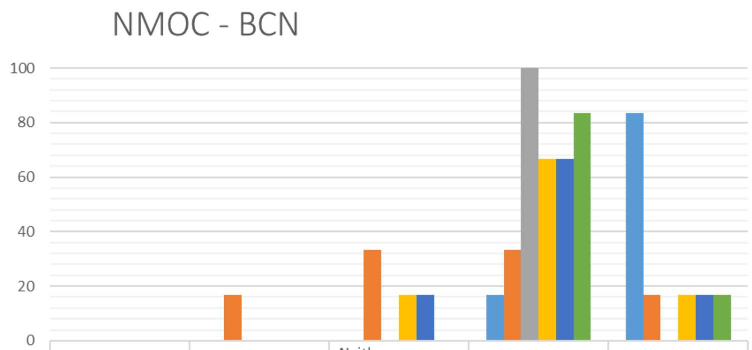
NMOC operators asked how equitability was addressed with TTA. It seems that the basic principles used for TTA assignment i.e. respect the initial plan (as scheduled by airline) and reduce knock-on effect were not known by operators or not communicated. Furthermore, there were some cases in which few flights received significant amount of delay, unusual in previous regulations at LEBL/LEPA arrivals. These cases were identified either by the NMOC or indicated by AUs through telephone/e-Helpdesk slot improvement requests. As NMOC were instructed not to allow swapping or slot improvements to flights captured by TTA regulation, the Network Chery Pick regulation for TTA was replaced by a classic regulation in several cases.

A difficult case for NMOC was when A-CDM ADEP requests for last minute extension (CTO+STW+10 minutes) had to be rejected by procedure during the trial, as it would compromise meeting TTA constraint provided by ADES, knowing it would have a significant impact on the departure of those flights.

Further details on unexpected behaviour/results can be found in section E.3.4.

LEBL

TTA trial had a duration of 4 weeks for LEBL (from 20th May to 12th June) when 20 TTA related NCP regulations were created in May and 15 in June for LEBL arrivals. During the trial period, 6 questionnaires have been received from NMOC, related to TTA regulations on 20th, 24th and 26th May. Therefore, the results depicted in the figures below and the conclusions are based on the questionnaires received, which are linked to 5 TTA NCP regulations out from the total of 35 regulations, namely 14% of the trial.



	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
I was aware of the PJ24 trial and I was able to respond quickly to the LECB and LECP FMP requests for trial Network Cherry Pick arrival measures.	0	0	0	16,67	83,33
The workload to apply a Network Cherry Pick arrival measure was acceptable, including the use of the special REGID (CPEPA or CPEBL).	0	16,67	33,33	33,33	16,67
The workflow impact of applying the rate calculation (FMP rate x3) to the Network Cherry Pick arrival measure was acceptable.	0	0	0	100	0
I was able to maintain situational awareness of the Network Cherry Pick arrival measure.	0	0	16,67	66,67	16,67
I was able to monitor for traffic surges (bunching) using the slot list influenced regulations tool in the slot list.	0	0	16,67	66,67	16,67
I was able to recognize that the regulation was a Network Cherry Pick arrival measure when dealing with AU calls/e-help requests.	0	0	0	83,33	16,67

Figure 62: NMOC questionnaires replies for TTAs at LEBL

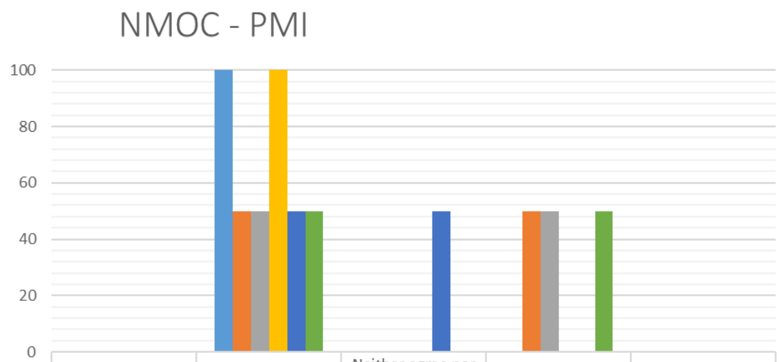
The questionnaires' replies received from NMOC indicate operators were aware of the PJ24 trials thanks to the printed out sheets at their position. The situational awareness regarding the applied NCP and its monitoring were maintained during the trial and the NMOC operators were able to recognize that NCP when dealing with users requests through telephone or E-Helpdesk.

The workload required for the applicable rate (FMP rate x 3) was acceptable as well as the workload for NCP regulation application. NMOC indicated in the questionnaires that higher workload was needed once when applying NCP regulation, but this was due to the fact that the user originally created the regulation as a classic regulation (even with the improved trial communication cards for

NMOC present) and the NCP regulation was created quickly afterwards. Therefore, the NMOC workload does not seem to represent an issue for future implementation.

LEPA

TTA trial had a duration of 3 weeks at LEPA (from 27th May to 12th June) when 2 NCP Regulations were created in May and 7 in June. During the trial period, 2 questionnaires have been received from NMOC, related to TTA NCP regulations on 1st and 11th June. Therefore, the results depicted in the figures below and the conclusions are based on the questionnaires received, which are linked to 2 TTA NCP regulations out from the total of 9 regulations, namely 22% of the trial.



	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
I was aware of the PJ24 trial and I was able to respond quickly to the LECB and LECP FMP requests for trial Network Cherry Pick arrival measures.	0	100	0	0	0
The workload to apply a Network Cherry Pick arrival measure was acceptable, including the use of the special REGID (CPEPA or CPEBL).	0	50	0	50	0
The workflow impact of applying the rate calculation (FMP rate x3) to the Network Cherry Pick arrival measure was acceptable.	0	50	0	50	0
I was able to maintain situational awareness of the Network Cherry Pick arrival measure.	0	100	0	0	0
I was able to monitor for traffic surges (bunching) using the slot list influenced regulations tool in the slot list.	0	50	50	0	0
I was able to recognize that the regulation was a Network Cherry Pick arrival measure when dealing with AU calls/e-help requests.	0	50	0	50	0

Figure 63: NMOC questionnaires replies for TTAs at LEPA

The questionnaires' replies received from NMOC indicate lack of awareness of the PJ24 trials, which might have been caused by missing information sheets at the operator's position or overall limited attention devoted by operators to the trial due to the busy network traffic period. The situational awareness regarding the applied NCP and its monitoring were difficult to maintain and only one of the replying NMOC operators was able to recognize the NCP when dealing with users requests through telephone or E-Helpdesk.

The answers regarding the workload required for the applicable rate (FMP rate x 3) and the workload for NCP regulation application are opposite, as one operator found the workload acceptable while the other one not.

The available evidence does not provide a tendency regarding the workload, but it does in terms of lack of awareness. Trial execution and the applicable procedures should be reminded periodically during the duration of the trial to ensure communicated information has reached all operators. In addition, FMPs difficulty on communicating the NCP parameters added confusion to the execution of the trial and NMOC's awareness on the situation. Moreover, the period of the trial (May – June) played a part in NMOC having to focus on more priority tasks, probably in detriment of being well prepared and aware of PJ24 trial, especially on busiest days.

1. EX3-OBJ-VLD-01-001 Results

FMP questionnaire:

As can be seen in the following figure, the increase in workload when applying a proposed TTA measure to optimally use network capacity is acceptable. This means that the overall actors implied in the process (76%) gave a positive feedback, stating that the TTA measure did not interfere with their other tasks.

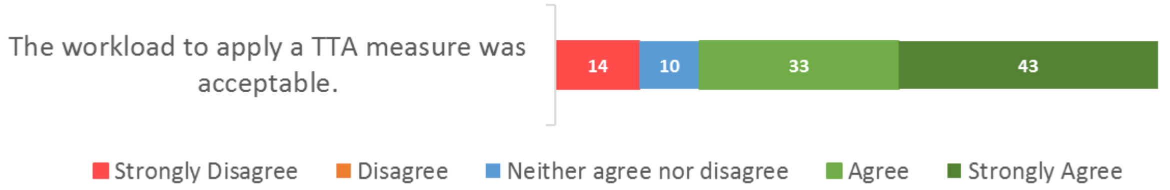


Figure 64: Query #1 from FMP questionnaire

NM questionnaire:

Concerning the quantity of work, NM consider that TTA measure increases the workload, only 50% perceive it as acceptable. As for NM, 33% think that TTA measure process creates an excessive workload.

Figure 65: Query #2 from NM questionnaire

Conclusions:

TTA regulations are feasible and can work in an operational environment, with a non-negligible impact.

2. EX3-OBJ-VLD-01-003 Results

ATCO questionnaire:

Regarding the reduction of necessary ATC interventions to de-bunch and optimally sequence traffic entering departure and arrival sectors, the results are very positive. From all ATCs implied in the TTA measure, more than 60% largely agreed, that the workload was similar compared to a standard CASA regulation. Only 20% of them slightly disagreed and the other 20% gave a neutral feedback.

It has to be mentioned that the sample gathered for objective (9 questionnaires submitted) is considerable smaller in comparison with the sample representative of the other objectives commented in this section (19 questionnaires submitted).

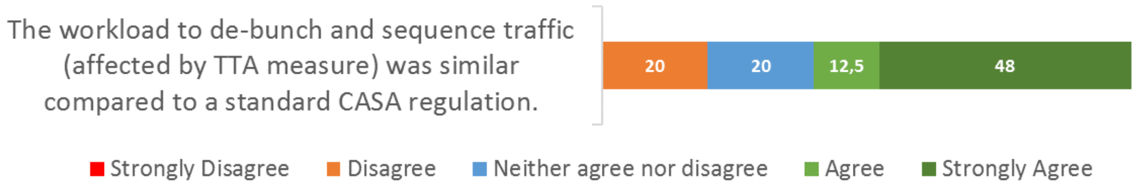


Figure 66: Query #1 from ATCO questionnaire

Conclusions:

FMPs agreed that the increase in workload when applying a proposed TTA measure was acceptable. As well, ATCs implied in TTA measure coincide in stating that the workload was very similar to the experienced when using a standard CASA regulation.

3. EX3-OBJ-VLD-01-004 Results

FMP questionnaire:

As for situational awareness, all actors regarding the TTA measure applied strongly agreed that the situational awareness is greater than current situation (90%).

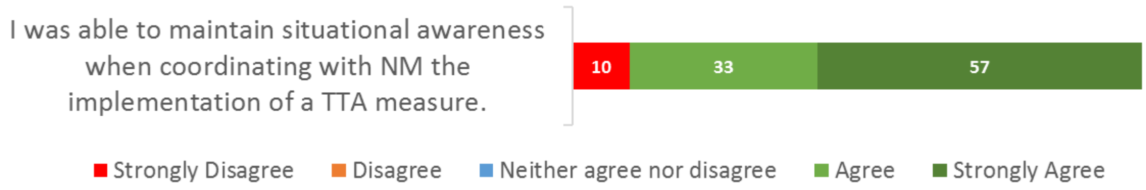


Figure 67: Query #2 from FMP questionnaire

From the point of view of the FMP staff, the time spent in monitoring, analysing, coordinating and implementing TTA measures to solve the imbalance, was adequate and admissible. Only 17% of FMP showed a marginally disagreement.

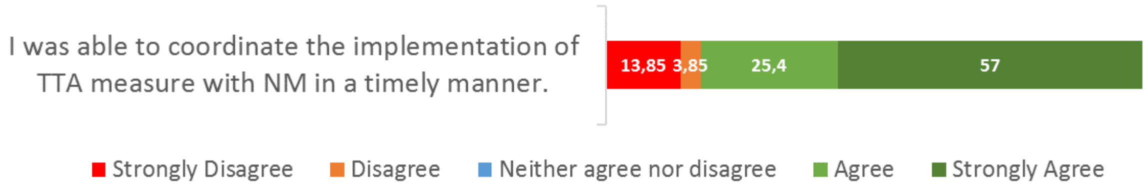


Figure 68: Query #3 from FMP questionnaire

NM questionnaire:

Regarding the situation awareness, 42% of participating NM think that TTA measure maintain the level of situation awareness.

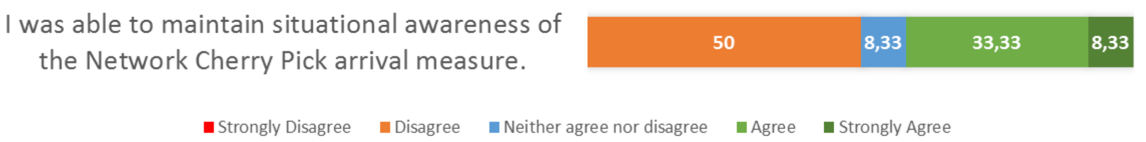


Figure 69: Query #4 from NM questionnaire

Regarding the coordination with FMPs in the implementation of TTA measure, 50% of participating NM think that can respond quickly to the FMP requests.

Figure 70: Query #1 from NM questionnaire

Conclusions:

It can be deduced from the results that FMP perceive that TTA measure is able to maintain the level of situation awareness and coordinate the implementation of TTA measure with NM in a timely manner. On the contrary, NM results suggest that the situational awareness of the Cherry Pick Arrival measure was difficult to maintain.

4. EX3-OBJ-VLD-02-001 Results

#PI-21 Departure predictability improvement in the TTOT information provided by EDPIs (extended DPIs) when using "business trajectory" concept and XTTT

The extended DPI trial included the new P-DPI service that extends departure-planning times frames from the filing time of the ICAO FPL. This new message can be sent up to 20h before the flight's EOBT, while the legacy CDM sends the E-DPI (first DPI message) 3h before EOBT.

The extended DPI fields include the following 3 Target Take-off Times (TTOTs):

- tTTOT = Turnaround TTOT: TTOT based on EOBT/SOBT or individual flight constraint (late ELDT, TTA or TOBT). Set by the airline or handler
- eTTOT = Earliest TTOT: TTOT based on departure capacity constraint (in addition to individual flight constraint). Set by the AOP
- cTTOT Consolidated TTOT: TTOT based on all constraints including downstream constraints reflected in the CTOT of the flight. Set by the AOP in response to the Network constraints.

These fields were sent by the AOP in Predicted, Early and Target DPI messages. The main objective of sending this information is to improve take-off time predictability up to 9 hours before the flight time. In order to capture this benefit, the accuracy of the TTOT has been evaluated and compared to the accuracy achieved with:

- The ETOT + taxi time available in the NM system from the flight plans (FPL);
- The legacy A-CDM (i.e. without extended DPI fields nor P-DPI messages) for LEBL and LEPA;
- The legacy Advanced Tower (i.e. without P-DPI, e-DPI, tDPIt or tDPIs) for LEAL.

As the extended DPIs were tested in the operational environment, it was not possible to simulate and evaluate the accuracy that could have been achieved through the legacy systems in parallel. Therefore, the baseline for comparison is the TTOT accuracy obtained the same day but the week before and the week after the trial.

The baseline for DPI messages is the flight plan information, so the accuracy achieved through the DPIs is influenced by the accuracy in the flight plans as well. Additionally, the take-off time flight plan accuracy during the trial is compared to the baseline days. This comparison will allow identifying if the improvement/detriment of the take-off time accuracy is due to the extended DPIs or the quality of the information in the flight plans.

The accuracy is calculated as:

- During the trial
    - Difference between ATOT and the TTOT or tTTOT or eTOT or cTOT (in this order) from the DPI messages;
- Legacy systems:
    - Difference between ATOT and the TTOT from the DPI messages;
- Flight plans
    - Difference between ATOT and the ETOT from FPL/CHG/DLA messages plus the standard taxi- out time (15 min).

These values have been collected and compared for each one of the airports under trial: LEBL, LEPA and LEAL.

LEBL

Extended DPI filed and P-DPI messages were sent between 16th May and 12th June, with specific stops on the following days and times:

- 20th May: planned maintenance of the LEBL ACDM system
- 22nd and 23rd May: extended DPI and P-DPI sending was suspended to investigate bad SID and RWY information
- 28th May: planned maintenance of the LEBL ACDM system
- 3rd and 4th June: no B2B messages for DPI PET(S) received by NM from 03-20:00 until 04-09:00 UTC for LEBL due to software intervention to fix a TTA issue failed to re-introduce the B2B service
- 5th, 6th and 10th June: planned maintenance of the LEBL ACDM system between 05-22:00 and 06-03:00UTC
- 12th June: trial finished at 14:00 UTC.

As this analysis also compares the trials with the normal LEBL operation that has legacy A-CDM implemented, two different days have been captured as baseline: the same weekday before and after the trial. As the accuracy gain that can be achieved with the DPI messages is influenced by the accuracy in the flight plans, the comparison with two different baseline days will help extract conclusions and indicate the tendency.

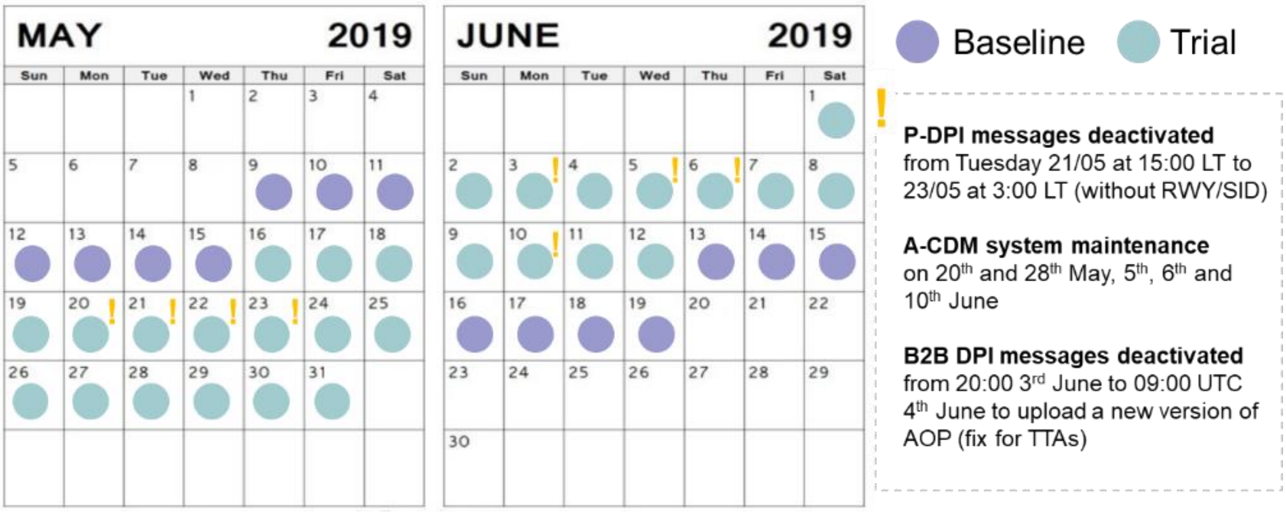


Figure 71: LEBL extended DPIs, P-DPIs baseline, and trial duration

Figures 52 and 53 below present the take-off accuracy for the baseline days (Fridays) and Figure 54

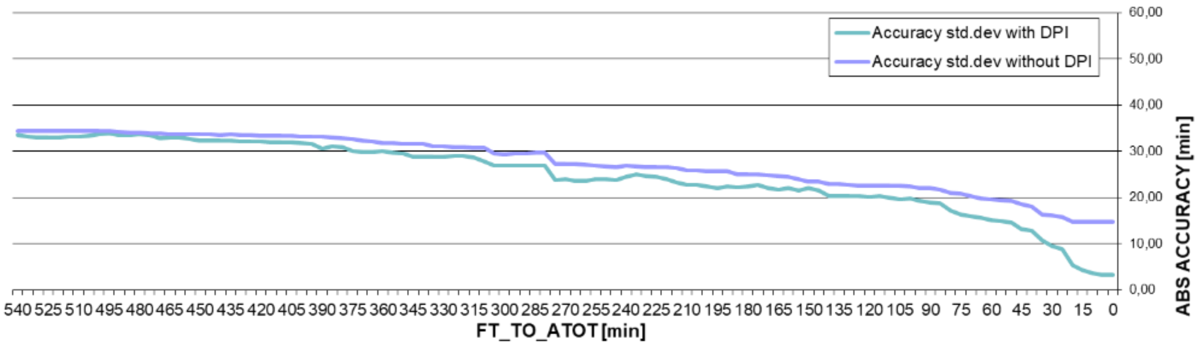
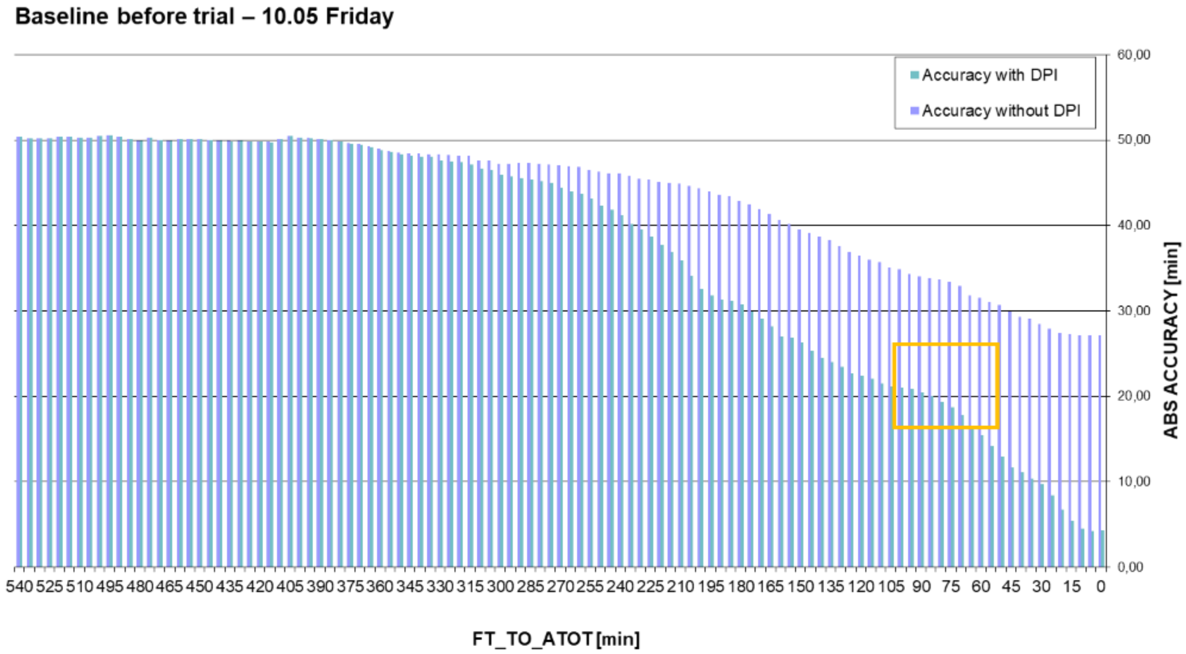


Figure 74 presents the accuracy obtained during the trial on 31st May. The graph has the following characteristics:

- The X-axis is the time horizon that starts at -540 min and ends at 0 (at ATOT or actual take off).
- Lila bars represent the accuracy from flight plans, calculated as the difference between ATOT and ETOT from FPL/CHG/DLA messages plus the standard taxi- out time (15 min);
- Lila line represents the standard deviation of the accuracy from flight plans;
- Blue bars take the TTOT from DPI messages and present the difference between ATOT and the TTOT or tTTOT or eTOT or cTOT in this order) from the DPI messages.
- Blue line represents the standard deviation of the accuracy of TTOT from DPI messages.



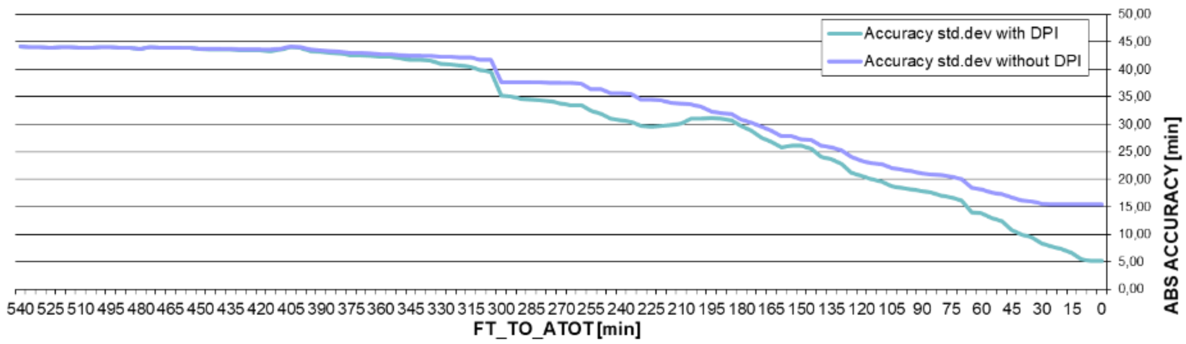
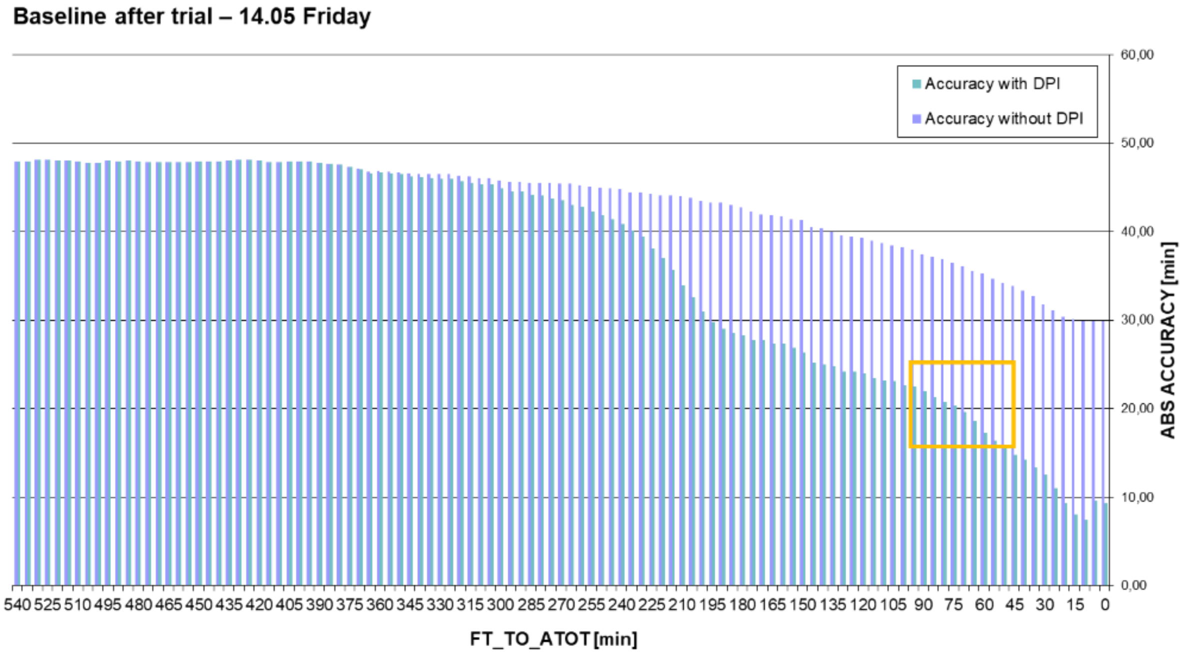


Figure 72 – LEBL Baseline take-off time accuracy improvement – Friday 10th May



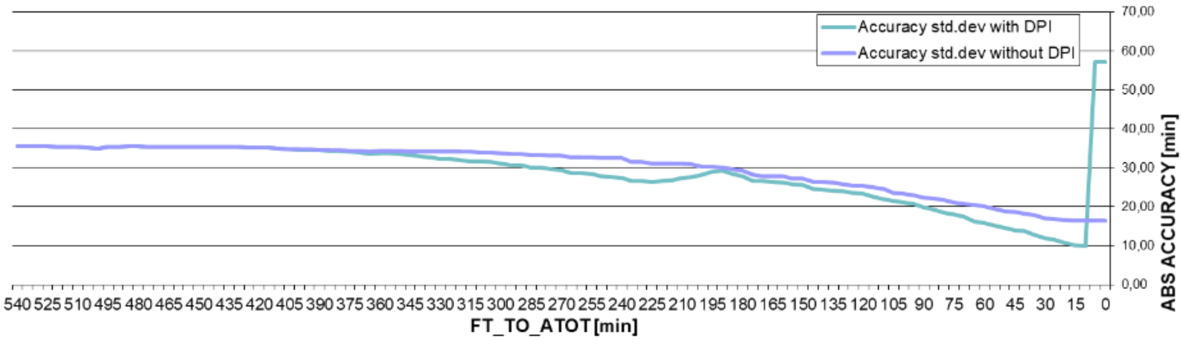
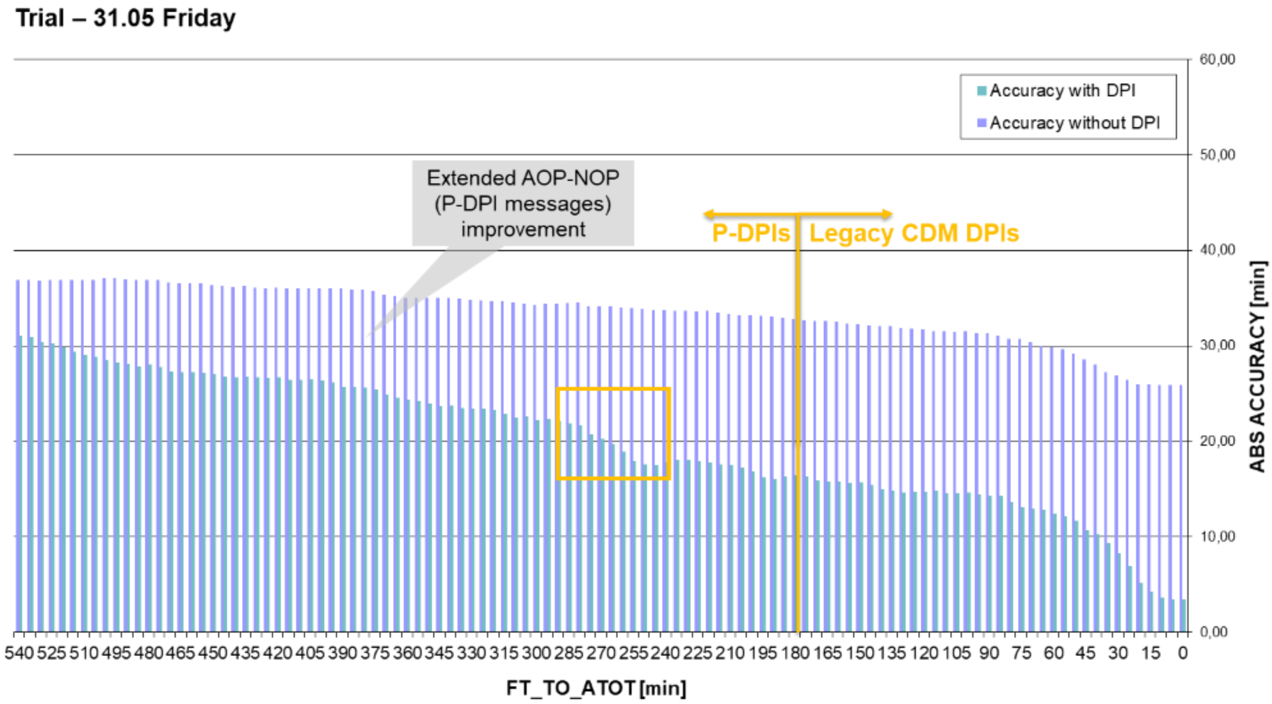


Figure 73 – LEBL Baseline take-off time accuracy improvement – Friday 14th May



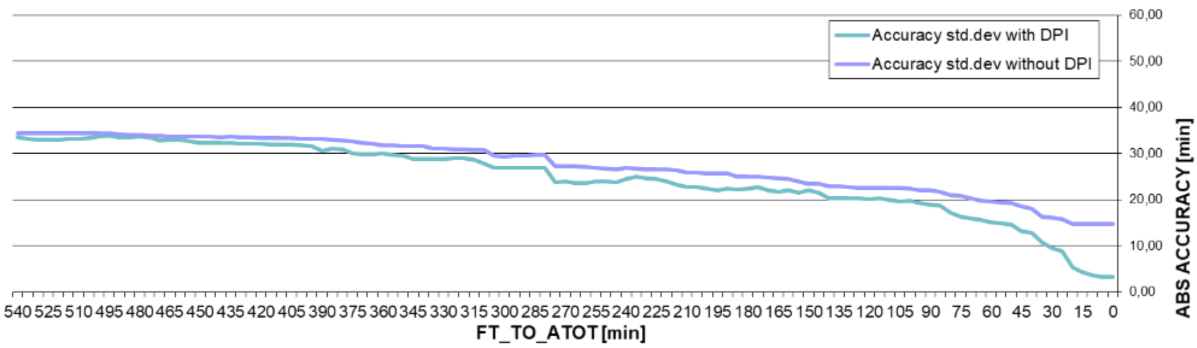


Figure 74 – LEBL Take-off time accuracy improvement due to P-DPI messages – Friday 31st May

The TTOT in the trial on the 31st May with extended DPIs differs from the ATOT (inaccuracy) in 31,1 min at -540 min and in 16,4 min at -180min before ATOT, with an average of 23,8 min, in contrast to the inaccuracy of 36,9 min at -540 min and of 32,8 min at -180min before ATOT, with an average of 35,2 min inaccuracy, from flight plans.

From -180 min before ATOT onwards the legacy A-CDM system provides TTOTs with an average inaccuracy of 12,2 min during the trial day and 18 min on 10th May and 19,7 on 14th June baseline days. The difference between trial and baseline days is not so marked as before 180 minutes, which demonstrates that extended DPI concept is aligned with current A-CDM in the overlapping period.

In terms of standard deviation, the results obtained during the trial are below the flight plan deviation indicating more stable predictability of the take-off time.

Additionally, the inaccuracy drops below 20 min much earlier during the trial thanks to the TTOT in the P-DPIs: 265 minutes before EOBT, while it drops below 20 min only 80 minutes before EOBT with the legacy A-CDM system in the baseline days.

The gain achieved using extended DPI has been calculated for all days in the trial and compared to the flight plan accuracy, which corresponds to EOBT + taxi out time. Table 26 below compiles the results of all days of the trial. It shows the gain in minutes of the average TTOT vs. average EOBT plus taxi-out time in the different timeframes. The area of improvement of this trial corresponds to the two first columns (-9h to -6h and -6h to -3h). The next two columns are covered by the legacy A-CDM and are only added in the table to provide the progression and overall gain until ATOT of the extended DPI solution.

	Avg 9-6h			Avg 6-3h			Avg 3-1h			Avg 1-0h		
	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain
16-05-2019	23,83	27,96	**4,13**	19,67	27,41	**7,74**	10,87	25,41	**14,54**	6,03	22,24	**16,21**
17-05-2019	39,49	54,05	**14,56**	25,21	50,35	**25,14**	16,92	42,30	**25,38**	7,41	30,24	**22,84**
18-05-2019	25,83	34,12	**8,29**	20,21	32,62	**12,40**	13,80	29,75	**15,95**	6,57	25,56	**18,99**
19-05-2019	20,05	31,19	**11,14**	15,57	30,19	**14,62**	11,39	27,20	**15,81**	5,77	24,05	**18,28**
20-05-2019	23,43	34,26	**10,83**	18,87	33,22	**14,35**	13,27	30,63	**17,36**	7,16	26,07	**18,91**
21-05-2019	18,45	26,60	**8,15**	15,25	25,65	**10,40**	11,02	24,02	**13,00**	6,18	21,15	**14,97**
22-05-2019	28,40	28,40	**0,00**	24,74	27,59	**2,86**	11,61	25,08	**13,46**	6,01	22,48	**16,47**
23-05-2019	19,07	27,93	**8,86**	14,74	26,46	**11,72**	10,42	25,23	**14,81**	6,42	22,59	**16,17**
24-05-2019	31,57	40,96	**9,39**	21,04	39,01	**17,97**	15,14	35,17	**20,03**	7,78	28,61	**20,83**
25-05-2019	26,75	34,86	**8,11**	20,03	33,15	**13,12**	13,95	30,23	**16,29**	7,46	26,46	**19,00**
26-05-2019	22,61	30,64	**8,03**	17,21	29,02	**11,81**	12,13	27,07	**14,94**	6,38	23,06	**16,68**
27-05-2019	20,76	27,61	**6,85**	15,67	26,57	**10,90**	10,59	23,89	**13,30**	5,98	21,44	**15,47**
28-05-2019	20,06	27,07	**7,01**	15,05	25,67	**10,62**	9,75	23,61	**13,86**	5,59	21,40	**15,80**
29-05-2019	18,98	26,45	**7,47**	14,58	26,07	**11,49**	9,85	24,05	**14,20**	5,33	21,04	**15,71**
30-05-2019	21,06	28,74	**7,68**	15,38	27,68	**12,30**	10,99	25,84	**14,85**	6,50	22,77	**16,27**
31-05-2019	27,37	36,36	**8,99**	20,10	34,06	**13,96**	14,61	31,58	**16,97**	7,42	27,13	**19,71**
01-06-2019	25,73	33,75	**8,02**	18,86	31,96	**13,10**	13,14	29,76	**16,61**	6,59	25,56	**18,97**
02-06-2019	25,65	36,64	**10,99**	20,16	35,36	**15,20**	15,99	33,75	**17,76**	8,13	28,96	**20,83**
03-06-2019	25,17	33,55	**8,38**	18,12	31,89	**13,78**	11,71	29,84	**18,13**	6,52	26,20	**19,68**
04-06-2019	28,73	31,92	**3,19**	24,35	30,30	**5,95**	18,62	28,32	**9,70**	7,44	24,26	**16,82**
05-06-2019	24,12	34,14	**10,03**	17,67	32,16	**14,49**	13,38	29,74	**16,36**	6,77	26,70	**19,93**
06-06-2019	24,71	34,60	**9,89**	18,88	33,85	**14,97**	13,52	31,44	**17,92**	6,73	26,55	**19,82**
07-06-2019	73,00	103,87	**30,87**	34,17	59,82	**25,65**	23,51	49,51	**26,00**	10,47	42,52	**32,05**
08-06-2019	36,82	49,25	**12,43**	25,98	45,85	**19,87**	18,97	42,10	**23,13**	8,45	34,19	**25,74**
09-06-2019	31,67	47,23	**15,55**	24,95	44,41	**19,46**	17,45	39,18	**21,73**	8,92	31,64	**22,72**
10-06-2019	25,08	35,37	**10,29**	19,08	33,69	**14,61**	13,56	31,17	**17,61**	6,91	26,33	**19,42**
11-06-2019	35,03	47,69	**12,66**	24,89	44,31	**19,42**	16,58	40,09	**23,51**	7,67	30,10	**22,42**
12-06-2019	25,52	36,38	**10,86**	19,74	34,98	**15,25**	13,84	31,99	**18,16**	6,88	28,02	**21,14**
Average gain	9,74			14,04			17,19			19,35		

Table 26: Gain of extended DPIs TTOT (trial) vs EOBT + taxi from FPL - LEBL

As can be observed, as from 9 hours before the flight time, the provided predictability by the AOP during the trial is better than the predictability based on flight plan data. The gain increases steadily the closer it gets to take off. On overall, there is an average gain of over 9,7 minutes between 9 and 6 hours before ATOT that increases to over 14,0min in the next 3 hours, gets to 17,2min in the next 2 hours and achieves 19,4min in the last hour before flight.

Flight plans data has higher variability during heavy traffic and high delay days when the predictability gain is higher. The highest the inaccuracy from the flight plans, the better the gain from the AOP and the P-DPIs. For example, in –9h to -6h timeframe the gain is 14,6 min and 30,9 min for the 17th May and 7th June, respectively. The gain reaches its maximum in the last hour before ATOT with an average of over 19,4 min and a maximum gain of 32 min on the 7th June.

As a whole, the improved predictability during the trial is clearly explained by the rolling exchange of DPIs that provide the most up-to-date take off times according to the (heavy) traffic situation; unlike the flight plan messages, updating the EOBT that are sent late or very late and not for all flights. The key improved provided by the extended DPIs is before 3h of the flight time when legacy CDM airport do not send any information to NM, while during the trail P-DPI messages were sent. The timeframe between 3 hours before flight and the ATOT is already covered by legacy A-CDM system that provides increased take-off accuracy.

The gain with respect to the legacy A-CDM is presented in Table 27 below. It is calculated per weekday, as traffic and flight plans have a direct impact on the capacity of DPIs accuracy gain. In addition, two baseline days have been selected: the same weekday after and before the trial. This allows comparing the gain obtained with the legacy A-CDM during the baseline days and the gain with the extended DPIs during the trial. Table 27 presents both the average gain achieved with legacy A-CDM (Gain legacy A-CDM vs EOBT + taxi) and the average gain with the extended DPIs during the trial (Gain trial vs EOBT + taxi) and also the difference between them as the average "Gain trial vs legacy A-CDM" for each weekday.

		Avg 9-6h			Avg 6-3h			Avg 3-1h			Avg 1-0h		
		TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi
Thursday	Baseline before trial (09/05/2019)	89,03	90,45	**1,42**	66,87	79,21	**12,34**	44,94	63,19	**18,25**	25,32	52,60	**27,27**
Thursday	Baseline after trial (13/06/2019)	37,00	37,02	**0,02**	31,21	35,14	**3,93**	15,82	31,48	**15,66**	6,78	27,58	**20,80**
Thursday	**Gain legacy A-CDM vs EOBT + taxi**			**0,72**			**8,14**			**16,96**			**24,03**
Thursday	16-05-2019	23,83	27,96	**4,13**	19,67	27,41	**7,74**	10,87	25,41	**14,54**	6,03	22,24	**16,21**
Thursday	23-05-2019	19,07	27,93	**8,86**	14,74	26,46	**11,72**	10,42	25,23	**14,81**	6,42	22,59	**16,17**
Thursday	30-05-2019	21,06	28,74	**7,68**	15,38	27,68	**12,30**	10,99	25,84	**14,85**	6,50	22,77	**16,27**
Thursday	06-06-2019	24,71	34,60	**9,89**	18,88	33,85	**14,97**	13,52	31,44	**17,92**	6,73	26,55	**19,82**
Thursday	**Gain trial vs EOBT + taxi**			**7,64**			**11,68**			**15,53**			**17,12**
Thursday	**Gain trial vs legacy A-CDM**			**6,92**			**3,55**			**-1,42**			**-6,92**
Friday	Baseline before trial (10/05/2019)	**50,04**	**50,06**	**0,03**	42,18	46,51	**4,34**	22,69	36,67	**13,98**	8,64	28,57	**19,93**
Friday	Baseline after trial (14/06/2019)	**47,82**	**47,83**	**0,02**	40,85	45,15	**4,29**	23,58	39,05	**15,48**	11,81	31,82	**20,01**
Friday	**Gain legacy A-CDM vs EOBT + taxi**			**0,02**			**4,31**			**14,73**			**19,97**
Friday	17-05-2019	**39,49**	**54,05**	**14,56**	25,21	50,35	**25,14**	16,92	42,30	**25,38**	7,41	30,24	**22,84**
Friday	24-05-2019	**31,57**	**40,96**	**9,39**	21,04	39,01	**17,97**	15,14	35,17	**20,03**	7,78	28,61	**20,83**
Friday	31-05-2019	**27,37**	**36,36**	**8,99**	20,10	34,06	**13,96**	14,61	31,58	**16,97**	7,42	27,13	**19,71**
Friday	07-06-2019	**73,00**	**103,87**	**30,87**	34,17	59,82	**25,65**	23,51	49,51	**26,00**	10,47	42,52	**32,05**
Friday	**Gain trial vs EOBT + taxi**			**15,95**			**20,68**			**22,10**			**23,86**
Friday	**Gain trial vs legacy A-CDM**			**15,93**			**16,37**			**7,37**			**3,89**
Saturday	Baseline before trial (11/05/2019)	**30,17**	**30,18**	**0,02**	26,58	29,36	**2,78**	13,36	26,52	**13,16**	6,39	23,60	**17,20**
Saturday	Baseline after trial (15/06/2019)	**43,41**	**43,66**	**0,25**	36,11	40,81	**4,70**	18,24	35,52	**17,28**	7,78	30,83	**23,05**
Saturday	**Gain legacy A-CDM vs EOBT + taxi**			**0,13**			**3,74**			**15,22**			**20,13**
Saturday	18-05-2019	**25,83**	**34,12**	**8,29**	20,21	32,62	**12,40**	13,80	29,75	**15,95**	6,57	25,56	**18,99**
Saturday	25-05-2019	**26,75**	**34,86**	**8,11**	20,03	33,15	**13,12**	13,95	30,23	**16,29**	7,46	26,46	**19,00**
Saturday	01-06-2019	**25,73**	**33,75**	**8,02**	18,86	31,96	**13,10**	13,14	29,76	**16,61**	6,59	25,56	**18,97**
Saturday	08-06-2019	**36,82**	**49,25**	**12,43**	25,98	45,85	**19,87**	18,97	42,10	**23,13**	8,45	34,19	**25,74**
Saturday	**Gain trial vs EOBT + taxi**			**9,21**			**14,62**			**18,00**			**20,68**
Saturday	**Gain trial vs legacy A-CDM**			**9,08**			**10,88**			**2,78**			**0,55**
Sunday	Baseline before trial (12/05/2019)	**30,78**	**30,78**	**0,00**	26,42	29,11	**2,69**	13,04	26,68	**13,63**	6,53	24,28	**17,74**
Sunday	Baseline after trial (16/06/2019)	**32,23**	**32,26**	**0,03**	27,76	31,52	**3,75**	13,40	28,93	**15,54**	6,46	26,50	**20,04**
Sunday	**Gain legacy A-CDM vs EOBT + taxi**			**0,02**			**3,22**			**14,59**			**18,89**
Sunday	19-05-2019	**20,05**	**31,19**	**11,14**	15,57	30,19	**14,62**	11,39	27,20	**15,81**	5,77	24,05	**18,28**
Sunday	26-05-2019	**22,61**	**30,64**	**8,03**	17,21	29,02	**11,81**	12,13	27,07	**14,94**	6,38	23,06	**16,68**
Sunday	02-06-2019	**25,65**	**36,64**	**10,99**	20,16	35,36	**15,20**	15,99	33,75	**17,76**	8,13	28,96	**20,83**
Sunday	09-06-2019	**31,67**	**47,23**	**15,55**	24,95	44,41	**19,46**	17,45	39,18	**21,73**	8,92	31,64	**22,72**
Sunday	**Gain trial vs EOBT + taxi**			**11,43**			**15,27**			**17,56**			**19,63**
Sunday	**Gain trial vs legacy A-CDM**			**11,41**			**12,05**			**2,97**			**0,74**
Monday	Baseline before trial (13/05/2019)	**29,64**	**29,68**	**0,04**	25,54	28,01	**2,47**	12,42	24,68	**12,26**	5,58	21,68	**16,10**
Monday	Baseline after trial (17/06/2019)	**32,39**	**31,94**	**-0,45**	27,54	30,06	**2,52**	12,96	27,91	**14,95**	6,38	24,90	**18,52**
Monday	**Gain legacy A-CDM vs EOBT + taxi**			**-0,21**			**2,50**			**13,60**			**17,31**
Monday	20-05-2019	**23,43**	**34,26**	**10,83**	18,87	33,22	**14,35**	13,27	30,63	**17,36**	7,16	26,07	**18,91**
Monday	27-05-2019	**20,76**	**27,61**	**6,85**	15,67	26,57	**10,90**	10,59	23,89	**13,30**	5,98	21,44	**15,47**
Monday	03-06-2019	**25,17**	**33,55**	**8,38**	18,12	31,89	**13,78**	11,71	29,84	**18,13**	6,52	26,20	**19,68**
Monday	10-06-2019	**25,08**	**35,37**	**10,29**	19,08	33,69	**14,61**	13,56	31,17	**17,61**	6,91	26,33	**19,42**
Monday	**Gain trial vs EOBT + taxi**			**9,08**			**13,41**			**16,60**			**18,37**
Monday	**Gain trial vs legacy A-CDM**			**9,29**			**10,91**			**3,00**			**1,06**
Tuesday	Baseline before trial (14/05/2019)	**25,07**	**25,07**	**0,00**	21,86	23,96	**2,10**	10,36	22,67	**12,31**	6,96	20,97	**14,01**
Tuesday	Baseline after trial (18/06/2019)	**33,55**	**33,67**	**0,12**	28,28	31,16	**2,88**	15,03	27,02	**11,99**	6,60	23,62	**17,02**
Tuesday	**Gain legacy A-CDM vs EOBT + taxi**			**0,06**			**2,49**			**12,15**			**15,52**
Tuesday	21-05-2019 (no P-DPI from 15:00)	**18,45**	**26,60**	**8,15**	15,25	25,65	**10,40**	11,02	24,02	**13,00**	6,18	21,15	**14,97**
Tuesday	28-05-2019	**20,06**	**27,07**	**7,01**	15,05	25,67	**10,62**	9,75	23,61	**13,86**	5,59	21,40	**15,80**
Tuesday	04-06-2019	**28,73**	**31,92**	**3,19**	24,35	30,30	**5,95**	18,62	28,32	**9,70**	7,44	24,26	**16,82**
Tuesday	11-06-2019	**35,03**	**47,69**	**12,66**	24,89	44,31	**19,42**	16,58	40,09	**23,51**	7,67	30,10	**22,42**
Tuesday	**Gain trial vs EOBT + taxi**			**7,75**			**11,60**			**15,02**			**17,51**
Tuesday	**Gain trial vs legacy A-CDM**			**7,69**			**9,11**			**2,86**			**1,99**
Wednesday	Baseline before trial (15/05/2019)	**22,75**	**22,77**	**0,02**	20,57	22,42	**1,85**	10,78	21,75	**10,97**	6,04	20,47	**14,43**
Wednesday	Baseline after trial (19/06/2019)	**36,02**	**36,02**	**0,00**	31,86	35,26	**3,40**	16,75	32,46	**15,70**	7,29	29,10	**21,82**
Wednesday	22-05-2019 (no P-DPIs)	**28,40**	**28,40**	**0,00**	24,74	27,59	**2,86**	11,61	25,08	**13,46**	6,01	22,48	**16,47**
Wednesday	**Gain legacy A-CDM vs EOBT + taxi**			**0,01**			**2,70**			**13,38**			**17,57**
Wednesday	29-05-2019	**18,98**	**26,45**	**7,47**	14,58	26,07	**11,49**	9,85	24,05	**14,20**	5,33	21,04	**15,71**
Wednesday	05-06-2019	**24,12**	**34,14**	**10,03**	17,67	32,16	**14,49**	13,38	29,74	**16,36**	6,77	26,70	**19,93**
Wednesday	12-06-2019	**25,52**	**36,38**	**10,86**	19,74	34,98	**15,25**	13,84	31,99	**18,16**	6,88	28,02	**21,14**
Wednesday	**Gain trial vs EOBT + taxi**			9,45			13,74			16,24			18,93
Wednesday	**Gain trial vs legacy A-CDM**			**9,44**			**11,04**			**2,86**			**1,35**
All days	**Gain trial vs legacy A-CDM**			**9,97**			**10,56**			**2,92**			**0,38**

Table 27: Gain of extended DPIs TTOT (trial) vs legacy A-CDM - LEBL

It can be observed that the extended DPIs provide more accurate information between 9 and 6 hours before the flight, as the gain achieved during the trial compared to the baseline days reaches 10 minutes of improvement on average, minimum gain registered for Thursdays of 6,9 min and maximum gain for Fridays of 15,9min.

The improvement achieved through the P-DPIs is even higher when looking at the 6 to 3 hours before timeframe: 11 minutes gain in average, minimum gain registered for Thursdays of 3,6 min and maximum gain for Fridays of 16,4min.

Note that the gain average of legacy A-CDM in the periods -9h to -6h and -6h to -3h is only due to flights that depart later that EOBT +15min taxi, so the period of receiving A-CDM messages extends over the three hours before ATOT. For instance, 9th May traffic was more disturbed, with up to 11.973 ATFM delay on arrivals, and flight plans had more inaccuracy than on the 13th June, with only 1731 min of ATFM delay on arrival. This reflects on the gain average in periods -9h to -6h and -6h to -3h.

The additional gain that the AOP with the extended DPIs can bring to the legacy A-CDM in the last 3 hours before the flight is minor, reaching only 3 minutes on average for the 3 to 1 hours before ATOT timeframe and 0,4 minutes during the last hour. This is an expected result as the extended DPI concept builds on – and extends- the current A-CDM.

In brief, it can be concluded that the extended DPI concept highly increases the predictability of the legacy A-CDM in the horizon -9h to -3h before ATOT and slightly improves the current predictability of A-CDM in the last 3 hours.

This improvement, among other things, lies in the combination of the AOP sequencing horizon (i.e. 4 hours before take off) and the AOP statistical XTTA model based on relevant turnaround factors (e.g. airline, boarding type, …). These have helped to improve the TTOT sent in the E-DPIs and T-DPI-t from AOP compared to the current A-CDM.

LEPA

Extended DPI filed and P-DPI messages were sent between 16th May and 12th June, with specific stops on the following days and times:

- 2nd June stop to upload a new version of AOP (fix for TTAs);
- 4th-5th, 5th - 6th June: planned maintenance of the LEPA ACDM system;
- 10-11th June transition to eVEREST;
- 12th June: trial finished at 14:00 UTC.

As this analysis also compares the trials with the normal LEPA operation that has legacy A-CDM implemented, two different days have been captured as baseline: the same weekday before and after the trial. As the accuracy gain that can be achieved with the DPI messages is driven by the accuracy in the flight plans, the comparison with two different baseline days will help extract conclusions and indicated the tendency.

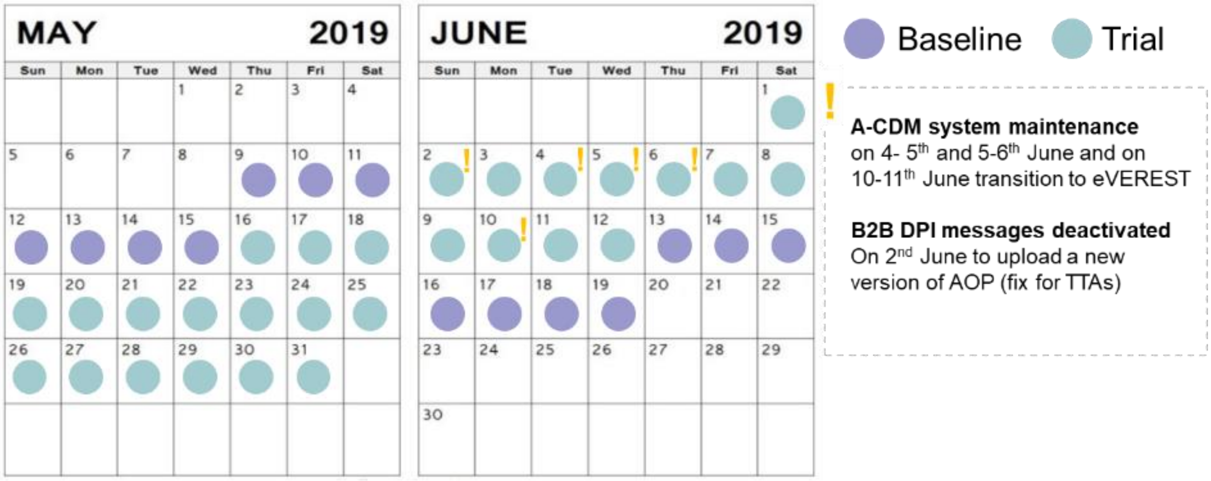
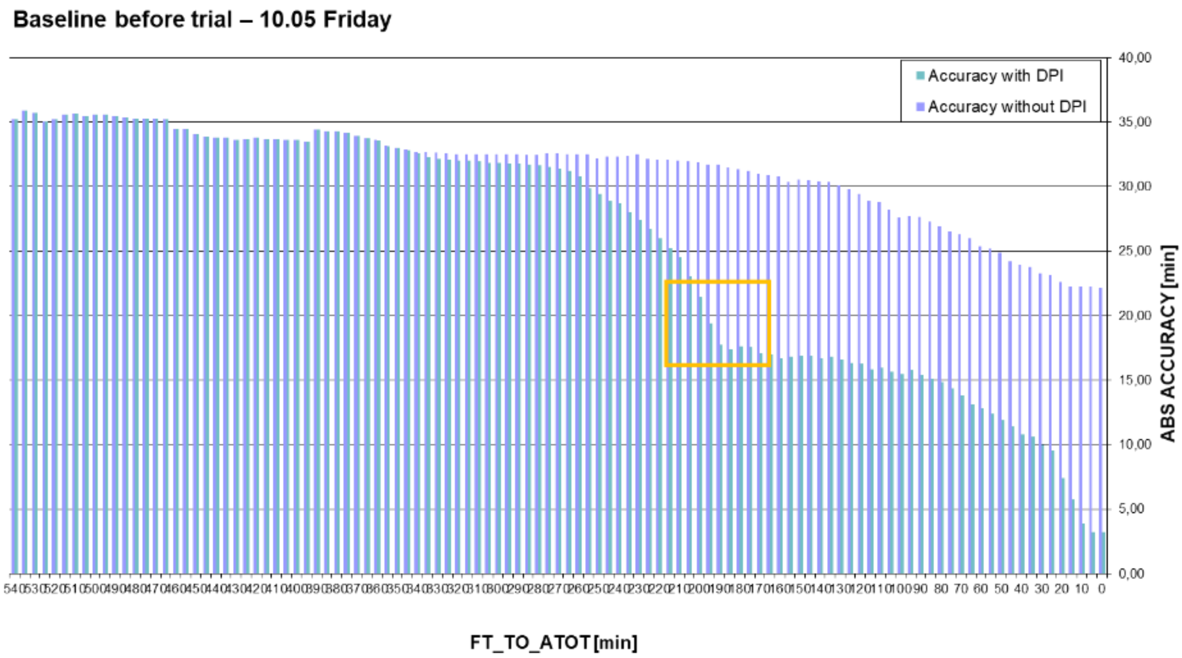


Figure 75: – LEPA extended DPIs and P-DPIs baseline and trial duration

Figure 56 and Figure 57 below present the take-off accuracy for the baseline days (Fridays) and Figure 58 presents the accuracy obtained during the trial on 31st May.



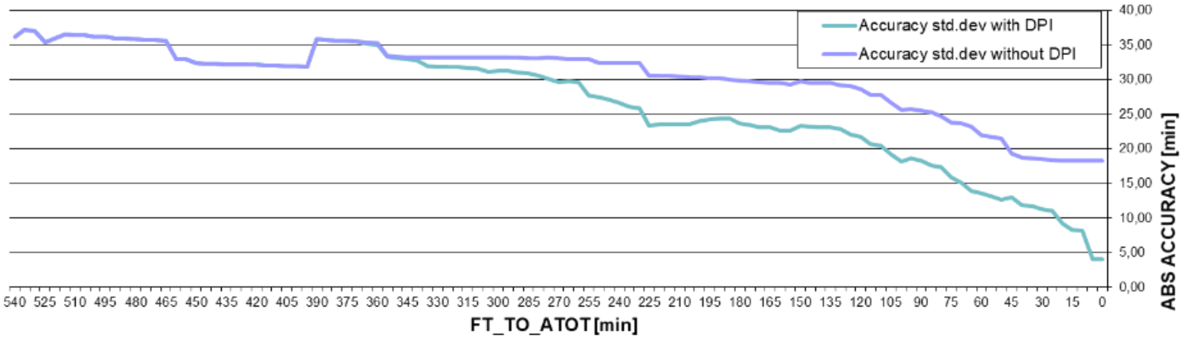


Figure 76: LEPA Baseline take-off time accuracy improvement – Friday 10th May

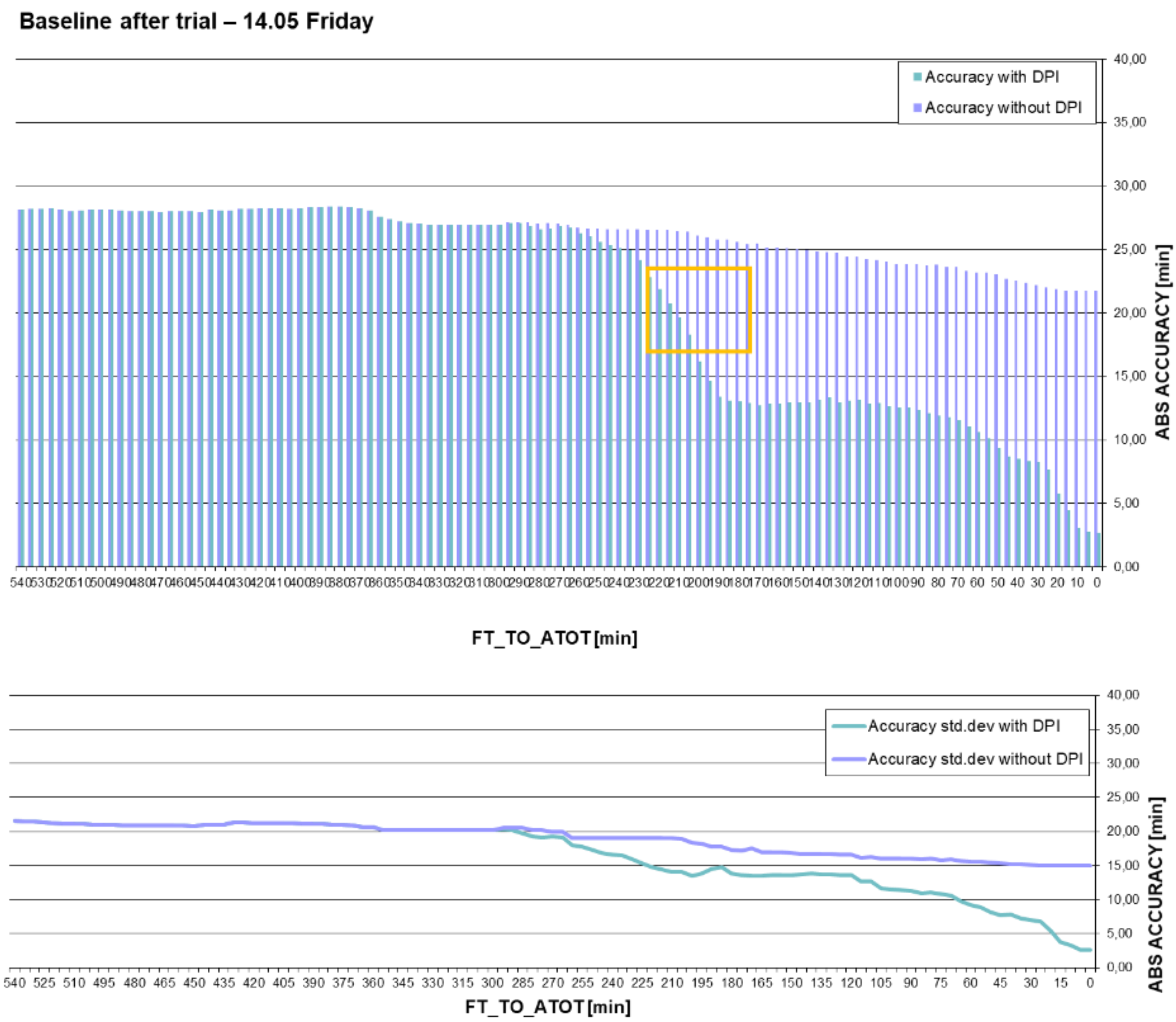
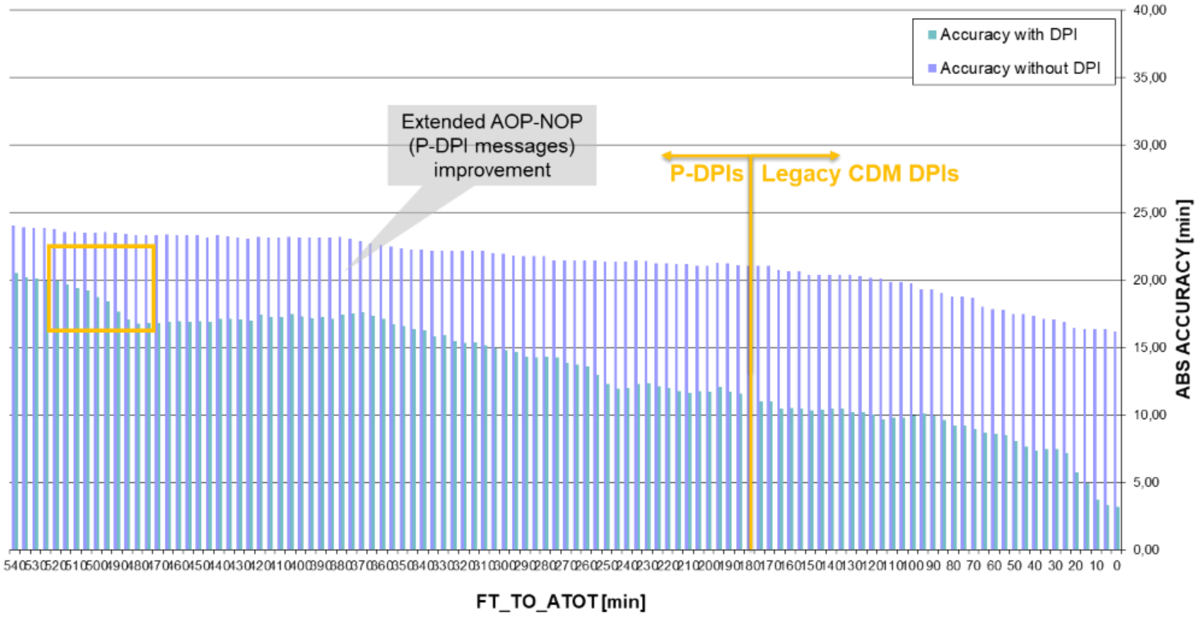


Figure 77: LEPA Baseline take-off time accuracy improvement – Friday 14th May

Trial – 31.05 Friday



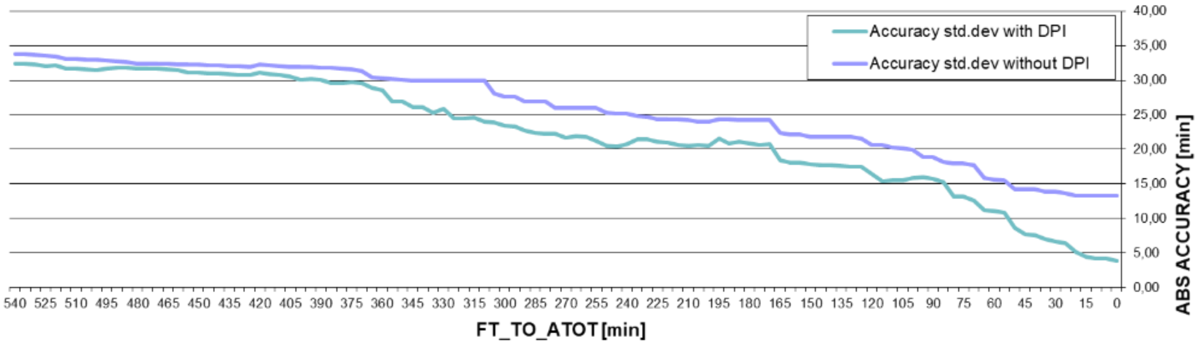


Figure 78: LEPA Take-off time accuracy improvement – Friday 31st May

The TTOT in the trial on the 31st May with extended DPIs differs from the ATOT (inaccuracy) in 20,5min at -540 min and in 11,3 min at -180min before ATOT, with an average of 15,8 min, in contrast to the inaccuracy of 24,0 min at -540 min and of 21,1 min at -180min before ATOT, with an average of 22,5 min inaccuracy, from flight plans.

From -180 min before ATOT onwards the legacy A-CDM system provides TTOTs with an average inaccuracy of 18,9 min during the trial day and 27,0 min on 10th May and 23,7 on 14th June baseline days. The difference between trial and baseline days is not so marked as before 180 minutes, which demonstrates that extended DPI concept is aligned with current A-CDM in the overlapping period.

In terms of standard deviation, the results obtained during the trial are below the flight plan deviation indicating more stable predictability of the take-off time.

Additionally, the inaccuracy drops below 20 min much earlier during the trial thanks to the TTOT in the P-DPIs: 525 minutes before ATOT, while it drops below 20 min around 210 minutes before ATOT with the legacy A-CDM system in the baseline days.

The gain achieved using extended DPI has been calculated for all days in the trial and compared to the flight plan accuracy, which corresponds to EOBT + taxi out time. Table 26 below compiles the results of all days of the trial. It shows the gain in minutes of the average TTOT vs. average EOBT plus taxi-out time in the different timeframes. The area of improvement of this trial corresponds to the two first columns (-9h to -6h and -6h to -3h). The next two columns are covered by the legacy A-CDM and are only added in the table to provide the progression and overall gain until ATOT of the extended DPI solution.

	Avg 9-6h			Avg 6-3h			Avg 3-1h			Avg 1-0h		
	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain
16-05-2019	20,81	17,11	-3,70	16,91	15,72	-1,19	9,95	13,87	3,92	6,74	11,83	5,09
17-05-2019	24,13	32,50	8,37	18,99	31,12	12,13	14,81	27,89	13,07	8,09	22,07	13,98
18-05-2019	17,77	23,95	6,18	13,95	22,71	8,75	10,95	20,94	9,99	6,52	18,17	11,65
19-05-2019	19,54	26,13	6,59	15,20	24,56	9,36	11,50	22,68	11,18	7,55	20,21	12,66
20-05-2019	22,95	30,06	7,11	17,24	28,12	10,89	12,89	24,70	11,81	8,44	21,14	12,70
21-05-2019	16,00	20,86	4,86	12,30	19,28	6,98	9,09	17,44	8,35	6,26	15,62	9,37
22-05-2019	15,05	19,69	4,64	11,43	18,17	6,74	8,80	16,65	7,85	6,02	15,22	9,20
23-05-2019	14,05	18,55	4,50	11,01	17,42	6,41	7,81	15,94	8,14	5,31	14,87	9,56
24-05-2019	22,24	30,10	7,87	17,26	27,65	10,39	12,82	24,27	11,45	7,49	20,62	13,14
25-05-2019	21,61	26,00	4,40	19,25	24,85	5,60	15,43	23,08	7,65	9,03	21,09	12,06
26-05-2019	15,76	21,22	5,46	13,25	20,65	7,41	10,11	18,90	8,79	6,44	16,61	10,17
27-05-2019	16,19	21,81	5,62	12,38	19,92	7,54	9,16	18,31	9,14	6,02	15,96	9,95
28-05-2019	18,48	24,10	5,62	14,57	22,83	8,27	10,66	20,93	10,27	7,26	18,58	11,32
29-05-2019	18,22	22,07	3,85	12,69	20,28	7,60	8,10	16,21	8,11	5,33	14,48	9,15
30-05-2019	18,33	23,40	5,07	13,70	21,56	7,86	9,92	18,97	9,05	6,22	16,90	10,68
31-05-2019	17,83	23,32	5,49	13,71	21,63	7,93	9,96	19,83	9,87	6,23	16,91	10,68
01-06-2019	29,24	35,01	5,78	24,98	33,05	8,07	20,55	30,95	10,39	10,67	26,08	15,41
02-06-2019	26,15	33,47	7,32	21,56	31,83	10,27	15,06	28,53	13,46	9,07	24,93	15,86
03-06-2019	21,99	29,16	7,17	15,71	27,38	11,68	11,37	23,95	12,58	7,12	21,34	14,22
04-06-2019	25,76	27,76	1,99	19,81	24,94	5,13	14,93	22,65	7,72	7,88	19,88	11,99
05-06-2019	20,59	29,54	8,95	16,73	28,49	11,76	13,43	25,92	12,49	7,86	23,42	15,56
06-06-2019	21,56	29,58	8,02	16,25	26,93	10,68	12,56	23,85	11,29	7,79	21,59	13,80
07-06-2019	48,68	76,35	27,66	42,28	77,06	34,78	38,50	64,01	25,52	20,29	61,57	41,28
08-06-2019	28,59	40,99	12,40	20,78	35,84	15,06	15,92	31,04	15,12	8,96	27,14	18,18
09-06-2019	20,46	31,28	10,82	16,24	29,50	13,26	13,02	26,45	13,43	7,35	23,10	15,75
10-06-2019	21,54	32,02	10,48	16,03	29,93	13,90	12,90	27,70	14,80	8,08	25,23	17,14
11-06-2019	23,15	31,30	8,15	16,92	27,77	10,84	12,76	25,14	12,38	7,23	22,39	15,17
12-06-2019	22,01	31,69	9,68	17,23	29,62	12,39	13,99	26,87	12,88	7,43	22,50	15,07
Average gain	7,15			10,02			11,10			13,60		

Table 28: Gain of extended DPIs TTOT (trial) vs EOBT + taxi from FPL - LEPA

It can be observed that as from 9 hours before the flight time, the provided predictability by the AOP during the trial is better than the predictability based on flight plan data. The gain increases steadily the closer it gets to take off. On overall, there is an average gain of over 7,2 minutes between 9 and 6 hours before ATOT that increases to over 10,0min in the next 3 hours, gets to 11,1min in the next 2 hours and achieves 13,6 min in the last hour before flight.

As seen in the case of LEBL, the highest the inaccuracy from the flight plans due to days with high ATFM delays, the better the gain from the AOP and the P-DPIs. For example, in –9h to -6h timeframe the gain is 27,7 min and 12,4 min for the 7th and 8th June respectively. The gain reaches its maximum in the last hour before ATOT with an average of over 13,6min and a maximum gain of 41 minutes on the 7th June, similar to the LEBL case.

The gain with respect to the legacy A-CDM is presented in Table 29 below. Following the same approach as in the case of LEBL, two baseline days have been selected: the same weekday after and before the trial. This allows comparing the gain obtained with the legacy A-CDM during the baseline days and the gain with the extended DPIs during the trial. Table 29 presents both the average gain achieved with legacy A-CDM (Gain legacy A-CDM vs EOBT + taxi) and the average gain with the extended DPIs during the trial (Gain trial vs EOBT + taxi) and also the difference between them as the average “Gain trial vs legacy A-CDM” for each weekday.

		Avg 9-6h			Avg 6-3h			Avg 3-1h			Avg 1-0h		
		TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi
Thursday	Baseline before trial (09/05/2019)	79,83	81,12	**1,29**	52,43	72,24	**19,82**	37,44	63,51	**26,07**	20,47	58,65	**38,18**
	Baseline after trial (13/06/2019)	33,07	33,94	**0,87**	26,49	29,76	**3,27**	15,98	27,84	**11,86**	7,95	23,94	**15,99**
	Gain legacy A-CDM vs EOBT + taxi			**1,08**			**11,54**			**18,97**			**27,09**
	16-05-2019	20,81	17,11	**-3,70**	16,91	15,72	**-1,19**	9,95	13,87	**3,92**	6,74	11,83	**5,09**
	23-05-2019	14,05	18,55	**4,50**	11,01	17,42	**6,41**	7,81	15,94	**8,14**	5,31	14,87	**9,56**
	30-05-2019	18,33	23,40	**5,07**	13,70	21,56	**7,86**	9,92	18,97	**9,05**	6,22	16,90	**10,68**
	06-06-2019	21,56	29,58	**8,02**	16,25	26,93	**10,68**	12,56	23,85	**11,29**	7,79	21,59	**13,80**
	Gain trial vs EOBT + taxi			**3,47**			**5,94**			**8,10**			**9,78**
	Gain trial vs legacy A-CDM			**2,39**			**-5,60**			**-10,87**			**-17,30**
Friday	Baseline before trial (10/05/2019)	**34,58**	**34,58**	**0,00**	28,65	32,37	**3,73**	15,83	28,88	**13,05**	8,35	23,33	**14,98**
	Baseline after trial (14/06/2019)	**28,14**	**28,14**	**0,00**	23,99	26,72	**2,73**	12,53	24,38	**11,85**	6,65	22,26	**15,61**
	Gain legacy A-CDM vs EOBT + taxi			**0,00**			**3,23**			**12,45**			**15,30**
	17-05-2019	**24,13**	**32,50**	**8,37**	18,99	31,12	**12,13**	14,81	27,89	**13,07**	8,09	22,07	**13,98**
	24-05-2019	**22,24**	**30,10**	**7,87**	17,26	27,65	**10,39**	12,82	24,27	**11,45**	7,49	20,62	**13,14**
	31-05-2019	**17,83**	**23,32**	**5,49**	13,71	21,63	**7,93**	9,96	19,83	**9,87**	6,23	16,91	**10,68**
	07-06-2019	**48,68**	**76,35**	**27,66**	42,28	77,06	**34,78**	38,50	64,01	**25,52**	20,29	61,57	**41,28**
	Gain trial vs EOBT + taxi			**12,35**			**16,31**			**14,98**			**19,77**
	Gain trial vs legacy A-CDM			**12,35**			**13,08**			**2,53**			**4,47**
Saturday	Baseline before trial (11/05/2019)	**23,67**	**23,90**	**0,23**	19,91	21,99	**2,08**	11,31	20,50	**9,19**	7,13	19,11	**11,98**
	Baseline after trial (15/06/2019)	**34,35**	**34,41**	**0,06**	28,04	31,48	**3,44**	16,07	28,63	**12,56**	9,05	25,58	**16,54**
	Gain legacy A-CDM vs EOBT + taxi			**0,14**			**2,76**			**10,88**			**14,26**
	18-05-2019	**17,77**	**23,95**	**6,18**	13,95	22,71	**8,75**	10,95	20,94	**9,99**	6,52	18,17	**11,65**
	25-05-2019	**21,61**	**26,00**	**4,40**	19,25	24,85	**5,60**	15,43	23,08	**7,65**	9,03	21,09	**12,06**
	01-06-2019	**29,24**	**35,01**	**5,78**	24,98	33,05	**8,07**	20,55	30,95	**10,39**	10,67	26,08	**15,41**
	08-06-2019	**28,59**	**40,99**	**12,40**	20,78	35,84	**15,06**	15,92	31,04	**15,12**	8,96	27,14	**18,18**
	Gain trial vs EOBT + taxi			**7,19**			**9,37**			**10,79**			**14,33**
	Gain trial vs legacy A-CDM			**7,05**			**6,61**			**-0,09**			**0,07**
Sunday	Baseline before trial (12/05/2019)	**21,63**	**21,67**	**0,04**	18,46	20,45	**2,00**	9,55	19,05	**9,50**	6,02	17,09	**11,07**
	Baseline after trial (16/06/2019)	**29,39**	**29,40**	**0,00**	24,31	27,35	**3,04**	13,47	24,68	**11,21**	7,70	22,25	**14,55**
	Gain legacy A-CDM vs EOBT + taxi			**0,02**			**2,52**			**10,36**			**12,81**
	19-05-2019	**19,54**	**26,13**	**6,59**	15,20	24,56	**9,36**	11,50	22,68	**11,18**	7,55	20,21	**12,66**
	26-05-2019	**15,76**	**21,22**	**5,46**	13,25	20,65	**7,41**	10,11	18,90	**8,79**	6,44	16,61	**10,17**
	02-06-2019	**26,15**	**33,47**	**7,32**	21,56	31,83	**10,27**	15,06	28,53	**13,46**	9,07	24,93	**15,86**
	09-06-2019	**20,46**	**31,28**	**10,82**	16,24	29,50	**13,26**	13,02	26,45	**13,43**	7,35	23,10	**15,75**
	Gain trial vs EOBT + taxi			**7,55**			**10,08**			**11,72**			**13,61**
	Gain trial vs legacy A-CDM			**7,52**			**7,56**			**1,36**			**0,80**
Monday	Baseline before trial (13/05/2019)	**16,79**	**16,84**	**0,05**	14,59	15,80	**1,21**	8,19	15,50	**7,31**	5,83	14,57	**8,74**
	Baseline after trial (17/06/2019)	**26,20**	**26,41**	**0,21**	22,11	24,53	**2,43**	11,45	21,55	**10,10**	6,76	18,50	**11,74**
	Gain legacy A-CDM vs EOBT + taxi			**0,13**			**1,82**			**8,71**			**10,24**
	20-05-2019	**22,95**	**30,06**	**7,11**	17,24	28,12	**10,89**	12,89	24,70	**11,81**	8,44	21,14	**12,70**
	27-05-2019	**16,19**	**21,81**	**5,62**	12,38	19,92	**7,54**	9,16	18,31	**9,14**	6,02	15,96	**9,95**
	03-06-2019	**21,99**	**29,16**	**7,17**	15,71	27,38	**11,68**	11,37	23,95	**12,58**	7,12	21,34	**14,22**
	10-06-2019	**21,54**	**32,02**	**10,48**	16,03	29,93	**13,90**	12,90	27,70	**14,80**	8,08	25,23	**17,14**
	Gain trial vs EOBT + taxi			**7,59**			**11,00**			**12,08**			**13,50**
	Gain trial vs legacy A-CDM			**7,46**			**9,18**			**3,38**			**3,26**
Tuesday	Baseline before trial (14/05/2019)	**21,54**	**21,54**	**0,00**	18,88	20,80	**1,92**	11,19	19,13	**7,94**	6,84	16,10	**9,25**
	Baseline after trial (18/06/2019)	**24,23**	**24,25**	**0,02**	20,50	22,55	**2,05**	11,11	20,78	**9,67**	7,05	19,18	**12,13**
	Gain legacy A-CDM vs EOBT + taxi			**0,01**			**1,98**			**8,80**			**10,69**
	21-05-2019 (no P-DPI from 15:00)	**16,00**	**20,86**	**4,86**	12,30	19,28	**6,98**	9,09	17,44	**8,35**	6,26	15,62	**9,37**
	28-05-2019	**18,48**	**24,10**	**5,62**	14,57	22,83	**8,27**	10,66	20,93	**10,27**	7,26	18,58	**11,32**
	04-06-2019	**25,76**	**27,76**	**1,99**	19,81	24,94	**5,13**	14,93	22,65	**7,72**	7,88	19,88	**11,99**
	11-06-2019	**23,15**	**31,30**	**8,15**	16,92	27,77	**10,84**	12,76	25,14	**12,38**	7,23	22,39	**15,17**
	Gain trial vs EOBT + taxi			**5,16**			**7,80**			**9,68**			**11,96**
	Gain trial vs legacy A-CDM			**5,15**			**5,82**			**0,88**			**1,27**
Wednesday	Baseline before trial (15/05/2019)	**16,46**	**16,47**	**0,00**	14,74	15,95	**1,21**	8,43	14,72	**6,29**	6,12	13,90	**7,78**
	Baseline after trial (19/06/2019)	**26,82**	**26,93**	**0,11**	22,26	24,74	**2,48**	11,34	22,55	**11,21**	7,60	20,64	**13,04**
	22-05-2019 (no P-DPIs)	**15,05**	**19,69**	**4,64**	11,43	18,17	**6,74**	8,80	16,65	**7,85**	6,02	15,22	**9,20**
	Gain legacy A-CDM vs EOBT + taxi			**1,58**			**3,48**			**8,45**			**10,01**
	29-05-2019	**18,22**	**22,07**	**3,85**	12,69	20,28	**7,60**	8,10	16,21	**8,11**	5,33	14,48	**9,15**
	05-06-2019	**20,59**	**29,54**	**8,95**	16,73	28,49	**11,76**	13,43	25,92	**12,49**	7,86	23,42	**15,56**
	12-06-2019	**22,01**	**31,69**	**9,68**	17,23	29,62	**12,39**	13,99	26,87	**12,88**	7,43	22,50	**15,07**
	Gain trial vs EOBT + taxi			7,50			10,58			11,16			13,26
	Gain trial vs legacy A-CDM			5,91			7,10			2,71			3,25
All days	**Gain trial vs legacy A-CDM**			**6,83**			**6,25**			**-0,02**			**-0,60**

Table 29: Gain of extended DPIs TTOT (trial) vs legacy A-CDM - LEPA

It can be observed that the extended DPIs provide more accurate information between 9 and 6 hours before the flight, as the gain achieved during the trial compared to the baseline days reaches 6,8 minutes of improvement on average, minimum gain registered for Thursdays of 6,9 min and maximum gain for Fridays of 12,4min.

The improvement achieved through the P-DPIs is similar when looking at the -6 to -3 hours timeframe: 6,3 minutes gain in average. The trial results provided less accurate TTOTs than the baseline days with legacy for Thursdays, mainly due to the fact that the gain registered with legacy A-CDM on the 9th May was very high as it was a difficult day with up to 9705 minutes of ATFM delay on arrivals. The gain achieved in such a complicated day is much higher than the gain that can be achieved during normal operations. In this way, these results obtained for the 9th May blur the overall comparison, being the gain obtained better than what it seems.

There is no additional gain from the AOP with the extended DPIs with respect to the legacy A-CDM in the last 3 hours before the flight, similar to the one in the last hour. This is an expected result as the extended DPI concept builds on – and extends- the current A-CDM.

In line with the conclusion from LEBL results, the extended DPI concept highly increases the predictability of the legacy A-CDM in the horizon -9h to -3h before ATOT and slightly improves the current predictability of A-CDM in the last 3 hours.

LEAL

Extended DPI filed and P-DPI messages were sent during 5 days between 3rd and 7th June.

As this analysis also compares the trials with the normal LEAL operation that has legacy Advanced Tower implemented, two different days have been captured as baseline: the same weekday before and after the trial. As the accuracy gain that can be achieved with the DPI messages is driven by the accuracy in the flight plans, the comparison with two different baseline days will help extract conclusions and indicated the tendency.

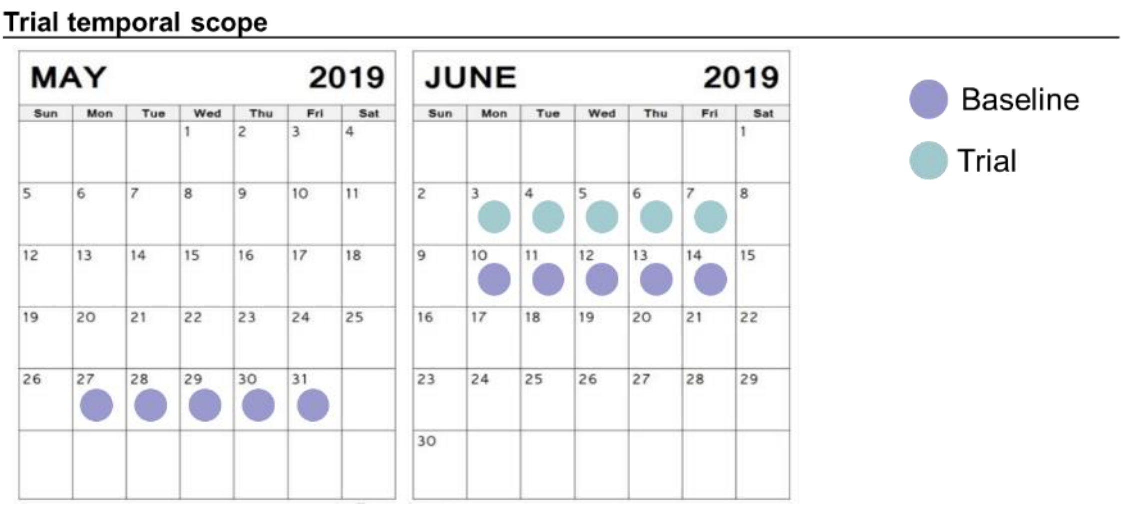
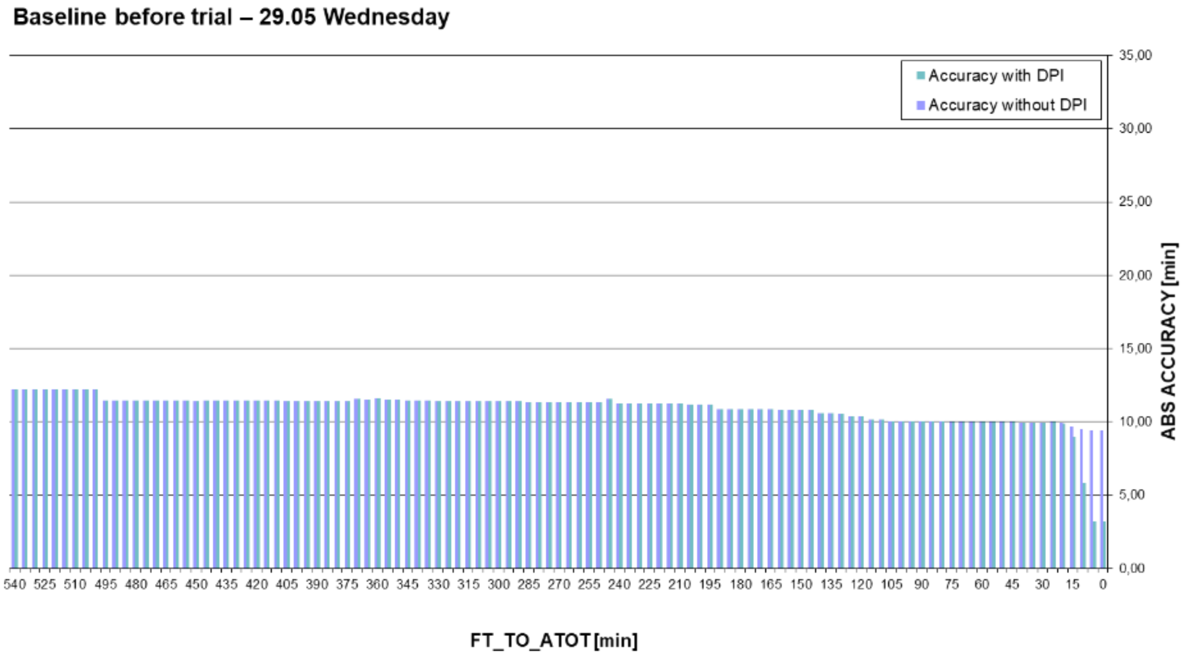


Figure 79: LEAL extended DPIs and P-DPIs baseline and trial duration

Figures 60 and 61 below present the take-off accuracy for the baseline days (Wednesdays) and 62 presents the accuracy obtained during the trial on 05th June.



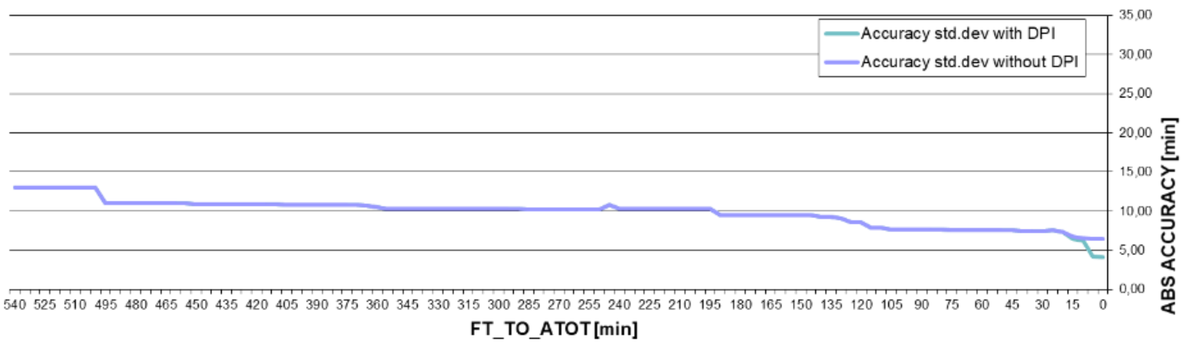
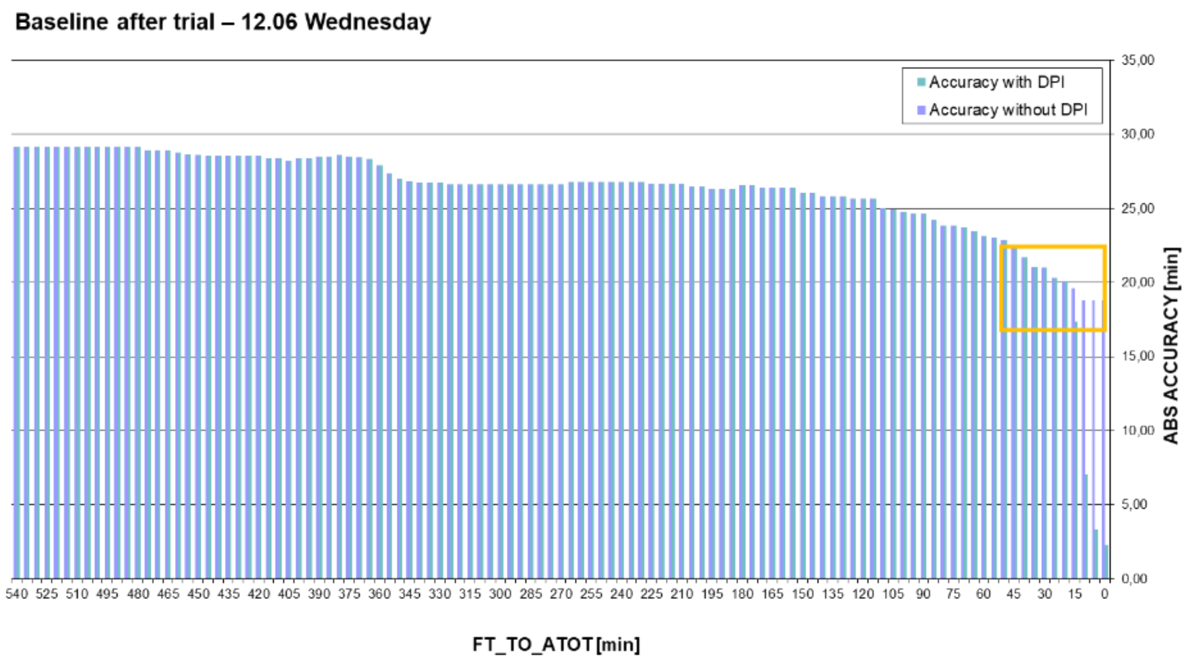


Figure 80: LEAL Baseline take-off time accuracy improvement – Wednesday 29th May



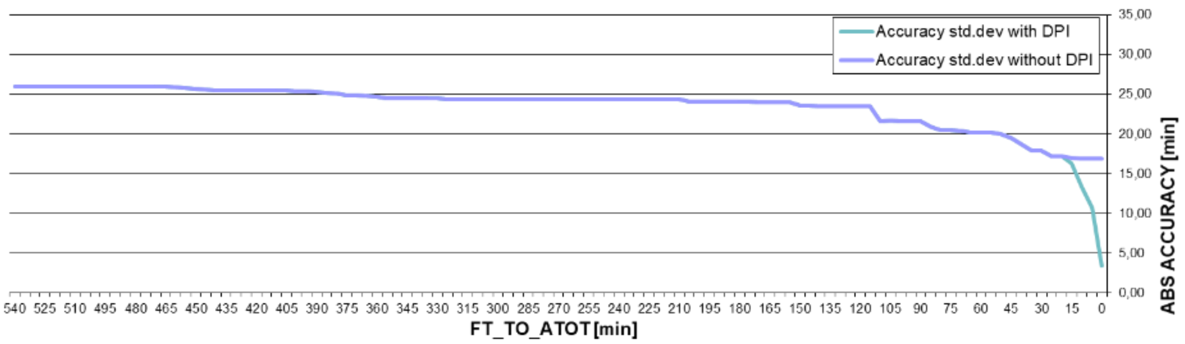
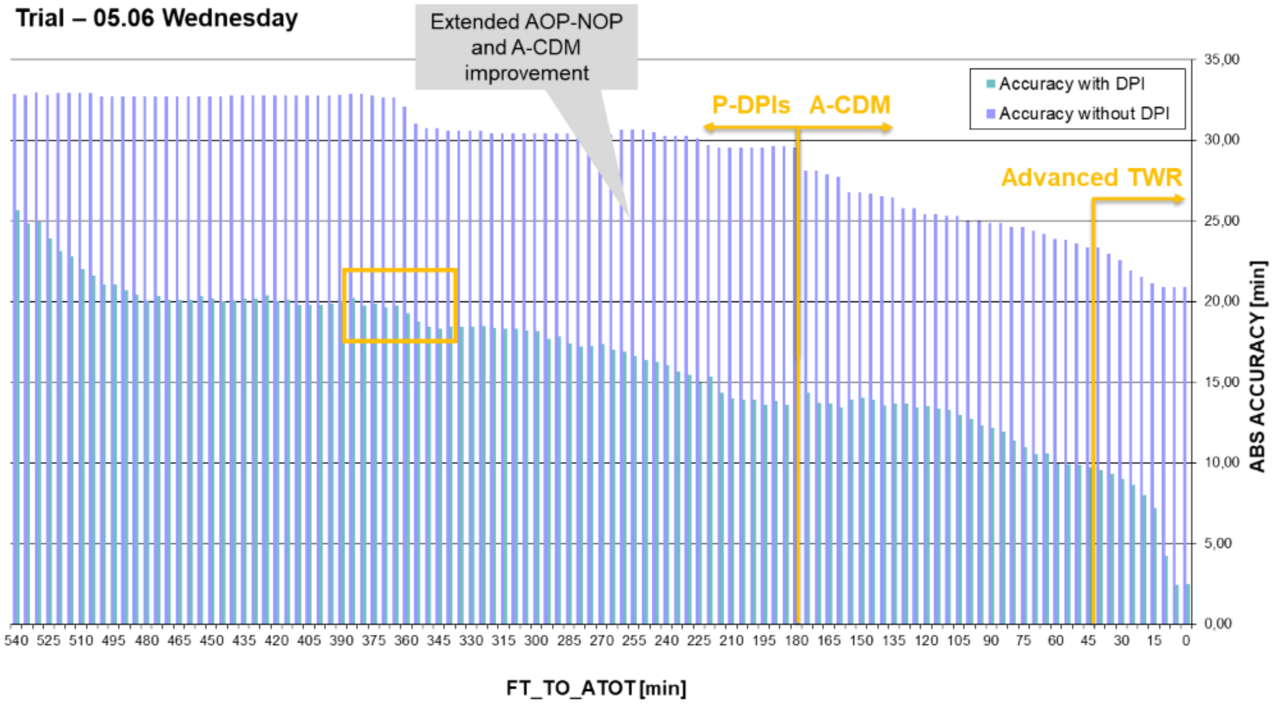


Figure 81: LEAL Baseline take-off time accuracy improvement – Wednesday 12th June



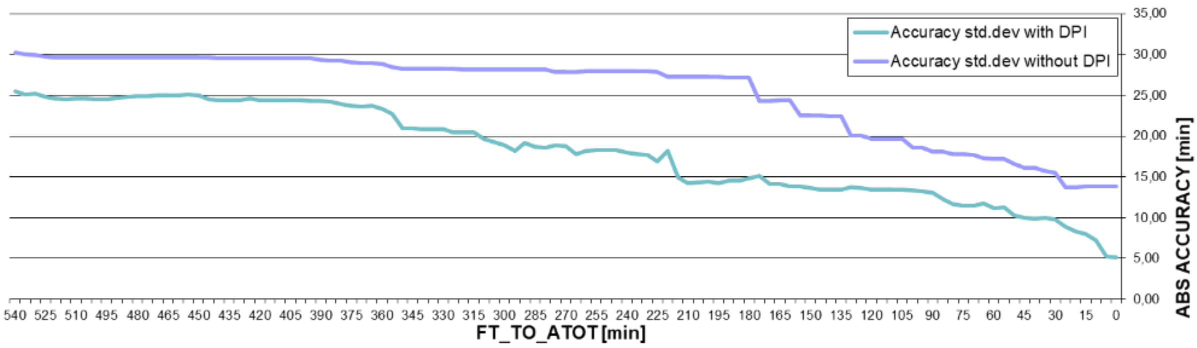


Figure 82: LEAL Take-off time accuracy improvement – Wednesday 5th June

Currently, LEAL airport operates as Advanced Tower airport, but during the trial, it operated as a full A-CDM airport with extended DPIs. The improvement seen during the trial goes from -540 to ATOT up to -40 min approximately, which is the time that the Advanced Tower usually starts sending A-DPI messages to NM. Therefore, the inaccuracy improvement in this case is due to both legacy A-CDM DPIs and also extended DPIs within the AOP concept.

The TTOT in the trial on the 5th June with extended DPIs differs from the ATOT (inaccuracy) in 32,9 min at -540 min, in 13,9 min at -180 min and 9,5 min at -40 min before ATOT, with an average of 17 min, in contrast to the inaccuracy of 25,7min at -540 min, in 29,5 min at -180 min and 23,4 min at -40 min before ATOT, with an average of 30 min inaccuracy, from flight plans.

From -40 min before ATOT onwards the legacy Advanced TWR system provides TTOTs with an average inaccuracy of 6,4 min during the trial day and 7,6 min on 29th May and 14,1 min on 12th June baseline days. The difference between trial and baseline days is still high, which demonstrates the effect of operating as full A-CDM airport and not as Advanced Tower as in normal operations.

In terms of standard deviation, the results obtained during the trial are below the flight plan deviation indicating more stable predictability of the take-off time.

The inaccuracy drops below 20 min during the trial thanks to the TTOT in the P-DPIs: 360 minutes before ATOT, while it drops below 20 min around 40 minutes before ATOT on 12th June baseline day with Advanced Tower system. The other baseline day considered, 29th May, present an inaccuracy below 20 minutes during the whole period, which does not represent a relevant baseline for comparison.

The gain achieved using AOP has been calculated for all days in the trial and compared to the flight plan accuracy, which corresponds to EOBT + taxi out time. Table 30 below compiles the results of all days of the trial. It shows the gain in minutes of the average TTOT vs. average EOBT plus taxi-out time in the different timeframes. The area of improvement of this trial corresponds mainly to the two first columns (-9h to -6h and -6h to -3h) but also the third one as LEAL was operating as A-CDM aiport, when it is an Advanced Tower airport in normal operation. The last column is covered by the Advanced Tower and is added to provide the progression and overall gain until ATOT of the extended DPI solution.

	Avg 9-6h			Avg 6-3h			Avg 3-1h			Avg 1-0h		
	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain	TTOT inaccuracy	EOBT + taxi inacurracy	Gain
03-06-2019	22,93	25,25	2,32	17,50	22,23	4,74	12,70	19,80	7,10	8,49	17,65	9,16
04-06-2019	28,60	32,79	4,19	22,24	29,02	6,78	16,44	25,68	9,24	9,50	22,36	12,86
05-06-2019	20,86	32,75	11,89	16,58	30,25	13,68	12,79	25,81	13,02	7,52	22,24	14,72
06-06-2019	20,54	29,06	8,52	15,05	26,21	11,16	11,37	23,50	12,13	7,04	20,80	13,76
07-06-2019	35,85	48,58	12,73	27,46	41,92	14,46	20,25	31,78	11,53	13,25	27,00	13,75
Average gain	7,93			10,16			10,60			12,85		

Table 30: Gain of extended DPIs TTOT (trial) vs EOBT + taxi from FPL – LEAL

It can be observed that as from 9 hours before the flight time, the provided predictability by the AOP during the trial is better than the predictability based on flight plan data. The gain increases steadily the closer it gets to take off. On overall, there is an average gain of over 7,9 minutes between 9 and 6 hours before ATOT that increases to 10,2 min in the next 3 hours, gets to 10,6min in the next 2 hours and achieves 12,9 min in the last hour before flight.

As seen in the previous analysis for LEBL and LEPA, the highest the inaccuracy from the flight plans due to days with high ATFM delays, the better the gain from the AOP and the P-DPIs. For example, in –9h to -6h timeframe the gain is 12,7 min for 7th June, which registered high delays.

The gain with respect to the Advanced Tower is presented in Table 31 below. Following the same approach as in the case of LEBL and LEPA, two baseline days have been selected: the same weekday after and before the trial. This allows comparing the gain obtained with the Advanced Tower during the baseline days and the gain with the extended DPIs during the trial. Table 31 presents both the average gain achieved with Advanced Tower (Gain legacy ATWR vs EOBT + taxi) and the average gain with the extended DPIs during the trial (Gain trial vs EOBT + taxi) and also the difference between them as the average “Gain trial vs ATWR” for each weekday.

		Avg 9-6h			Avg 6-3h			Avg 3-1h			Avg 1-0h		
		TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi	TTOT inaccuracy	EOBT + taxi inacurracy	Gain TTOT vs EOBT + taxi
Monday	Baseline before trial (27/05/2019)	19,10	19,10	0,00	17,66	17,66	0,00	16,57	16,57	0,00	11,87	14,17	2,30
Monday	Baseline after trial (10/06/2019)	25,38	25,38	0,00	24,23	24,23	0,00	21,32	21,32	0,00	15,19	18,39	3,20
Monday	**Gain ATWR vs EOBT + taxi**			0,00			0,00			0,00			2,75
Monday	03-06-2019	22,93	25,25	2,32	17,50	22,23	4,74	12,70	19,80	7,10	8,49	17,65	9,16
Monday	**Gain trial vs EOBT + taxi**			2,32			4,74			7,10			9,16
Monday	**Gain trial vs ATWR**			2,32			4,74			7,10			6,41
Tuesday	Baseline before trial (28/05/2019)	19,00	19,00	0,00	17,96	17,96	0,00	16,50	16,50	0,00	11,15	13,75	2,59
Tuesday	Baseline after trial (11/06/2019)	28,13	28,13	0,00	26,53	26,53	0,00	23,79	23,79	0,00	15,14	18,35	3,22
Tuesday	**Gain ATWR vs EOBT + taxi**			0,00			0,00			0,00			2,90
Tuesday	04-06-2019	28,60	32,79	4,19	22,24	29,02	6,78	16,44	25,68	9,24	9,50	22,36	12,86
Tuesday	**Gain trial vs EOBT + taxi**			4,19			6,78			9,24			12,86
Tuesday	**Gain trial vs ATWR**			4,19			6,78			9,24			9,96
Wednesday	Baseline before trial (29/05/2019)	11,65	11,65	0,00	11,31	11,31	0,00	10,37	10,37	0,00	8,42	9,81	1,39
Wednesday	Baseline after trial (12/06/2019)	28,75	28,75	0,00	26,68	26,68	0,00	25,21	25,21	0,00	16,86	20,70	3,84
Wednesday	**Gain ATWR vs EOBT + taxi**			0,00			0,00			0,00			2,61
Wednesday	05-06-2019	20,86	32,75	11,89	16,58	30,25	13,68	12,79	25,81	13,02	7,52	22,24	14,72
Wednesday	**Gain trial vs EOBT + taxi**			11,89			13,68			13,02			14,72
Wednesday	**Gain trial vs ATWR**			11,89			13,68			13,02			12,11
Thursday	Baseline before trial (30/05/2019)	79,66	79,66	0,00	56,37	56,38	0,01	30,81	30,82	0,00	15,18	17,25	2,08
Thursday	Baseline after trial (13/06/2019)	26,83	26,83	0,00	24,56	24,56	0,00	22,02	22,02	0,00	14,92	18,26	3,35
Thursday	**Gain ATWR vs EOBT + taxi**			0,00			0,00			0,00			2,71
Thursday	06-06-2019	20,54	29,06	8,52	15,05	26,21	11,16	11,37	23,50	12,13	7,04	20,80	13,76
Thursday	**Gain trial vs EOBT + taxi**			8,52			11,16			12,13			13,76
Thursday	**Gain trial vs ATWR**			8,52			11,16			12,13			11,05
Friday	Baseline before trial (31/05/2019)	31,07	31,07	0,00	26,01	26,01	0,00	22,29	22,29	0,00	15,40	18,64	3,24
Friday	Baseline after trial (14/06/2019)	32,97	32,97	0,00	29,03	29,03	0,00	25,60	25,60	0,00	16,45	20,19	3,74
Friday	**Gain ATWR vs EOBT + taxi**			0,00			0,00			0,00			3,49
Friday	07-06-2019	35,85	48,58	12,73	27,46	41,92	14,46	20,25	31,78	11,53	13,25	27,00	13,75
Friday	**Gain trial vs EOBT + taxi**			12,73			14,46			11,53			13,75
Friday	**Gain trial vs ATWR**			12,73			14,46			11,53			10,26
All days	**Gain trial vs ATWR**			7,93			10,16			10,60			9,96

Table 31: Gain of extended DPIs TTOT (trial) vs legacy A-CDM - LEPA

It can be observed that the extended DPIs provide more accurate information between 9 and 6 hours before the flight, as the gain achieved during the trial compared to the baseline days reaches 7,9 min of improvement on average, minimum gain registered for Mondays of 2,3 min and maximum gain for Fridays of 12,7 min.

The improvement achieved through the P-DPIs is higher when looking at the -6 to -3 hours timeframe: 10,2 minutes gain in average. There is also additional gain of 10,6 min from the AOP with respect to the Advanced Tower in the next 2 hours before the flight, capturing the fact that LEAL operates as A-CDM during the trial and as Advanced Tower in the baseline days. Similarly, a gain is registered in the last hour before ATOT of 10 minutes of average. These results reflect the effect of the A-CDM up to -180 minutes before ATOT and of the extended DPI concept from -540 to -180 before ATOT, which extends the A-CDM.

5. EX3-OBJ-VLD-02-002 Results

#PI-29 Estimated Landing time of arrival flights vs Actual Landing Time

The AOP-NOP integration also included the sharing of Arrival Planning Information (API) from the airport to NM using the API service through B2B service. The General API message included the following airport information shared with NM:

- Arrival Apron Stand
- Arrival Procedure (STAR)
- Arrival Runway
- Arrival Taxi Time
- Arrival Terminal
- Estimated Off-block Time
- Impact Severity Indicator
- In Block Time
- Landing Time
- Minimum Turnaround Time
- Registration Mark

These fields were sent by the AOP in General API messages for all arriving flights. NM processed and used only the information regarding the Actual Landing Time from the General messages sent by the AOP, the other field being still under analysis. Landing Time information sent by the AOP comes from 2 different sources depending on the flight status:

- ETFMS Estimated Landing Time before the flight enters any of the Spanish FIRs;

- SACTA (ATC system) after the flight enters any of the Spanish FIRs.

The objective of this analysis is to evaluate the accuracy of the Estimated Landing Time (ELDT) provided by the AOP and to identify if it is more accurate than the information NM already has. Therefore, the difference between the Actual Landing time (ALDT) and the ELDT coming from the AOP through General API messages has been compared to the difference between ALDT and the ELDT available in NM system, extracted from EFD (ETFMS Flight Data) messages. These values have been collected and compared for LEBL and LEPA airport involved in the trial.

LEBL

General API messages were sent between 20th May and 12th June, with specific stops on the following days and times:

- 20th May: General API sending was suspended due to STAR errors detected and an investigation was started. The impact upon the LECB operation of poor STAR information from the airport affecting the ATFM TMA view was considered "considerable" because all ATFM traffic count graphs showed incorrect Traffic Demand.
- 23rd May: General API sending was re-started without STAR and RWY information
- 28th May: planned maintenance of the LEBL ACDM system
- 3rd and 4th June: no B2B messages for DPI PET(S) received by NM from 03-20:00 until 04-09:00 UTC for LEBL due to software intervention to fix a TTA issue failed to re-introduce the B2B service
- 5th, 6th and 10th June: planned maintenance of the LEBL ACDM system between 05-22:00 and 06-03:00UTC
- 12th June: trial finished at 14:00 UTC.

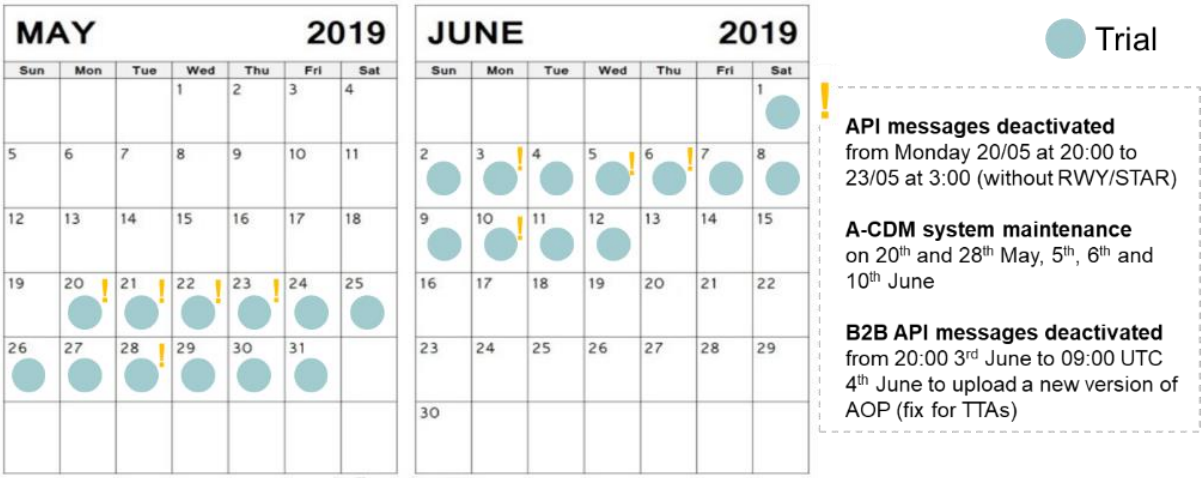


Figure 83: LEBL General API trial duration

The ELDT accuracy analysis has been performed for 4 different days, randomly selected from the trial days with no technical issues or stops.

Figure 84 below provides the accuracy of ELDT compared to the ALDT coming from APIs and available in NM system (EFD) for the 31st May. As the AOP uses NM ELDT before flights enter any of the Spanish FIRs, the accuracy in both case is identified. A slight difference in the distribution can be appreciated when getting closer to the ALDT, around 100 min before, when the API seems to provide estimations that are more accurate.

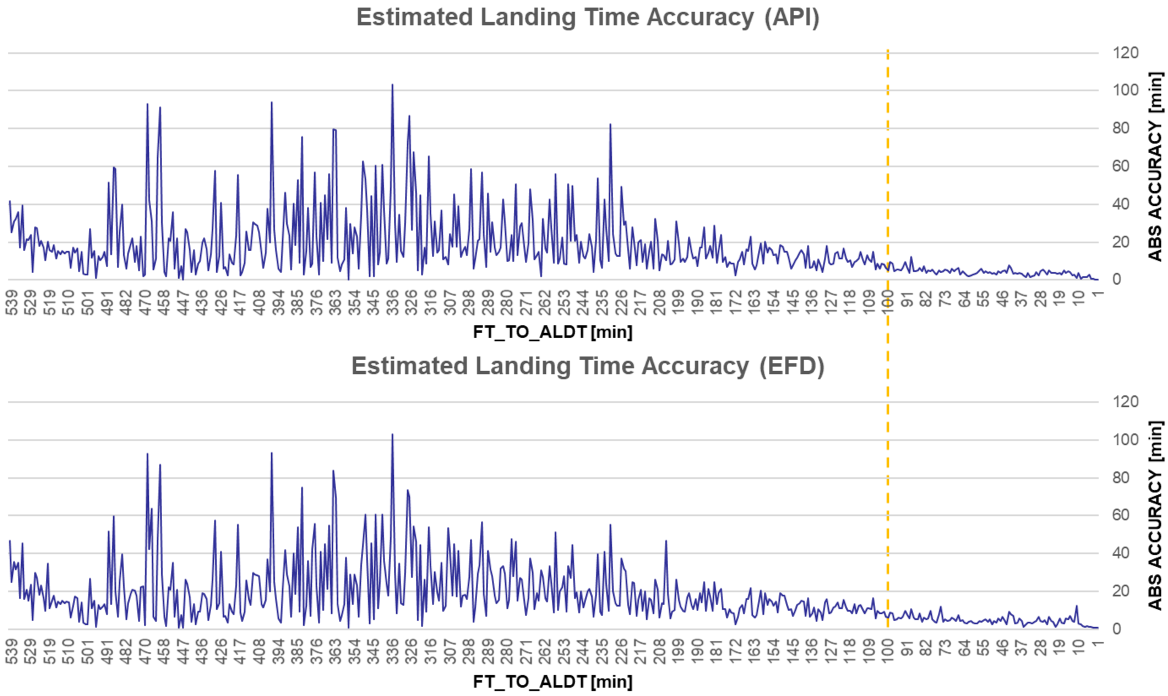


Figure 84: LEBL General API ELDT accuracy progress from 540 minutes to ALDT – 31st May

Having a closer look at the ELDT accuracy from 100 min before landing in Figure 85 below, the API provides slightly more accurate Estimated Landing Time. The API ELDTs differ from ALDT in 4,09 min, while the EFD ELDTs in 4,78 min. This is due to the fact that the AOP uses SACTA information to update arrival information coming from ATC systems once the flight enters any of the Spanish FIRs, which can happen from 2h to 30 minutes before landing.

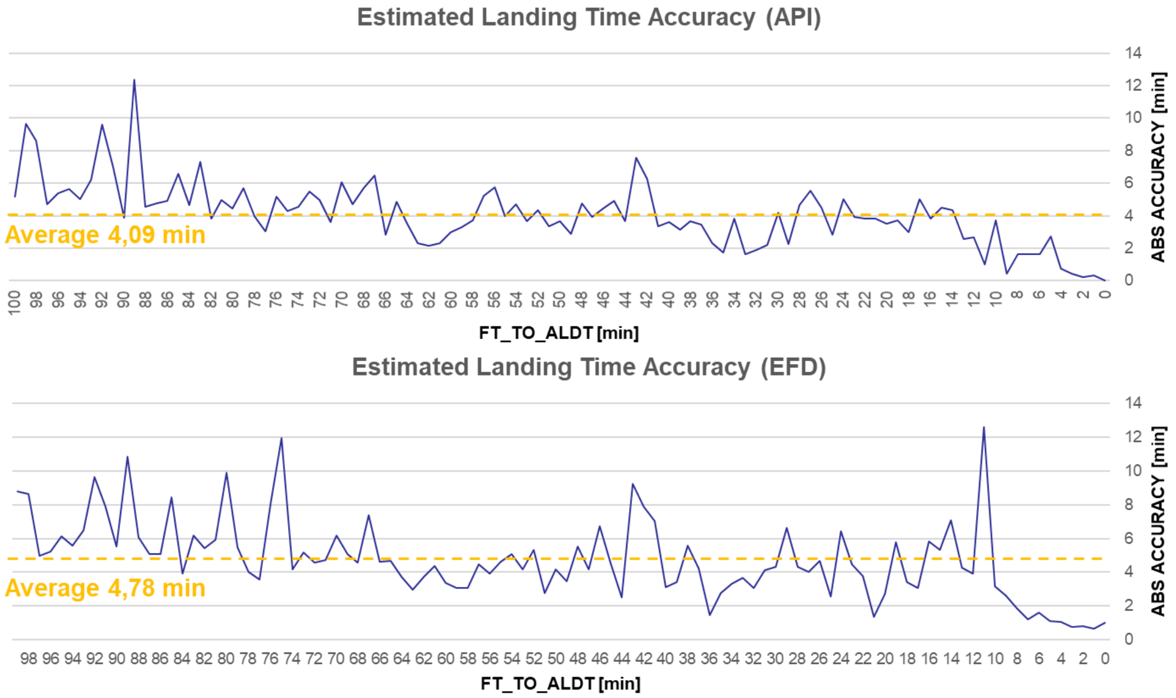


Figure 85: LEBL General API ELDT accuracy progress from 100 minutes to ALDT – 31st May

Similar tendencies have been identified for the other 3 days analysed, the accuracy average for the last 100 minutes before landing being collected in the Table 32 below. The General APIs provided better Estimated Landing Times, except for 6th June which might have been caused by the maintenance for A-CDM system. The highest improvement was captured on 9th June and also 31st May with higher traffic than the other analysed days: 528 and 533 arrivals, respectively.

Date	API ELDT accuracy average (from 100 before to ALDT)	EFD ELDT accuracy average (from 100 before to ALDT)
20/05/2019	4,11 min	4,29 min
31/05/2019	4,09 min	4,78 min
06/06/2019	4,65 min	4,28 min
09/06/2019	5,50 min	6,33 min

Table 32: LEBL ELDT accuracy average comparison (from 100 before to ALDT)

LEPA

General API messages were sent between 20th May and 12th June, with specific stops on the following days and times:

- 21st May: General API sending was suspended due to bad STAR & RWY information in the LEBL case
- 23rd May: General API sending was re-started without STAR and RWY information
- 4th- 5th and 5th - 6th June: planned maintenance between 22:00 and 06-03:00UTC
- 12th June: trial finished at 14:00 UTC.

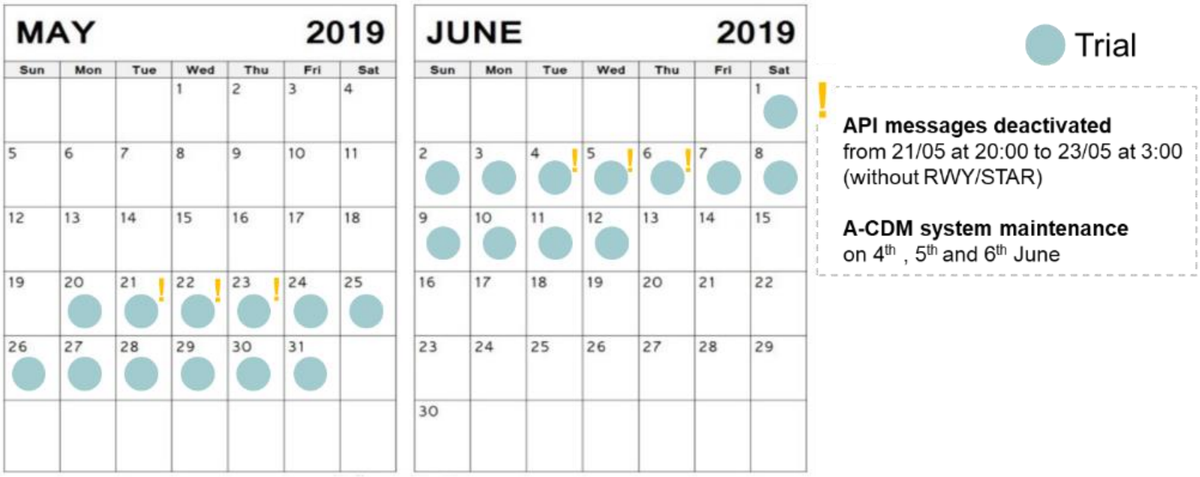


Figure 86: LEPA General API trial duration

The ELDT accuracy analysis has been performed for 4 different days, randomly selected from the trial days with no technical issues or stops.

Figure 847 below provides the accuracy of ELDT compared to the ALDT coming from APIs and available in NM system (EFD) for the 31st May. As the AOP uses NM ELDT before flights enter any of the Spanish FIRs, the accuracy in both cases is identified. A slight difference in the distribution can be appreciated when getting closer to the ALDT, around 100 min before, when the API seems to provide estimations that are more accurate.

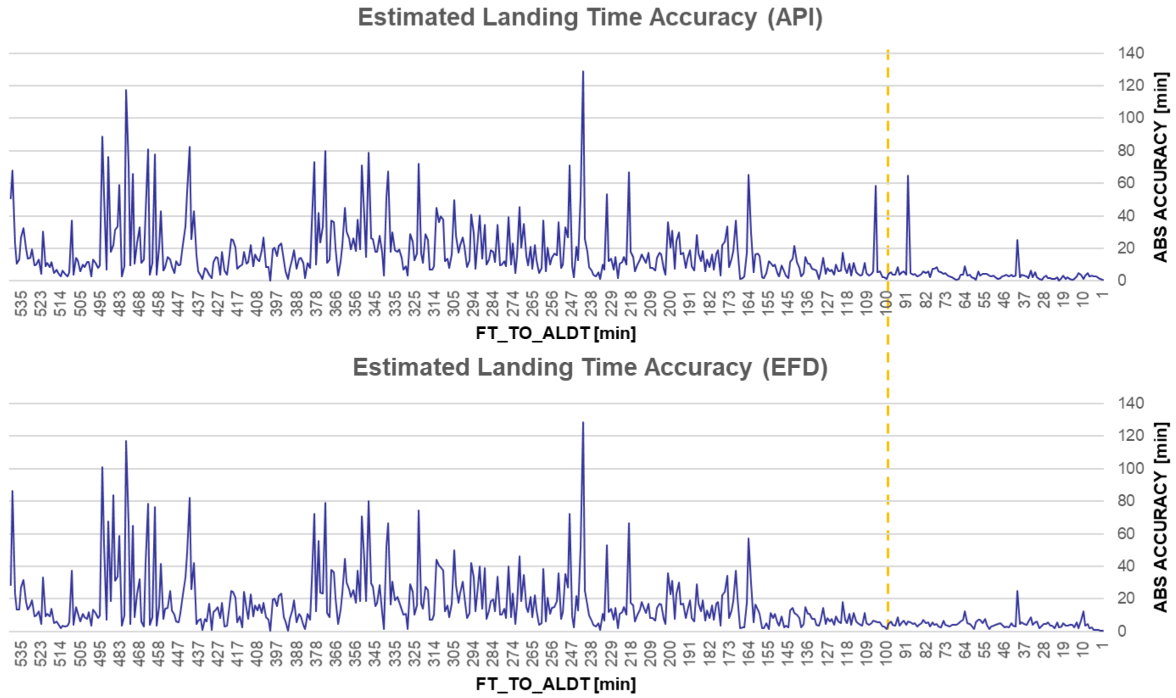
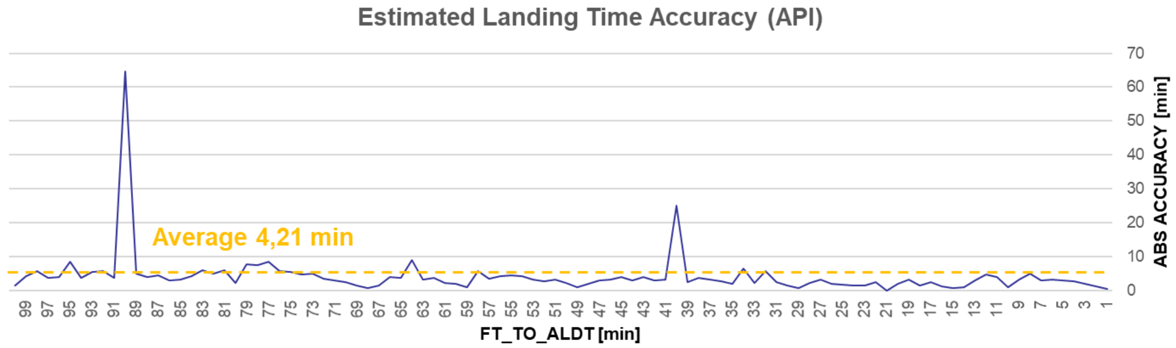


Figure 87: LEPA General API ELDT accuracy progress from 540 minutes to ALDT – 31st May

Having a closer look at the ELDT accuracy from 100 min before landing in Figure 858 below, the API provides slightly more accurate Estimated Landing Time. The API ELDTs differ from ALDT in 4,21 min, while the EFD ELDTs in 4,60 min. This is due to the fact that the AOP uses SACTA information to update arrival information coming from ATC systems once the flight enters any of the Spanish FIRs, which usually happen from 1h to 15 minutes before landing.



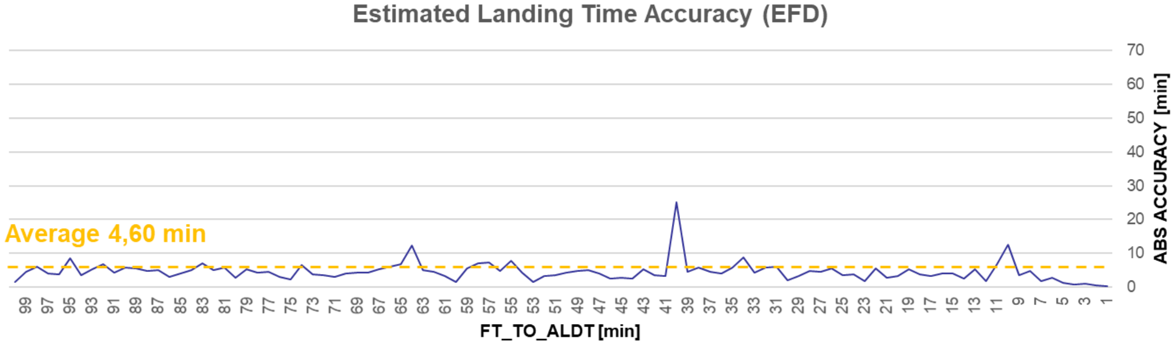


Figure 88: LEPA General API ELDT accuracy progress from 100 minutes to ALDT – 31st May

Similar tendencies have been identified for the other 3 days analysed, the accuracy average for the last 100 minutes before landing being collected in the Table 32 below. The General APIs provided better Estimated Landing Times, except for 9th June when the highest number of arrivals (460 flights) and the highest delay (1126 minutes) was registered when compared to the analysed days. This indicated that the amount of traffic and the registered delay does not influence the ELDT accuracy, as LEBL results provided more accurate ELDTs for the day with higher traffic and delay while LEPA results provided worst accurate ELDTs for the day with higher traffic and delay.

Date	API ELDT accuracy average (from 100 before to ALDT)	EFD ELDT accuracy average (from 100 before to ALDT)
21/05/2019	3,71 min	3,76 min
31/05/2019	4,09 min	4,78 min
06/06/2019	4,88 min	4,93 min
09/06/2019	5,28 min	4,34 min

Table 33: LEPA ELDT accuracy average comparison (from 100 before to ALDT)

Conclusions:

Despite the fact that the AOP can provide more accurate information on ELDT, the improvement is only of decimals and it is around 100 minutes before landing when the aircraft in is execution. It should be further evaluated to decide if this improvement could bring benefit to NM or other stakeholders to consider including the ELDT coming from General API messages into ETFMS flight data. Nevertheless, there is more information at the airport that can be used to enhance this ELDT, such as MVT messages received from the airlines, especially for long-haul flights, that should be considered to achieve a better ELDT accuracy for flights before entering European airspace.

6. EX3-OBJ-VLD-02-003 Results

#PI-29 Estimated Landing time of the TTA flights vs Actual Landing Time

See Section E.3.35.

7. EX3-OBJ-VLD-04-001 Results

NM questionnaire:

According to the NM questionnaire, the workflow impact of applying the rate calculation to the Network Cherry Pick arrival measure is acceptable by 75% of participating NM.

Figure 89: Query #3 from NM questionnaire

Regarding the ability to monitor for traffic surges using the slot list, 42% of NM participants shared a positive input.

Figure 90: Query #5 from NM questionnaire

As for the ability to recognize that the regulation was a network Cherry Pick Arrival measure, 75% of NM participants largely agreed.

Figure 91 : Query #6 from NM questionnaire

Conclusions:

Regarding coordination and implementation of TTA measure, both FMP and NM participants agreed in the ability to monitor, recognize and deal with the measure and to coordinate in timely manner with ease with the other agents involved.

8. EX3-OBJ-VLD-04-002 Results

#PI-4 Recovery and Mitigation of Reactionary Delay and PI-23 Knock-on effect reduction

ECTL CODA has provided for the months of May and June and for LEBL and LEPA per day for all flights, the average departure delay per flight, a breakdown of primary and reactionary delays as well as the 15 minutes punctuality, for both arrival and departure and the number of flights that reported reactionary delay. CODA has also provided the above information for the next legs of the TTA flights.

The 15-minute punctuality means flights departing or arriving within of earlier that 15 minutes of their scheduled time or arrival/departure so the on-time performance. The Reactionary Delay to the reactionary delay reported by at departure and includes the two types the rotational (code 93) and non-rotational (code 91, 92, and 94)

The reactionary delay of TTA flights in LEBL have been obtained by linking the affected TTA flights with the next immediate leg departing LEBL and then taking the reactionary delay reported by the immediate departure flight. It has been checked that no night-stops are counted (correctly, no reactionary delay codes were reported for departures after a night stop).

In the table ALL-Flights, all flights are included including the TTA flights.

We have calculated statistics for LEBL but not for LEPA as the sample is too small (only 6 dates with TTA, and several fine tuning that was necessary during the trials).

The solution scenario is TTA flights (LEBL departures following an arrival affected by TTA regulations i.e. CPEBL) and this scenario covers 17 days.

The reference scenario consists of all flights in the ALL-flights sample from dates that did not have a TTA regulation, it covers 44 days. For the record as days are not the same traffic and delays wise, we also provide the reference scenario of the 61 days, but knowing that TTA days are part of this scenario.

Delay Performance All-Flights May June 2019 LEBL						
DAY	ADEP	Average Departure Delay per Flight	Reactionary Delay/Flight	Primary Delay per Flight	15 Minute Punctuality	No. Flights with Reported Reactionary Delay
01May2019	LEBL	7,8	2,1	5,9	87%	58
02May2019	LEBL	11,9	2,3	9,6	78%	60
03May2019	LEBL	12,6	5,2	7,5	73%	101
04May2019	LEBL	13,0	4,3	8,7	81%	69
05May2019	LEBL	13,4	4,7	8,7	75%	97
06May2019	LEBL	10,8	4,4	6,5	80%	104
07May2019	LEBL	7,8	2,7	5,1	85%	61
08May2019	LEBL	16,5	7,1	9,6	69%	122
09May2019	LEBL	64,1	24,3	39,8	39%	139
10May2019	LEBL	32,9	18,2	14,8	48%	205
11May2019	LEBL	11,0	4,0	7,0	81%	72
12May2019	LEBL	11,1	4,4	6,7	80%	76
13May2019	LEBL	12,4	5,3	7,2	78%	96
14May2019	LEBL	8,8	3,0	6,0	84%	47
15May2019	LEBL	6,5	1,4	5,3	87%	47
16May2019	LEBL	11,0	2,7	8,3	80%	64
17May2019	LEBL	33,2	19,7	13,4	45%	215
18May2019	LEBL	14,5	3,4	11,3	73%	71
19May2019	LEBL	11,6	3,6	8,5	74%	89
20May2019	LEBL	15,2	6,8	9,0	70%	109
21May2019	LEBL	12,0	3,2	8,8	79%	67
22May2019	LEBL	10,2	2,9	7,4	83%	64
23May2019	LEBL	9,7	2,6	7,1	82%	79
24May2019	LEBL	20,3	9,1	11,1	58%	166
25May2019	LEBL	14,4	5,3	9,1	75%	83
26May2019	LEBL	16,6	5,9	10,7	79%	97
27May2019	LEBL	10,5	4,0	6,6	80%	86
28May2019	LEBL	9,4	3,3	6,3	80%	70
29May2019	LEBL	8,7	3,2	5,5	84%	72
30May2019	LEBL	10,5	3,4	7,1	83%	81
31May2019	LEBL	12,4	4,3	8,1	70%	98
01Jun2019	LEBL	13,1	5,0	8,2	74%	78
02Jun2019	LEBL	14,8	6,3	8,5	69%	115
03Jun2019	LEBL	14,2	6,3	7,8	74%	127
04Jun2019	LEBL	14,8	7,0	7,8	74%	120
05Jun2019	LEBL	13,2	5,5	7,6	72%	132

06Jun2019	LEBL	14,9	7,0	7,9	70%	136
07Jun2019	LEBL	22,1	9,2	12,9	58%	190
08Jun2019	LEBL	26,5	14,0	12,5	50%	181
09Jun2019	LEBL	22,0	9,4	12,6	60%	185
10Jun2019	LEBL	16,6	7,5	9,1	69%	151
11Jun2019	LEBL	27,4	15,4	12,0	53%	224
12Jun2019	LEBL	14,8	7,0	7,8	68%	151
13Jun2019	LEBL	17,6	8,8	8,8	64%	168
14Jun2019	LEBL	26,1	11,9	14,3	50%	224
15Jun2019	LEBL	20,0	8,8	11,2	60%	154
16Jun2019	LEBL	11,5	4,1	7,4	73%	112
17Jun2019	LEBL	14,0	7,2	6,8	76%	130
18Jun2019	LEBL	14,4	4,7	9,6	78%	115
19Jun2019	LEBL	14,8	6,3	8,6	69%	126
20Jun2019	LEBL	20,6	8,6	12,0	56%	170
21Jun2019	LEBL	23,1	9,6	13,5	50%	188
22Jun2019	LEBL	22,4	8,0	14,5	58%	124
23Jun2019	LEBL	20,3	8,0	12,3	66%	153
24Jun2019	LEBL	20,7	9,1	11,6	59%	175
25Jun2019	LEBL	15,4	6,6	8,8	67%	142
26Jun2019	LEBL	22,5	9,2	13,3	60%	176
27Jun2019	LEBL	22,8	9,2	13,6	55%	154
28Jun2019	LEBL	21,0	7,6	13,4	64%	135
29Jun2019	LEBL	24,0	7,6	16,5	51%	121
30Jun2019	LEBL	31,1	16,5	14,6	41%	212

Table 34: Delay Performance All Flights LEBL

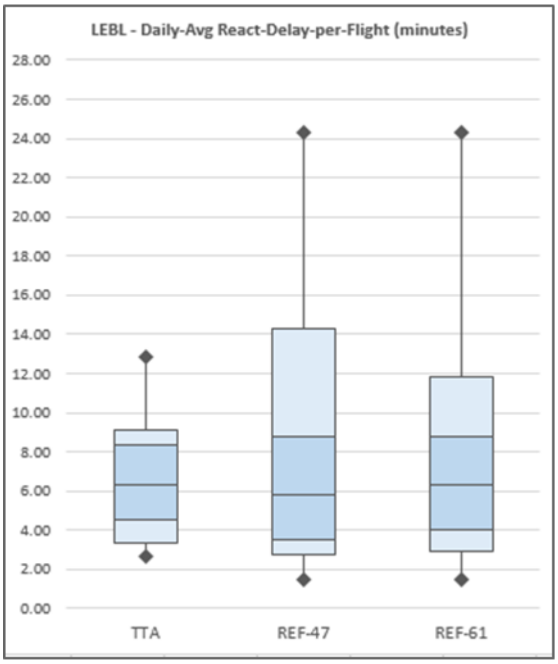
	Includes all reported reactionary delay on CPEBL next-departures			
Date	**nb flights**	**tot delay**	**avg dly per flt**	**ratio reactionary-to-total delay**
20/05/2019	4	21	5.250	9.38%
24/05/2019	63	521	8.270	30.25%
25/05/2019	33	88	2.667	17.35%
26/05/2019	108	410	3.796	18.30%
30/05/2019	70	208	2.971	20.51%
31/05/2019	114	698	6.123	19.97%
01/06/2019	34	173	5.088	19.83%
02/06/2019	65	611	9.400	22.36%
03/06/2019	91	669	7.352	30.47%
04/06/2019	18	155	8.611	45.45%
05/06/2019	42	335	7.976	38.85%

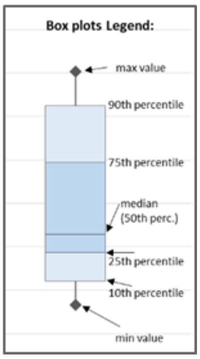
06/06/2019	47	186	3.957	26.07%
07/06/2019	120	762	6.350	19.56%
08/06/2019	42	540	12.857	35.67%
09/06/2019	90	755	8.389	30.13%
tot	941			

Table 35: Table Delay Performance CPEBL regulated flights LEBL

Daily Average delay-per-flight

	TTA	REF-47	REF-61
min	2,67	1,43	1,43
perc-10	3,30	2,71	2,91
q1	4,52	3,51	4,03
median	6,35	5,79	6,3
q3	8,33	8,76	8,75
perc-90	9,08	14,32	11,85
max	12,86	24,28	24,28
average	6,04	7,110	7,02





Daily Average ratio-reactionary -to-total

	TTA	REF-47
min	9.38%	19.54%
perc-10	17.73%	26.65%
q1	19.70%	33.20%
median	22.36%	38.85%
q3	30.36%	43.02%
perc-90	37.58%	51.10%
max	45.45%	59.52%
average	45.45%	38.39%

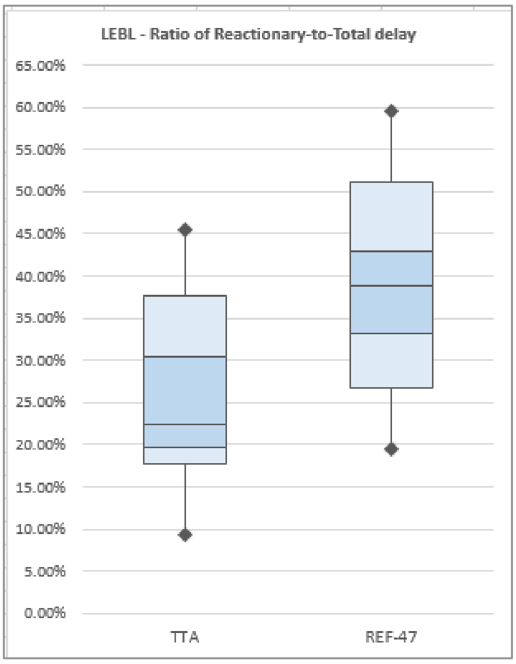


Table 36: Table statistical comparisons reactionary delay solution versus solution reference and box plot representation

The observations for LEBL derived by analysing table 15 above are:

A reduction in delay dispersion, with much lower perc90 and maximum delays although slightly higher minimum and perc10 delays. Indeed, the maximum delay is 12,86 minutes, whereas in the Reference scenario is 24,28 minutes. Same for the 90th percentile, where we have 9,08 minutes with TTA compared to 14,32min in the Reference. The mean value is in the same order. **This means TTA provides a much more balanced and concentrated range of delay**

repartition, reducing significantly the high delay; very clearly observable in the box plot representation.

Regarding the ratio reactionary delay to total delay, we observe a systematic **reduction in the ratio at all delay levels, minimum, central and maximum;** very easily observable in the box plot representation. Reactionary delays are especially harmful for the overall network because of its propagation; reducing the proportion of reactionary delay is an important goal and these results fully align to this goal.

In addition to the calculations made using CODA, we provide below values for departure punctuality, calculated from the data recorded from AOP and SCENA. In this sense, for each day of the validation and each airport, the percentage of departure flights that have finally departed on time (+/- 3min), when the arrival flight was actually delayed (% Departures (AOBT-SOBT)< +/- 3 mins when AOBT<AIBT+XTTT-). For the sample at the three airports, the punctuality percentage due to Recovery and Mitigation of Reactionary Delay is above 95 percent.

9. EX3-OBJ-VLD-04-003 Results

FMP questionnaire:

Regarding the confidence about TTA measure resolving demand and capacity imbalance, the feedback obtained is more diverse. Depending on the conditions of traffic, although TTA measure was implemented on time, some FMPs did not feel comfortable enough and had to change to a standard CASA regulation. Even though some FMPs showed an adverse opinion (23,63%), the general results demonstrated a positive insight (42,73%).

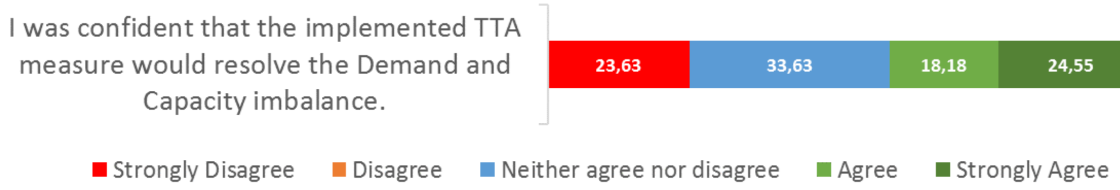


Figure 92: Query #5 from FMP questionnaire

Conclusions:

Regarding the confidence about TTA measure resolving demand and capacity imbalance, even though some FMPs showed an adverse opinion, the general results demonstrated a positive insight. This slight difference might be due to the fact that some FMPs had to change the TTA measure for a standard CASA regulation because of the uncertainty they felt of how the regulation was working. Nevertheless, with more information of this new method and training, this lack of confidence can be sorted.

10. Additional results

This trial focuses on the planning phase, but additional analysis has been performed on the execution phase to identify any improvement or change in the AUs behaviour with respect to the adherence to the Target Time defined by the AOP and allocated by NM under the CP regulations during the trial. This analysis has been driven by the fact that traffic predictability also depends on the flight execution phase and the adherence to the Target Time Over, which go beyond the scope of this trial.

NM system captures both the target time allocated to each flight captured by a regulation (i.e. Target Time Over as the entry time into the congested airspace/airport) and the actual time over (i.e. Actual Time Over as the actual entry time into the regulated airspace/airport). The difference between these two values represents the deviation of the flight from its target time or the adherence to it.

As the execution phase was not part of the trial, there were no specific instructions for flight crews to adhere to the target times. However, AUs part of the A-Team supporting PJ24 and main local AUs and the corresponding flight crews were informed about the trial and the implication of the target times. They were recommended to try to adhere to the target time, while complying with their usual operational and business rules.

Figure 93 and **Figure 94** below present the evolution of both Take-Off Time (TOT) and Target Time Over (TTO) adherence of the flights going to LEBL/LEPA and being affected (as most penalising regulation) by regulations applied on LEBLARR and LEPAARR traffic volumes, respectively. Slight improvement in flight adherence to the TTOs has been identified for those flights captured by the trial 78%, compared with the previous months where all value were below. This indicates that flights captured by cherry pick regulations during the trial have tried to fly towards the assigned target time at each of the airports and a higher percentage have arrived within the slot tolerance window (-5/+10 minutes).

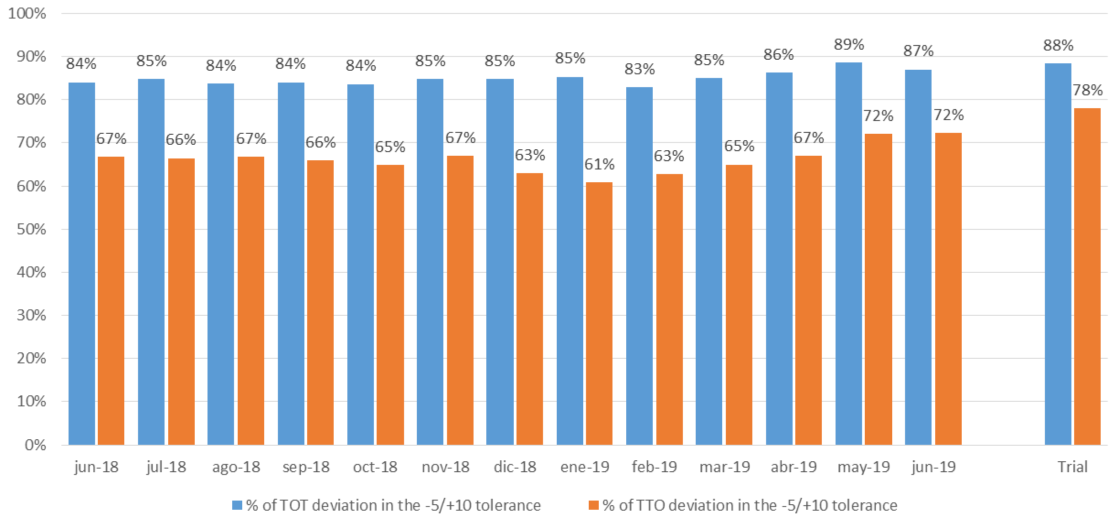


Figure 93: Take-off Time (TOT) and Target Time Over (TTO) adherence - LEBL

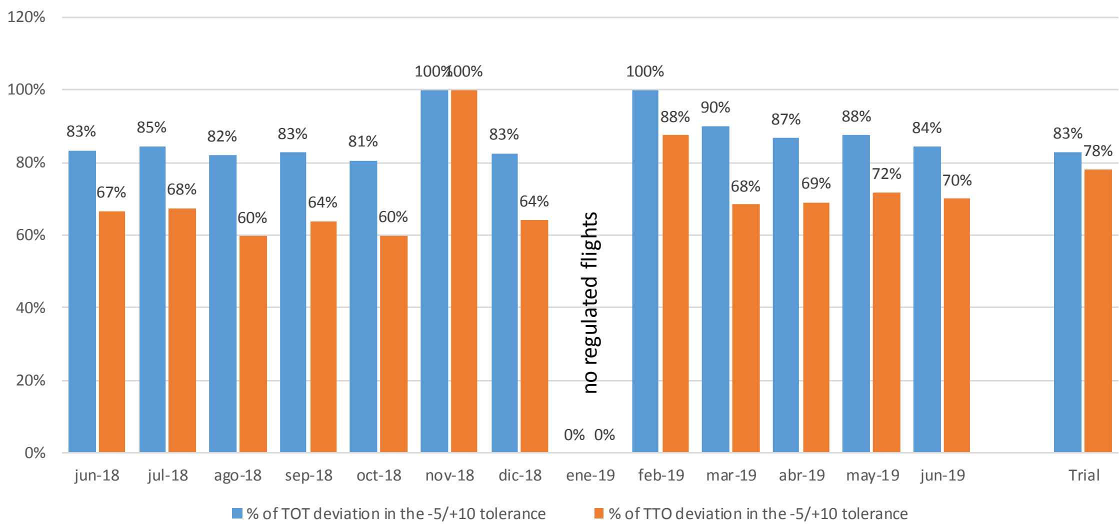


Figure 94: Take-off Time (TOT) and Target Time Over (TTO) adherence - LEPA

Airspace Users behaviour on take-off and arrival at the congested airport has been analysed by calculating the share of flights in each one of the following categories:

- Category 1: Take-off and flying time deviations are all positive (late), contributing proportionally to the time over deviation;

- Category 2: Take-off time deviation is positive (late) and flying time deviation compensates it;
- Category 3: Take-off time deviation is negative (early) and en-route deviation compensates it;
- Category 4: Take-off and flying time deviations are all negative (early), contributing proportionally to the final TTO deviation.

Figure 95 and **Figure 96** below show the evolution of AUs behaviour in terms of deviation at take-off and at target time of the flights going to LEBL/LEPA and being affected (as most penalising regulation) by regulations applied on LEBLARR and LEPAARR traffic volumes, respectively.

In the case of LEBL, there is a significant difference in terms of categories share if comparing results during the trials and the previous months. The percentage of flights departing early and arriving earlier at the airport (category 4) as well as the percentage of flight taking-off late and arriving earlier quite is lower during the trial, while the percentage of category 1 and 3 are both higher during the trial. This indicates that flights in the trials have not sped up to get to the airport, which is not what usually happened during the previous year.

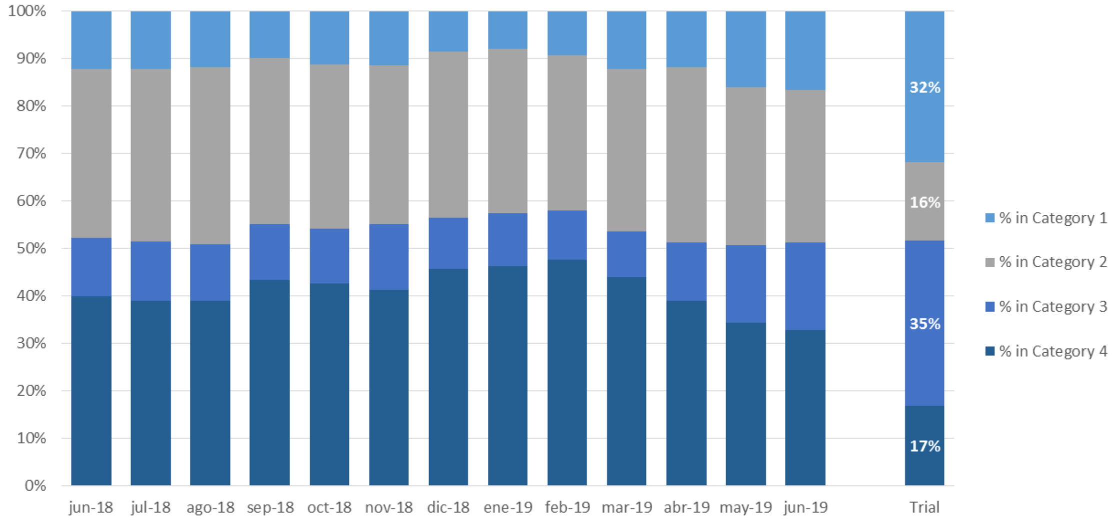


Figure 95: Airspace Users behaviour based on TOT and TTO deviation – LEBL

AUs behaviour during the trials seem in line with the previous months, with slight reduction on category 4. This is aligned with the conclusion obtained for LEBL, as AUs did not sped up to arrive earlier to the airport, as the usually do in a higher percentage.

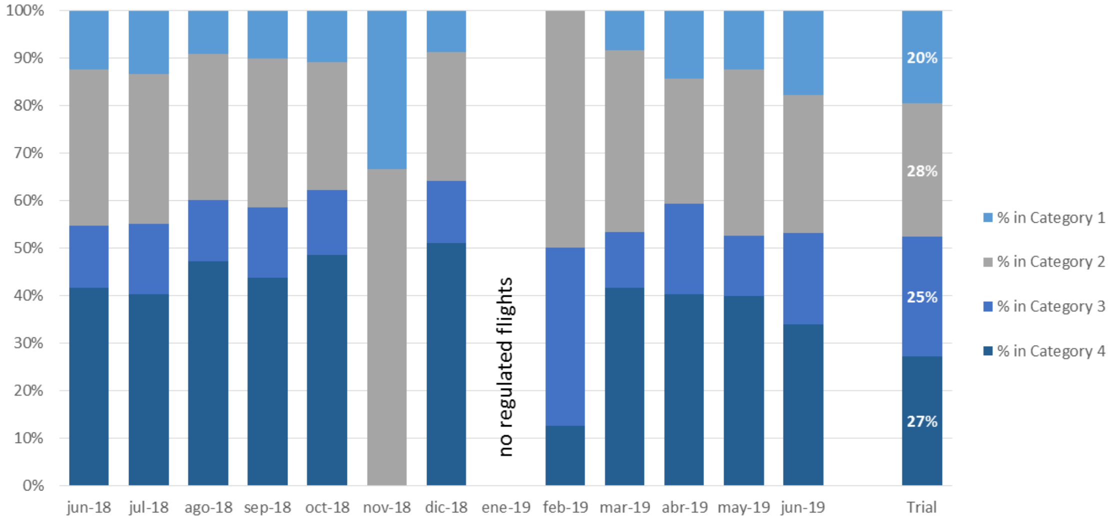


Figure 96: Airspace Users behaviour based on TOT and TTO deviation - LEPA

E.3.4 Results per Airspace User

Lufthansa:

For LHG, the analysis of the trial period was only possible for LHR and BCN as PMI and ALC were out of scope of the internal analysis.

Both showed a similar trend of improved arrival punctuality compared to PY figures and a reduction of ATFM related delays. However, this trend started well before the trial period and it remained very difficult the assign these improvements solely to the EXE as they could have been influenced by other external factors. Traffic numbers for LHR and BCN were comparable (2018 vs. 2019).

The analysis of LHR during the trial phase revealed some examples were a large number of LHG flights experienced some delays that for other airlines were spread across flights more evenly.

Ryanair:

From a quantitative perspective, we have not perceived significant differences in delays between CASA and TTA regulations.

During the exercise (20th May – 12th June), 193 flights were impacted by TTA regulations in BCN and PMI of which 117 were delayed at least 1 minute. Please see the breakdown in the table below:

	Total flights	Flight delayed (all regulations)	Flight delayed by LEBLTMA or LECPFMP	Flights dly by TTA reg.	Avg. delay per delayed flight
BCN	1,600	421	212	103	12.95 min
PMI*	964	257	23	14	8.71 min

*Source Eurocontrol *27th May to 12th June*

We perceived that the TTA regulations were only applied in specific cases: ATC Capacity (BCN and PMI), Aerodrome Capacity (BCN) and Environmental (BCN) restrictions. For the rest of the regulations, FMP applied CASA regulations. As the PMI sample was not significant enough (only 14 flights were delayed by a TTA regulation), we have focused our analysis in BCN arrivals. Please find below the key points:

Flights delayed arriving to BCN airport and regulated by BCN TMA:

	TTA Regulation		Rest of regulations	
MP Regulation Reason	**# of flights**	**Avg delay**	**# of flights**	**Avg delay**
C - ATC Capacity	77	11.63	21	12.48
G - Aerodrome Capacity	4	8.25	1	2.00
V - Environmental Issues	22	18.41	30	12.60
Subtotal (C+G+V)	**103**	**12.95**	**52**	**12.35**
W - Weather	0	n/a	57	16.74
Total	**103**	**12.95**	**109**	**13.82**

The figures show that around 50% of the delayed flights were affected by TTA regulations during the period. The average delay of the MP regulation reasons C, G and V when FMP applied a CASA regulation is slightly better compared to TTA regulations (12.35 vs 12.95 min/flt), being the difference not significant enough to make any conclusions. On the other hand, the average delay when FMP applied an environmental restriction shows better results for CASA regulations (12.60 vs 18.41 min/flt)

Number of flights delayed >15 min:

	TTA regulations		Rest of regulations	
MP Regulation Reason	**# flt delayed >15 min**	**# flt delayed > 60 min**	**# flt delayed >15 min**	**# flt delayed > 60 min**
C - ATC Capacity	17	0	4	-
G - Aerodrome Capacity	1	0	-	-
V - Environmental Issues	8	1	10	-
Subtotal (C+G+V)	26	1	14	-
W - Weather	-	n/a	27	-
Total	26	1	41	-

In this case, the difference is not significant enough either, being the share of flights delayed over 15 minutes around 25% in both cases (27% with CASA regulation and 25% with TTA regulations).

Highlight that the only flight delayed more than 1 hour was impacted by a TTA regulation on 7/06/19.

Date	Aircraft ID	DEP	ARR	ATFM Dly (min)	Reg ID	MP Regulation Reason

07/06/19	RYR40HH	LPPR	LEBL	70	CPEBL07N	Environmental Issues

BCN ATFM delays – 2018 Baseline

After comparing 2019 stats with 2018 baseline, we consider that the record ATC crisis lived across Europe and the special situation of Barcelona in 2018 would lead to non-accurate conclusions. For example, in the same period of 2018, 441 up to 599 flights were affected by Special events (BRAIN project) or severe weather conditions in BCN, not part of the scope of TTA regulations during the exercise.

The 2018 reference scenario cannot be used for this comparison.

Ryanair contribution during the trial

From an operational point of view, no specific action was required from any airline to comply specifically with the TTA exercise except for the early submission of the flight plans, however Ryanair tried to validate the internal exercise set-up defined to notify, monitor and fly according to the TTAs provided. More details about this contribution can be seen in the conclusions section.

Regarding AIMA Algorithm and the prioritization mechanism defined, we have also perceived an increase in the workload without providing clear benefits. Ryanair Ops controller dedicated 1-2 hours daily to monitor, analyse, decide and send the flights to be prioritized via email in a csv file based on several sources and flight planner experience. The final sequence was not communicated to the airspace users so there was no transparency about the impact of our selection.

More details included in the exercise conclusions and recommendations sections.

Air France:

No significant differences appear between "reference" and "solution" scenarios, but the sample of AFR flights is relatively small.

Period: May 6 until June 30, 2019.

There have been 55 instances of LEBLA regulations on AFR flights (reference scenario).

There have been 14 instances of CPEBL regulations on AFR flights (solution scenario).

General statistics

Of the exercise airports (Alicante, Barcelona, Palma de Mallorca) Air France only has significant traffic in Barcelona, so only that airport has been analyzed.

The TTA exercise was active on 22 instances, on 16 different dates.

Exercise instances in which AFR flights were scheduled were 17. On 14 of these instances (82%) the concerned AF flight received a cherry-picking regulation.

Regulations on flights inbound to BCN

Period: May 6 until June 30, 2019.

55 instances of LEBLA regulations (reference scenario).

14 instances of CPEBL regulations (solution scenario).

	LEBLA	CPEBL
Average ATFCM delay	21,75	12,23
Average Arrival delay	24,20	10,38
Nb. of regulated flights	55 (over 40 days)	14 (over 16 days)
Nb. of regulated flts day average	1.375	0.875

Delay causes

Delay codes of AFR BCN-CDG departures (to evaluate knock-on delay)

Group		with TTA Exe	outside TTA Exe
0x	Internal		0,96%
1x	Passenger/Baggage	6,67%	11,54%
2x	Cargo/Mail		
3x	Handling	6,67%	5,29%
4x	Technical		3,37%

5x	Damage/Failure		
6x	Operation		2,88%
7x	Weather		
8x	**Air Traffic Control**	**66,67%**	**64,42%**
81	Atc En-Route	6,67%	2,88%
82	Atc Staff Or Equipm		8,17%
83	Atc At Arrival Stn		0,48%
84	Atc Weath At Destina	6,67%	3,85%
85	Mandatory Security		3,37%
86	Police/Customs Auth		0,48%
87	Apt Facilities		3,85%
89	Restriction/Closure At Dest.Arpt	53,33%	41,35%
93	**Transit Time**	**20,00%**	**11,54%**

(no other 9x codes, eg. 91 or 92, have been declared in the period)

Delay on delay code 93

	Outside TTA Exe	with TTA
nb flights with delay code 93	24	3
flts with delay code 93 per day	0.60	0.19
avg departure delay with code 93	19.56 min	35 min
avg knock-on with code 93 (*)	-2.60 min	-4.33 min

(*) this is arrival delay minus departure delay of the same aircraft

E.3.5 Unexpected Behaviours/Results

The unexpected behaviours occurred are depicted below:

AOP/NOP integration

On 16 May: Some issues noted with C-DPI being sent from AODB (SCENA) for already cancelled flights. SCENA sends a C-DPI if the flight is cancelled in the AODB before the CNL is received for the correlated FPL. This can happen when CNL arrives at the same time than the C-DPI is being generated and send.

On 20 May: NMOC noted that AOP systematically set cTTOT=CTOT. This differed from the NM expectation that cTTOT would be set when <>CTOT and hence NM would be provided with planning information. The effect on NMOC of the APT blindly repeating the CTOT information in the cTTOT field is the flights CTFM model is created and ATOTs distributed at T-DPI-t event. Prior to PJ24, this ATOT and CTFM combination would only occur when the flight had been sequenced. NMOC found this very confusing because from their perspective an ATOT provides an initial, false, impression that that a flight can no longer be improved by NMOC. It requires a great deal of attention for NMOC to understand the true picture which is not always possible during busy periods.

On 20 May: STAR errors were detected, as local ATM system sent to AOP not the planned runway, but the runway in use for all flight plans, affecting the ATFM TMA view as most flights had an incorrect STAR. All ATFM traffic count graphs showed in this way incorrect Traffic Demand. As NMOC had the correct information (provided by manual inputs from local ANSP), the G-API's were suspended in order not to send the wrong information.

On 22 May: Same issue occurred for departure runways, so P-DPI sending from AOP was suspended to avoid sending wrong SIDs. The selected solution, for being the faster and easier to implement, was to remove the STAR and SID information from the G-APIs/P-DPIs

On 23 May: G-API without STAR information was re-started. Only ELDT information was sent by the AOP and processed in NM systems.

On 24 May: NM noted that its technical system performance was slowing. The average DPI/API response time reduced from 1 to 5 seconds. The NM CUA system configuration was patched to improve its performance.

On 4 Jun: There was a strange effect on one flight BAW473 LEBL to EGLL and caught in EXE3B Heathrow arrival regulation CPGLL04. EGLL acted upon the obsolete PDPI information from LEBL and delayed the flight for 112 minutes. This was quickly spotted by NMOC and HOEC excluded the flight from the regulation. It could be argued that NM is not adequately self monitoring the timely receipt of anticipated DPI data. In this case – NM should detect when it has not received PET DPIs for any flights during many hours OR for this BAW473 flight, that it had not received an E-DPI at OBT-3 hours or a T-DPI at OBT-2 hours. At the very least NMOC should be informed that there is a general loss of DPI update data OR possibly more TBD interventions could have been made. Such interventions would need further investigation and need to answer the general question: is aged DPI information better quality than FPL data? In the case of BAW473 it isn't but over the whole population of all flights affected on 04 June it could be.

TTA Management process

The following provides a detailed description of specific events, questions and issues reported by NMOC, raised during the trial and involving FMPs and sometimes airlines as well. The result of the investigation of the reported issues is also provided.

On 20 May: The quantitative assessment's: OPEVAL parallel (test) classic regulation process - failed (first day teething issues)

During the first TTA regulation there were two issues:

Firstly, NMOC created a normal regulation which was quickly replaced with the correct Network Cherry Pick regulation (TTA).

Secondly, the regulation period was exactly one hour, which was exactly the overloaded period, so the TTA regulation did not have the desired result (basically it had no effect).

- According to INDRA, AOP needs to have a longer period with a "valley" in order to accommodate all delayed flights.
- From FMP perspective, they are used to NEVER tell NM the end of the Regulation period because they expect NM operator to choose the best one, and they usually do.
- But during the trials the NM User did not have the AOP view and could not determine the period of the TTA regulation
- The FMP agreed to a 1h regulation period but this only represented the hotspot period and not the hotspot plus solution period

In order to mitigate this from happening again the project asked:

- Is it possible for NMOC flow controller to select an appropriate "ending" time for the TTA cherry picking regulation as precisely as they usually do with standard regulations? (preferred option)
- Should the FMP try to select the regulation period ending time instead? (guidelines would be needed on how to do this or how much margin to take into account).

The agreed approach was for the FMP to propose a good end time and to ask the advice of NMOC. NMOC flow controller could then suggest the best time and the two parties could agree to apply it.

  - To propose a good time is based on knowing the peak hotspot period and then mentally shifting excess demand (above the monitoring value line) into the valley and extrapolating the end time accordingly.

- The FMP can only identify the hotspot period with their AOP tools
- Unfortunately, NMOC could not see the *hotspot* peak that was concerning the FMP. NMOC tools could not see the desired regulation rate because it was hidden with the x3 rule
- (FMP could have made a tactical capacity update with the available capacity but chose not to do this)

On 24 May: The FMP requested a classic weather regulation to begin with and later asked for this to be replaced with a TTA regulation. NMOC refused this action for network (not trial) reasons. Later, NMOC was advised that TTA regulations would only be requested for ATC CAPACITY and AERODROME CAPACITY reasons, not for WEATHER. TTA regulation was implemented @ 0800 UTC. Firstly, incorrectly as a classic regulation and then replaced with a TTA regulation. The first regulation was a consequence of human error.

On 26 May: The regulation period deep rectify with TTA CP does not work. TTA regulation needs a longer period from the start to avoid peaks of bunching that do not dissolve with period extension. CPEBL26A Some confusion arose when the LECB FMP phoned NMOC to say that the regulation was not working as anticipated. LECB requested NMOC to deep-rectify the regulation. Such an action is common with classic arrival regulations but it would have nil effect on a cherry pick regulation. This was explained to the FMP who was concerned by 4 flights above the 39 MV showing in the LEBLARR counts. This was detected at 1700 UTC <40 minutes notice time. NMOC advised the FMP that adjustments to the flight positions within the slot list were the responsibility of the AOP/DCB system and should not be adjusted by NMOC. The only other option would have been to replace the Cherry pick regulation with a classic regulation HOWEVER, at this late notice, the effects would have been small. A replay of the situation could be made post operatively should a request be made from the AENA/ENARIE/PJ24/FMP.

On 30 May: Some issues were found in the TTA regulation CEBL30N, and it did not work because the demand continued to be over the capacity in some periods. During the course of the regulation. A large number of ehelpdesk and telephone requests were received from operator VLG regarding high delays given to some of their fleet by this regulation. VLG requested slot improvements for these flights which could not be granted whilst complying with instruction OI/19-101. An analysis of the CPEBL30M regulation showed that it had low total delay but was penalising a few flights and some of these with comparatively high delay. A coordination took place with LECB FMP and it was agreed to replace this cherry pick with a classic arrival regulation.

On 31 May: The TTA exercises were suspended at night (2000 UTC and 0000UTC) for performance reasons in Barcelona and Palma. Outside of this restricted period, the TTA exercise continued.
AOs sometimes did not associate night flights with departure flights for the following day. These flights were ruled out by the DCB algorithm because there was no turnaround time associated to the inbound flight. This meant that the TTA regulation excluded these flights from its processing. The APOC staff had to start manually associating flights to save the exercise but this was impractical because of the fluidity of the planning. Outside the restricted period, TTA exe keeps on running as planned (until otherwise indicated).

Some issues were identified in the TTA regulation CPEBL30M, which did not work because the demand continued to be over the capacity in some periods. During the course of the regulation, a large number of E-Helpdesk and telephone requests were received from operator VLG regarding high delays given to some of their fleet by this regulation, as can be seen in the Figure 97 below. The total delay caused by this regulation was 721 minutes. Due to the registered high delay, the regulation was cancelled at 7h57.

```
09:33 AN  EJU96WH  LFBD LEBL Fpl ......I 08:03 08:38       08:58 08:58  09:34          35   1   SRM

09:44 AN  VLG267S  LEMD LEBL Fpl ...U..I 08:01 08:52       08:52 08:07  09:44          51   1   SRM

09:44 FN

09:57 AN  VLG2975  LFRS LEBL Fpl ...U..R 07:56 08:53       09:01 09:01  09:58          53   1   REA

-----------------------------------------------------------------------------------------------------

10:00 AN  VLG8989  EBBR LEBL Fpl ......R 07:53 08:30       09:22 09:22  10:00          37   1   SRM

10:00 FN

10:27 AN  VLG35TQ  LEIB LEBL Fpl ......I 09:05 09:47       09:45 09:45  10:28          42   1   SRM
```

Figure 97: High delays registered on 31st May for Vueling

Looking at the details of each on the affected flight in the Figure 97, it has been seen that:

- EJU96WH
  - 35 min delay;
  - Send a REA message and CTOT adjusted;
  - Final delay 22 min.

- VLG267S evolution of events:
  - sent DLA at 06:16 which leaded to 45 min delay
  - The flight was not regulated
  - At 6:47 SAM with CTOT 08:25
  - Then SRM with up to 56 min
  - Last SRM 20 min.

- VLG2975
  - at 6h30 received CTOT 08:00
  - at 7h40 received CTOT 08:53
  - at 7h55 received CTOT 08:09
  - The max delay received by this flights was 52 min and the final delay was 9 min.

- VLG8989
  - At 6h30 40 min delay CTOT 08:33;
  - At 6h47 6 min;
  - At 6h50 52 min;
  - Final delay 37 min.

- VLG35TQ
  - Regulated with delay 42 min
  - Then another regulation gives 0min
  - Vueling sends two DLA with EOBT 5min later each time, after second DLA the flight gets a CTOT immediately of 32 min delay.

The analysis of CTOT shows relatively high variability in CTOT evolution of the assigned delay, such as the case of VLG2975, VLG8989 etc.. It need further investigation.

Regarding delays, Figure 98, Figure 99 and Figure 100 show that the TTA regulation had a comparable total delay to the classic regulation, the average delay per flight is also very similar and the maximum delay provided to flights is lower or significantly lower in the TTA regulation than in the classic one. On overall, no issues identified for the CPEBL30M behaviour.

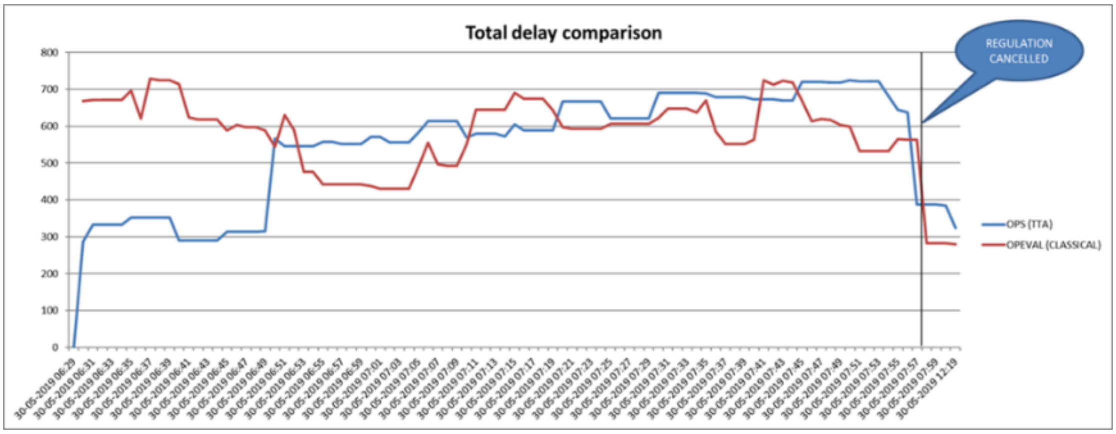


Figure 98. Total delay comparison for CPEBL30M

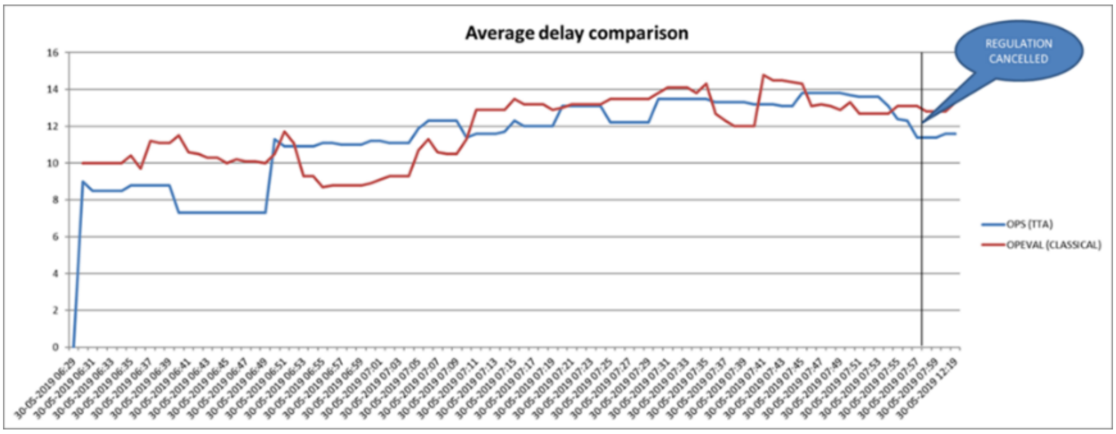


Figure 99. Average delay comparison for CPEBL30M

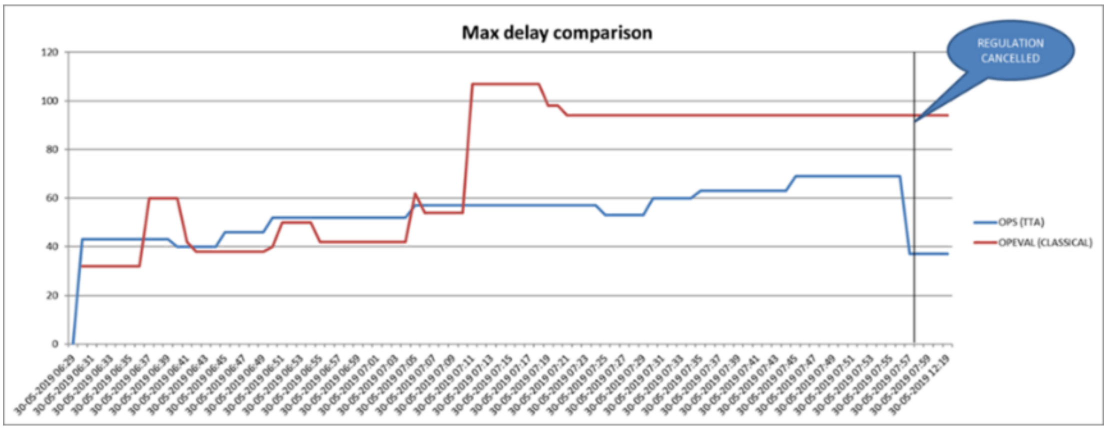


Figure 100. Maximum delay comparison for CPEBL30M

On 1 June: Several E-Helpdesk and telephone requests were received from different AUs regarding high delays given by CPEPA01 regulation on 1st June. After discussion between NMOC and LEPA FMP, it was decided to cancel the NCP regulation and apply a LEPAARR classical regulation. The NCP regulation was initially created at wef 05 until 8:00 and then extended at 6h00 to (unt) 12h40, to be then cancelled at 08:36.

The regulation CPEPA01 showed very high delays, maximum total delay at 8h35 being 2510 min in TTA regulation compared to 336min in classic OPVAL, as shown in Figure 101. The max delay for a flight is 101 min while the average delay is 21,6 min, indicated in Figure 103 and Figure 102 respectively. This also implies that for a flight the delay has been almost 5 times more than the average.

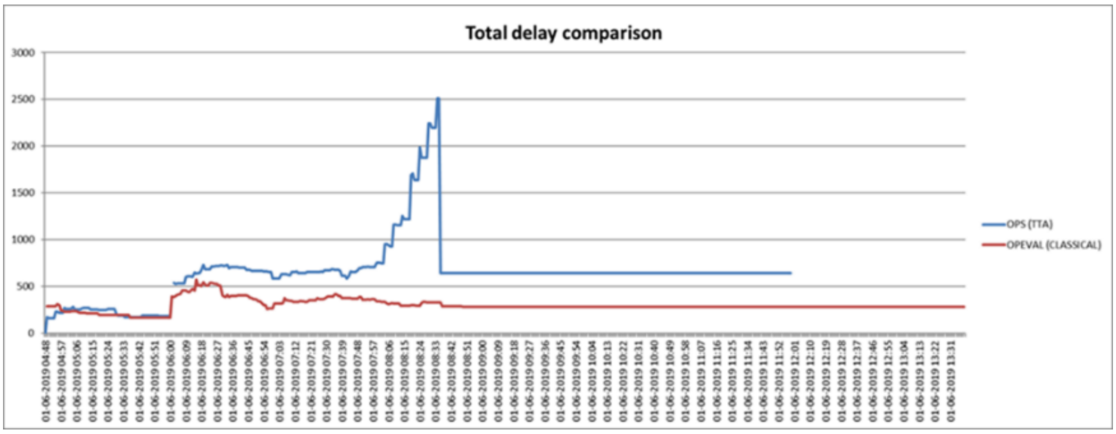


Figure 101. Total delay comparison for CPEPA01

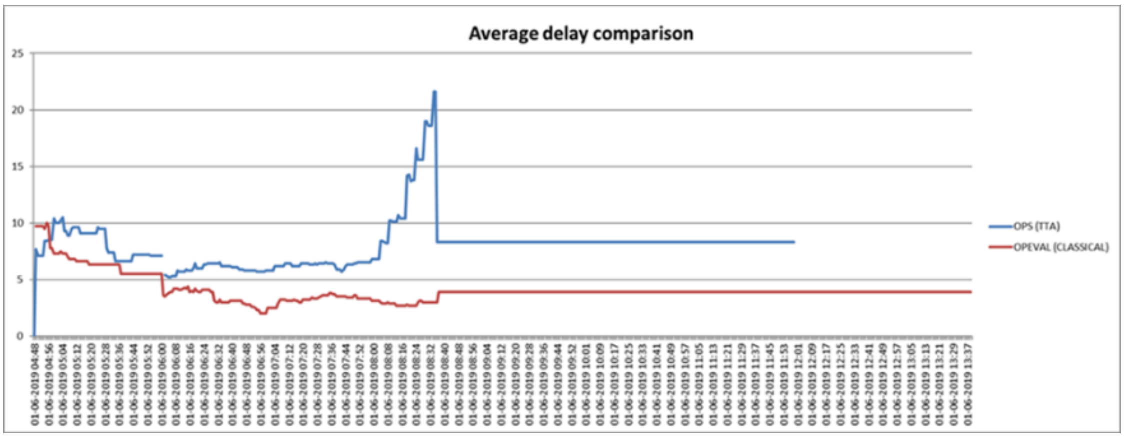


Figure 102. Average delay comparison for CPEPA01

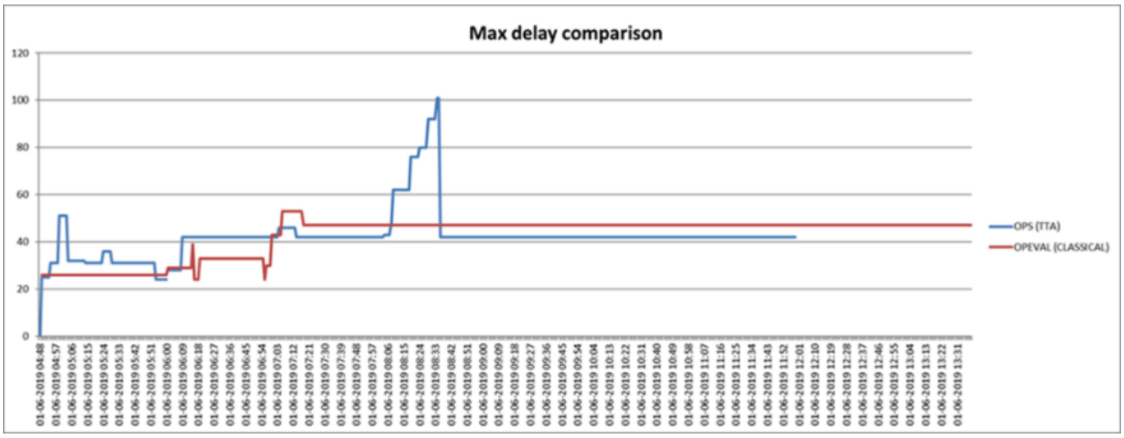


Figure 103. Maximum delay comparison for CPEPA01

On 2 June: Contrary to the instruction to suspended night-time TTA trials, a TTA regulation was activated by the FMP. The TTA regulation over- delivered traffic in one period and at the same time also generated very high delays for some flights. These delays were between 60-100 minutes, and of course, the affected AOs called NMOC for improvements. NMOC questioned the high delays as they appear abnormal compared with the usual experience of classic LEBLARR regulations; that never generate such high delays. The NM instruction was to reject AO requests for slot improvements, but together with the FMP NMOC decided to exclude a few flights from the TTA regulation and to improve the highest delays.

The average delays caused by regulation for TTA trials and its equivalent classical regulation simulated on OPEVAL system are presented in the table below and show that the classical regulation would have provided higher delays if applied to that specific situation.

	OPS (TTA)	OPEVAL (CLASSICAL)
W ef-1h	52,50	47,00

W ef	34,00	143,00
U nt	49,00	111,50

Table 37. Average delay per flight caused by CPEBL02A

The equivalent classical regulation created in parallel in OPEVAL was analysed at three timeframes (Wef-1h, wef and unt) and it was seen that delays were even higher in the classic regulation than the ones registered in Ops. After a finer check analysing all sampling periods, the Table 38 show that the delays considered high in OPS (with TTA), over 60 min, were actually worse[9] with the classic regulation in OPVAL. Therefore, it can be concluded that the TTA concept did not act abnormal, but it was responding to the situation providing the most suitable solution according to its internal rules, being better than it would have been a classical regulation in that particular case.

Row Labels	OPS	OPEVAL
AEA846	85	84
DLH61F	95	98
EJU37XU	71	143
EJU43XT	67	65
RYR7H	96	91
RYR8KT	100	103
TAP1048	67	73
VLG15EN	74	100
VLG20JM	82	78
VLG35WN	85	73
VLG3901	62	60
VLG71UN	95	83

[9] in most cases

Table 38. Flights with more than 60 min delay created by CPEBL02A compared to the classic regulation delay

On 3 June: An upgrade version of the AOP algorithm was deployed. The new version no longer ruled out the non-associated flights for the DCB algorithm. AOP algorithm previously discarded those arrival flights with no departure flight associated (AOP cannot calculate the knock-on effect for those flights). This flaw had affected LEBL because Vueling (have a Hub at LEBL) does not associate their late (night) flights that stop overnight at the airport with their departure in the following morning. To mitigate that, AOP from that version included these not-associated flights in the algorithm by considering these flights with severity -1 (no impact in the departure flight).

On 5 June: NMOC OI explicitly forbids the improvement of flights in the CP arrival regulations. This is interpreted to also apply to AO and ADEP Tower TOT extension requests also. NMOC needs advice on what to do here – if the extension requests are refused the flight has to return to stand, file a change message and start the process again. For the ADES, they know the flight won't arrive early but will not know when the flight will arrive (late). Is it better for NMOC to grant the extension requests for these arrival regulation flights? They only grant the extension if there is capacity. The CP regulation rate is 3x the "capacity rate" so this is very difficult to monitor

On 6 June: A CASA improvement was identified thanks to the PJ24 analysis.

On 8 June: LECP FMP complained that the LEPA trial measure was 'not working' and the delays were 'unnecessarily high'. They asked for a simulation to replace the measure with a standard arrival regulation. As the simulation result indicated significant reduction in total delay, the trial measure was replaced by a standard LEPA arrivals regulation. The total delay was reduced from 620 minutes to 229 minutes.

The simulation request came in during the ETFMS problems (freezing screens, delayed response time) and loading SIMEX took much longer time than usual, blocking one of the workstations. I think running these trials during busy periods needs to be re-considered.

On 11 June: The CPEPA11 regulation was replaced by a classic regulation.

E.3.6 Confidence in the Demonstration Results

1. Quality of Demonstration Exercise Results

The evaluation was conducted through a qualitative and quantitative assessment. A tailored questionnaire was submitted to the FMPs, NM and AU participating to the trials via an online support. Even if the quantity of participants answering the questionnaire was small (answered on a voluntary base), the findings collected were corroborated and completed with the feedback collected from quantitative assessment.

The evaluation of the reduction of ATFM delays in the network was performed through a quantitative assessment. As described in E.1.1G.1.1, the data collected, can be considered accurate and reliable.

The obtained results can be extrapolated and considered as sufficient to understand how TTA measure and AOP-NOP integrations affects the Network.

2. Significance of Demonstration Exercises Results

Final results are based on qualitative results obtained from the AU questionnaire, FMP questionnaire and NM questionnaire and quantitative results obtained from data collected of different sources. As exposed above, even if the quantity of participants answering the questionnaires was small (answered on a voluntary base), the findings collected were corroborated and completed with the findings collected from the other sources. Thus, results are considered statistically significant.

E.4 Conclusions

The exercise was executed as planned during an extremely busy Network period. This exercise experienced many boundary conditions and operational situations that provided very valuable insight about the strengths and weakness of the AOP-NOP integration process. The exercise also demonstrated the feasibility of the TTA Management process and highlighted where improvements can be made, the quantitative and qualitative results obtained show the performance benefits.

The two major objectives of this exercise and pillars of the concept under demonstration, the increase of predictability of the extended DPI and the reduction of the knock-on effect by the use of TTA regulations, have been demonstrated to a greater or lesser degree with the live trials.

The AOP-NOP exercise has demonstrated that the extended DPI concept significantly and consistently increases the predictability- take off time predictability- of the legacy A-CDM in the extended horizon. The confidence on the results is high as the trial spread over 28 days for LEBL, LEPA, and 5 days for LEAL.

The extended DPIs provide more accurate information **between 9 and 6 hours** before the flight, as the gain achieved during the trial compared to the baseline days reaches **for LEBL 10 minutes of improvement on average**, with a maximum gain registered for Fridays of 15,9min; and reaches **for LEPA 6,8 minutes** of improvement on average, with a maximum gain registered for Fridays of 12,4min. **Between 6 and 3 hours** before the flight, the improvement achieved through the P-DPIs is even higher for **LEBL with 11 minutes** gain in average and **6,3 min for LEPA** , with maximum gain registered for Fridays on both of 16,4 min and 13,1 min respectively . In the A- CDM period, the additional gain that the AOP with the extended DPIs can bring to the legacy A-CDM is minor. This is an expected result as the extended DPI concept builds on – and extends- the current A-CDM.

For LEAL that is an Advanced Tower airport, the extended DPIs provide similar gains than for the LEBL and LEPA CDM airports, a gain of over **7,9 minutes between 9 and 6 hours** before flight that increases to **10,2 min in the next 3 hours**.

Interesting to point out that, for all airports, the highest the inaccuracy from the flight plans due to days with high ATFM delays, the better the gain from the AOP and the P-DPIs. Thus, it works better when it is more needed.

Additionally, it is important to mention the actual benefits in traffic demand predictions produced by the integration of statistical airport models through the use in the departure calculations of the XTTA (typical turn around time) during the P-DPIs timeframe (t<EOBT-3h). It is recommended to further investigate and develop this concept for its positive impact on the whole ATM community.“

The AOP-NOP exercise has demonstrated that General API messages providing arrival-planning information need to be improved for the arrival STAR and RWY, before it can reliably integrate data in the network. The ELDT provided in the API message is marginally more accurate than the current ELDT.

The exercise has also demonstrated that the TTA regulations provide a reduction of the reactionary delay and contribute to the efficiency of Airspace Users and ANSPs processes to solve DCB issues, increasing situation awareness for all actors and AU regarding local/network DCB. However, the TTA exercise has also identified a wide number of deficiencies (both technical and procedural) which would require to be rectified before the phase of industrialisation.

The confidence in the results is high for the reactionary delay calculation as they are provided by the mature CODA application.

For LEBL we observe a reduction in delay dispersion, with much lower perc90 and maximum delays although slightly higher minimum and perc10 delays. Indeed, the maximum delay in the TTA solution is 12,86 minutes, whereas in the Reference scenario is 24,28 minutes. Same for the 90th percentile, where we have 9,08 minutes with TTA compared to 14,32min in the Reference. The mean value is in the same order. This means TTA provides a much more balanced and concentrated range of delay repartition, reducing significantly the high delays.

Regarding the ratio reactionary delay to total delay, we observe a systematic reduction in the ratio at all delay levels, minimum, central and maximum. E.g 17,73 % in TTA vs. 26,65% in reference for perc10 meaning small delays and 37,58 % in TTA vs. 51,10% in reference for perc90 meaning high delays. Reactionary delays are especially harmful for the overall network because of its propagation;

reducing the proportion of reactionary delay is an important goal and these results fully align to this goal.

For LEPA the reactionary delay statistics has not been calculated as the sample was not representative enough.

Airspace Users:

Lufthansa

Generally, the introduction of AOP-NOP integration worked quite well during the EXE.

The goal of better demand predictions due to AOP-NOP integration was achieved.

As the TTA adherence was not an objective of the EXE, its impact on flight crews could not be observed.

For LHG up to now it remains unclear if benefits (reduction in delay) have been achieved. Anyway, working with the concept, discussing it internally, and finding a way to make the concept work inside our operations, a few points came up and are worth mentioning. One major point is the fact that meeting TTA`s increases the workload in the Cockpit (even if inside acceptable limits) and may result in changing “normal” Pilot`s behaviour, such as requesting directs, other levels to optimise a flight in respect to punctuality and/or fuel efficiency. It is necessary that pilots have knowledge about why, how and for what reason they must meet a certain time at a certain point. If that is unclear to crews, acceptance will be low and benefits not created. A Pilot must understand the concept of doing something for the network to optimise it, even when a single flight event must therefore be penalized. Therefore, information or even training must be taken into account before implementing such concepts.

Another point is the possible increase in cost by flying faster/higher cost index and therefore burning more fuel. A fair concept must be established where AU`s that follow the concepts are rewarded and it must be clearly measurable what the benefits are, so proper CBA`s can be made.

Ryanair

The trial results confirm that the AOP-NOP integration worked according to the expectations increasing predictability and showing a positive impact in reactionary delays. The estimated time of arrival was more accurate after integrating the DP/API messages with more time to be processed. However, it is still uncertain how this improvement will benefit airlines operations. Ryanair OCC was not able to determine any relevant improvement in terms of capacity increase or delay reduction; therefore, we suggest further analysis before making any conclusion.

Apart from the core exercise, Ryanair also tried to validate the internal exercise set-up defined to notify, monitor and fly according to the TTAs provided. In this sense, we are concerned that the process and system adaptations to communicate the Target Time of Arrivals (TTAs) and prioritize flights as defined in the exercise set-up have considerably increased the workload of our OCC staff and could potentially impact the cost of our operation. The set-up should be reviewed before deployment stage in order to be ensure that it is aligned with airlines procedures.

AOP-NOP Integration

The results confirm an increase in predictability. However, it is not clear how this improvement benefits airlines operations.

In terms of delay reduction, we have not seen relevant differences using TTA regulations versus CASA regulations. The delays and punctuality observed in our flights landing or departing from Barcelona and Palma were similar to the internal baselines defined. However, it is also noticed that a more detailed analysis in a longer period would be useful to provide a better comparison and measure the impact of this change. Further analysis is required to see how the increase in predictability benefits airspace users.

TTA Management

During the trial, we have not detected any significant improvement when the FMP applied TTA instead of CASA regulations. Our analysis shows that delays are similar when comparing with different baselines therefore we have not been able to determine if there is a benefit regarding delay reduction.

On the other hand, Ryanair also tried to validate the internal exercise set-up defined to notify, monitor and fly according to the TTAs provided despite no specific action was required from any airline to comply specifically with the TTA exercise except for the early submission of the flight plans. In this sense, we have performed an ad-hoc analysis beyond the exercise scope and suggestions for future steps:

- We consider that the process applied during the exercise is not practical and needs further elaboration before deployment phase. Future works need to involve airlines to ensure airlines requirements are included.
- The set-up defined in the exercise highly-time consuming and not practical for identifying the flights affected by TTA regulations. During the exercise, The TTA/TTOs were communicated via SAM message to the OCC. To be aware of this notification, flight planners and ops controllers need to review manually each of the SAM messages received to get the details regarding the corresponding TTA regulation. Due to the size of Ryanair's fleet, the action was

not practical to carry out and therefore, flight crew didn't receive the information/questionnaires on time. Additionally, we have also detected that this approach could lead to a peak in the workload just before the departure time.

- FMP/Network Manager should provide (at least) a previous notification of the flights that are going to be impacted by the regulation and create a tool that streamline the process (notification, review and prioritization). Additionally, the TTA should be provided with enough time to ensure that the flight crew is notified accordingly.
- Additionally, we noticed that some changes in our current operation like different cost indexes or fuel calculations might be required to fly according to the TTA provided, with the corresponding economic impact. This could limit the benefits and negatively affect the performance of the flights. In this sense, the process should be reviewed to avoid this issue.

AIMA Algorithm and prioritization mechanism

Ryanair considers that the exercise, due to previously mentioned set-up and prototype limitations, has not demonstrated taking into account airlines' input and therefore, we suggest defining a collaborative process that takes on board equally both airspace users and airports needs to balance the benefits obtained.

In this sense, we find necessary for the next steps of the process to take into account the next points:

- The algorithm and mechanism should be refined/redesigned before the deployment phase.
- Regarding the AU input mechanism, SESAR community should look for a homogenous and integrated "prioritization" mechanism instead of creating a different tool per exercise. The process should be flexible enough to allow airlines prioritize and swap flights according to daily requirements and the prioritization should be done as close as possible to the departure time.
- Moreover, we consider that the current mechanism to provide AUs priorities is not practical nor accurate and require dedicated resources. The solution should be easier and simpler and does not affect airlines usual operation. Airlines should be involved in the development of this mechanism to ensure that the procedure is aligned and efficient.
- The mechanism should also be transparent and show the impact of the regulation at individual and overall level. It could be difficult to decide without considering all relevant information. These details have been provided in other PJ24 exercises with positive results.

Air France

AOP-NOP Integration

The results measured by the exercise team in terms of increased predictability show quite clearly that the estimated times of arrival are more accurate when integrating API and DPI messages long in advance of the airport-CDM processes.

The limited timeframe of the exercise did not show how this increased predictability translates into benefits for the airspace users, in terms of increased capacity (for example with less margins taken by ATC in case of capacity constraints or demand peaks) or reduced delay.

A side effect of the new procedure has been observed by Air France: The early dissemination of API and DPI messages has triggered DLA messages for later flights of the aircraft rotation, sent unusually early (several hours before departure). This had penalizing consequence to for these flights in the NM systems.

The origin of this behavior has been traced to manual procedures internal to the airline (three instances during the exercise execution). This shows that the side effects of very early updates to the flights estimated timings needs to be carefully analyzed, and adjustments to the A-CDM habits may be necessary.

TTAs

Target Times of Arrival were used in the exercise only as a tool for the airport and FMP to drive cherry-picking regulations. No specific action was in fact required from the airlines, apart from awareness of the way the departure constraint was calculated.

Air France did not observe any deviation from the procedures currently in place upon reception of SAM/SRM messages.

The statistics on regulations issued for BCN arrival constraints indicate that ATFCM delay (total, maximum, average) and number of regulated flights are very similar to classical regulations. The quantitative analysis of CODA delay-reasons data does not allow to draw definite conclusions about the fact that with equivalent, "not worse than CASA" arrival delay, there is a reduction in reactionary delay on the departures, thanks to the selective choice of how to assign delay to incoming aircraft.

AIMA algorithm and AU input

Air France has not yet a clear position concerning the AIMA algorithm.

Its benefits in terms of reduced reactionary delay are not yet completely clear from the exercise results, because the analysis of the quantitative data is not yet finalized.

The prioritization of flights based on constraints on the arrival airport has consequences on the departure side, and these have not been fully investigated.

Even if AIMA algorithm is designed to accommodate individual flight priority/ criticality, due to prototype limitations, the airlines could not easily provide these values nor monitor the results. In conclusion this feature could not be properly demonstrated.

Another element not covered in the exercise and not clear how it would be incorporated in AIMA is the airline swaps; the presence at an airports of several aircraft of the same operator (presence of a "base") gives the possibility to the airline to decide aircraft swaps as a way to avoid reactionary delay from a delayed inbound. Different specialized models of "AIMA rules" will need to exist; these rules should be discussed locally, within the A-CDM community. We acknowledge the fact that adherence to the AOP means adherence to the departure time that the airline had scheduled, and this is of course a target that is of value to the Airspace Users.

Concerning the "AU input mechanism" proposed in the exercise, it needs to be redesigned or properly elaborated before next phase of deployment.

In "swapping based" prioritization mechanisms (slot swap itself, or UDPP) an operator "exchanges" priorities between multiple of its own flights, so these mechanisms are inherently fair.

Prioritization in STAM-type measures concerns only those operators whose flights are captured in the measure. An appropriate way to ensure fairness seems more difficult to design upfront.

We recommend that the solution is based on the work on this subject done in other SESAR projects, such as for example PJ07.01 and PJ09.03.

E.5 Recommendations

E.5.1 Recommendations for industrialization and deployment

In view of the results and some particular anomalies encountered during the trial, FMP considers TTA Regulations shall require a dedicated technical implementation by NM and some specific improvements in AOP algorithm that address specifically the drawbacks detected during the trial.

The TTA-regulation final operational implementation should not be based on the Network Cherry Pick mechanism, and have instead a specific implementation that ensures a stable behaviour, closer to the behaviour of current standard CASA Regulations, and that is not affected by the trial implementation limitations:

- The rate applied to the NCP regulation had to be triple the right rate, which caused few cases of misunderstanding, and an suboptimal monitoring of the measure implementation, as the scale of the graph presented by CHMI was hardly interpretable if not zoomed in and deeply analysed.
- But above all, the effect of the measure on the regulation period selected was not stable. If the period regulated was not long enough to accommodate all affected traffic, the regulation would not push traffic out of the regulated period (as a standard CASA regulation does), but instead it would let the traffic build up *inside* the regulated period. This kind of behaviour is not tolerable as it forces the FMP to very frequently monitor the status of the regulation, and

leaves him/her with very little margin of manoeuvre if a later overload is detected. If the traffic was instead pushed towards the period right after the regulation, even if bunched, the FMP would have more margin to react in time to debunch it if necessary.

Special care should be taken in order to ensure the right synchronization between the flight list managed by Airport AOP and CHMI/B2B. Due to some issues to be investigated, in some cases there was a discrepancy between both counts. Therefore, the sequence provided by the AOP algorithm was counting more aircraft than present in the CHMI graph (therefore pushing them further, generating stronger delays than needed and leaving unused capacity) and in some cases the other way around. It is critical for the concept to work that these two flight lists (and therefore graphs) are fully synchronized.

As a summary of FMP recommendations, TTA regulations:

- Should not be based on Cherry-Pick measures (own mechanism)
- Should not have the “window” limitation for delay assignment
- Should ensure the flight list managed by Airport AOP and CHMI/B2B and therefore the counts are fully synchronized
- Should correct and when necessary avoid overdeliveries and unnecessary delays
- Shall not be stronger (in terms of ATFM delay) than Standard Regulations

AOP should consider:

- When consolidatedTTOT matches the CTOT then it should not be provided to NM.
- Elaborating a Manual
- Implementing alerting and reporting functions
-

NM should consider:

- ETFMS could be updated to not create the CTFM/ATOT when the cTTOT=CTOT
- The benefits of monitoring and reacting to shortfalls in receiving DPI information; or to recognise aged DPI data {P-DPI but missing E-DPI, T-DPI and then receiving the T-DPI-s very late}.
- An automated method of calculating the regulation period (start and end time) is required based upon the desired rate and the needs of the AOP/DCB algorithm.
- Provide guidance on AO flight extension requests for flights regulated in TTA regulations
- NM B2B regulation proposal can be used to communicate the Network Cherry Pick regulation to avoid the manual process workaround.
- Find a solution for the technical constraint that does not affect the rate. (Solution identified and implementation agreed for NM24.0).
- How NMOC shall process ADEP extension requests for flights in an API TTA CP regulation.
- Accept cTTOT prior to CTOT, from CTOT-5 minutes
- Not to reject TTAs outside the regulation period as it is done with CASA regulations

NM should investigate

- The quantity of flights being excluded from TTA regulations as this is a candidate performance indicator for the quality of the AOP/DCB algorithm.

- Define a KPI to measure algorithm AO fairness/Equity.

Airspace Users:

- Accommodate "AU input" in the AIMA algorithm as a fully collaborative process (possibly specialized in different locations, depending on the specific operational constraints of each airport).

- Clarify TTA concept: No active role for airlines and crew in the implementation of TTAs used for targeted regulations, besides a reasonable effort to inform the crew about the nature and location of the regulation constraint, and recommend to "fly as planned".
- (The overall concept of Target Times in planning plus execution, where the role of the AU would go further are being developed as part of other notions, such as CTA, tTTA, etc.)

- Put in place standardized and dedicated information exchange channels for the new collaborative processes (either machine-machine SWIM messages or human-machine interfaces included in NM AU tools).
-
- Monitor the extent of collaboration and compliance of each AU in each DCB measure, with the purpose to measure fairness or establish incentives of some form.

As in other recommendations the integration in existing tools is essential for the success and possible implementation (STAM linkage must be there and followed up accordingly)

E.5.2 Recommendations on regulation and standardisation initiatives

In the field of standardization, it is recommended to reduce the variability in TTO definition on the best way to carry out that TTA process to meet the requirements required by operations, whether it be last fix or ELDT.

It should be assessed whether TTA measures should work as a Cherry Picking mechanism or under another mechanism in a standard way

Appendix F Demonstration Exercise #03b AOP-NOP integration and Arrivals Management

The PJ24 Exercise 03b Very Large Demonstration (VLD) was designed to demonstrate the capability of London Heathrow's Airport Demand Capacity Balancing (A-DCB) tool to predict runway capacity imbalances during periods of excessive demand and/or reduced capacity. Additionally, the VLD was designed to demonstrate that such imbalances may be resolved via the determination of Target Times of Arrival (TTA) by the A-DCB solution, and the onward promulgation of these to aircrew by their conversion into intelligent Calculated Take Off Times (CTOT). Therefore, PJ24 Exercise 03b VLD was also designed to demonstrate the exchange of TTA data between the Airport Operations Plan (AOP) and Network Operations Plan (NOP). The VLD instigated a key change for operations at London Heathrow Airport (LHR), Airspace Capacity Managers (ACM) and Terminal Control (TC) at NATS Swanwick Control Room. It demanded a move away from the use of, and reference to, conventional tactical ATFCM regulations for runway flow control, except during unplanned and emergency events (i.e. short-term severe capacity limiting events such as single runway operations or equipment failure). The VLD was planned to operate from the 18th March 2019 to the 16th June 2019.

The following six statements summarise the results from this exercise:

1. Heathrow's TTA derived regulation delivered a significant reduction in overall ATFM delay when compared to that which conventional CASA derived regulation would have delivered

2. Heathrow's A-DCB systems and processes were able to predict and subsequently resolve all periods of excessive runway demand, and resultant predicted airborne delay, during the VLD

3. Heathrow's TTA derived regulation was demonstrated to be no more penalising, in terms of ATFM delay per flight, than conventional CASA derived regulations

4. Heathrow's TTA derived regulation, based upon agreed A-DCB algorithms and prioritisation criteria, provided equitable distribution of ATFM delay per flight across all Airspace Users

5. Heathrow's TTA derived regulation provided a more stable resolution to the delay hotspot, with the average number of update messages per flight being significantly lower for TTA flights when compared to conventional regulations

6. Heathrow, Europe's busiest airport, successfully used TTA derived regulations to resolve periods of excessive runway demand and associated airborne holding during peak operational days with record numbers of Air Traffic Movements.

1. Exercise description and scope

The scope of the VLD was limited to assessing the arrival demand at Heathrow Airport and solving any predicted demand/capacity imbalances. Within the scope of the VLD it was decided that the decision criteria as to whether to intervene with either ATFCM regulation or intelligent Calculated Take Off Time (CTOT) derived from TTAs generated by A-DCB should not change. In a similar vein, the decision as to whether to use ATFCM regulation or to use the intelligent CTOT derived from A-

DCB was included in the scope, as was the effect of the intervention. The scope also included the technical and procedural aspects of the new A-DCB → AOP → NOP processes, and the VLD was used as an opportunity to include the provision of Extended DPI messages to further enhance the accuracy of information originating from Heathrow Airport to the Network Manager. This was in conjunction with assessing the ease and effectiveness of use of the A-DCB tool, including the TTA input processes, and the extent to which the outcomes matched the input requests.

The actors referred to in the above introduction were tasked with the following aims as part of the VLD:

1. To demonstrate that the A-DCB tool could be used effectively to predict periods when regulation would be required

2. To demonstrate that the A-DCB tool delivered the required outcomes during periods of regulation

3. To demonstrate that the TTA concept worked as intended from a technical point of view, i.e. the interaction between the A-DCB tool, the Airport Operations Plan, the NM B2B service and Network Operations Plan operated correctly

4. To demonstrate that the TTA concept worked as intended from a people and procedures point of view, i.e. the interaction between the Heathrow Operations Efficiency Cell (HOEC), NATS ACM and NM operated correctly

5. To satisfy the allocated SESAR PJ24 Demonstration Plan Objectives.

2. Summary of Demonstration Exercise #03b Demonstration Objectives and success criteria

The VLD was established with the following objectives and success criteria:

Use Case	Demo Plan Use Case Description	NATS-HAL Interpretation of evidence required
UC-3.1	Detect Arrival Demand & Capacity imbalance during the planning phase	Performance evidence to show that predicted hotspots on D-1 are accurate
UC-3.2	Analysis and Coordination of the A-DCB management proposals during the planning phase	Evidence to show that the proposed solution is sound
UC-3.3	NM acceptance of the A-DCB management proposals during the planning phase	Evidence to show that the CASA interaction can produce a sound solution to the predicted hotspot
UC-3.4	Detect and Resolve Arrival and Departure Demand & Capacity imbalance between multiple airports during the Short-Term planning and Execution	Evidence that the plan actually delivers the predicted outcomes in the execution phase

	phases. Depart to CTOT and FLY to TTA Partial validation. Detection and resolution will only be for Heathrow. Aircraft will depart to the CTOT but will not necessarily fly to the TTA	
UC-3.5	Dynamic exchange of arrival and departure information from airport to network as from FPL reception	Evidence that the predicted flight times are accurate and can be sent to NM once FPLs have been distributed
UC-3.6	Dynamic exchange of arrival and departure information from airport to network before FPL is filed	Evidence that the A-DCB predicted flight times are accurate and can be sent to NM before FPLs have been distributed

The overarching requirement of the VLD was to predict and identify 'hotspots' (i.e. periods when runway demand exceeded available capacity, resulting in excessive Airborne Holding) and provide a suitable resolution for such 'hotspots', through the identification of Target Time of Arrivals proposals, which would smooth that demand.

For the purposes of the VLD, 'hotspots' were identified and quantified by the following metric:

Predicted Airborne Holding of 17 minutes or more for a duration of 30 minutes or longer (i.e. a delay bucket). At the commencement of the VLD this metric had a tolerance of +/- 3 minutes (i.e. a maximum Airborne Holding time of between 14 and 20 minutes) to allow the Heathrow Traffic Co-ordinators (HTC) and/or ACM and/or TC to adopt a more in-depth review of whether such an occurrence was due to short-term demand and would resolve itself naturally, or whether the use of TTA was required. During the VLD there was evidence that the -3 minute tolerance would benefit from further reduction, as a more stringent parameter would drive the system to deliver resolutions using "cold spots" (i.e. periods where runway demand is less than available capacity) more effectively.

In addition to the above parameters an additional measure was scheduled to be applied for part of the VLD. At the start of the VLD, ACM were asked to apply an over-arching standard ATFCM regulation on the Heathrow Terminal Control Area (EGLLTC) volume with a flow rate which was in excess of that expected to be required. This gave protection against A-DCB failing to provide effective regulation for any reason, while not interacting with the primary A-DCB regulation.

Initially it was planned that this over-arching regulation could be discarded after evidence that A-DCB had performed satisfactorily in at least 3 instances of weather regulation and 3 instances of capacity regulation. The over-arching regulation was in fact removed earlier than planned (after only two instances of use), because of the success of the TTA based regulations that had been applied, providing an initial indication of support and confidence in the TTA based resolution.

To ensure that the VLD did not cause undue pressure on any actor it was agreed that the use of a conventional regulation could be requested at any time. If ongoing issues were found with the TTA based operation, or if the end-to-end processes were not working as expected, a suspension could be triggered to allow time to investigate and put improvements in place to proceed. It was agreed that following the suspension of TTA operations a conference call would be held as soon as reasonably practicable to discuss the reasons and any rectification.

During the VLD a regular conference call was held every weekday discussing any issues ongoing with the VLD or TTA based operation, the operation of that day, forthcoming events and any learnings. Attendance was not mandatory however participation was encouraged.

F.1.1 Summary of Validation Exercise #03b Demonstration scenarios

The reference scenario at Heathrow Airport is founded on the use of AOP as the key method for the promulgation of the planned intention of every departure from the airport as well as the provision of information on arrival traffic. By adopting this approach, Heathrow ensures that there is 'one version of the truth' presented across the airport displaying the latest information to assist in informed and collaborative decision making. AOP is also used during adverse weather such as de-icing conditions, to provide appropriate information to stakeholders, but this was not in scope for the VLD.

The airport, for the majority of the time, operates its two runways with one being dedicated to arrivals and the other mainly for departures. On occasions (e.g. with excessive holding, emergency traffic etc.) arrivals traffic may use the departure runway. This method of operation did not change for the VLD.

Airlines or their appointed handlers are responsible for maintaining the Target Off-Blocks Time (TOBT) for departures within AOP and this in turn allows the airport systems to calculate a Target Start Approval Time (TSAT) and Target Take-Off Time (TTOT), and for the Network Manager to subsequently assign a Calculated Take Off Time (CTOT), if necessary.

Should there be a period of excessive runway demand that manifests itself through excess Airborne Holding, the current methodology for resolution is the application of a CASA regulation. This equates to a limit on the number of aircraft that can enter the Heathrow arrival holds, or stacks, in each hour, and this regulation is generally set at a figure slightly higher than the anticipated landing rate per hour, to ensure a steady flow of traffic.

A CASA regulation may also be imposed for other reasons such as:

- To provide a greater impact to arrivals flow for a significant unplanned event (such as the loss of availability of a runway) than that which would be provided if the event was known and planned for. This provides Air Traffic Control Officers (ATCOs) and the Terminal Control Operations Supervisor (TC OS) in TC at Swanwick with an opportunity to scope out a plan, based on the issue at hand, using any time freed up by the reduction in arrivals traffic;
- To provide some flexibility for a known event with unknown timing (Runway direction change, runway anti-icing etc.);
- To reduce the number of aircraft vectoring to the stacks to allow Airborne Holding to reduce, or in preparation for poor weather likely to affect the stacks;
- To react to equipment serviceability, and in extreme cases, ATCO shortages.

For the duration of the VLD when the A-DCB tool predicted excessive Airborne Holding due to runway demand i.e. a 'hotspot', the following methodology was applied:

Once a 'hotspot' had been verified by the Heathrow Traffic Co-ordinator, NMOC was contacted via existing standard processes and a 'Network Cherry Pick' measure (designated EGLLSTAC) requested. This measure was based on a Continuous Decent Approach (CDA) airspace area designated EGLLHOLD, which was contained within the perimeter formed by connecting the four Heathrow arrival hold, or stack, entry points. A-DCB was used to identify flights suitable for receiving a Target Time of Arrival (TTA) into those stack entry waypoints for Heathrow, removing them from the identified 'hotspot' and thus smoothing demand to give an acceptable level of Airborne Holding. This was finally actioned through the application of a CTOT for affected arrival traffic which was issued to flight crews by Network Manager systems.

Not all aircraft that were issued a TTA would necessarily have received the same delay and should an aircraft have been predicted to arrive early, the resultant TTA may not have absorbed this early arrival time completely. The A-DCB algorithms, whilst designed to primarily issue TTAs to flights that were predicted to arrive early or on time, may, in certain demand conditions, have resulted in TTAs being assigned to aircraft that were already predicted to be subject to delay in order to resolve a hotspot.

Once the A-DCB tool had calculated the necessary TTAs and they had been logged under the TTA regulation, A-DCB sent them to the AOP portal. Here a member of Heathrow Airport staff sent them to the Network Manager in small batches. A confirmation message was subsequently received back into A-DCB which then passed it to AOP. Actioned TTAs were then visible in the arrivals page of AOP.

For those occasions when a TTA operation was not required the airport maintained the CASA regulation method of operation.

F.1.2 Summary of Demonstration Exercise #03b Demonstration Assumptions

As described in the Demo Plan, the VLD was subject to the following assumption:

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
EX3-A1	Fight profile		Flight trajectories will be used by NM to back-calculate CTOTs	When TTAs are sent to NM, NM will back-calculate intelligent CTOTs in line with the trajectories in their system (which is taken from flights plans). We assume that these are accurate.	Planning Phase		Expert opinion		PJ24 WP6	Medium

As the results in Figure 1 (below) highlight, flights generally adhered to their TTAs, which suggest that the CTOTs given, derived from their flight plan trajectories, were correct.

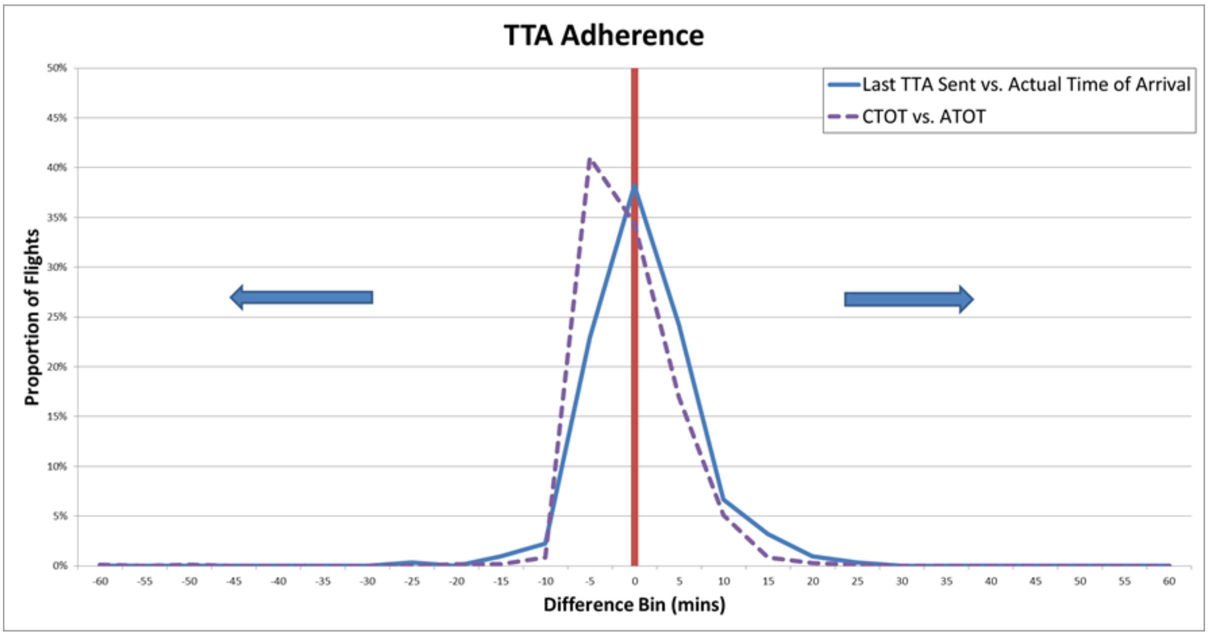


Figure 104: A summary of TTA adherence for the duration of the VLD.

F.2 Deviation from the planned activities

The original plan was for the VLD to commence on 18th March 2019. Following the identification and resolution of several issues that were identified through the application of thorough and rigorous checking procedures, unfortunately the final approval and sign-off processes could not be completed by this date. This was due to required safety information not being submitted to the European Agency for Safety in Aviation (EASA) in time to allow sufficient review prior to commencement, however, this issue was quickly addressed by the EUROCONTROL team and EASA representatives.

Subsequently, the final Go/No-Go call was undertaken on the 26th March 2019. This call reviewed a summary of all the key training, familiarisation, process creation and technical solutions that had to be in place and operational prior to go-live. The decision was then made to start the VLD on 27th March so the amended dates for the trial became 27th March 2019 to 16th June 2019 with a commencement time of 04:00 UTC.

The following messaging solutions were put in place to support the VLD:

- A-DCB → AOP → NOP →P-DPI, E-DPI, T-DPI-t via an NM 'serialiser' to the NM B2B interface.
- Manual Network Cherry Pick regulations on EGLLSTAC.
- AOP-NOP API Target Take-Off (Target Times of Arrival) via an NM 'serialiser' to the NM B2B interface

The Extended DPIs messages commenced from 27 Mar at 10:00 UTC. The NM 'serialiser' was in place prior to the go live and the NM B2B service interface was used for TTA regulations.

The NM 'serialiser' was implemented just before commencement of the VLD. During testing it had been determined that the IT systems within EUROCONTROL could not accept the numbers of messages that Heathrow's AOP was sending, at the rate at which they were being sent. The message limit at the time was set at 50 messages per minute, whereas Heathrow's AOP and A-DCB solution needed to send substantially more for TTA based operations.

There were occasions during the VLD when Heathrow used a CASA regulation rather than a TTA derived regulation. An overview is provided below, with some case studies investigated further to allow for a greater degree of understanding.

Case studies

Date	Issue/incident	Were TTAs issued?	Total delay allocated TTA/CASA	Commentary
30/03	The TTA regulation did not resolve the problem.	No	N/A as resolution not achieved.	Three solutions identified: Make the algorithm more conservative (find less space to move flights in) – Implemented on 04/04/2019. Remove 60-minute limit on aircraft moves – Not

				implemented. Set the delay threshold to 17 minutes instead of 11 minutes.
18/04	TTAs were not correctly issued due to human error.	No	N/A for TTA. Circa 468 minutes CASA	Re-training provided.
19/04	TTAs applied at 17-minute threshold between 0600-1300. TTAs forecast to generate 2103mins. A SIMEX was run with a conventional regulation at 42/60 which generated 1514 mins with 11.7 mins average and 33 mins max delay. The regulation was cancelled at 0640 due to high single delays to flights being issued, with 63 TTAs received generating 270 minutes of ATFM delay. EGLLTC regulation applied 0700-1100 at 46/60. Cancelled at 0744 generating only 28mins delay. This was done as a precaution.	Yes, 316	TTA – 270 mins CASA circa 28 minutes of delay.	Split solution to hotspot resolution due to stakeholder feedback of excessive delays to some individual flights.
24/04	Attempted to use TTAs in the afternoon. Incorrect Regulation ID meant that all TTAs were rejected and conventional regulation was used instead. It was noted that was not making use of available capacity.	No	TTA – N/A CASA circa 609 minutes of delay.	Administrative error prevented TTAs being issued. This has now been resolved.
27/04	A whole day regulation was required due to strong winds. A conventional regulation was used rather than a TTA regulation because the TC OS was not comfortable using a TTA regulation for a whole day regulation. On 26/04/2019 TTA rules were tested on an S plan in to see if that solved the issue - 3 TTA rules were added to the plan with a 17 minute threshold between 0430 – 0800, a 15 minute threshold between 0800 – 1700 and a 17 minute threshold between 1700 – 2100. The TTA rule in A-DCB did not fully resolve the delay during the period where the target delay was 15 minutes, with delay peaking around 20 minutes.	No	TTA – N/A CASA – Circa 9,886 minutes of delay.	Hotspot could not be resolved with TTA. This was a day with significant weather challenges and one of the airports busiest days ever in terms of ATMs.
07/06	TTAs were issued to smooth demand during a period of Thunderstorms. There was an element of concern from TC	Yes, 167	TTA – 6,283 minutes CASA - 999 minutes	The OC exercised their right to select a CASA regulation due to unfamiliarity with the tool during thunderstorms and the

	regarding the effectiveness of the resolution. In order to avoid suspending the TTA rule, the HTC ran a new plan with a reduced air holding trigger of 14 mins. The OC Sup elected to use a CASA regulation.			number of ATMs affected by the weather.
08/06	In a similar vein from 07/06 there was a prolonged period of forecasted Thunderstorms. The OS felt less confident in accepting the resolution that TTAs offered.	Yes, 582	TTA – circa 2,398 minutes CASA – 1,203 minutes.	Again, in a similar vein to yesterday the OS was not familiar with the tool resolving hotspots during thunderstorms.

During the VLD it became evident that further development of the use of Extended DPIs was required. Challenges caused by the earliest Target Take Off Time (eTTOT) and turnround Target Take Off Time (tTTOT) led to the exchange of Extended DPIs being suspended on 23rd April. The VLD identified that on many occasions some regulated flights were receiving greater than the average delay in the relevant regulation. Whilst it was anticipated that a resolution would be in place for part of the remaining duration of the VLD, one could not be implemented in time. At the time of writing resolution of this issue is planned be implemented in-time for a subsequent Heathrow short-haul TTA trial in late 2019/early 2020.

F.3 Demonstration Exercise #03b Results

F.3.1 Summary of Demonstration Exercise #03b Demonstration Results

For the purposes of the demonstration exercise and any results or conclusions derived from them, data and information from demonstrations that were fully undertaken and resolved through TTA operations along with those that were only partly resolved through TTA operations have been included when relevant.

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Demonstration Objective Status
OBJ-VLD-01-001	Impacts of using enhanced A-DCB measures and TTs on ATMC workload (NM, ATC and Airport)	CRT-VLD-01-001	The usage of enhanced A-DCB and TTs does not have a negative impact on ATM operational staff (NM, ATC and Airport) workload.	There were comments in the TC observations book and from HOEC, that at busy times some participants	OK

				viewed TTAs as an additional workload. This was mainly due to unfamiliarity with the tool.	
OBJ-VLD-01-003	Assess the impact of using enhanced A-DCB measures and TT in TWRs, APPs	CRT-VLD-01-003	The usage of TTs does not have a negative impact on ATC TWR/APP operational staff workload, e.g. reduced vectoring, holding, changes to departure sequences, etc.	No feedback was received during the trial that ATC TWR/APP operational staff workload was impacted by the use of TTs	OK
OBJ-VLD-01-004	Transparent coordination processes	CRT-VLD-01-004	Positive feedback from all actors regarding A-DCB overall processes.	Overall, feedback from NATS and Network Manager on A-DCB processes has been positive, with only minor changes identified for the next round of trials (outside of PJ24)	OK
OBJ-VLD-02-003	Improve predictability of flights for an Airport	CRT-VLD-02-003	The distribution of early/late arrivals at the entry points of the AoR of ANSPs is narrower than current operations.	A-DCB has been proven to provide an accurate traffic forecast. Analysis undertaken during the VLD has shown that aircraft have largely complied with their TTAs, and A-DCB has provided a stable solution.	OK
OBJ-VLD-04-001	Increased cost-efficiency from more efficient	CRT-VLD-01-004	Positive feedback from NMOC staff to apply	NMOC undertake equivalent	OK

	processes for NMOC		measures. Reduced time to achieve the DCB cycle	actions to create TTA or conventional regulations. A future workload saving can be considered when TTA regulations are digitally proposed machine-to-machine via NM B2B services. Communication of A-DCB principles to the AUs will reduce the quantity of AU e-help requests to NMOC, which will have a positive impact upon NMOC workload.	
OBJ-VLD-05-003	Increase the use of available Airport capacity.	CRT-VLD-05-003	The usage of enhanced DCB and TT reduces airport delay compared to airport regulations	The VLD has proved that use of TTA derived regulations has reduced ATFM delay compared to when conventional regulations are applied.	OK

The rest of this section provides a summary of a selection of the key results generated by the VLD.

Week Commencing	TTA Regulations		Conventional Regulations	
	Number of Days with TTA Regulations	Number of flights given a TTA	Number of Days with Conventional Regulations	Number of flights given a Conventional Regulation
25/03/2019	0	0	2	109
01/04/2019	0	0	6	783
08/04/2019	2	104	6	615
15/04/2019	1	63	5	357
22/04/2019	1	27	4	387
29/04/2019	0	0	4	442
06/05/2019	0	0	3	349
13/05/2019	1	53	1	47
20/05/2019	1	64	3	126
27/05/2019	0	0	2	142
03/06/2019	5	673	5	509
10/06/2019	1	97	5	808
TOTAL	12	1081	46	4674

Figure 105: Summary of regulated days during the VLD.

In total, the TTA regulation was run on 12 days of the VLD period, and over 1,000 flights were given a TTA. Figure 2 provides a comparison between the number of incidences a TTA regulation and CASA regulation were applied during the VLD period.

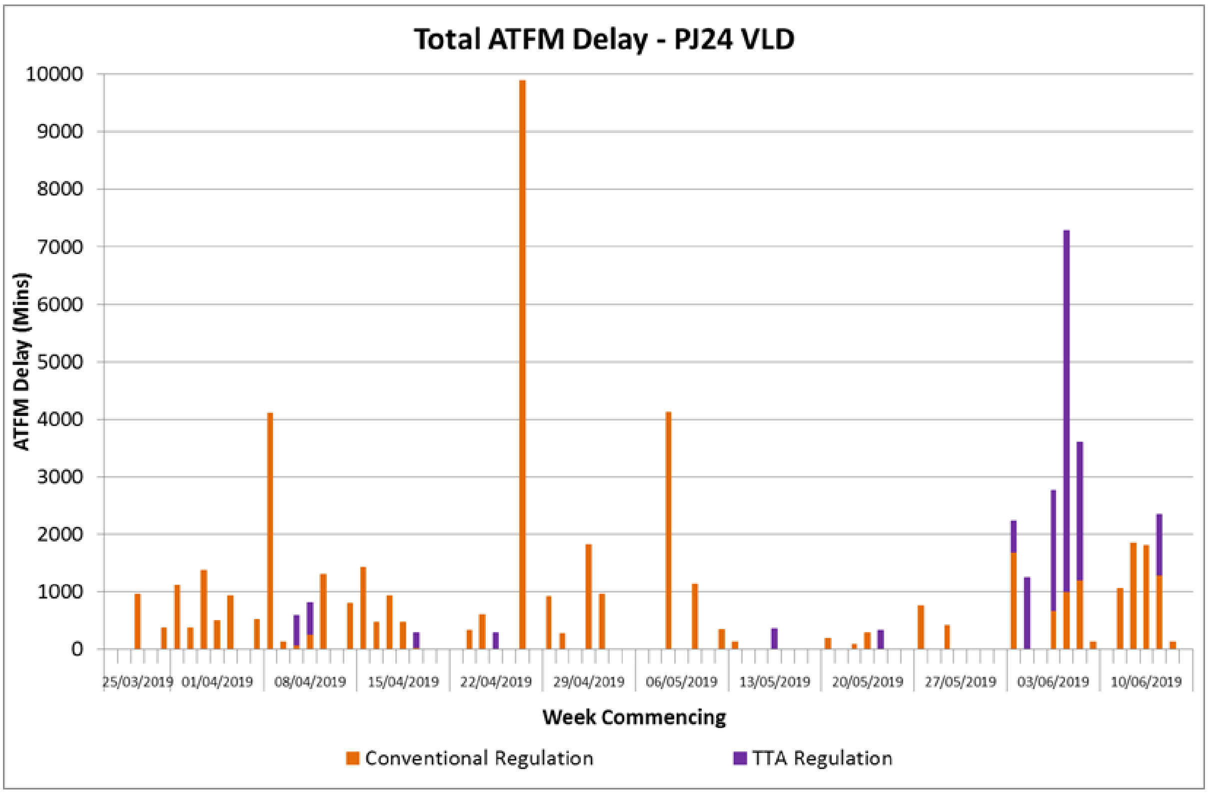


Figure 106: Total AFTM delay during VLD.

Figure 3 shows the total ATFM delays incurred through the application of a CASA regulation (orange) or a TTA (purple) throughout the VLD period. Similar weather patterns and traffic loads were identified on 27/04 and 07/06 with TTAs providing approximately 30% less delays against CASA on these dates.

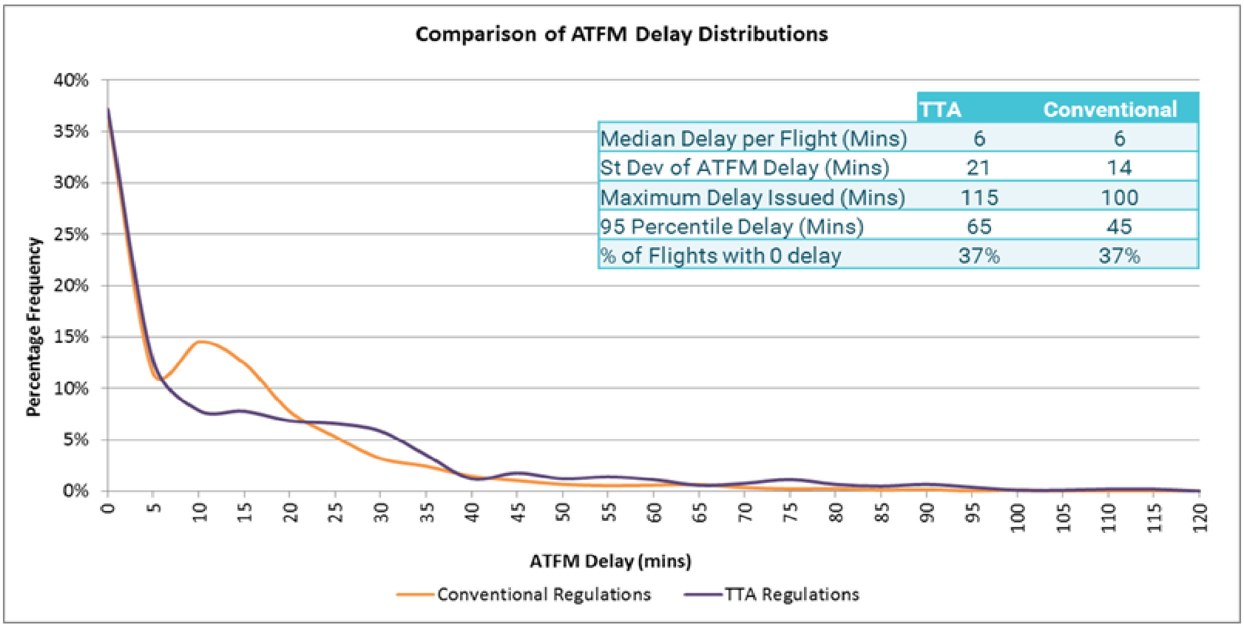


Figure 107: Distribution of ATFM delay – comparison between ATFM delay applied with TTA rules and conventional regulations during the VLD

Figure 4 provides a comparison between the distribution of ATFM delay when a TTA rule was applied, with the distribution of ATFM delay for when conventional regulations were applied in the VLD period. Comparison of overall TTA regulations vs conventional regulations during the VLD Trial period found that:

- The median delay applied to flights did not differ between conventional regulations and TTA regulations.
- The maximum delay applied to a single flight was only slightly higher for TTAs compared to conventional regulations. This conclusion was made after several abnormal TTA resolutions were excluded from the calculation as they provided an opportunity to further improve the algorithm.
- The update to the TTA algorithm made a measurable improvement to the distribution of delays.
- For similar days with similar total levels of delay, the TTA regulation generated a significantly higher proportion of flights with 0 ATFM delay compared to a conventional regulation. An example of this is given in Figure 5 below (TTA regulation on 07/06/2019 and conventional regulation on 27/04/2019).
- For a less challenging day, the TTA regulation provided a resolution with low median ATFM delay and a substantial proportion of nil delay to flights.

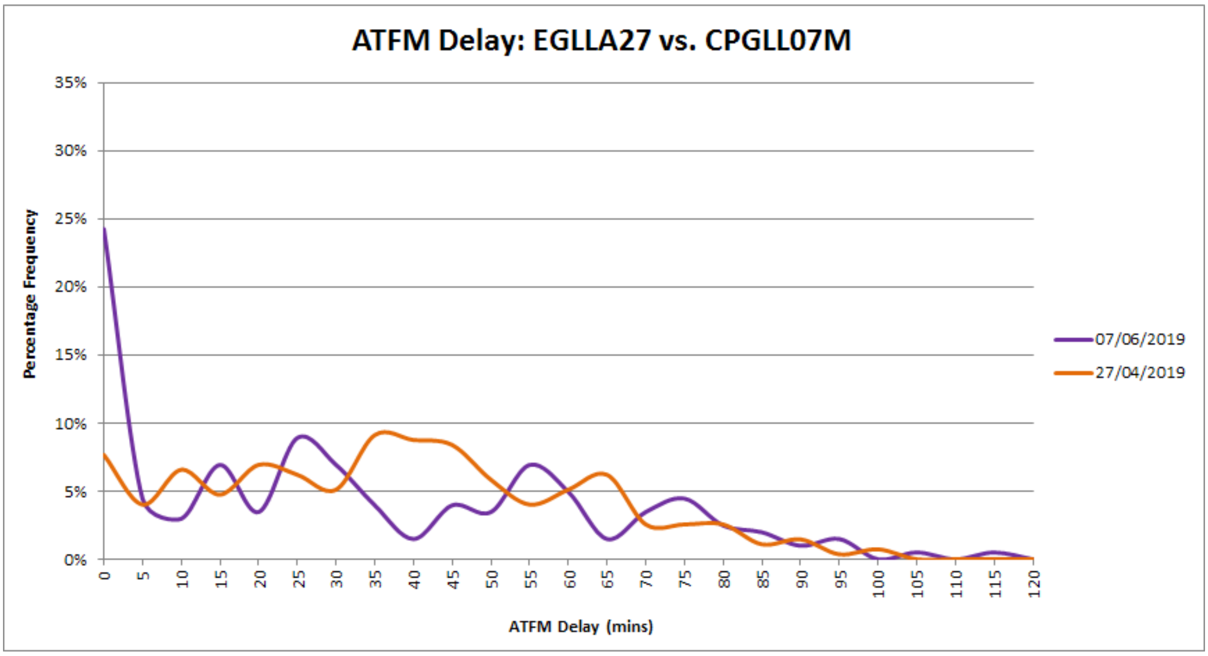


Figure 108: Distribution of ATFM delay – comparison between ATFM delay applied using a TTA regulation on the 7th June and a conventional regulation on 27th April.

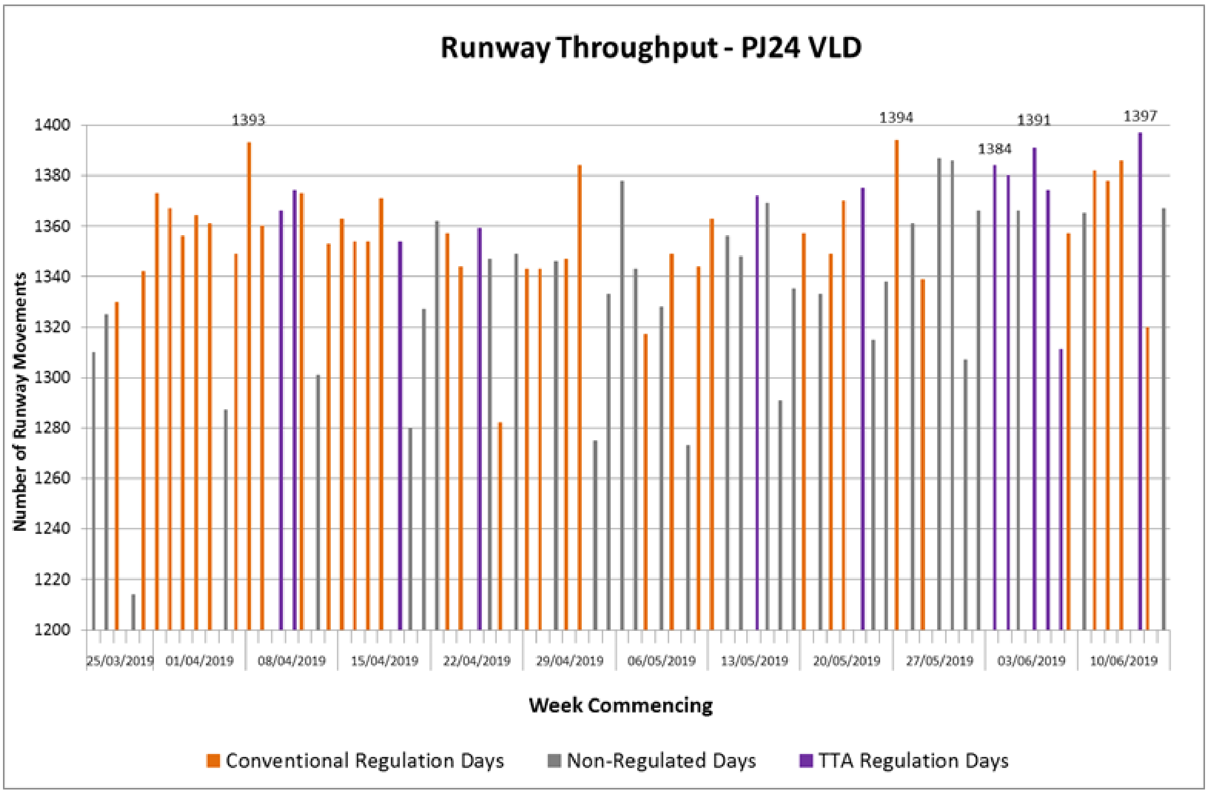


Figure 109: Runway throughput.

Figure 6 demonstrates that there was no negative impact to runway throughput on days when TTAs were issued during the VLD, with the airport experiencing record breaking days for ATMs in May and June.

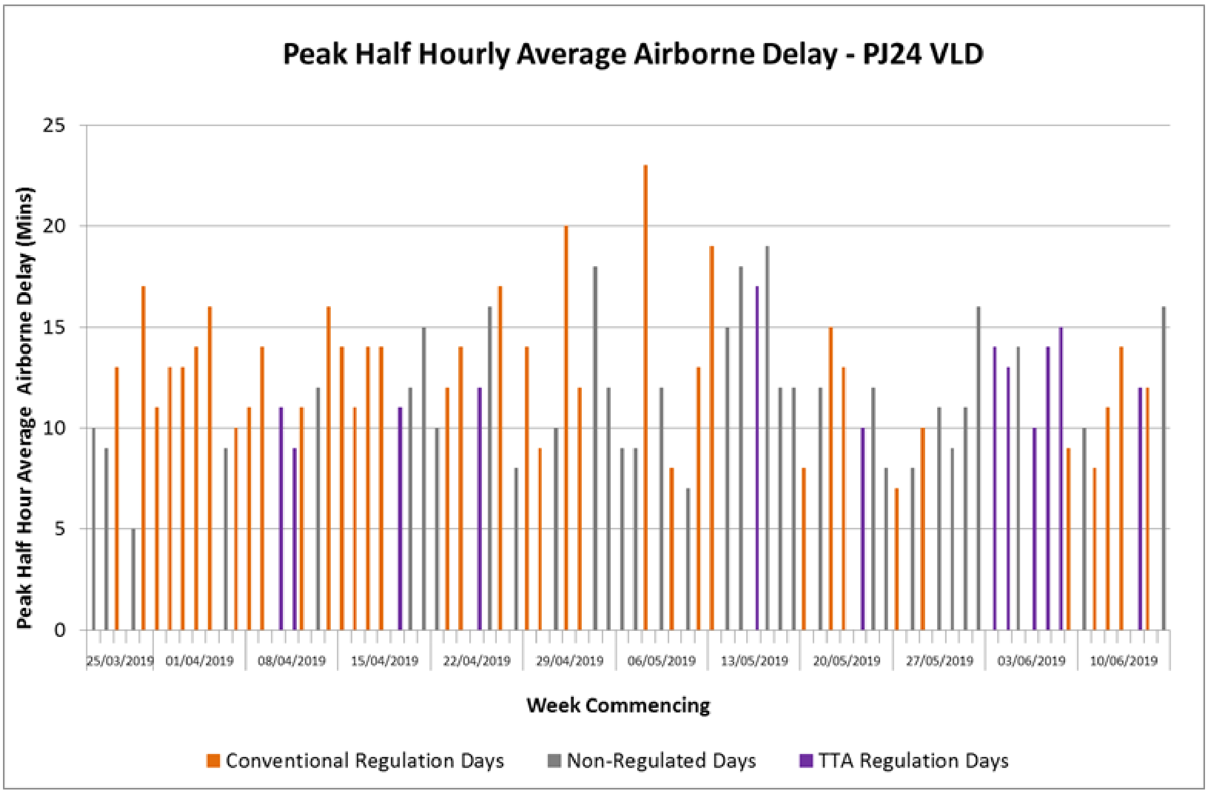


Figure 110: Peak Half Hourly Average Airborne Delay.

Figure 7 shows that the A-DCB tool consistently provided a manageable level of airborne holding delay, operating well within the agreed tolerance levels, and compared favourably with days when a CASA regulation was applied (on average, peak half hourly delay of 13 minutes for conventional regulations and 12 minutes for TTA regulations).

It should be noted that airborne delay was generally lower than expected for TTA regulations due to the A-DCB system including additional delays within the operational environment. This was identified as part of the VLD and therefore the TTA solutions provided conservative delay figures. Heathrow would expect these to be closer to the target delay threshold values used once the software is enhanced.

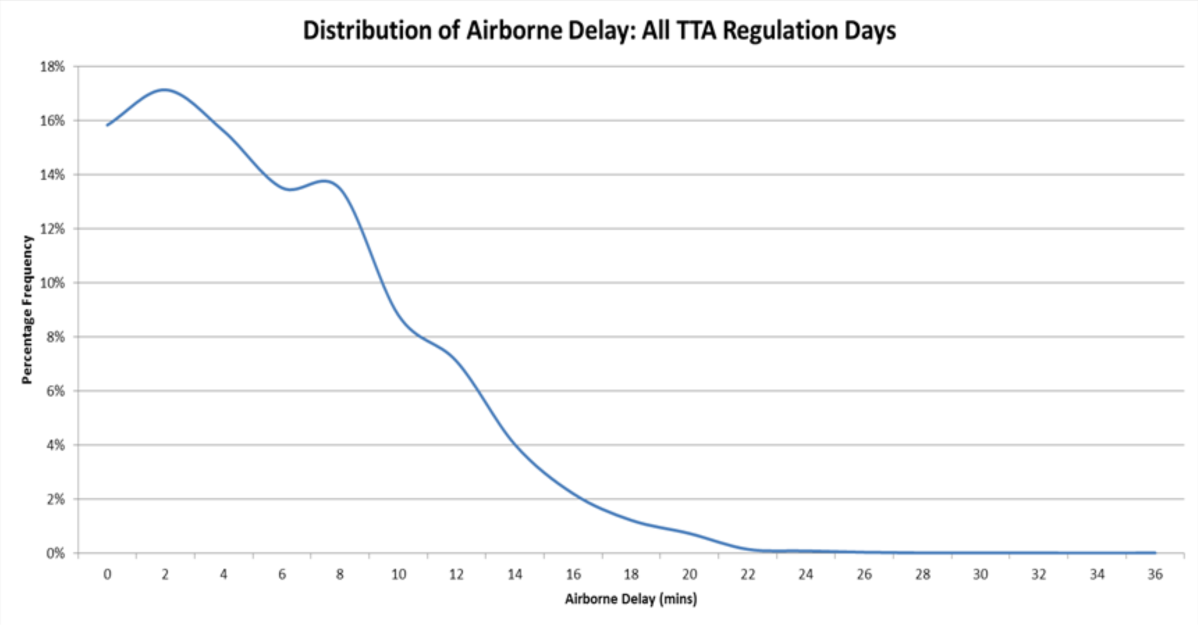


Figure 111: Distribution of airborne delay.

In order to meet a target delay of, for example, 17 minutes, it is expected that airborne delays should be distributed around this value (i.e. some flights would have slightly less delay than the target threshold and some may have slightly more).

Figure 8 highlights that 95% of flights with a TTA regulation had less than 14 minutes of airborne delay. It is expected that this would increase following the proposed future enhancements of A-DCB as the VLD algorithm maintained a certain amount of historic delay in its calculation.

Date	Count of 30 min bins in TTA period	% Resolved Bins	Peak average airborne delay in TTA period	Target Delay in TTA period	Count of TEAM movements in TTA period
10/04/2019	11	100%	11	17	13
11/04/2019	3	100%	4	17	2
19/04/2019	2	100%	6	17	0
25/04/2019	0	100%	0	17	0
16/05/2019	3	100%	7	17	1
24/05/2019	10	100%	10	17	7
03/06/2019	7	100%	10	17	2
04/06/2019	19	100%	13	17	5
06/06/2019	12	100%	9	17	3
07/06/2019	21	100%	14	17 & 14	12
08/06/2019	16	100%	14	17	34
14/06/2019	7	100%	10	17	0
Total	**111**	**100%**	**14**	**17**	**79**

Figure 112: Peak average airborne delay in TTA operations.

Figure 9 shows that TTAs consistently delivered peak airborne delay lower than the requested target delay threshold and which matched the plan proposed by A-DCB and accepted through the TTA processes. The 8th of June provided an unusual event (a flypast) which was planned for, but for which Heathrow had to stop all flights for a 15-minute period, hence the exceptionally high level of Tactical Enhanced Arrivals Mode (TEAM) movements on that day, which allows arrival traffic to utilise the departure runway.

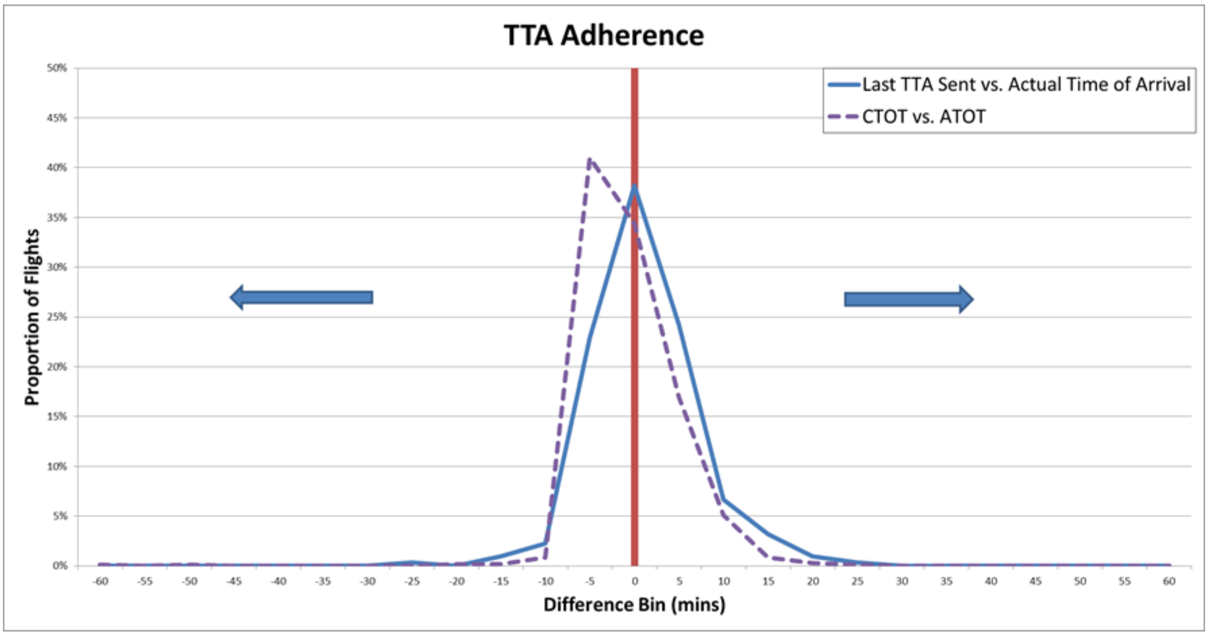


Figure 113: TTA adherence.

Figure 10 (above) and 11 (below) show that 92% of flights arrived within -5/+10 minutes of the requested TTA for all TTAs sent as part of the VLD. This is broadly in line with typical CTOT performance for conventional regulations.

	CTOT vs. ATOT	Last TTA Sent vs. Actual Time of Arrival
Median	-1.60	0.58
Mean	-0.73	1.06
5% Percentile	-5.90	-6.60
95% Percentile	8.12	11.28

Figure 114: TTA Adherence summary statistics.

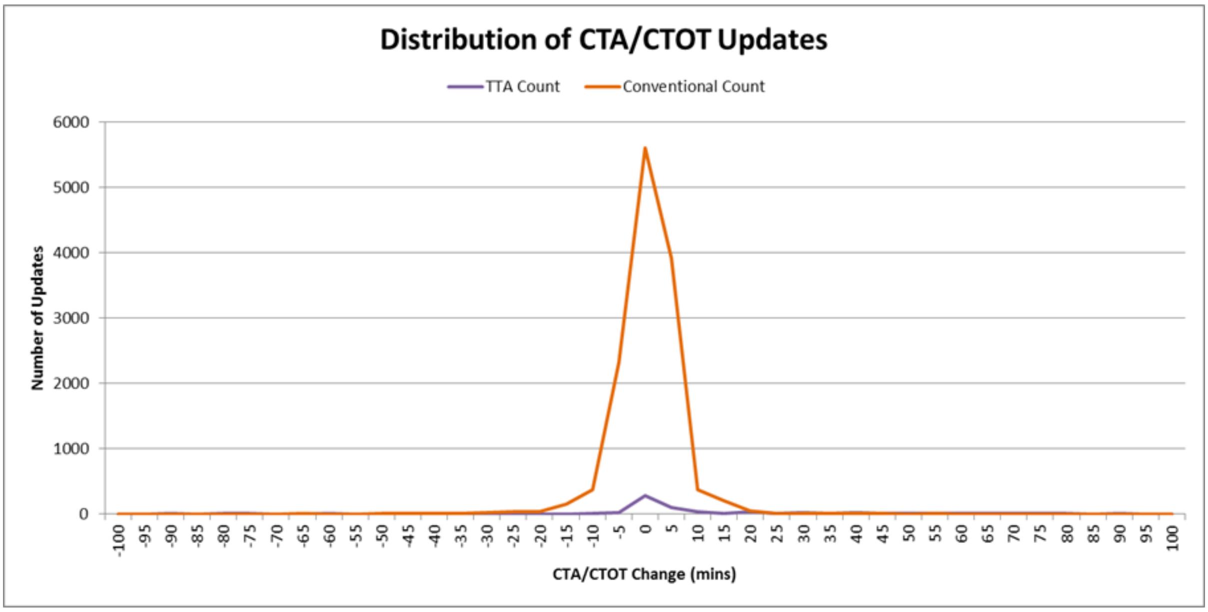


Figure 115: Distribution of Updates: Conventional regulation vs. TTA regulation.

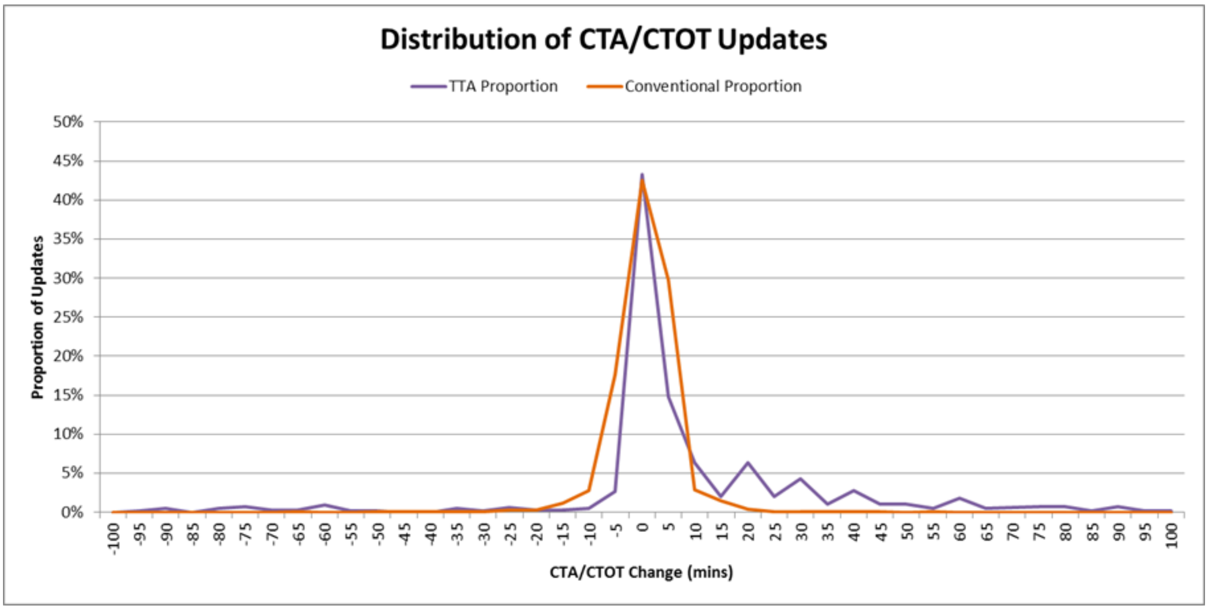


Figure 116: Proportional Distribution of Updates: Conventional regulation vs. TTA regulation.

Figures 12 and 13 (above) compare the number of updates for a conventional regulation (27th April 2019) and a TTA regulation (7th June 2019). These regulations had comparable numbers of regulated flights (384 and 354 respectively); however, figure 12 shows that there were significantly more updates for the conventional regulation. Figure 13 demonstrates that, although the TTA values were updated less frequently, when flights were moved the magnitude of the change tended to be larger than the conventional case. It should also be noted that when flights with TTA regulations were issued updated times, these often increased ATFM delay, although a small set of flights had decreased delays. This is expected to change with the identified software improvements.

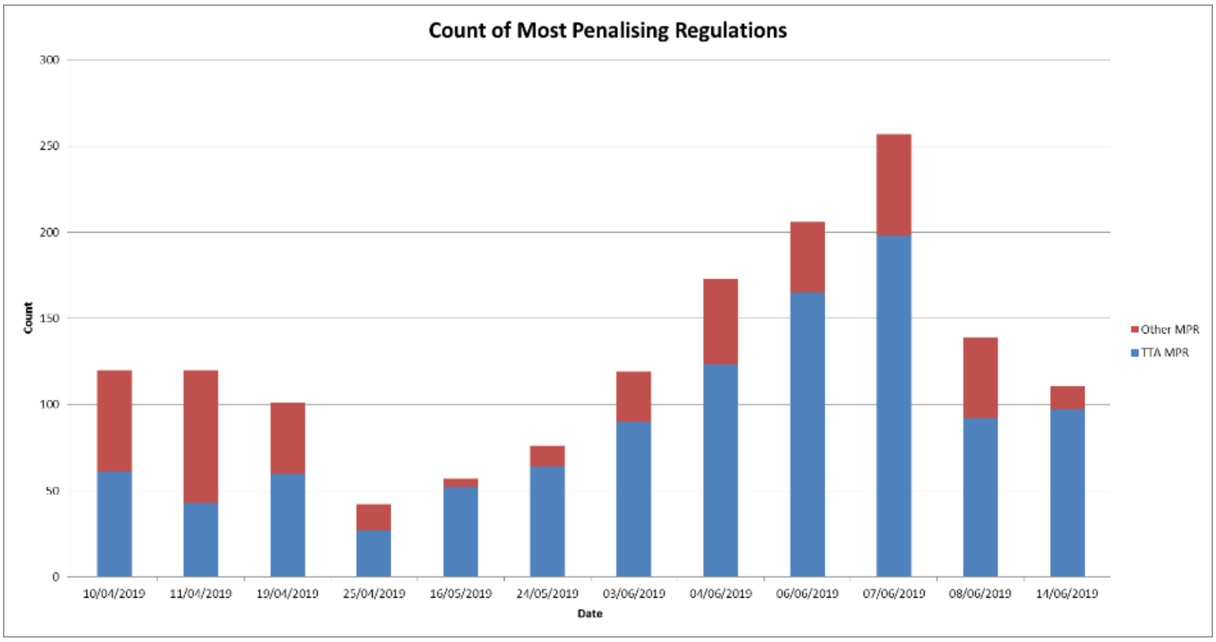


Figure 117: More Penalising Regulations.

Figure 14 shows the number of flights with more penalising regulations that were experienced by Heathrow arrivals on days when a TTA regulation was applied. The A-DCB tool was able to react to flights that were caught up in more penalising regulations elsewhere, so that those affected did not also receive a significant AFTM delay through TTAs, but the overall solution was still able to appropriately resolve the hotspot.

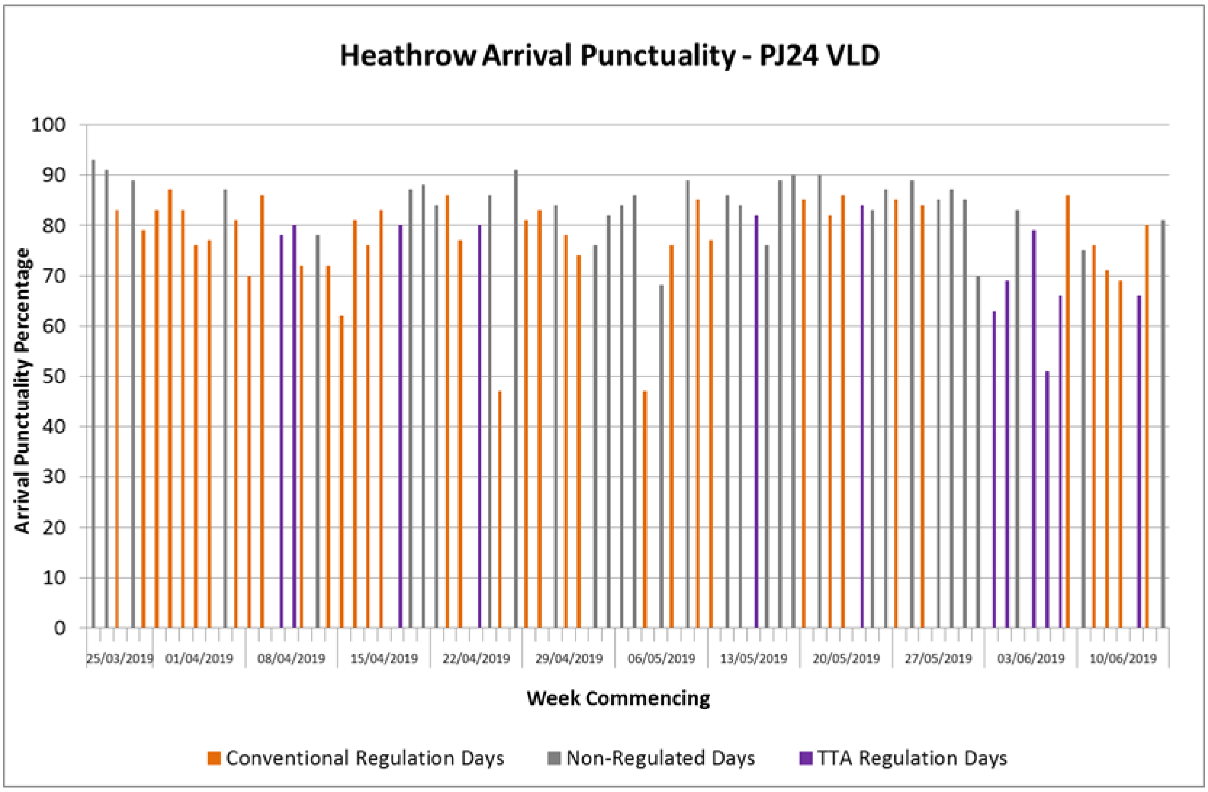


Figure 118: Arrival Punctuality split by regulation type.

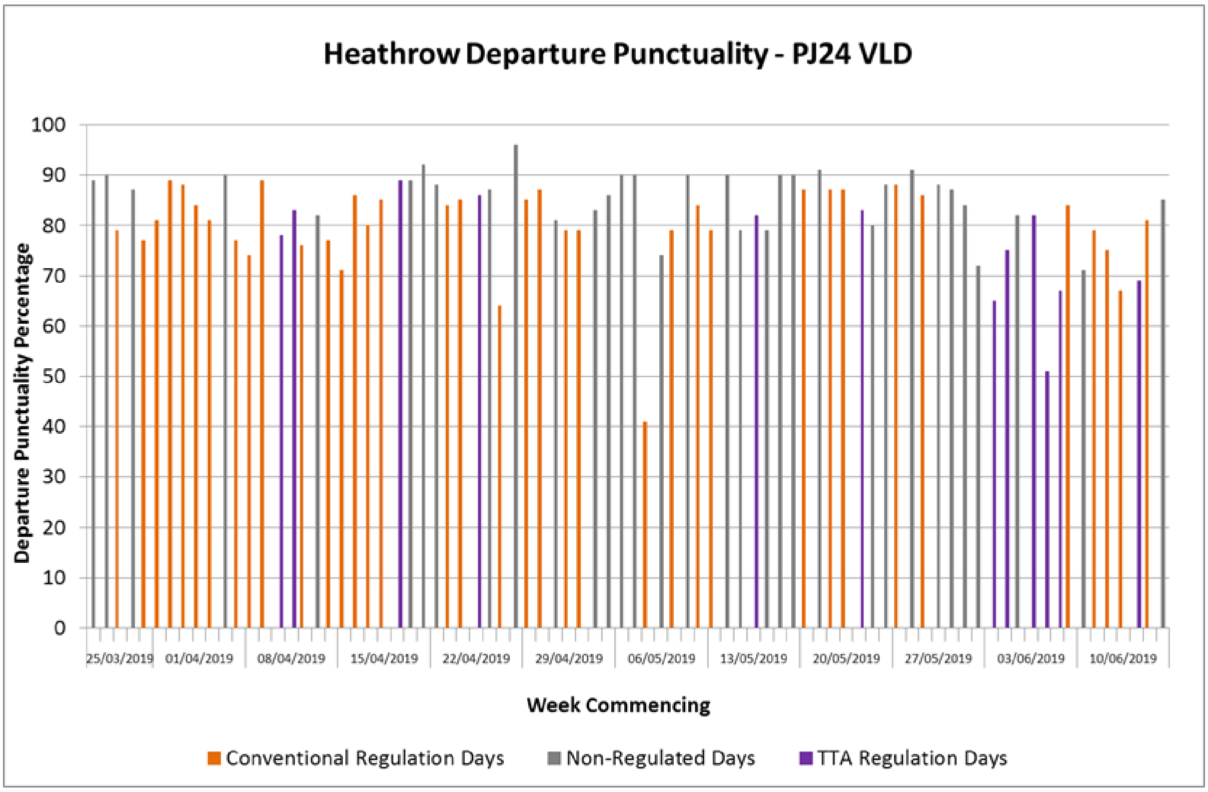


Figure 119: Departure Punctuality split by regulation type.

	Median Arrival Punctuality	Median Departure Punctuality
Conventional Regulation Days	80%	81%
TTA Regulation Days	79%	80%
Non-regulation Days	86%	88%

Figure 120: Punctuality statistics.

Figures 15-17 (inclusive) show how arrivals and departures punctuality varied over the VLD period. Broadly speaking, punctuality remained at a similar level when the TTA regulations were applied when compared to days when CASA regulations were applied. This is expected to improve as operational teams become more familiar with the use of the TTAs, and when enhancements have been made to A-DCB to prevent it from over-resolving hotspots.

TTA regulation				Assumed regulation rate	NEST simulated delay, min	Percentage Increase
Date	Start	End	Actual delay, min			
03/06/2019	06:00	09:12	555	41 – 42	505 to 1,296	-9% to 134%
04/06/2019	10:00	19:00	1,246	40 – 41	1,373 to 2,015	10% to 62%
06/06/2019	09:00	12:40	1,192	41	609	-49%
06/06/2019	17:30	18:59	899	34 – 42	190 to 497	-79% to -45%
07/06/2019	06:00	15:34	6,283	38	10,550	68%
08/06/2019	05:20	12:40	2,398	38	3,371	41%
14/06/2019	16:30	19:24	1,056	41 – 42	529 to 832	-50% to -21%
Total			**13,629**		**17,127 to 19,170**	**26% to 41%**

Figure 121: NEST simulation results for delay compared to actual delay figures achieved when using TTA derived regulations.

When comparing total delay given by a TTA rule with the outcome of what might have occurred with a CASA regulation, there is an amount of judgement involved as to the level of flow rate that would have retrospectively been applied at the time. In addition, a direct comparison in absolute numbers does not consider the fact that conventional regulations are often ‘stepped out of’ by increasing the rate gradually, so again, there is a level of judgement involved in assessing the average flow rate that would have retrospectively applied over the whole period. Therefore, when analysing theoretical CASA outcomes, the results are given as a range to account for this.

NEST (the NEtwork Strategic Tool) is a Eurocontrol piece of simulation software for network capacity planning and airspace design, which allows the user to replicate and simulate airspace operations for benefit analysis, forecasting and optimisation. The level of ATFM delay predicted by the NEST simulations, provided by NATS, was between 26% and 41% higher than the ATFM delay generated by applying a TTA regulation through A-DCB.

Date	Start	End	Actual Delay	Assumed regulation rate	SIMEX FTFM simulated delay of conventional CASA regulation	Conventional CASA Regulation Percentage increase
03/06/2019	06:00	09:12	555	41-42	612 to 834	10% to 50%
04/06/2019	10:00	19:00	1246	40-41	499 to 663	-60% to -47%
06/06/2019	09:00	12:40	1192	41	1276	7%
06/06/2019	17:30	18:59	899	34-42	251 to 618	-72% to -31%
07/06/2019	06:00	15:34	6283	38	10227	63%
08/06/2019	05:20	12:40	2398	38	3006	25%
14/06/2019	16:30	19:24	1056	41-42	1388 to 1483	31% to 40%
			13629		17259 to 18107	**27% to 33%**

Figure 122: SIMEX simulation results for delay compared to actual delay figures achieved when using TTA derived regulations.

Note that on the 06/06/2019, if a 34 rate had been applied, it is likely that the regulation would have had to be extended and stepped out beyond 19:00.

Figure 19 above provides a comparison between delays attributed to the TTA regulation and those predicted by SIMEX simulation, which was provided by EUROCONTROL. Again, the benefits are shown as a range to account for the fact that conventional regulations are often 'stepped out of' by increasing the flow rate gradually. The range given by SIMEX is broadly in line with those given by NEST.

The table below provides some detail on the success of the VLD being able to deliver enough quality information against each use case to assist in assessing the exercise.

Use Case ID	Use Case Description	Coverage/comments on coverage of use case during VLD	Demonstration Exercise 3B objectives	Demonstration Exercise3B criteria	Success rating based on VLD evidence
UC-3.1	Detect Arrival Demand &	A-DCB performance evidence to show that	To identify a "hotspot" and provide a	EXE3b-CRT-VLD-02-001 More actual	**OK** **Reasoning:**

	Capacity imbalance during the planning phase.	predicted hotspots on D-1 are accurate	resolution using the A-DCB tool to issue TTAs. The resolution must operate within the normal operating parameters of runway availability.	(compared to airport data and/or actuals) flight departure and arrival time estimates	During the first few periods when a TTA rule was applied to resolve a hotspot the HTCs noticed on occasions that there were several sub optimal imbalances identified. The algorithm was amended, and the issue was mitigated with a statistically significant sample base of TTAs issued with the amended algorithm.
UC-3.2	Analysis and Coordination of the A-DCB management proposals during the planning phase.	Evidence to show that the A-DCB proposed solution is sound	To prove that the A-DCB tool does not select an excessive number of TTAs or too few and thus providing a disproportionate delay to TTA flights.	EX3-OBJ-VLD-05-003 The usage of enhanced A-DCB and TT reduces airport delay compared to airport regulations Reduction of the knock-on effect of the reactionary delay compared to the airport regulations.	**OK** **Reasoning:** There were numerous opportunities to assess the A-DCB proposal. Sub optimal solutions were identified at the start of the VLD and the NATS Analytics team used these to further enhance the calculations. There were occasions during the VLD when a conservative holding figure was provided, and air holding was less than expected. Median ATFM delay applied to flights did not differ between Conventional

					Regulations and TTA Regulations and the maximum delay applied to a single flight was only slightly higher for TTAs compared to Conventional Regulations. Delay was shared equally between airlines.
UC-3.3	NM acceptance of the A-DCB management proposals during the planning phase	Evidence to show that the A-DCB-CASA interaction can produce a sound solution to the predicted hotspot	To prove that the NM can receive, certify/reject and confirm all TTAs back to A-DCB. To prove that the process does not place too onerous a task on NM.	EXE3b-CRT-VLD-02-001 More actual (compared to airport data and/or actuals) flight departure and arrival time estimates	**OK** **Reasoning:** There were several initial issues with the NM B2B interface which delayed the commencement of the VLD. For most of the periods of TTA regulation the process operated as expected but there were a small number of events where NM could not certify the TTAs within time and this impacted the AOP operation.
UC-3.4	Detect and Resolve Arrival and Departure Demand & Capacity imbalance between multiple airports during the Short-Term planning and Execution phases. Depart	Evidence that the A-DCB plan delivers the predicted outcomes in the execution phase	To prove that the issuance of TTAs to NM is displayed to pilots at the departure airport via an CTOT. To prove that airspace users fly aircraft to arrive at the stack entry point at the TTA time.	EXE3b CRT-VLD-01-002 Positive feedback from all actors regarding process trialled	**OK** **Reasoning:** The VLD enabled us to collect and analyse a statistically relevant sample size. The A-DCB system identified a requirement for a hotspot TTA resolution on twelve different

	to CTOT and FLY to TTA. Partial validation. Detection and resolution will only be for Heathrow. Aircraft will depart to the CTOT but will not necessarily fly to the TTA				dates. Over 1,000 TTA's were issued during the VLD. With some minor exceptions the A-DCB tool provided a suitable number of TTAs within a suitable time period to smooth holding. For the handful of times there was a more optimal solution available the Analytics team were able to enhance the algorithm stability. The VLD did not provide any evidence of CTOT issues. However, we did not check with departure airports, as the CTOT was sent to them by NMOC (as per current procedures).
UC-3.5	Dynamic exchange of arrival and departure information from airport to network as from FPL reception	Evidence that the A-DCB predicted flight times are accurate and can be sent to NM once FPLs have been distributed	To prove that the flow of messages between A-DCB, AOP and NM can operate with many hundreds of TTAs. To prove that System updates as new flight plans are received.	EXE3b-CRT-VLD-02-001 More actual (compared to airport data and/or actuals) flight departure and arrival time estimates	**OK** **Reasoning:** There were two occasions where the transferring of information to NM failed. This believed to be due to user error and retraining was offered to remedy the situation. On all other days with a TTA regulation the system stability

					and resilience caused no issues.
UC-3.6	Dynamic exchange of arrival and departure information from airport to network before FPL is filed	Evidence that the A-DCB predicted flight times are accurate and can be sent to NM before FPLs have been distributed.	To prove that the number of TTAs not certified by the NM is statistically irrelevant. To ascertain the level of pilot concern (if any) over the flight times they have been sent.	EX3-CRT-VLD-05-003 The usage of enhanced A-DCB and TT reduces airport delay compared to airport regulations. Reduction of the knock-on effect of the reactionary delay compared to the airport regulations.	**OK** **Reasoning:** A-DCB was able to publish a TTA without a flight plan on the vast majority of the TTA days. TTA flights did not cause any operational issues at Heathrow Airport, for example through the creation of additional Night Jet Movements in any proposed solution. This would be seen as a major disadvantage by airlines, handlers, Heathrow Airport and the airport's local community should such a sub optimal solution have been suggested. We received some commentary regarding the level of delays on some specific flights. Tests were investigated with one algorithm enhancement being generated through this review.

1. Results per KPA

For the VLD the following metrics and success criteria were identified and checked for relevance amongst VLD actors. The summary chart below shows the assessment number(s) that a given KPA was assessed against where supporting evidence from the VLD identified a positive impact on the KPA. More detailed information on each assessment is provided in the main table.

KPA	KPI ID number which meets this KPA (see table below, which lists the KPIs and how they were met in the VLD)	Brief justification
Efficiency (Fuel)	1, 2, 3, 6	A reduction in air holding and a more stable prediction of that metric was identified through the VLD. This benefit was enjoyed by all arrivals during a TTA operation, regardless of whether an airline was participating or not. This reduces fuel burn and may provide a marginal reduction in fuel load prior to departure in the long term.
Efficiency (Cost))	1,2, 3, 6, 9	A reduction in holding leads to a reduction in flight time, not only saving fuel but also reducing the impact/wear and tear that flying can expose consumables to. Again, this benefit is extended to all arrivals during TTA operations, regardless of whether an airline is participating or not.
Environmental Sustainability	1	In a similar vein to the two cases above, shorter flying durations due to TTAs provides optimal holding for ALL arrivals in the hotspot period. This reduces both aural and air pollution.
Safety	4	No reported safety issues were raised against the testing, implementation or operation of the TTA process. There was no

		reported loss of standard separation due to the use of TTAs. All actors' observation books were regularly reviewed with actions taken as appropriate. There were no reported work-related absences where TTA operations were mentioned as a contributing factor to the absence.
Improved predictability	5, 9	As flights with CTOTs are more effectively managed by default these flights can be highlighted to create the foundations of reduced holding via the TTA process. As the TTA process becomes more widespread there is an exponential effect.

ID	Type of KPI	Requirement	Metric	Means of obtaining	Demo Plan Use Case	Results from VLD
1	Baseline delay predictions	On non-regulated day: predicted airborne holding vs. actual airborne holding, i.e. can we use A-DCB as a basis for identifying hotspots?	Holding number of minutes delta	Analytics from A-DCB1 Has A-DCB2 changed the underlying holding predictions?	3.1 (A-DCB)	**OK** **Reasoning:** During the VLD it was proven that hotspots could be identified appropriately by A-DCB when using a target airborne holding delay value of 17 minutes. A pre-tactical TTA regulation was successfully applied during the VLD, proving that hotspots can be accurately identified using A-DCB at a D-1 timeframe.
2	Delay	Opeval/VLD: allocation of delay to the stack and to pre-departure on flight by flight basis. How does that compare with CASA?	Individual delay values	Analytics from opeval/VLD	3.2	**OK** **Reasoning:** On every demonstration (excluding those with IT issues) we were able to confirm that the TTAs applied created less aggregate delay (mins) than a SIMEX simulated CASA

						regulation. During the VLD we did not consistently measure the “compliance” of an aircraft not approaching the stack entry point before their TTA and as such the allocation of actual delay cannot be proved to be totally a factor of TTA operations. The reduction in delay through TTA operations provides positive data for several of the KPAs for most cases. Efficiency (fuel) and Efficiency (cost) are both enhanced as the aircraft is spending less time holding, albeit on occasions there may be a flight that has a greater delay than an ATFCM measure. The overall reduction in delay also improves safety as again, the aircraft is generally flying for a shorter period.
3	Delay	Assess all flights and identify max delay, average delay, min delay across all aircraft, both in stack and as CTOT delay	Delay values	Analytics from OPEVAL/VLD.	3.2	**OK** **Reasoning:** The following metrics were collated. Count of dates TTAs issued Count of dates TTAs should have been used but CASA regulation was utilised instead Time duration of TTA regulation Average ATFM delay per flight Max ATFM delay Total delay if CASA regulation applied as part of SIMEX. Similar to the answer above, Efficiency (Fuel) and Efficiency (Cost) are both enhanced with a reduced delay.
4	Stack holding – safety	Evidence that A-DCB delivers the requested airborne holding, detailed as variations, peaks troughs over the whole period	Stack holding	Analytics from OPEVAL/VLD.	3.2	**OK** **Reasoning:** The distribution of airborne delay for flights within TTA regulation periods was mostly below 17 minutes target delay, which suggests the A-DCB

						system produced conservative delay outputs but was able to deliver the inputted target delay figure.
5	Performance	TTA adherence per flights in minutes (TTA vs ATA per flight. Median)	Punctuality	Analytics from OPEVAL/VLD. Apply delta of CASA CTOT and DCB CTOT equivalent to the actual arrival times (based on CASA CTOTS) to derive TTA ATAs and hence likely airborne holding	3.2	**OK** **Reasoning:** Good adherence to TTAs shown in the analysis of results, and certainly in line with typical CTOT performance that is in place today.
6	Performance	Actual delays vs Predicted Delay	Ground Delay	Analytics from VLD	3.4	**OK** **Reasoning:** We collected data on over 1,000 TTAs and did not receive any complaints from either GH or AO reporting missing or incorrect CTOT issuance. Overall delays were reduced compared with a conventional regulation. As mentioned before, a reduction in delay enhances Efficiency (fuel) and Efficiency (Cost).
7	Performance	Hotspot resolution rate (proportion of delay hotspots solved in the trial)	Punctuality Night Jet Movement	Analytics from VLD	3.4	**OK** **Reasoning:** Results from the VLD show that A-DCB resolved hotspots using TTA derived regulations successfully. There were no occasions when the use of TTA operations led to a Night Jet Movement. There was no discernible

						negative impact to punctuality using TTA operations.
8	Performance	Most Penalising Regulation impacts - which proportion of original TTA were impact by an MPR upstream and what was the response of the TTA allocation to solving the hotspot?	%age	Analytics from VLD	3.4	**OK** **Reasoning:** Between 10/04 and 14/06 there were circa 1500 More Penalising Regulations with circa 160 flights affected, giving a demonstration that there is a 16% chance that a TTA may give way to the precedent of a more penalising regulation. The TTA solution interacted with More Penalising Regulations successfully throughout the VLD.
9	Performance	How frequently were TTA revisions issued and by what amount of time?	Time value	Analytics from VLD	3.4	**OK** **Reasoning:** There were 175 reissues of TTAs during the 12 dates during the VLD when TTAs were issued. This figure is lower than that the airport would expect under a CASA regulation and as such provides a greater degree of predictability and proves that the TTA solutions are stable.
11	Accuracy	Accuracy of PAHTs passed to NM in API message format	Time delta	Analytics from VLD	3.3 interactions between A-DCB and NM	**Successful** The VLD demonstrated that the A-DCB system could accurately predict PAHTs. This was evident through the correct identification of hotspots as well as the A-DCB tool's ability to solve them.

F.3.2 Results impacting regulation and standardisation initiatives

N/a

F.3.3 Analysis of Exercises Results per Demonstration objective

The table below summarises the results by demonstration objective. Further details on each are given underneath.

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 3B Objectives	Demonstration Exercise 3B Success criteria	Success rating based on VLD evidence
OBJ-VLD-01-001	CRT-VLD-01-001	Impacts of using enhanced A-DCB measures and TTs on operational staff's workload (NM, ATC and Airport)	EXE3b OBJ-VLD-01-001 To demonstrate that the process will not increase workload for the VLD	EXE3b CRT-VLD-01-001 Workload will remain within acceptable limits	**OK** **Reasoning:** Some feedback from HOEC and TC operational teams suggested that workload had increased slightly, however, this should subside as familiarity with the tool and process increases.

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 3B Objectives	Demonstration Exercise 3B Success criteria	Success rating based on VLD evidence
OBJ-VLD-02-001	CRT-VLD-02-001	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solutions contribute therefore partially to the objective as described.	EXE3b-OBJ-VLD-02-001 Assess the improved network predictability due to the earlier, beyond the current A-CDM, departure and arrival data and estimates exchanges	EXE3b-CRT-VLD-02-001 More actual (compared to airport data and/or actuals) flight departure and arrival time estimates	**OK** **Reasoning:** A-DCB forecasts were proven to be accurate during the VLD.
OBJ-VLD-01-004	CRT-VLD-01-004	Improved situational/planning awareness for all actors regarding local/network A-DCB situation and the measures applied.	EXE3b OBJ-VLD-01-002 To demonstrate that the process results in improved situational awareness	EXE3b CRT-VLD-01-002 Positive feedback from all actors regarding process trialled	**OK** **Reasoning:** Positive feedback has been received by HOEC, TC and NM operational teams. The end-to-end process was mostly successful.

Demonstration Objective	Demonstration Success criteria	Coverage and comments on the coverage of Demonstration objectives	Demonstration Exercise 3B Objectives	Demonstration Exercise 3B Success criteria	Success rating based on VLD evidence
OBJ-VLD-05-003	CRT-VLD-05-003	Partially covered: Exercise 3 activities form part of overall network cooperative processes and the proposed solutions contribute therefore partially to the objective as described.	EX3-OBJ-VLD-05-003 Reduction of airport (involved in the exercise) delay resulting A-DCB issues by using enhanced A-DCB and TT mechanism (TTA EXE)	EX3-CRT-VLD-05-003 The usage of enhanced A-DCB and TT reduces airport delay compared to airport regulations Reduction of the knock-on effect of the reactionary delay compared to the airport regulations.	**OK** **Reasoning:** ATFM delay was reduced between 26-41% through the use of TTAs compared to the use of CASA regulations.

1. EXE3B-OBJ-VLD-01-001 Results

Impacts of using enhanced A-DCB measures and TTs on ATFCM workload (NM, ATC and Airport)

Shadow mode trials conducted in September – December 2018 helped to embed the new procedure between HOEC, NM and one watch in TC, and meant that procedures could be tweaked prior to the full VLD if they were found to be sub optimal. Some comments were received during the VLD that some operational colleagues in TC and the HOEC found that use of TTAs added to their workload, however, it should also be noted that increased familiarity with the tool and procedures should mitigate this to some extent.

In the initial stages of the VLD, an overarching conventional regulation was applied (at a rate of 52) on top of the TTA regulation. This acted as a safety buffer in case the A-DCB tool did not act in the way expected when a TTA rule was used and would have meant that a conventional regulation at a lower rate could have been applied quickly had there been an unexpected issue. After 2 applications of the TTA rule it was agreed that the 52 regulation was not required, as all actors were confident that the tool was working as expected. It should also be noted that most of such concerns were raised during periods of high ATM figures whilst either Heathrow Airport or the wider London Traffic Management Area (LTMA) were experiencing the impact of abnormally severe convective storms, and are thus considered to be confidence related rather than workload related.

The VLD used the same process to back-calculate CTOTs applied to flight with TTAs as is used in current operations, when a conventional flow rate is applied (i.e. CTOTs were applied by NM once

TTAs had been received from Heathrow's AOP). This meant that there was no additional workload for flight crews, as they simply had to follow today's process for when a CTOT is applied to their flight.

Success Criteria: Workload will remain within acceptable limits

Conclusion: Success criteria met, and is expected to be met through the further development of A-DCB to improve the accuracy of historic airborne delay, and through more TTA trials which are being progressed by HAL and NM.

2. EXE3B-OBJ-VLD-02-001 Results

Assess the improved network predictability due to the earlier, beyond the current A-CDM, departure and arrival data and estimates exchanges

For TTA based operations at Heathrow during the VLD, aircrew at airports of origin were issued with intelligent Calculated Take-Off Times (CTOT), derived from TTA values that were determined by the A-A-DCB solution and published to NM via the integrated AOP/NOP. Standard tolerances for adherence to CTOTs, assumed by NM and A-CDM airports, are -5 minutes/+10 minutes. During the VLD Heathrow published TTAs to the Network Manager via AOP at circa 03:30 UTC when TTA operations were required to resolve a runway arrival demand hotspot. Flight information in AOP is updated from 3 hours before the departure with the same for arrivals traffic and is then updated by radar feeds or manual input based on information provided by the airline or handling agent. For arrival traffic AOP uses the Minimum Turn Round Time provided by each airline for each aircraft variant with the Predicted In-Blocks Time (PIBT) to calculate and then promulgate a Calculated Off-Blocks Time (COBT) for known linked departing flights that have been loaded into the system. For departure traffic this is the only impact of TTA operations.

For arrivals traffic the publication of a TTA (and an associated intelligent CTOT) provides a greater degree of predictability as these flights are managed more effectively to ensure the CTOT is met. This provides the ANSP with a much greater degree of confidence in the predictability of that flight operating within the parameters of the CTOT. To that extent, it is self-evident that those flights with an CTOT provide more predictability.

However, those flights that have not been subject to an CTOT must also be considered if we are to fully assess the predictability of flights. The very nature of more effective management of flights with an CTOT, leads to those without such a restriction naturally inheriting a risk of become less predictable as the departure from the airport may be affected by such management. This would be recognised by such flights receiving a CTOT. This is particularly notable in those airports with a discernible seasonal traffic bias or with capacity constraint issues, such as those endured by Heathrow. However, this is a metric that also affected by issues that could cause disruption to departures at all airports, including those not partaking in the VLD. The fact that arrivals traffic originating from outside the ECAC area currently cannot be subject to either a TTA or conventional ATFMC regulation provides further difficulty in assessing the impact of CTOTs to support TTA operations on other arrivals to Heathrow.

From an ANSP viewpoint a similar story is reflected in that the use of CTOTs and effective management of their delivery does improve predictability of these flights. This comes with the opportunity cost of a potential decrease in predictability for other flights, particularly at airports requiring access to airspace sectors with a large amount of TTA traffic.

Predictability must not be confused with punctuality. The parameters of the VLD allow a TTA flight to be given a CTOT that makes it unpunctual, regardless of whether the -5/+10 CTOT extension is applied.

For non ACDM/AOP airports the pilot will not be advised to any amended departure time to support adherence to a TTA until they call the tower to request start approval. This provides pilots with less spacial awareness than ACDM/AOP. However, the airline will be aware of the details and the arrival airport (Heathrow) would have already published it on the arrivals page allowing handlers to plan for any amended on-blocks time.

Success Criteria: More actual (compared to airport data and/or actuals) flight departure and arrival time estimates.

Conclusion: The VLD provided no evidence of deterioration of information at Heathrow. The use of TTA operations to resolve hotspots and its success in such resolution infers improvement.

3. EXE3B-OBJ-VLD-04-001 Results

Reduction in time for NMOC staff to monitor, analyse, coordinate and implement measures to balance demand – capacity

The semi automation of the TTA process to support the VLD provided a certain level of efficiency by providing the NMOC staff with a group/batch of TTAs that were predicted to resolve the excess runway demand if the airlines were able to fly to the TTA stack entry time. For the VLD there was a requirement to slightly amend the normal regulation process whereby NM added a specific identification for a TTA regulation in order to clearly identity that this was to support TTA operations. This requirement operated in tandem with the normal processes being followed by airports not partaking in the VLD, and therefore did create a very slight increase in workload. However, this should be balanced against the fact that TTA operations remove the requirement for an ATFCM regulation and for the purpose of this report it is assumed that the two actions and their related workload cancel each other out. This is a view that has gained the Network Manager’s support.

Whilst the application of TTAs and TTA operations may resolve a hotspot for Heathrow, only the NMOC staff have the oversight of the wider European ATM operation and as such they needed to analyse the impact that TTAs from Heathrow may have caused to Aircraft Operators, departure airports or a given areas of airspace.

There were several observations from staff at NMOC that they felt frustrated at not being able to intervene to amend a delay to a TTA flight they felt was excessive, or to assist a departure airport in a tactical response to a last-minute issue at the location. A potential solution is addressed in Recommendations for Industrialization and Deployment.

The process created to support VLD operations was specifically designed to allow for minimal workload should there be a requirement to revert to normal ATFCM demand resolution. This understandable decision did create a scenario where NMOC team members highlighted the ease of reversion when compared to the time they had to invest in e-desk or manual calls from airline operators requesting slot improvements which the VLD parameters precluded them from offering.

The Network Manager utilised existing technologies to receive TTAs from Heathrow's AOP system. Excluding any preparation or systems configuration works undertaken prior to the actual commencement of the VLD it is not considered that this would increase workload and the consideration regarding the front loading of preparatory works to enable the VLD is also referred to in EX1-OBJ-VLD-01-001.

Success criteria: Positive feedback from all actors regarding process trialled. A reduction in time for NMOC staff to monitor, analyse, coordinate and implement measures to balance demand – capacity.

Conclusion: Success criteria met.

4. EXE3B-OBJ-VLD-05-003 Results

Reduction of airport (involved in the exercise) delay resulting A-DCB issues by using enhanced A-DCB and TT mechanism (TTA EXE)

To provide evidence that there was a reduction in delay we must compare our TTA operation results with simulations undertaken by NATS and/or EUROCONTROL. The very nature of simulations means that they may not provide an exact replica of the TTA operation, however they are proven in the reference mode of operation and as such provide value and an identified margin of error. Due to the number of exercises undertaken and the number of TTAs issued it is believed that any variance caused by the margin of error would be minor.

Overall punctuality saw no significant change during the VLD. It is imperative however that the punctuality figures given earlier in this report are placed in context. They are based on the Heathrow Airport definition of punctuality which classes any arrival on blocks before Scheduled In Blocks Time (SIBT) as punctual, as well as those who record on blocks up to 15 minutes after their SIBT.

The nature of such measurements may inadvertently hide delay attributable to the VLD if it does not cause an arrival to be delayed in excess of 15 minutes to the SIBT, or if a smaller attributable delay to the arrival that is compounded by turnround issues or other delay that makes a known linked departure more than 15 minutes late off blocks. Punctuality figures naturally include all flights, including flights not subject to a TTA or CTOT and those originating from outside the ECAC area.

The table below is given again to emphasise the savings in ATFM delay when a TTA regulation was used, compared to if a conventional regulation had been applied.

TTA regulation				Assumed regulation rate	NEST simulated delay, min	Percentage Increase
Date	Start	End	Actual delay, min			
03/06/2019	06:00	09:12	555	41 – 42	505 to 1,296	-9% to 134%
04/06/2019	10:00	19:00	1,246	40 – 41	1,373 to 2,015	10% to 62%
06/06/2019	09:00	12:40	1,192	41	609	-49%
06/06/2019	17:30	18:59	899	34 – 42	190 to 497	-79% to -45%
07/06/2019	06:00	15:34	6,283	38	10,550	68%
08/06/2019	05:20	12:40	2,398	38	3,371	41%
14/06/2019	16:30	19:24	1,056	41 – 42	529 to 832	-50% to -21%
Total			**13,629**		**17,127 to 19,170**	**26% to 41%**

For the NEST simulation above an indicative arrivals flow regulation is simulated based on the likely CASA intervention that the excess demand, weather impact or special event would generate. There is an extremely large reference library that can be consulted to assist NATS team members with this decision making. We can see that on most days the TTA operations delivered a lower total delay than the NEST simulation predicted would have been generated with an ACTFM intervention. **Overall there was between a 26% and 41% reduction in actual delay experienced through TTA operations compared with the simulation.**

Date	Start	End	Actual Delay	Assumed regulation rate	SIMEX ATFM simulated delay of conventional CASA regulation	Conventional CASA Regulation Percentage increase
03/06/2019	06:00	09:12	555	41-42	612 to 834	10% to 50%
04/06/2019	10:00	19:00	1246	40-41	499 to 663	-60% to -47%
06/06/2019	09:00	12:40	1192	41	1276	7%
06/06/2019	17:30	18:59	899	34-42	251 to 618	-72% to -31%
07/06/2019	06:00	15:34	6283	38	10227	63%
08/06/2019	05:20	12:40	2398	38	3006	25%
14/06/2019	16:30	19:24	1056	41-42	1388 to 1483	31% to 40%
			13629		17259 to 18107	**27% to 33%**

A similar pattern is repeated with a SIMEX simulation, as shown above. **Overall there was between a 27% and 33% reduction in ATFM delay experienced through TTA operations compared with this simulation.**

The VLD initially planned to utilise Extended DPI messaging to further benefit the actors. However due to sub optimal calculations driven by two of the extended DPIs this element of the VLD was suspended after a short time. It should be acknowledged that there may be further favourable reductions in holding and delay during TTA operations should these messages become operational.

The fact that on occasions the TTA resolution provided an increase in delay to more aircraft than anticipated must be addressed. Certain errors in the A-DCB calculation have now been identified and rectified and this must be considered in line with the inherent challenges identified with comparing actual results with a simulation. This reinforces the need to view the VLD in its entirety and not focus on one particular result or metric unless it is utilised to further drive out inconsistencies.

Success criteria: The usage of enhanced A-DCB and TT reduces airport delay compared to airport regulations. Reduction of the knock-on effect of the reactionary delay compared to the airport regulations.

Conclusion: Success criteria met. The use of TTA operations provided a sharp reduction in predicted delays when compared with the simulations.

F.3.4 Unexpected Behaviours/Results

Two key findings have been identified using the TTA rule during the VLD. These are as follows:

1. The A-DCB tool's historic airborne delay values were found to be higher than expected. This meant that the tool applied automatic hotspot resolution more often than expected and therefore generated higher ATFM delays, lower airborne delays and possibly more regulated flights than anticipated.

2. As a result of this first finding, there were limited occasions during the VLD when the tool was able to enact its cold spot resolution. This meant that there was a selection of flights which could have been issued an CTOT in order to reduce excess runway demand, but were not, leading to higher amounts of delay and an extended duration of TTA operations than anticipated.

Solutions to both the points have been identified, and, when corrected, should improve the tool's ability to resolve both hot and cold spots, leading to a further reduction in ATFM delay when compared to a CASA regulation. In addition, this should also maintain punctuality figures on the occasions when the TTA rule is applied.

The list below shows issues or sub optimal outputs experienced on days where TTAs were to be issued as a rectification to a hotspot. The reason(s) why TTA operations were not selected, or the reason why a TTA operation was suspended is provided.

It should be noted that the participation in a VLD naturally incorporates a certain degree of risk and there should be an expectation that the opportunity to improve processes will arise.

Issue/event	Category	Severity to correct	Rectification
30/03. A-DCB's suggested TTAs did not resolve a hotspot.	Technical	Significant. The main foundation of the process is that TTAs should resolve the hotspot.	The algorithm was amended to adopt a more conservative view by reducing the length of the rectification timespan. The potential for amending the –3-minute buffer for the overall average of 17 minutes holding was also raised.
18/04. The TTAs issued by A-DCB were not completely processed through the systems involved.	Human	Minor. It is believed that this was human error and offered an opportunity for coaching	Resolved.
19/04. The TTA prediction of delay was greater than that delivered through the TTA resolution.	Technical	Moderate. A-DCB predicted higher levels of delay than what needed to be solved.	Enhancement to A-DCB identified and will be implemented ahead of more trials.
On several dates there was a delay in publishing the TTAs that was not promulgated to the wider audience. This led to a sub optimal hotspot resolution as by the time this omission was identified several selected flights had already departed.	Human	Minor. The manual batching of TTAs to send on to NM was implemented just before the VLD in response to NM's inability to accept more than 50 messages a minute. This should be rectified in future.	The need to manually batch messages and send to NM should be resolved in future, so that a fully automated process is implemented.
On several days the predicted total delay for TTAs was significantly higher than that measured when the TTAs were sent (e.g. 19/04) This impacted our ability to explain any concerns about delays attributed to a flight or airline. It also increased the risks of a less experienced member of staff electing to use a CASA regulation.	Technical	Moderate. This behaviour is also common in CASA simulations and predictions. As there is less historical evidence of TTA operations to base decisions on caution is advised if seeking to amend this issue without an operationally or statistically significant baseline	Monitoring is recommended; the A-DCB tool should dynamically update and respond to operational conditions as they unfold.

F.3.5 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

The execution of the VLD at Heathrow Airport provided a large number of significant data points for all participants and as such should be seen as a positive indicator to the validation of the TTA concept, along with the likely benefits additional participants to either a VLD or full TTA implementation should enjoy. This declaration is made from the following observations:

1. Over 1,000 flights were successfully issued TTAs during the VLD;

2. At Europe's busiest airport we were able to resolve hotspot(s) through the use of TTAs on two of the busiest days the airport has experienced in its history, with the benefit of more stable air holding predictions being felt by all arrivals flights landing during those TTA operations;

3. TTAs to resolve hotspots were created and promulgated to crews at departure airports via NM issued CTOTs;

4. All short haul carriers with arrivals to Heathrow Airport had the opportunity to be selected for participation in the VLD and provided an intelligent CTOT via the Network Manager to smooth runway demand if they operated during an identified hotspot.

Whilst these success metrics are important in enabling the collation and prediction of potential benefits to every short haul carrier offering services to Heathrow Airport, they should also be viewed as significant for the following wider implications:

1. The VLD provides a wide repository of data to enable airlines, ANSPs and EUROCONTROL to identify potential benefits to their business and customers should TTAs be developed further;

2. The feedback received from users overall was positive. Whilst there were occasions where the process delivered sub optimal results, these enabled further improvements to the process.

The fact that system failures and participant concerns were collated and addressed is also of significance. An "open door" policy to challenging elements of the VLD enabled engagement and thus promoted an air of understanding and learning.

2. Quality of Demonstration Exercise Results

There are several sub optimal considerations to be addressed for every time a demonstration exercise was instigated as part of the VLD. If the TTA was applied to smooth out air holding due to the impact of weather, the following considerations may lead to a sub optimal delivery:

- Type and severity of weather. The A-DCB tool which is used for the selection of TTAs is programmed to calculate the anticipated impact of each weather type and its severity. Therefore, should the weather type change from that in the forecast when the TTAs were issued or the severity of the weather changed then the risk of a sub optimal delivery is introduced to the process.

- Timing of start and finish of weather impact. Should the duration of the weather be different from that forecast at the time that the TTA operations were published the risk of a sub optimal delivery is introduced to the process.

Both points are mitigated by the automatic resolution on the evolving plan, which considers any changes in additional weather reports received by the A-DCB tool and amends the TTA operations accordingly.

Any potential areas of confusion in the VLD TTA operations may have led to inefficiencies in the application of the procedures. As this is a new procedure, there was an underlying risk that the process may not be as efficient as possible due to the fact it had never been utilised in the live environment (although shadow mode testing would have mitigated this), but also as it utilised several different systems with human machine interfaces required by several participants.

3. Significance of Demonstration Exercises Results

See section above entitled "Level of Significance / Limitations of Demonstration Exercises Results".

F.4 Conclusions

From the information and data listed above the following conclusions can be drawn.

1. There were distinct advantages for participants in the VLD through a reduction in delay compared to CASA regulations, a more definite Airport Plan through adherence to CTOTs at departure airports and a semi-automated TTA process. Over 1,000 TTAs were sent to NMOC who converted them to intelligent CTOTs and passed to the departure airports. No negative feedback was received from departure airports or flight crews receiving such messages;

2. The concept of using TTAs to manage excess runway demand has been validated;

3. End to end messaging to deliver TTAs for the VLD has been proven to work in the vast majority of occasions (except for when messaging limits were exceeded, which resulted in some TTAs pending in the system – but this should be rectified prior to go-live);

4. The concept of airport stakeholders, ANSPs and the Network Manager operating in a paradigm which looks at optimising runway utilisation for the benefit of the wider airport community is validated;

5. A reduction in AFTM delay of 26-41% can be expected when applying TTA operations compared with conventional regulation. This remarkable benefit is enjoyed by all arrivals during the hotspot resolution;

6. Based on the benefits realised through participation in the VLD Heathrow Airport is planning additional short haul trials for TTA operations for late 2019/early 2020.

F.5 Recommendations

F.5.1 Recommendations for industrialization and deployment

1. **Moving towards an airport where all stakeholders understand how we manage excessive runway demands through the smoothing of excessive air holding facilitated by the application of TTAs**

It cannot be over emphasised how ingrained the current CASA regulations are in all areas of airport operations, affecting many stakeholders. For the purposes of the VLD we did not undertake a full-scale review of all our paperwork and processes until the VLD had enough demonstrations to allow us to make meaningful assumptions based on the evidence of the demonstrations.

The list below provides a top-level view of considerations that should be considered before the commencement of TTAs.

1. Changes to the AOP portal to amend home page to reflect issuing of TTAs;

2. Amend daily paperwork used by ANSP to communicate likely runway performance at D-1, ANSP update at D0 for review and final confirmation, ANSP D+1 document reviewing actual performance against plan;

3. Updated AIP entry;

4. Amendments to Capacity Constraints agreement with airlines, including our Demand Versus Capacity process which is founded on using CASA regulations as an indicator for the requirement to request a schedule intervention;

5. Review of all Airside Local Operations Procedures (ALOPS) and Contingency Standard Operations Procedures (CSOPS) to transition away from CASA regulations;

6. Amending current process for dispensation consideration from Government when there has been considerable disruption to the airport;

7. Reviewing Aerodrome Manual and Emergency Orders to reflect the move to CASA regulation only being utilised for an unplanned significant loss of capacity or critical equipment.

Briefings for a TTA process should be undertaken with all stakeholders associated with the arrivals product. It is important to ensure that any part time workers or shift workers can attend briefings, so weekends and nights should be factored in to deliver briefings.

1. Supporting documentation

Documentation should be provided to those actioning the publication of TTAs (Power Users) well in advance of a go live date. Ideally it will be a digital distribution, which allows for rapid amendments to be made to ensure any changes to the system are reflected in documentation.

A more generic approach can be adopted to those stakeholders who are not in the above roles. This should provide the aims and objectives of the new process, clear guidance on any situations when TTAs would not be applied, contact details for the process owner (should any issues arise) and ideally some worked examples of how the application of TTAs would be shown around the airport.

If a trial is being considered it's also important to ensure that the success criteria are clearly defined and that all stakeholders are provided with a review of the trial to date, incorporating both successful TTA interventions and those that were less successful.

2. End to end process testing

Due to the international geography of the TTA participants end to end testing can be difficult to diarise and, should the proposed solution not work to an optimal validation, take a prolonged time period to resolve. Plan well in advance for the date the testing will be actioned but also clear diary slots to provide reserve dates as its highly likely some calls will be cancelled due to one or more participants being in a contingency event.

3. Considerations around NMOC team having the ability to intervene and improve or extend slots given in response to a TTA

During the VLD there were numerous observations from the NMOC team who felt some flexibility to the procedures would have allowed them to offer a better level of service and reactive response. The A-DCB tool is designed to dynamically change and improve flights without the need for manual interventions, and this will become clearer when further enhancements are implemented into A-DCB and further trials improve familiarity of the tool. When the tool is optimised, manually intervening on individual flights will degrade its overall solution.

That said, there will be rare occasions when it is right to intervene, if there is an event which the A-DCB tool hasn't been designed to manage. An example of this occurred during the VLD, when a runway at Glasgow Airport was closed and manual intervention needed to take place to ensure that the aircraft departed the airport before it closed.

In parallel with the A-DCB optimisations, it is recommended that the equitable principles of the A-DCB algorithms and prioritisation criteria are communicated in full to the airlines and the ATM community. A full appreciation of these principles will set the TTA regulation expectations of the airlines (OCCs) and should reduce the instances of flight improvement requests made to NMOC and HOEC.

It is recommended to study the TTA regulation flight best practises of FMP/Airport and NM for dealing with late occurring flight issues at the outstation that affect a flight's ability to meet a CTOT. In conventional regulations, 10-minute CTOT slot extension requests are often impact assessed by NMOC and applied accordingly to the flight to assist a departure airport in tactical response to a last-minute issue. These actions have been found to be an expedient solution that avoids flights returning to stand and filing FPL change messages. A similar response should be impact assessed for application to TTA regulations.

F.5.2 Recommendations on regulation and standardisation initiatives

N/A

Appendix GDemonstration Exercise #04 Extended CAP Report

G.1 Summary of the Demonstration Exercise #04 Plan

As defined in DEMO Plan PJ24 NCM EXE#4.

G.1.1 Exercise description and scope

Operational scope

Extended CAP exercise extends and assess the CAP process in a Network Collaborative approach. This process aims at improving the demand and capacity balance through fine-tuned measures in a collaborative process with Airspace Users during the planning phase. CAP process offers a set of alternative trajectory solutions to improve flight planning by AUs (for example flight level capping). These solutions are agreed and prepared in strategic phase and then coordinated in short term planning phase between FMPs and the Airspace Users. The objective is to off-load sector/hotspot, by acting only on a limited number of flights during the planning phase, and thus reducing the impact, or even the need, of applying a regulation. It is an additional measure in the ATFCM toolbox to manage the demand and capacity balancing.

The process in terms of actors and actions is the following:

1. Strategical phase
   - Participating FMPs: Discussion and agreement on a set of solutions to improve capacity and lower the impact of regulations on dedicated hotspots / traffic flows.
   - Airspace Users are informed about the set of flows and related solutions.

2. (Pre-)Tactical phase – Day of operations (the process starts ideally with a sufficient lead time to allow FPL filings/updates 3h-4h prior EOBT/ETO)
   - FMP: Identification of an overloaded sector.
   - FMP: Selecting candidate flights to follow CAP process and uploading them into the CAP repository.
   - (Optional, only if needed) FMP-FMP: Discussion and agreement through CDM chat about best proposal to be implemented.
   - FMP: Sending the proposal request to Airspace User via CAP tool.
   - Airspace User: Receiving the proposal through the CDM interface and by e-mail.
   - Airspace User: Acknowledging the reception of the CAP proposal to the FMP.
   - (Optional, if needed) Airspace User and FMPs can exchange via CDM chat on the solution or any other topic, for assistance or coordination.
   - Airspace User: Refiling the flight plan with the proposed solution.
   - Airspace User: Informing the FMP that the flight plan is refiled as per CAP proposal.

- Airspace User: (In case the CAP proposal does not suit the AU) Rejecting the CAP proposal via the CDM interface.

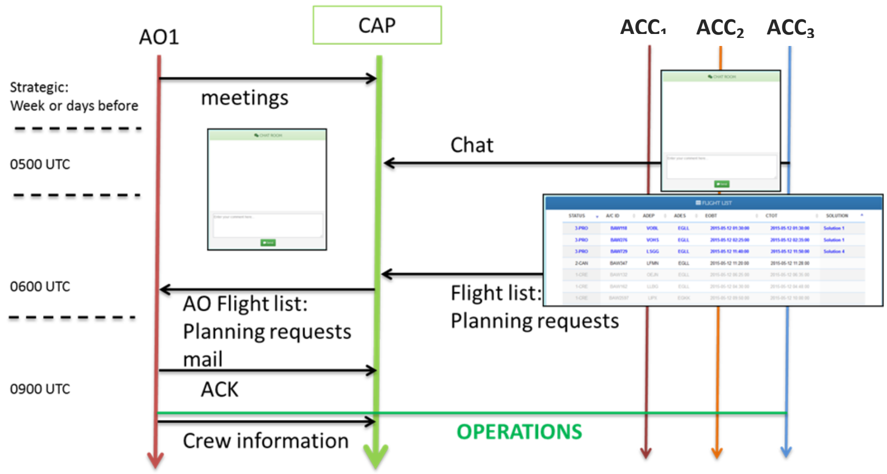


Figure 123 - Example of Collaborative Advanced Planning workflow

Find below the Collaborative Advanced Planning Sequence diagrams according to each participant:

- From ANSP perspective (example with 3 French ACCs: LFEE, LFFF and LFMM for a specific flow)

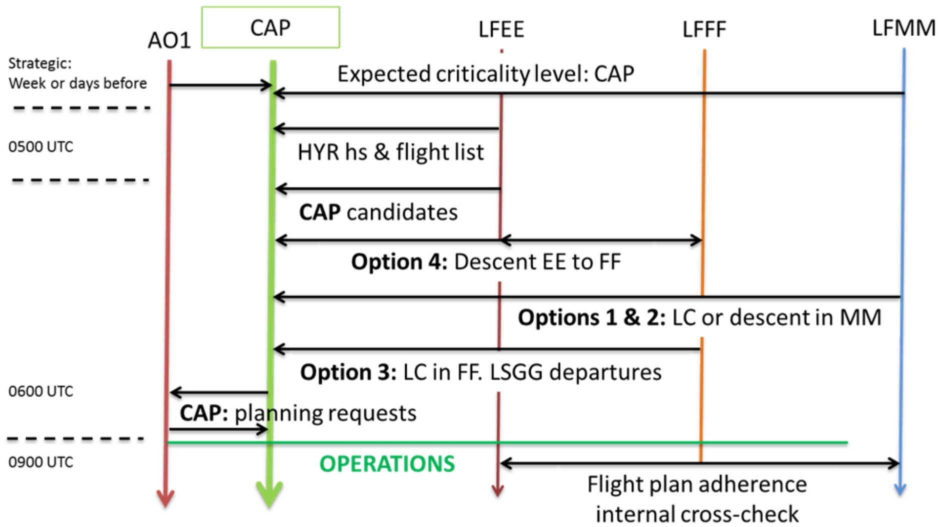


Figure 124 – Example of CAP Sequence diagram from ANSP perspective (Iteration 1)

- From AU perspective

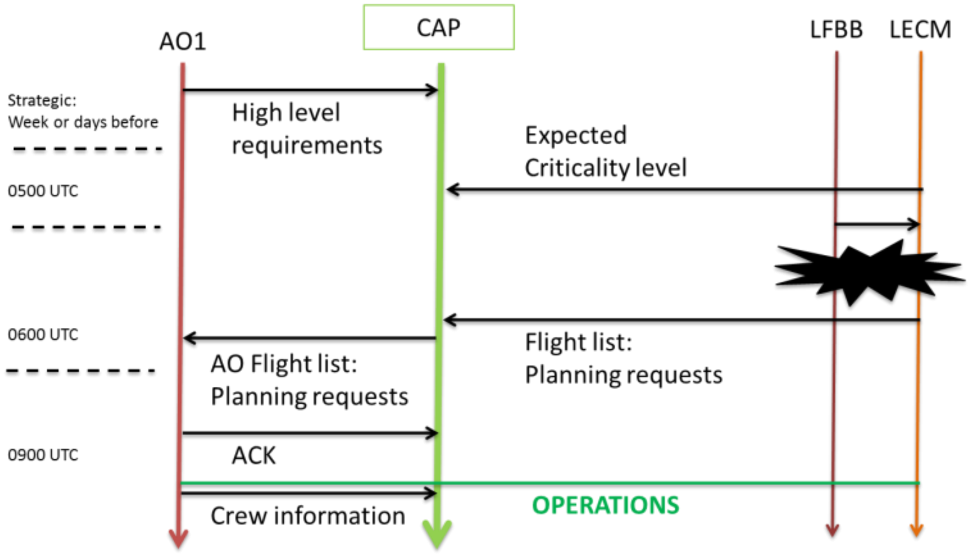


Figure 125 – Example of CAP Sequence diagram from AU perspective (Iteration 2)

Iterations

EXE#4 exercise iterations were split in two parts and three iterations:

The first iteration was intended to quantitatively assess the BRY-CLM CAP Process during one of the periods of highest traffic demand to prove the benefits of CAP at a local level and to show the direction towards a more refined and automatized assessment for future iterations.

The second and the third iterations aimed at extending the CAP process to cross-border flows (Madrid – Bordeaux) involving ENAIRE ANSP and Iberia, Air Europa, Air Nostrum and Air Europa Airspace Users.

Only DSNA participated in the first iteration whereas ENAIRE and Spanish airlines joined the demonstration exercise in the second and third one using CAP tool at their facilities. Note that second and third iterations of EXE#4 correspond to first and second iterations of EXE#6.

Platform used

CDM Portal developed by DSNA is the platform used for the Demonstration exercise. This platform allows the FMP and Airspace User to participate in the CAP Process.

The user only needs a PC and an internet connexion to be able to use the CDM Portal. The access to the portal is restricted to registered users. The portal makes use of B2B as provided by the NM, in particular to get the relevant flight lists and FPL details of candidate flights.

The portal allows the involved parties to share the same view and interact to initiate, update and confirm the proposed actions on flight plans. A "chat box" called CDM chat is also available between all participants.

To note that the CAP process is able operate without using the CDM Portal, by e-mail and telephone calls. However, the portal was designed with the purpose to standardize the exchanges in a unique platform and thus reducing the costs for all participants.

Find below the CDM Portal resource interactions for EXE#4 Demonstration exercises:

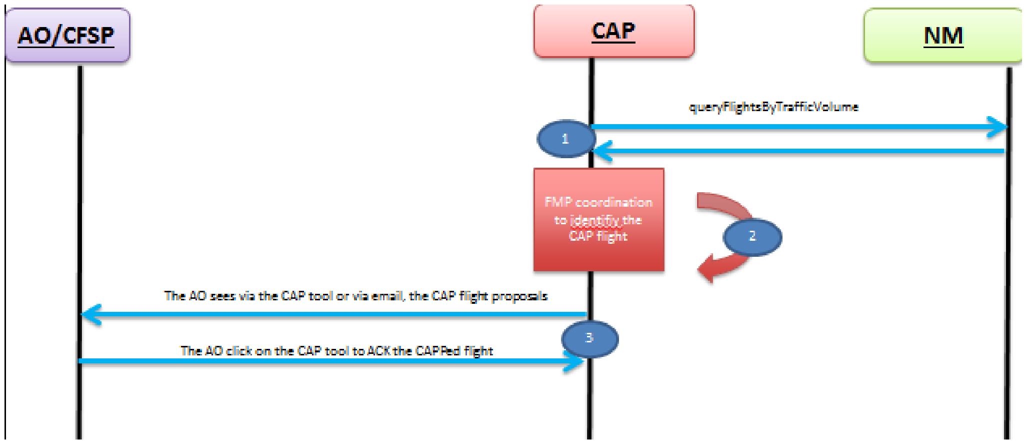


Figure 126 - Resource interactions EXE#4 Demonstration exercises

During the evaluations,

- the CDM Portal was used to follow the sequence of events of the CAP process
- and the NOP portal was used to perform the simulations of regulations (SIMEX) and the retrieval of the actual traffic data of the day (TL, RD, etc.). NMIR function from NOP portal was also used to obtain Post Operational data.

During the first iteration the FMP used the CDM Portal to send the details of the foreseen regulation to the person doing the SIMEX simulations.

Demonstration technique

To evaluate the demonstration exercise objectives, two types of assessment were defined; a quantitative assessment performed in the first iteration and a qualitative assessment of the results obtained from the second and third iterations.

Qualitative assessment

CAP is a new tool for a part of the Demonstration participants, with new functionalities and additional live interactions with other operational stakeholders. To qualitatively assess the impact of CAP tool and process supporting fine-tuned DCB resolution, the following means have been used:

- Questionnaires → Two different online questionnaires, one for the FMPs and the other one for the AU Flight Dispatchers, delivered to the participants at the end of each iteration to be answered.
- Debriefing sessions → Two debriefing sessions, one with FMP managers and the other one with AU Managers, were organized at the end of each iteration to gather the high level feedback (positive points, remarks, proposals for improvement, etc.).
- CDM chat live discussions → Analysis of the CDM chat to gather the main requests and benefits formulated by the operational stakeholders during the trials.
- Operational benefit button → A button has been created for the third iteration to allow the FMPs to inform about the foreseen operational benefit yielded by the CAP measure.

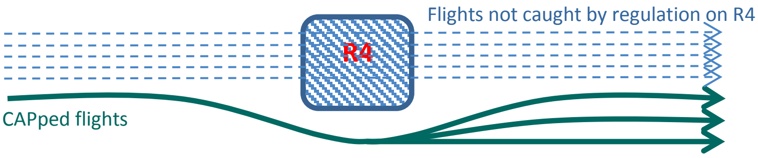
Quantitative analysis

During the exercises, the following data were logged every day to be analysed in a post-operations phase:

- Number of CAP proposals / accepted CAP proposals by the AU
- List of flights level capped (AU informing the flight has been refiled as per CAP proposal)
- List of activated/cancelled regulations and scenarios
- Operational benefit feedback

Besides, during the first iteration, a quantitative evaluation of a specific French airspace was done by performing daily simulations of regulation, in order to prove that local CAP process contributes to the reduction of the ATFM delays in the network (EXE#4-OBJ-VLD-05-002). The objective of CAP process is to off-load an overloaded volume presenting a limited traffic peak. The assumption is that, thanks to the removal of a limited quantity of flights from the volume, the regulation is either:

- avoided and all flights (except the ones CAPped) can fly through the initially planned TV without being caught by a regulation,
- or the regulation is not avoided but it impacts less flights on a shorter period of time



(and/ or with a less restrictive rate).

Figure 127 - Example of CAP process

The method used/steps followed to collect the quantitative results is the following:

- The day of operations, in preparation of late morning peak hours:
    1. FMP sending CAP proposals (flight level capping) to AUs around H-4h (before entry into over-loaded sector) to off-load a specific or a group of traffic volume(s).
    2. FMP informing the person in charge of doing the SIMEX, through CDM Portal, about foreseen regulation being replaced by CAP proposals.
    3. Creating a simulation of regulation at H-3h30 through SIMEX in NOP Portal with the foreseen regulation details provided by FMP
    4. AUs refiling FPL as per CAP proposals
    5. Creating a second simulation of regulation through SIMEX in NOP Portal once all the AUs have been refiled.
- In Post operations:
    5. Verification if any regulation was implemented in the off-loaded TV
    6. Analysis of the flight plan adherence of the flight level capped flights
    7. Extraction of RD and TL corresponding to "off-loaded" TV and schedule
    8. Extracting actual delays from list of flights caught in simulation (which correspond to Traffic Demand of the TV at that time) – TBD

    Most of the post operations data was obtained the same day of operations in the NOP portal, otherwise through the NMIR function.

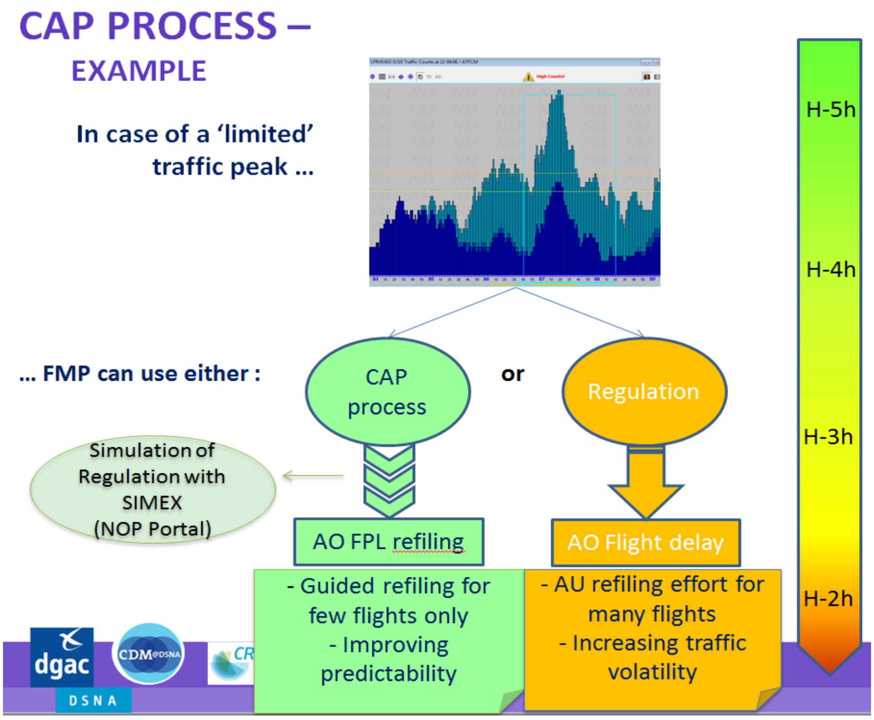


Figure 128 - Timeframe of the CAP process

G.1.2 Summary of Demonstration Exercise #04 Demonstration Objectives and success criteria

The table below provides a summary of the Demonstration objectives and the success criteria addressed by the exercise. Note that EX4-OBJ-VLD-04-001 objective has been removed as not applicable as per the final scope of the exercise (no participation of NMOC).

Demonstration Objective (as in section x.x)	Demonstration Success criteria (as in section x.x)	Coverage and comments on the coverage of Demonstration objectives (as in section x.x)	Demonstration Exercise 4 Objectives	Demonstration Exercise 4 Success criteria
OBJ-VLD-01-001	**CRT-VLD-01-001**	Partially covered: Exercise 4 activities form part of overall network cooperative processes and **"extended CAP" solution** contributes therefore partially to the objective as described.	**EX4-OBJ-VLD-01-001** Demonstrate the acceptable increase in workload for network operations planning actors to apply CAP measures to optimally use network capacity	**EX4-CRT-VLD-01-001** The usage of CAP measure does not have a negative impact on ATM operational staff (ATFCM) workload
OBJ-VLD-01-004	**CRT-VLD-01-004**	Exercise 4 activities form part of overall network cooperative processes and **"extended CAP" solution** contributes therefore partially to the objective as described.	**EX4-OBJ-VLD-01-004**: Demonstrate the improvement in situational/planning awareness for all actors regarding local/network DCB situation and the measures applied **in the frame of the CAP process.**	**EX4- CRT-VLD-01-004** Positive feedback from all actors regarding CAP process

Demonstration Objective (as in section x.x)	Demonstration Success criteria (as in section x.x)	Coverage and comments on the coverage of Demonstration objectives (as in section x.x)	Demonstration Exercise 4 Objectives	Demonstration Exercise 4 Success criteria
OBJ-VLD-02-002[10] **(New!)**	**CRT-VLD-02-002**	Partially covered: Exercise 4 activities form part of overall network cooperative processes and **CAP process** contribute therefore partially to the objective as described.	**EX4-OBJ-VLD-02-002**: Demonstrate the reduction of the margins between planning and actual for flight entering the ACC AoR due to unforeseen changes in the execution of the European Network operations.	**EX4-CRT-VLD-02-002**: Perception of a lower traffic volatility
OBJ-VLD-04-002	**CRT-VLD-04-002**	Exercise 4 activities form part of overall network cooperative processes and **"extended CAP" solution** contributes therefore partially to the objective as described.	**EX4-OBJ-VLD-04-002** Demonstrate the Reduction in time for AU staff to monitor, analyse, coordinate and implement measures to balance demand – capacity because of the predefined option in strategic phase.	**EX4-CRT-VLD-04-002** Positive feedback from AU Flight Dispatchers regarding the time to monitor, analyze, coordinate and implement fine-tuned DCB measures
OBJ-VLD-04-003	**CRT-VLD-04-003**	Exercise 4 activities form part of overall network cooperative processes and **"extended CAP" solution** contributes therefore partially	**EX4-OBJ-VLD-04-003** Demonstrate the reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity **thanks to**	**EX4-CRT-VLD-04-003** Positive feedback from FMPs regarding the time to monitor, analyze, coordinate and implement CAP measures

[10] EX4-OBJ-VLD-02-002 objective is not defined in DEMO Plan but it has been included because we considered the Live Trial was a good opportunity to assess the hypothesis that CAP process improves the predictability of the traffic.

Demonstration Objective (as in section x.x)	Demonstration Success criteria (as in section x.x)	Coverage and comments on the coverage of Demonstration objectives (as in section x.x)	Demonstration Exercise 4 Objectives	Demonstration Exercise 4 Success criteria
		to the objective as described.	**the preliminary coordination of options between partners in strategic phase.**	
OBJ-VLD-05-002	**CRT-VLD-05-002**	Exercise 4 activities form part of overall network cooperative processes and **"extended CAP" solution** contributes therefore partially to the objective as described.	**EX4-OBJ-VLD-05-002** Demonstrate the reduction in ATFM delay in the network **thanks to the CAP measures**	**EX4-CRT-VLD-05-002** The accumulation of ATFM delay due to DCB issues in the network is reduced thanks to the application of CAP measures.

G.1.3 Summary of Validation Exercise #04 Demonstration scenarios

SCN-EX4		
Scope of the Demonstration Exercise	Coordination of Flight Level Capping between two ACCs from different ANSPs: ENAIRE and DSNA. The French FMP (Bordeaux ACC) will coordinate with the corresponding ENAIRE FMP in the involved Spanish ACCs (Madrid ACC) the implementation of Level Capping in specific flights to reduce the creation of regulations or to minimize their effect.	
Validation Objectives	EX4-OBJ-VLD-01-001 EX4-OBJ- VLD-01-004 EX4-OBJ-VLD-02-002 EX4-OBJ-VLD-04-002 EX4-OBJ-VLD-04-003 EX4-OBJ-VLD-05-002	
Operational Context	Airspace Information The operational context for the demonstration activity will correspond to Bordeaux ACC boundary sectors and the corresponding sectors in the Spanish side. Free Route is not applicable.	
	Airport Information N/A	
	Traffic information Regular traffic for a typical summer and winter day in Bordeaux ACC.	
	Variants N/A	
Key Roles	FMP acts mainly in medium to short term; they lead the DCB processes for the ACC, monitor the situation at local level and anticipate hotspots and workload issues. In the exercise context, CAP tool helps FMP to optimize decisions to manage DCB through fine-tuned measures in a collaborative process with AUs during the planning phase. AUs involved in the CAP process participate by refilling their flight plan as per FMP proposal.	
Assumptions	Same as in section F1.4	

EXE#4 Extended CAP Demonstration exercise is divided into 3 iterations:

- Two iterations in 2017:
  - **Iteration 1 corresponds to the BRY-CLM CAP process**

At European scale, the BRY-CLM CAP process is represented by the green flows in the picture below:

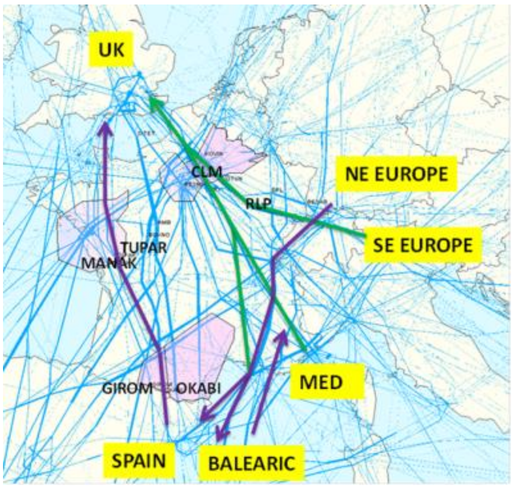


Figure 129 - BRY- CLM CAP process at European level

At a sector level, the scenario of reference for the exercise is the following:

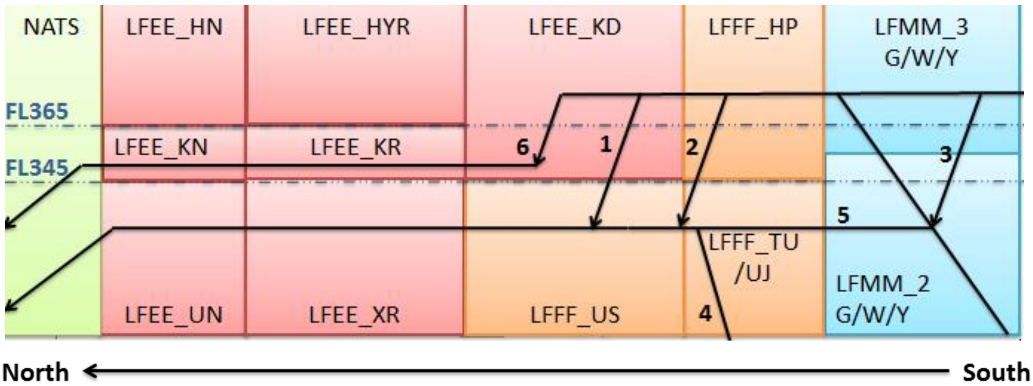


Figure 130 BRY-CLM Refiling Options in 2017

1. Descent from LFEE to LFFF
2. Descent within LFFF
3. Descent within LFMM
4. Level Capping to FL340 (ADEP LSGG, LFLL)
5. Level Capping to FL340
6. Level Capping from LFEE to LFEE

The picture above illustrates a set of trajectory options, defined in strategic phase, helping to mainly off-load LFEE_HYR sector and/or the neighboring sectors (in red color). This process involves coordination between 3 French ACCs (LFEE, LFFF and LFMM) and various Airspace Users.

- **Iteration 2 corresponds to the initialization of Madrid –Bordeaux CAP process with new partners**;

For this second iteration in 2017, new flows have been discussed between Madrid and Bordeaux FMPS, leading to the integration of new flows in the CAP tool, made available to 3 new AUs; Iberia, Air Nostrum and Air Europa.

The scenarios of reference for the exercise CAP Madrid Bordeaux are the following:

- LUSEM -> LULUT

  Principle: off-loading LFBBZ34 sector by refilling the lower sectors

  Impacted flights: flows south – north, via LUSEM-LULUT, landing to Paris airports (LFP*)

  Participating airlines: IBE, ANE, AEA

  FPL refiling options:

  a. Full Level CAP 340/360
  b. Late Climb LUSEM/BMC
  c. Free Request

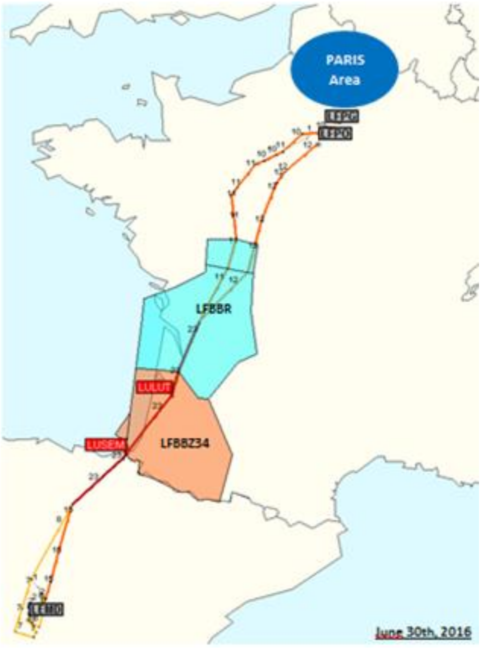


Figure 131 - Example of trajectory eligible to LUSEM - LULUT process

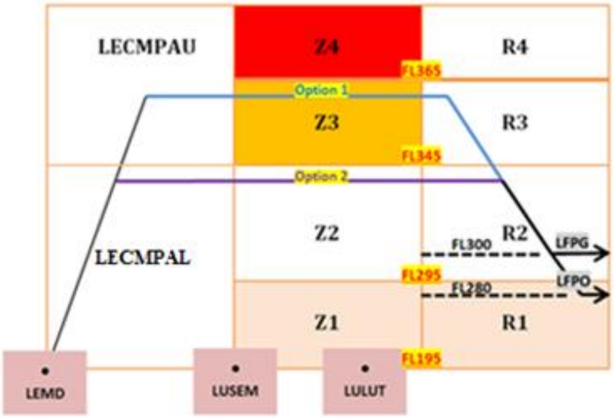


Figure 132 - Refiling options scheme for LUSEM - LULUT process

- LATEK -> GAI

  Principle: off-loading LFBBZ34 and LFBBN34 sectors by refilling the lower sectors

  Impacted flights: flow departing from LEMD via LATEK-GAI to Switzerland (LSG*; LSZ*), North Italy (LIM*; LIP*; LIR*) and Lyon (LFL*)

  Participating airlines: IBE, ANE, AEA

  FPL refiling options:

  a. Late Climb GAI 340/360
  b. Full Level CAP 340/360
  c. Free Request

Figure 133 - Example of trajectory eligible to LATEK - GAI process

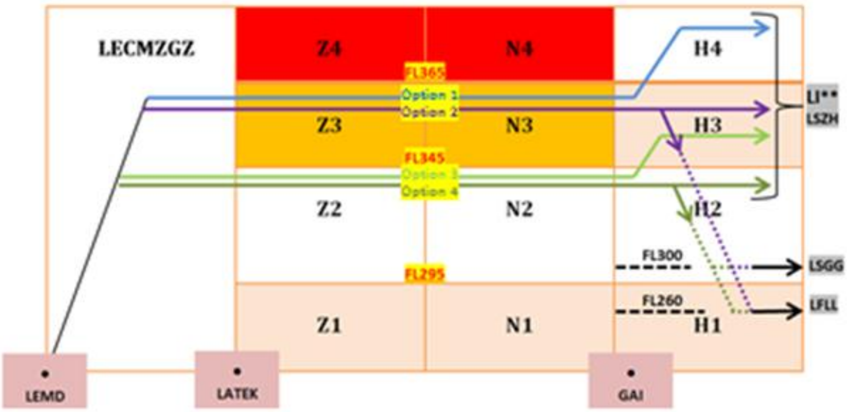


Figure 134 - Refiling options scheme for LATEK - GAI process

- ABRIX -> LUSEM

  Principle: off-loading LECMDGU and LECMPAU sectors by refilling the lower sectors

  Impacted flights: flow departing from LEMD via ABRIX – LUSEM to North Europe, Germany, France and Holland.

  Participating airlines: IBE, ANE, AEA

  FPL refiling options:

  a. Late Climb CEGAM/LUSEM 340
  b. Free Request

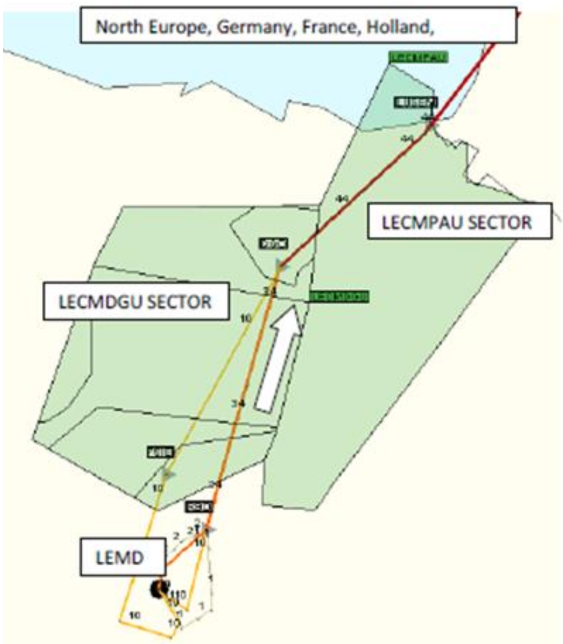


Figure 135 - Example of trajectory eligible to ABRIX - LUSEM process

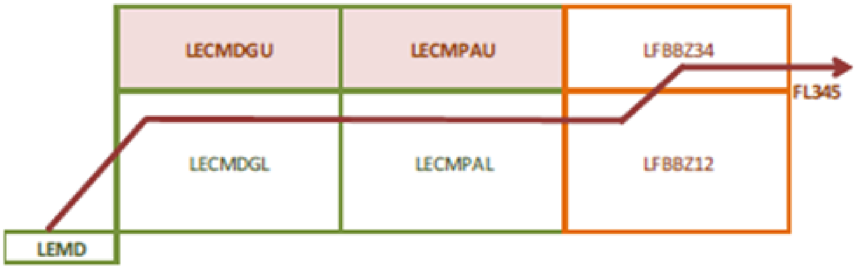


Figure 136 - Refiling options scheme for ABRIX - LUSEM process

- LFBB -> LECM

  Principle: off-loading LECMPAU sector by refilling the lower sectors

  Impacted flights: flow arriving to LEMD via THUNE from North Europe (ES*; EN*; EF*; EK*), Russia (ULLI), Germany (ED*), Belgium (EB*), France (LFP*; LFOB), United Kingdom (EG*) and Netherlands (EH*).

  Participating airlines: IBE, ANE, AEA

  FPL refiling options:

  a. Early Descent ENSAC 330
  b. Free Request

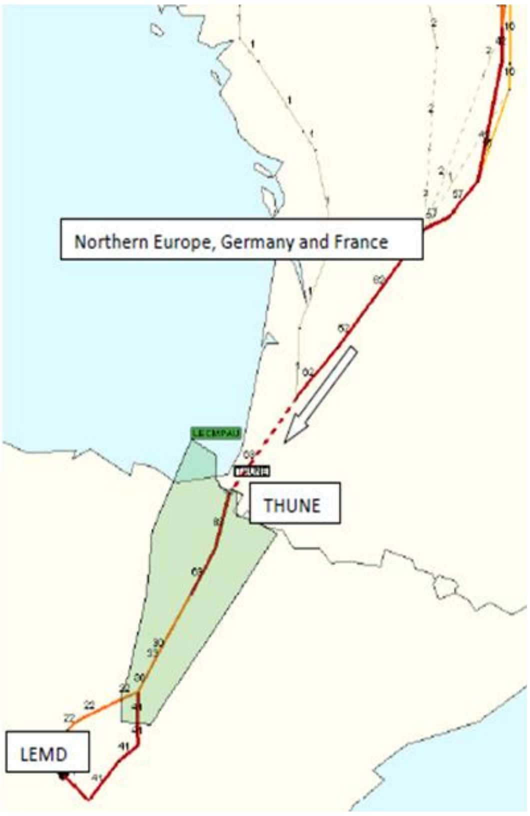


Figure 137 - Example of trajectory eligible to LFBB - LECM process

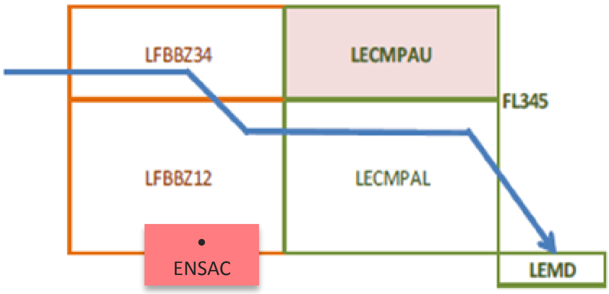


Figure 138 - Refiling option scheme for LFBB - LECM process

- One iteration in 2018:
  - **Iteration 3 corresponds to the consolidation of the coordination and evaluation of Madrid –Bordeaux CAP process**. Iberia Express has also joint the exercise.

The scenarios of this iteration corresponds to the ones used in Iteration 2 with few waypoints changed following the update of the routes.

To note that ENAIRE participated in the 2nd and 3rd iteration of EXE#4. This corresponds to the 1st and 2nd iteration of EXE#6.

G.1.4 Summary of Demonstration Exercise #04 Demonstration Assumptions

No change with respect to the DEMO Plan PJ24 NCM EXE#4.

G.2 Deviation from the planned activities

NM integration into CAP process

PJ24 activities have facilitated coordination between partners, especially with NM, who was not actively involved in CAP operational process before the Demonstration. EXE4 Demonstration has created the opportunity for CAP to take a step further towards Network Collaborative Management, with the objectives to:

- Standardize as much as possible the process and interface to limit the additional workload and the costs associated to human and technical resources (for both AUs and ANSPs).
- Give Network Visibility to CAP measures, for better traceability and post operations analysis,
- Secure the slot for AUs refiling according to CAP Proposal, to avoid the 'Late Updater Status', and more generally speaking, any 'double penalty' for the flights.

This opportunity has been identified during the first iteration of EXE4 in summer 2017, and coordination between PJ24 PM, NM representatives and DSNA Technical PoC have led to the decision to study the technical feasibility of NM B2B messages supporting CAP process, as described below.

Note: To secure realistic use of resources and avoid impact on operational NM Ops environment, it is important to note that the scope of this additional activity in SESAR 2020 PJ24 is strictly limited to the technical feasibility. Any further testing involving operational staff in live conditions is out of scope.

After several F2F meetings and coordination between DSNA and NM technical support during the first half of 2018, the following process has been built (**Error! Reference source not found.**):

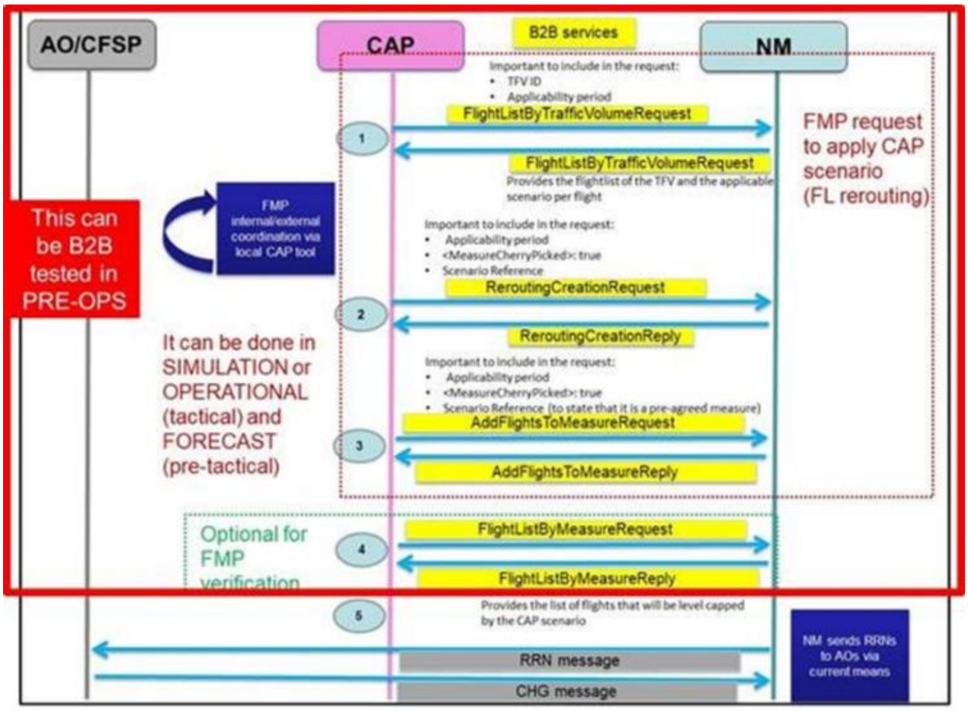


Figure 139 - Proposal for CAP supported by NM B2B services

G.3 Demonstration Exercise #04 Results

G.3.1 Summary of Demonstration Exercise #04 Demonstration Results

The following table summarizes the demonstration results by objective. Note that EXE#4 is planned through a cycle of three iterations refined in an iterative process. Results below are a pondered assembly of the results from the three iterations.

To set the conclusions, a ponderation of the results from second and third iteration was done (reminder: corresponding to first and second iteration for new FMP CAP users). More weight was given to results from third iteration, i.e. to the FMP Managers debriefing, to integrate the facts that tool improvements were done based on the feedback provided by FMPs and that the new FMP CAP users were more familiar and experienced with the tool and process.

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Sub-operating environment	Exercise Results	Demonstration Objective Status
EX4-OBJ-VLD-01-001	Acceptable increase in workload for network operations planning actors to apply CAP measures to optimally use network capacity	EX4-CRT-VLD-01-001	The usage of CAP measure does not have a negative impact on ATM operational staff (ATFCM) workload	En-route airspace – Medium Complexity	CAP process does not create an excessive workload for the FMPs and, if the quantity of work or mental workload increases, they mainly perceive it as acceptable.	OK
EX4-OBJ-VLD-01-004	Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied by the CAP process.	EX4-CRT-VLD-01-004	Positive feedback from all actors regarding CAP process.	En-route airspace – Medium Complexity	According to FMP feedback, CAP helps to improve the level of ATFCM situation awareness beyond the ACC boundaries and to increase the transparency and trust between FMPs and AUs. The improvement of situational/planning	OK

					awareness is not so clear for AUs but they think that CAP process encourages communication and team working between ACCs and airlines.	
EX4-OBJ-VLD-02-002[11] (New!)	Reduction of the margins between planning and actual for flight entering the ANSP's AoR due to unforeseen changes in the execution of the European Network operations.	EX4-CRT-VLD-02-002	Perception of lower traffic volatility	En-route airspace – Medium Complexity	The results of the FMP and AU questionnaires show that CAP process is moderately perceived as an influencer to the reduction of traffic volatility. 50% of the FMPs and 20% of the AUs think that CAP process brings better predictability.	Partially OK
EX4-OBJ-VLD-04-002	Reduction in time for AU staff to monitor, analyze, coordinate and implement measures to balance demand – capacity because of the pre-defined options in strategic phase.	EXE4-CRT-VLD-04-002	Positive feedback from AU Flight Dispatchers regarding the time to monitor, analyze, coordinate and implement CAP measures	En-route airspace – Medium Complexity	CAP process has a positive impact for AU staff	OK
EX4-OBJ-VLD-04-003	Reduction in time for FMP staff to monitor, analyse, coordinate and implement	EXE4-CRT-VLD-04-003	Positive feedback from FMPs regarding the time to monitor,	En-route airspace – Medium Complexity	The tool is considered easy to use and flexible by most of the FMPs. However, the two group of FMPs (different ACCs) differ regarding the	Partially OK

[11] EX4-OBJ-VLD-02-002 objective is not defined in DEMO Plan but it has been included because we considered the Live Trial a good opportunity to assess the hypothesis that CAP process improves the predictability of the traffic.

	measures to balance demand – capacity because of the pre-defined options in strategic phase.		analyze, coordinate and implement CAP measures		efficiency of CAP measures to solve DCB issue.	
EX4-OBJ-VLD-05-002	Reduce ATFM delay in the network thanks to CAP measures	EXE4-CRT-VLD-05-002	The accumulation of ATFM delay due to DCB issues in the network is reduced thanks to the application of CAP measures.	En-route airspace – Medium Complexity	12 out of 15 days of potential regulation were avoided corresponding to 4111min of ATFM delay (1st iteration of CAP VLD). The majority of FMPs and AUs perceives that CAP process has a positive impact on the reduction of regulations and ATFM delays in the network.	OK

Table 39: Exercise 4 Demonstration Results

1. Results per KPA

KPA	Objective ID	KPA result
Safety	Obj 01-001 Obj 01-004	As explained in G.3.21 and G.3.22, FMP thinks that safety is not compromised when applying CAP measures by using the CAP tool. Furthermore, results show that CAP process creates a feeling of working together, that is to say, it improves coordination between partners.
Predictability	Obj 02-002	As elaborated in G.3.23, results show that CAP process is moderately perceived as an influencer to the improvement of predictability of traffic for an ANSP.
Efficiency	Obj 04-002 Obj 04-003	As explained in G.3.25 and G.3.26, the use of CAP process and tool is perceived as easy to use, flexible and useful for most of the participants. Thus, the evaluated measure and tool from the ATFCM toolbox contributes to the efficiency of Airspace Users and ANSPs processes to solve DCB issues.
Capacity	Obj 05-002	Quantitative and qualitative results stated in G.3.27 show

		a tendency towards and perception of reducing the quantity of regulations and the ATFM delays to the network thanks to CAP process and thus increasing the use of available airspace capacity.

2. Results impacting regulation and standardisation initiatives

Not applicable.

G.3.2 Analysis of Exercises Results per Demonstration objective

This section presents the qualitative and quantitative analysis of the results gathered from the different iterations of the CAP Live Trial. The results are obtained from:

- The questionnaires answered by the FMPs and the AUs' Flight dispatchers that used the CAP tool. The FMPs filled it after the second iteration and the AUs after third iteration,
- the feedback of the FMPs and AUs managers during the debriefing sessions after second and third iterations,
- the SIMEX simulations of regulations held during the first iteration of CAP Live Trial,
- CDM chat live discussions between partners (FMPs and Flight Dispatchers) all along the three iterations and
- operational benefit shared by FMPs when proposing a measure via Operational Benefit button or CDM chat during the third iteration.

For further information regarding the demonstration technique, see cf. G.1.1 "*Demonstration technique*".

The following table correlates the objectives and associated success criteria with the items addressing them.

Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria	Items addressing the Objective
EX4-OBJ-VLD-01-001 Acceptable increase in workload for network operations planning actors to apply CAP measures to optimally use network capacity	**EX4-CRT-VLD-01-001** The usage of CAP measure does not have a negative impact on ATM operational staff (ATFCM) workload	• Queries 2, 13(ab), 14(ab), 15(ab) - FMPs questionnaire • FMP managers debriefing
EX4-OBJ-VLD-01-004 Improved situational/planning awareness for all actors regarding local/network DCB situation and the	**EX4-CRT-VLD-01-004** Positive feedback from all actors regarding CAP process.	• Queries 1(ghi), 21(efgh), 24(abcde), 26 – FMPs questionnaire

measures applied by the CAP process.		• Queries 1(fghi), 4(i) – AUs questionnaire • AU managers debriefing
EX4-OBJ-VLD-02-002 Reduction of the margins between planning and actual for flight entering the ANSP's AoR due to unforeseen changes in the execution of the European Network operations.	**EX4-CRT-VLD-02-002** Perception of lower traffic volatility	• Queries 1(f), 24 – FMPs questionnaire • Queries 1(f) – AUs questionnaire
EX4-OBJ-VLD-04-002 Reduction in time for AU staff to monitor, analyse, coordinate and implement measures to balance demand – capacity because of the pre-defined options in strategic phase.	**EXE4-CRT-VLD-04-002** Positive feedback from AU Flight Dispatchers regarding the time to monitor, analyse, coordinate and implement fine-tuned DCB measures	• Queries 2, 3, 4(abe), 5, 7, 8 • AU managers debriefing
EX4-OBJ-VLD-04-003 Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity thanks to the preliminary coordination of options between partners in strategic phase.	**EX4-CRT-VLD-04-003** Positive feedback from FMPs regarding the time to monitor, analyze, coordinate and implement CAP measures.	• Queries 2, 7, 9, 10, 11, 27, 28, 29 – FMP questionnaire • FMP managers debriefing
EX4-OBJ-VLD-05-002 Reduce ATFM delay in the network thanks to the application of CAP measures	**EXE4-CRT-VLD-05-002** The accumulation of ATFM delay due to DCB issues in the network is reduced thanks to the application of CAP measures.	• SIMEX simulations of regulation • Queries 1(abcd) - FMP questionnaire • Queries 1(abcd), 4(dgh) – AU questionnaire • Operational benefit FMP feedback • AU managers debriefing

Table 40 - Correlation between the objectives, success criteria and items addressing them

1. EX4-OBJ-VLD-01-001 Results

- **FMP questionnaire:**

Concerning the quantity of work, although 75% of FMPs consider that CAP reasonably increases the workload and 25% that it increases drastically, this rise is perceived acceptable (50% rather acceptable, 25% absolutely acceptable and 25% absolutely not acceptable) because it provides relevant benefits in return. Only 25% of FMP think that CAP process creates an excessive workload.

In case of inacceptable quantity of work, 67% of FMPs temporarily stop CAP process or decide to continue the process by phone (33%).

Note: the result of 25% of FMPs perceiving CAP as originator of unacceptable workload was gathered after the very first iteration for new CAP users. This negative feedback was softened after their second iteration, as confirmed during the debriefing sessions with FMP managers. CAP Tool gets easier to use and induced additional workload is reduced as users get used to the process and practice with the tool.

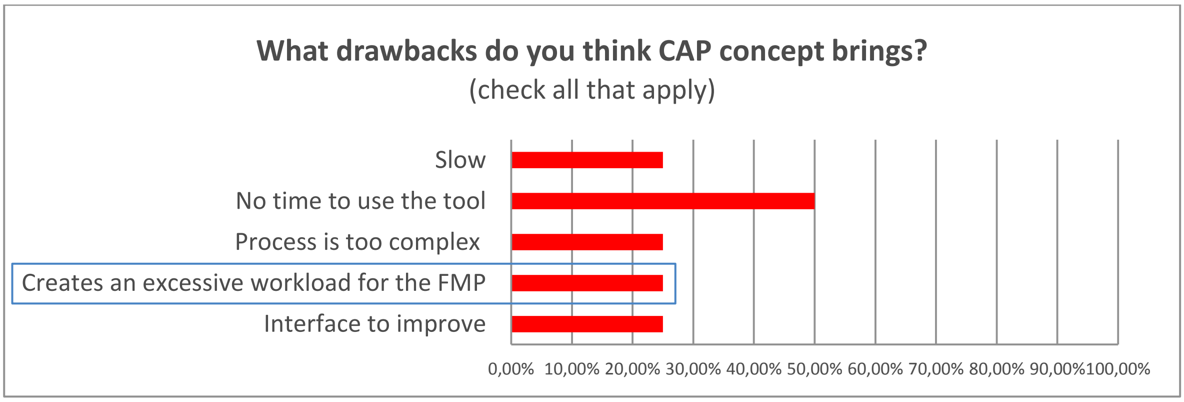


Figure 140 - Query #2 from FMP questionnaire

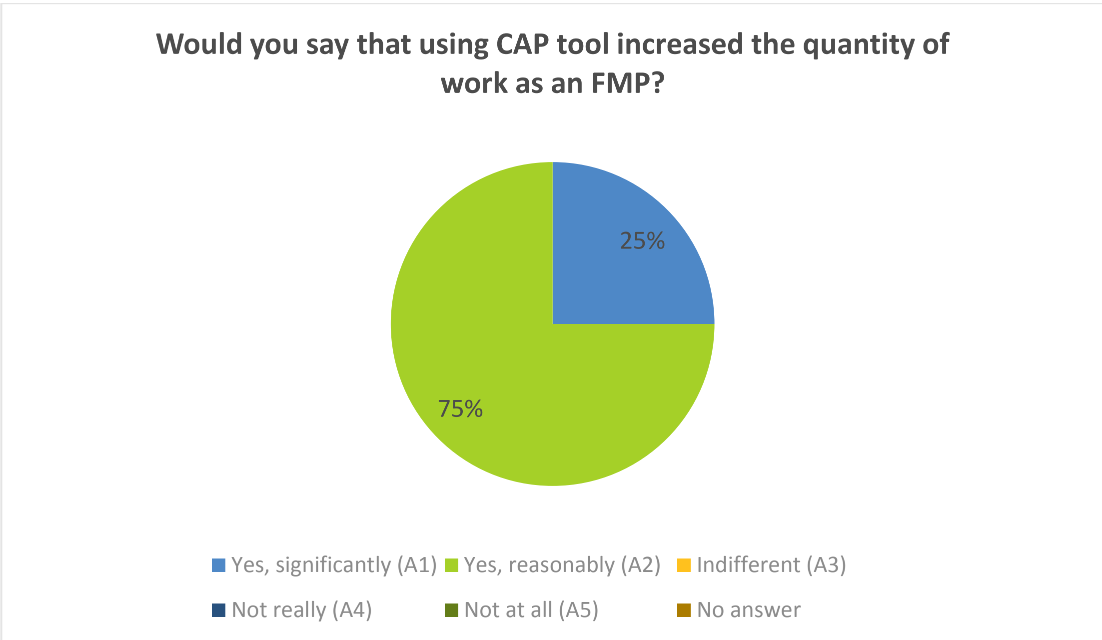


Figure 141 - Query #13a from FMP questionnaire

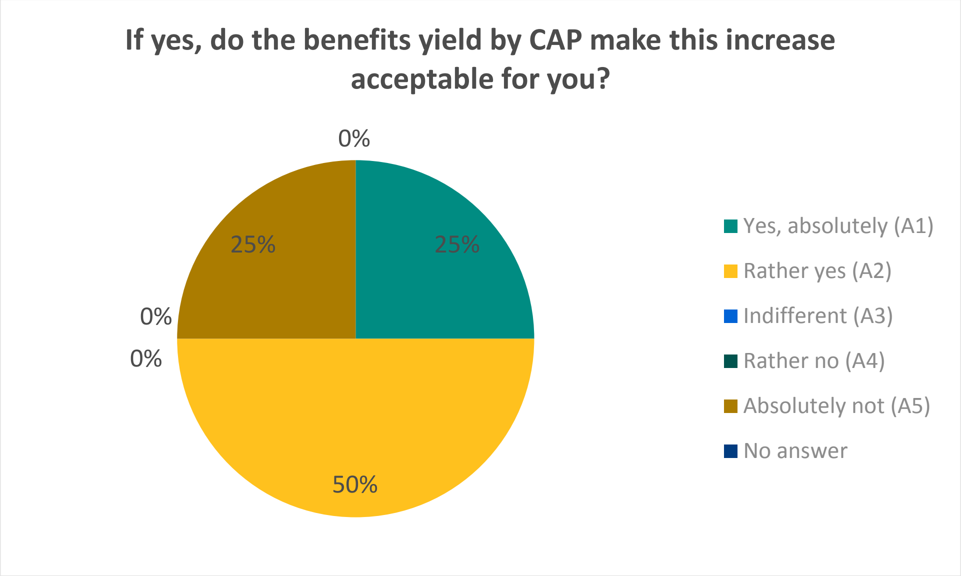


Figure 142 - Query #13b from FMP questionnaire

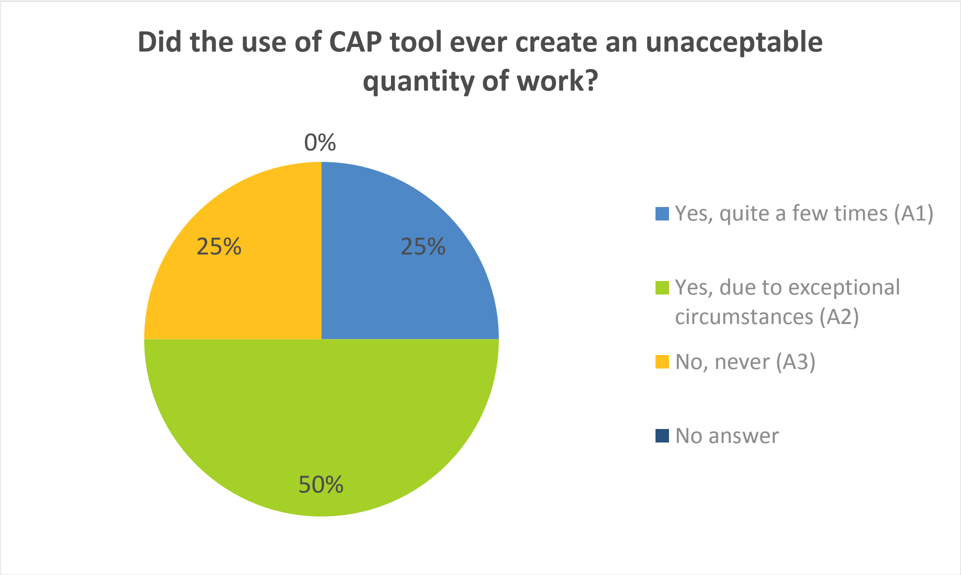


Figure 143 - Query #14a from FMP questionnaire

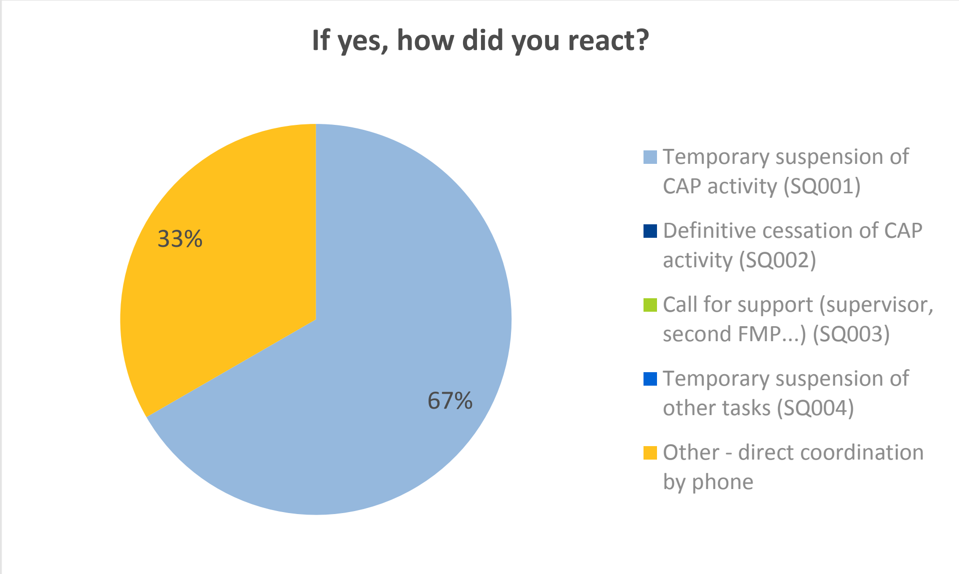


Figure 144 - Query 14b from FMP questionnaire

Concerning the mental workload, CAP tool is also assessed as creating a mental load for 25% to 50% of FMPs due to extra time-consumption, slowness and difficulties in monitoring. This can be accounted for the fact that CAP was a new tool for a group of FMP when the questionnaire was answered (the issue regarding the time consumption for the selection of candidates using the CAP tool standalone was solved in the following iteration as explained in the FMP managers' debriefing paragraph).

Besides, these drawbacks can be pondered against the 'nice-to-have' status of the CAP tool. CAP is an additional tool within the ATFCM toolset aiming at helping operational stakeholders but not essential to perform standard FMP tasks.

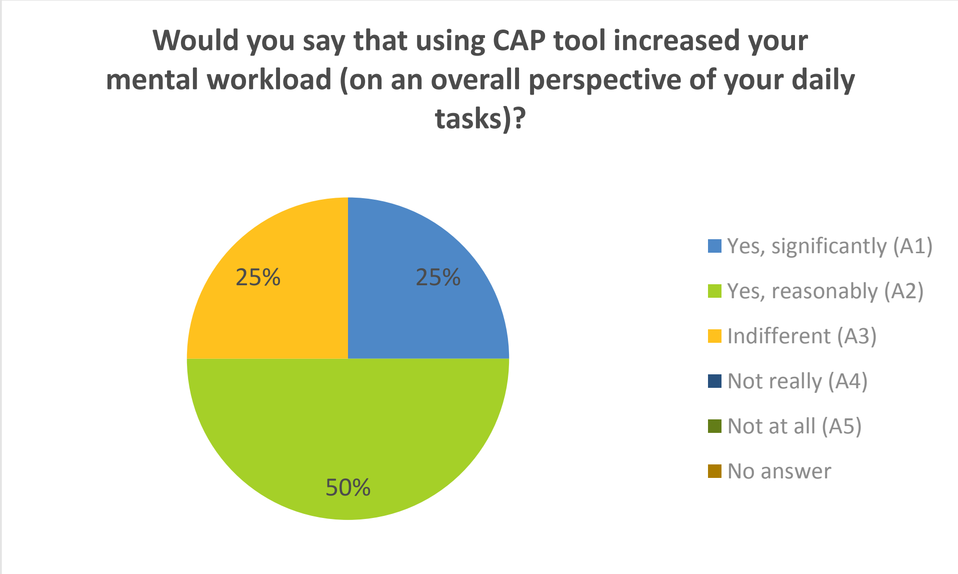


Figure 145 - Query #15a from FMP questionnaire

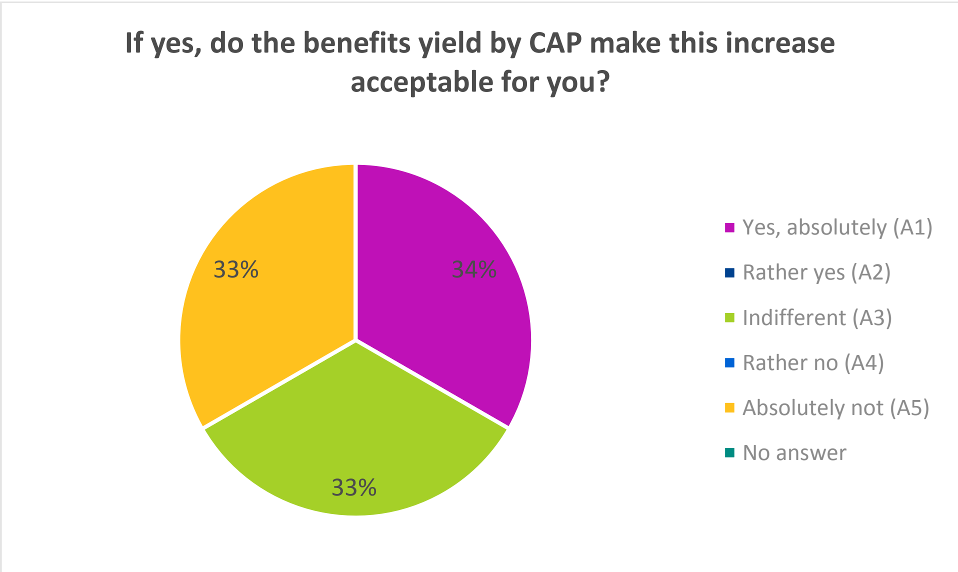


Figure 146 - #15b from FMP questionnaire

- **FMP manager debriefing:**

The manager of the new FMP group informed that new FMP CAP users appreciated the modifications made in the tool for the third iteration of CAP Live Trial. It contributed to the flexibility of use and to the higher quantity of candidates available. Thus, the feeling of loss of time in the selection of candidates and the increase of mental workload (expressed in the first iteration) reduced in the third iteration.

- **Conclusions:**

To set the conclusions, a ponderation of the results from second and third iteration (reminder: corresponding to first and second iteration for new FMP CAP users) has been done. More weight have been given to results from third iteration, thus to the FMP Managers debriefing, to integrate the fact that the tool was improved taking into account the feedback from FMPs and that the new FMP CAP users were more familiar with the tool and confident with the process.

We conclude that CAP process does not create an excessive workload for the FMP and, if the quantity of work or mental workload increases, this is mainly perceived as acceptable.

2. EX4-OBJ-VLD-01-004 Results

- **FMP questionnaire**:

From a CDM point of view, CAP is considered an efficient enabler for collaborative decision making: the totality of FMP have a '*feeling of working together'* between ATM actors thanks to CAP and they raised that it helps to have a better interaction with AUs and to improve the trust level between all participants. On a 75%, FMPs think that CAP helps them understanding AU business needs and they are more ready to achieve a positive outcome for all.

On the other side, only 50% of FMPs think that CAP concept improves the link with other FMPs. This may be explained by the fact that CAP has not increased the link between FMPs but changed the communication channel between them.

Regarding the situation awareness, 75% of participating FMPs think that CAP has a positive impact on ATFCM situation awareness beyond its ACC and a neutral (75%) to positive (50%) impact on the situation awareness within the Ops room and with the Supervisor and second FMP if any.

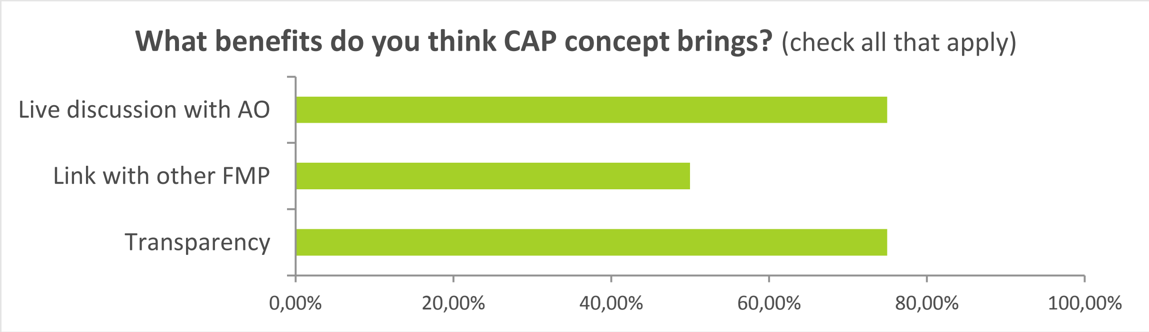


Figure 147 – Queries #1g, #1h and #1i from FMP questionnaire

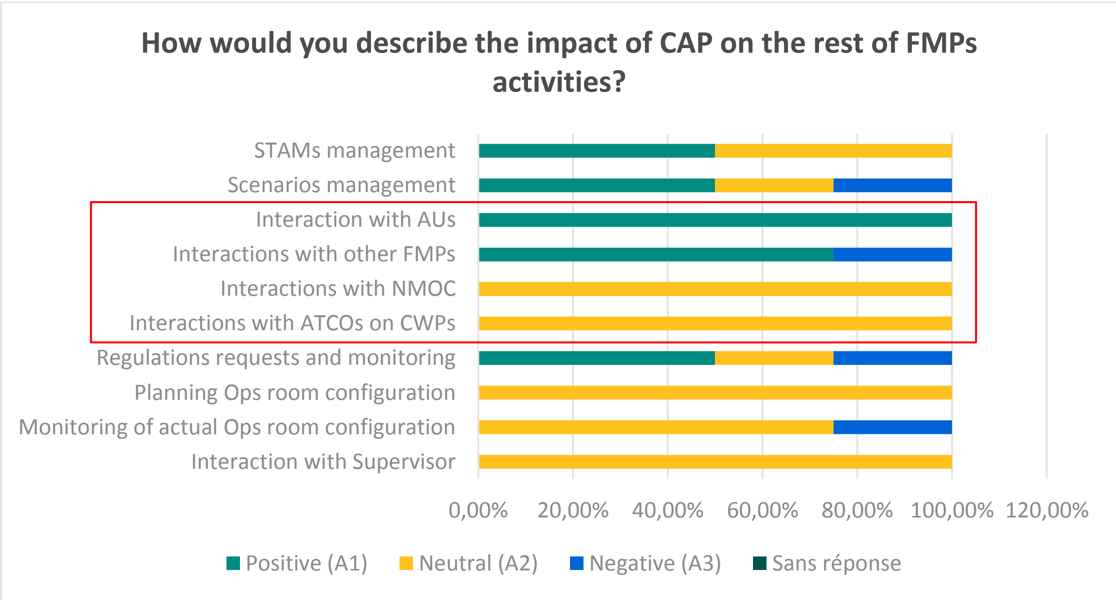


Figure 148 – Queries #21e, #21f, #21g, #21h from FMP questionnaire

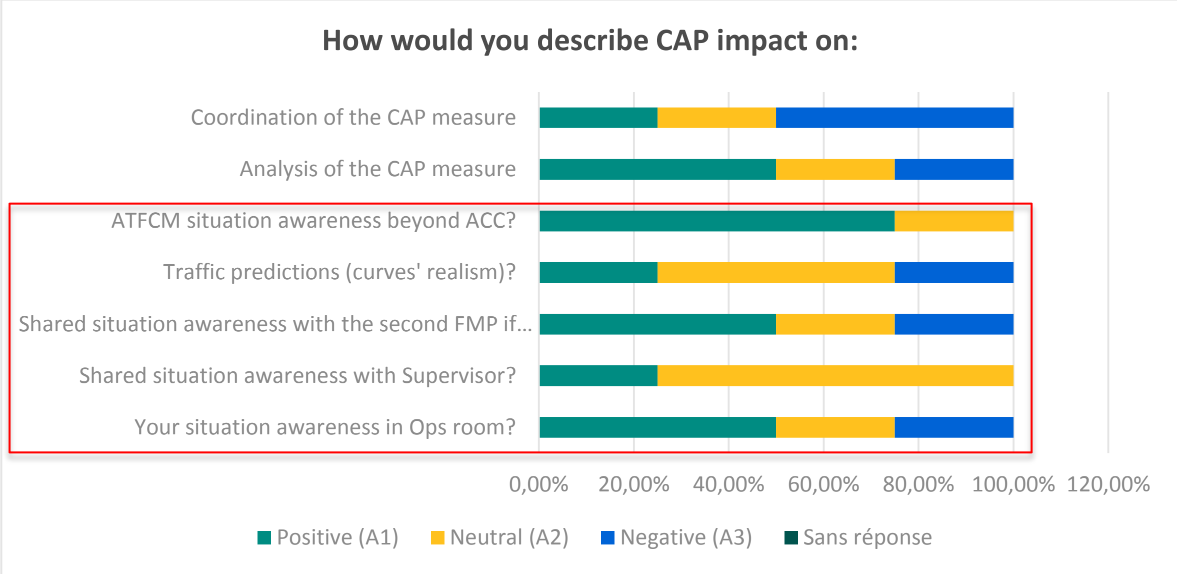


Figure 149 - Queries #24a, #24b, #24c, #24d and #24e from FMP questionnaire

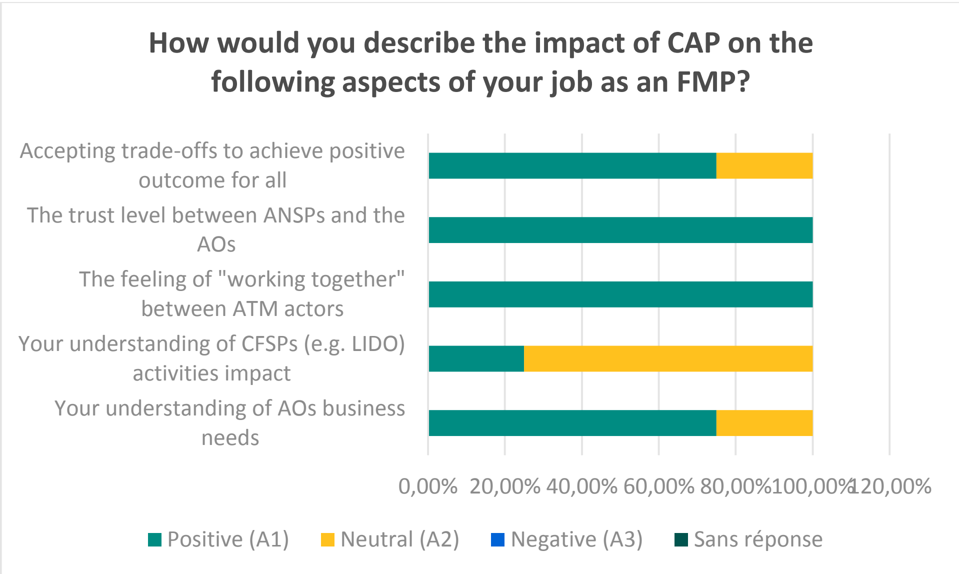


Figure 150 - Query #26 from FMP questionnaire

- **AU questionnaire**:

For Flight Dispatchers, CAP only lightly improves situational and planning awareness. The multiple choice query below shows that 40% of them think that CAP concept improves the direct link with FMPs and 20% of them that CAP concept improves the visibility of the shared situation awareness with ATM partners and reduces traffic volatility.

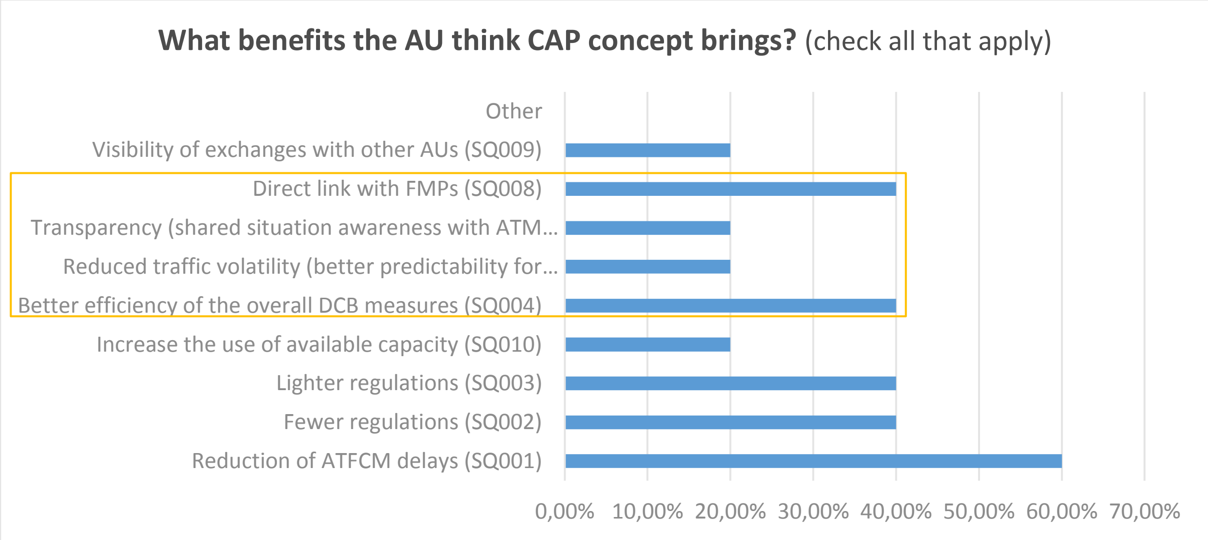


Figure 151 – Answers to queries #1f, #1g, #1h and #1i from AU questionnaire

Previous results contrast with this one where it shows that 60% of Flight Dispatchers think that CAP has a positive impact on the level of situational awareness for the AU. One of the reasons for this discrepancy may be the small amount of CAP measures during the first iteration and the little time of use, which can make general assessment and global perception of CAP benefits difficult.

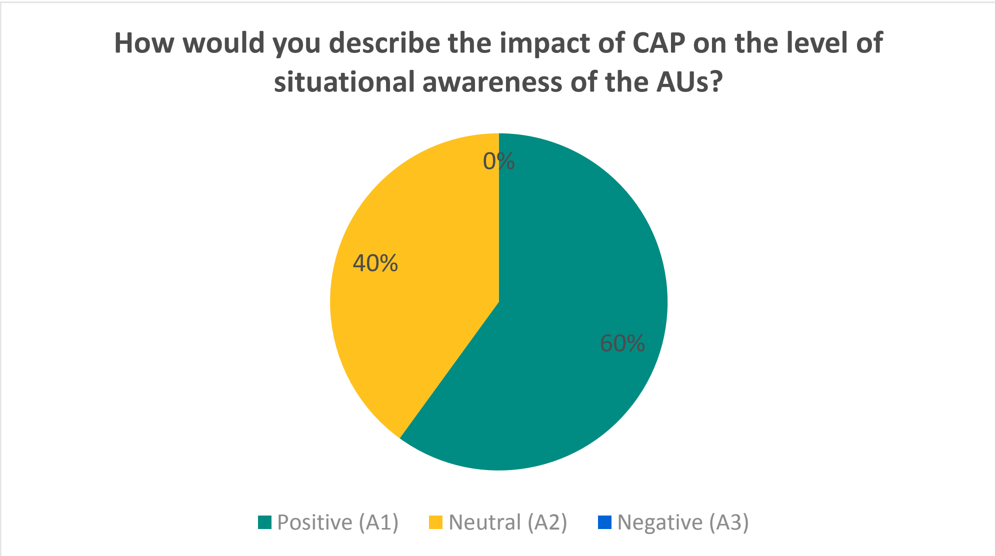


Figure 152 - Answers to query 4i from AU questionnaire

- **AU Managers debriefing** (WebEx and e-mail):

AUs informed during the debriefing WebEx that CDM chat is useful as it provides clear information avoiding misunderstandings. Phone call should remain as back-up. Another AU provided the feedback by e-mail that CAP process encourage communication and team working between ACCs and airlines.

Conclusion:

It can be deduced from the results that all participants perceives that CAP process enhances the communication between partners and thus the feeling of working together among ATM actors. Most of participants also think that CAP process improves the level of situation awareness.

3. EXE4-OBJ-VLD-02-002 Results

This objective was not initially defined in DEMO Plan. It was added in a later stage to evaluate the hypothesis that traffic volatility, caused by a regulation, can be avoided thanks to applying a CAP measure instead. Results below show that this assumption is not completely perceived likewise by FMPs and AUs.

- **FMP and AU questionnaires**

  Results below show that half of FMPs and 20% of flight dispatchers think CAP helps to reduce the traffic volatility. Furthermore, FMPs informed that CAP process has a rather neutral impact on traffic prediction.

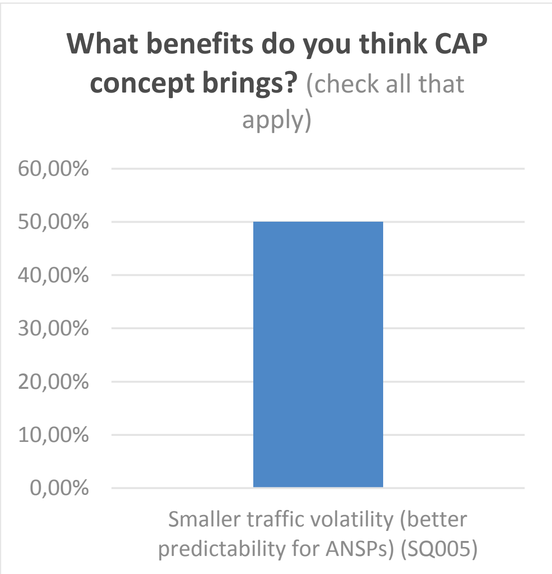


Figure 153 - Query #1f from FMP questionnaire

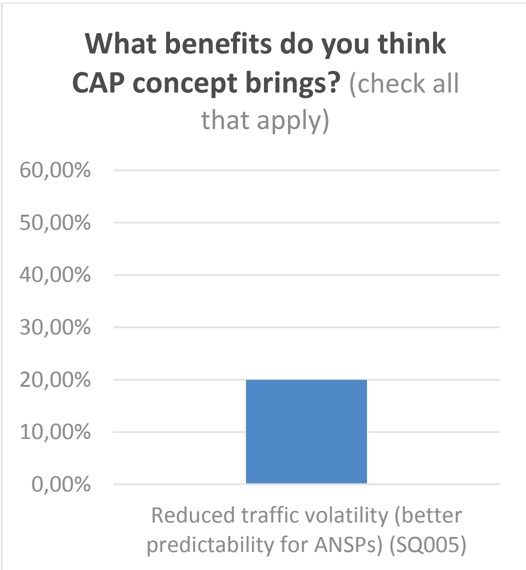


Figure 154 - Query #1f from AU questionnaire

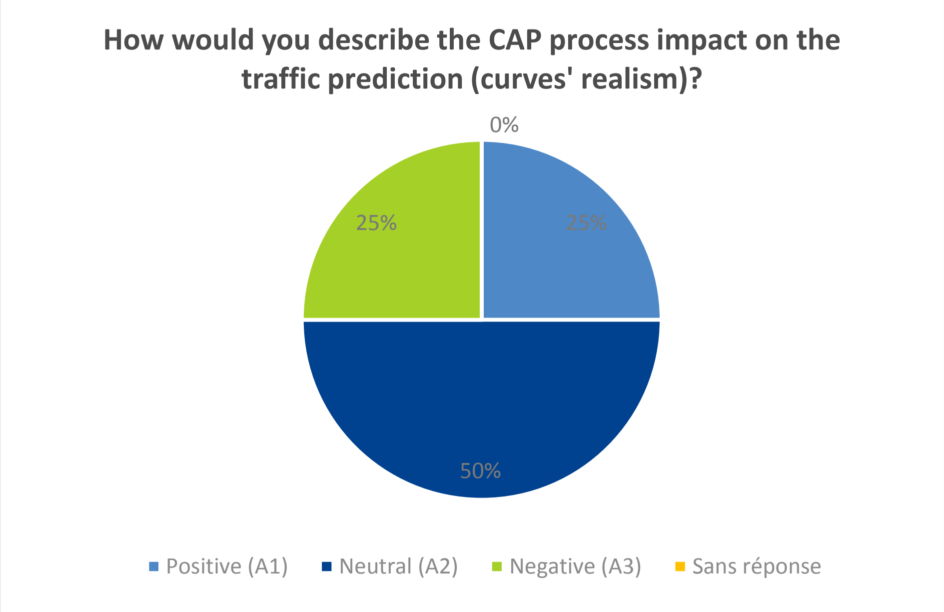


Figure 155 - Query #24d from FMP questionnaire

- **Conclusions**: Answers from the FMP and AU questionnaires show that CAP process is perceived as contributing only lightly to the reduction of traffic volatility.

4. EX4-OBJ-VLD-04-001 Results - abandoned

The objective regarding the *reduction in time for NMOC staff to monitor, analyze, coordinate and implement measures to balance demand and capacity* has been abandoned because finally the NM was not a participant of the Extended CAP Demonstration exercise.

5. EX4-OBJ-VLD-04-002 Results

- **AU questionnaire**:

The following figures show the results of the AU questionnaire answered by the Flight Dispatchers who participated in the CAP Live Trial:

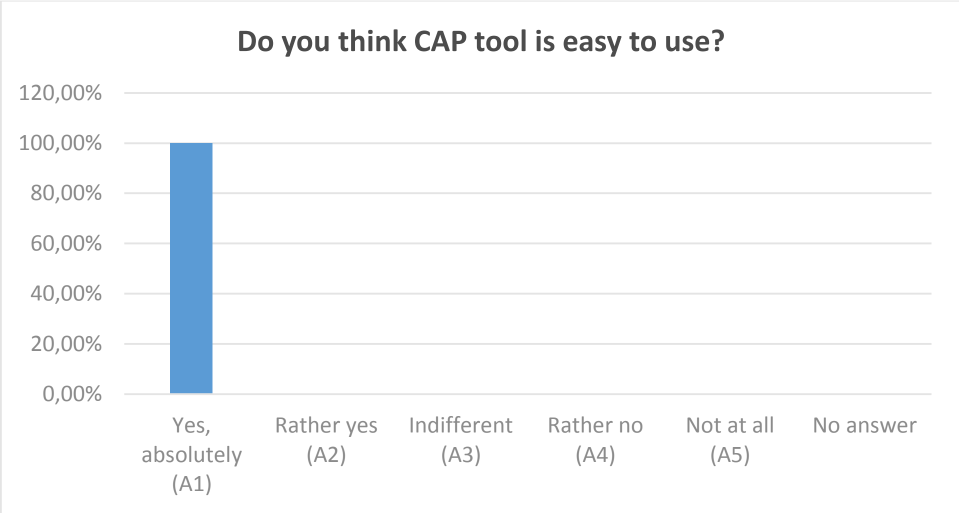


Figure 156 - Answers to query #2 from AU questionnaire

All Flight Dispatchers think that CAP tool is easy to use.

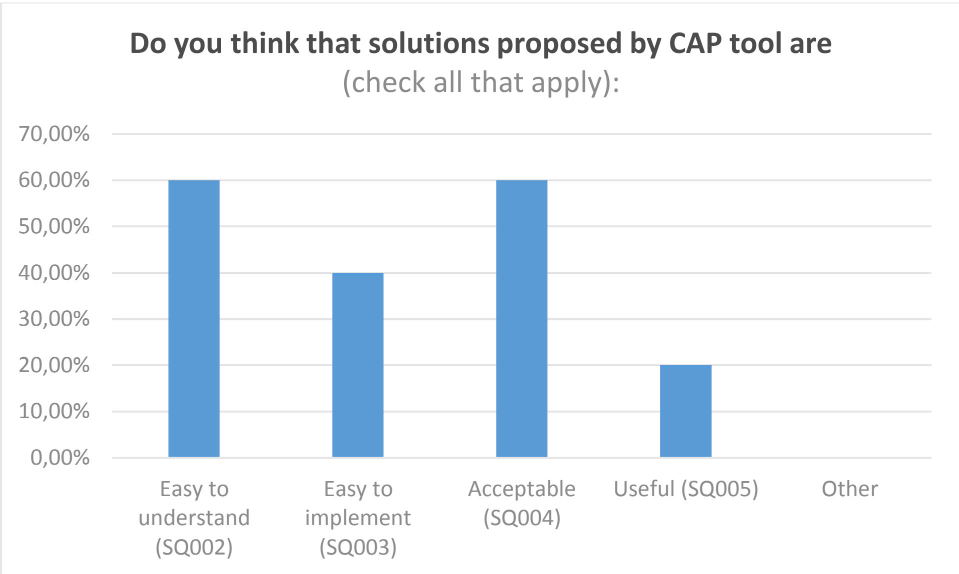


Figure 157 - Answers to query #3 from AU questionnaire

60% of Flight Dispatchers think that solutions proposed by CAP are easy to understand and acceptable. However, only 40% think that the solutions are easy to implement and 20% are confident that they are useful.

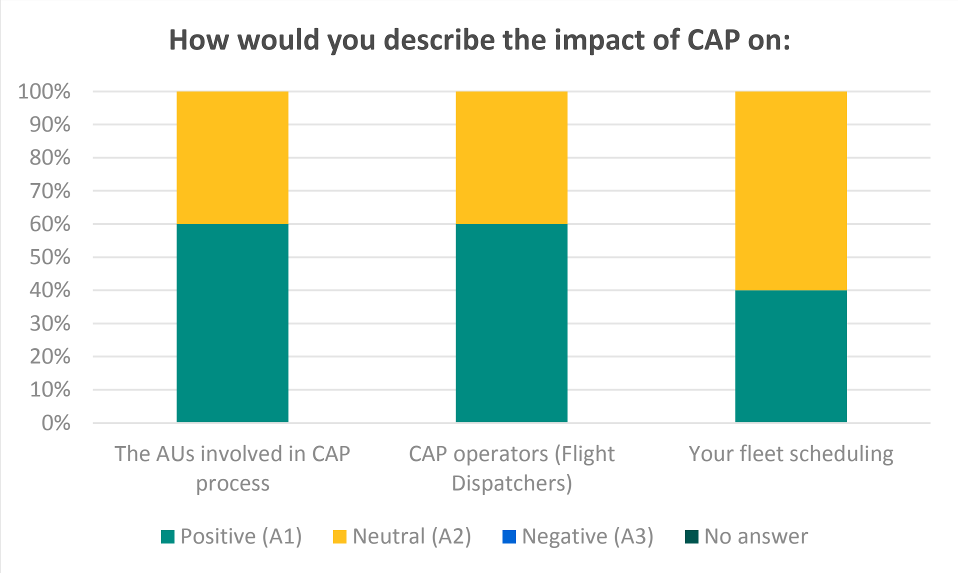


Figure 158 - Answers to queries #4a, #4b and #4e from AU questionnaire

60% of Flight Dispatchers think that CAP has a positive impact on the AUs involved in CAP process and on themselves. They think, with the same percentage, that CAP has a neutral impact on their fleet scheduling.

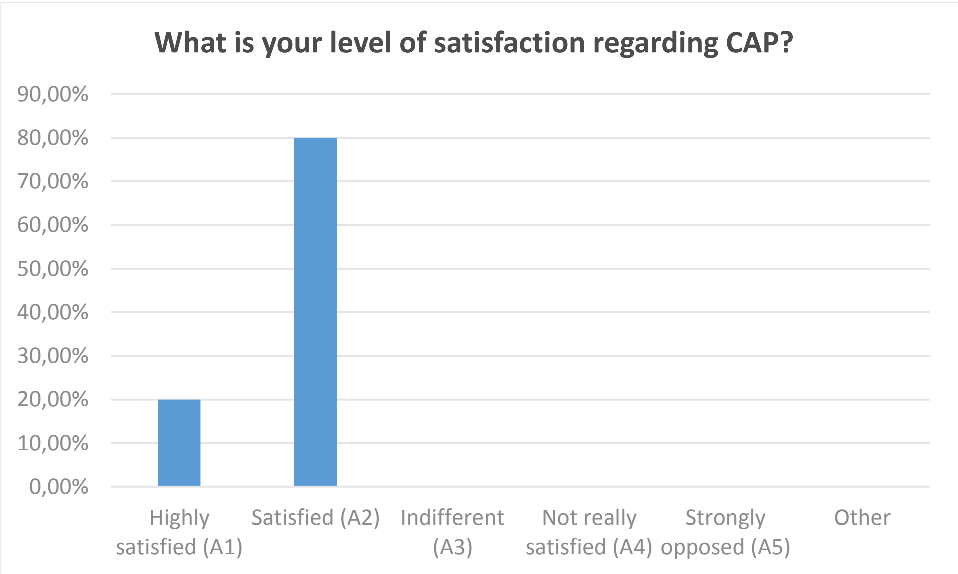


Figure 159 - Answers to query #5 from AU questionnaire

Most of Flight Dispatchers are satisfied (80%) or highly satisfied (20%) regarding CAP.

The FMPs think by unanimity that the CAP operating methods are clear and consistent.

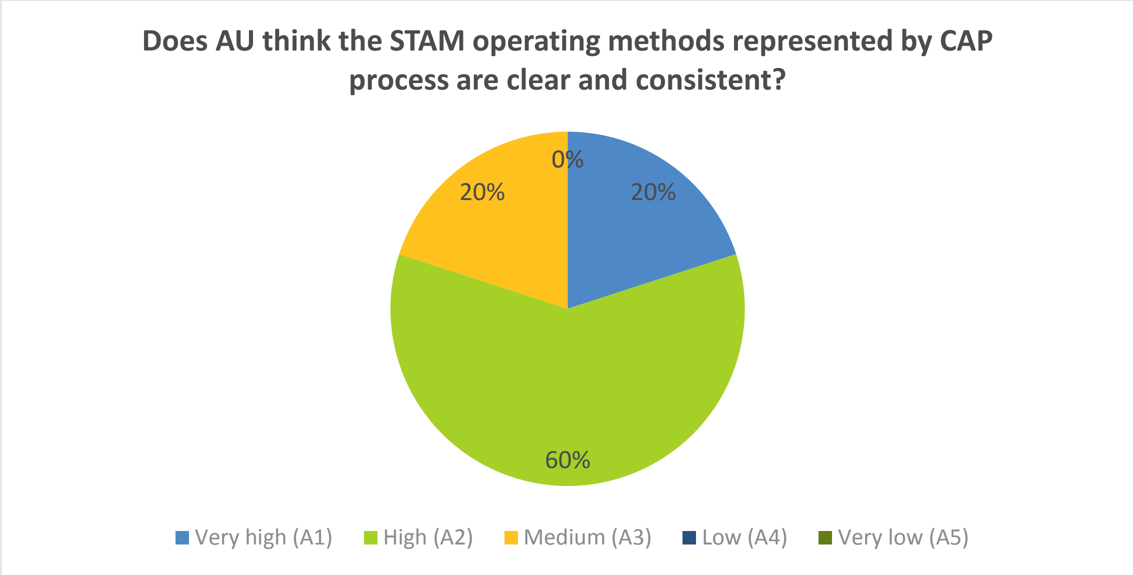


Figure 160 - Answers to query #7 from AU questionnaire

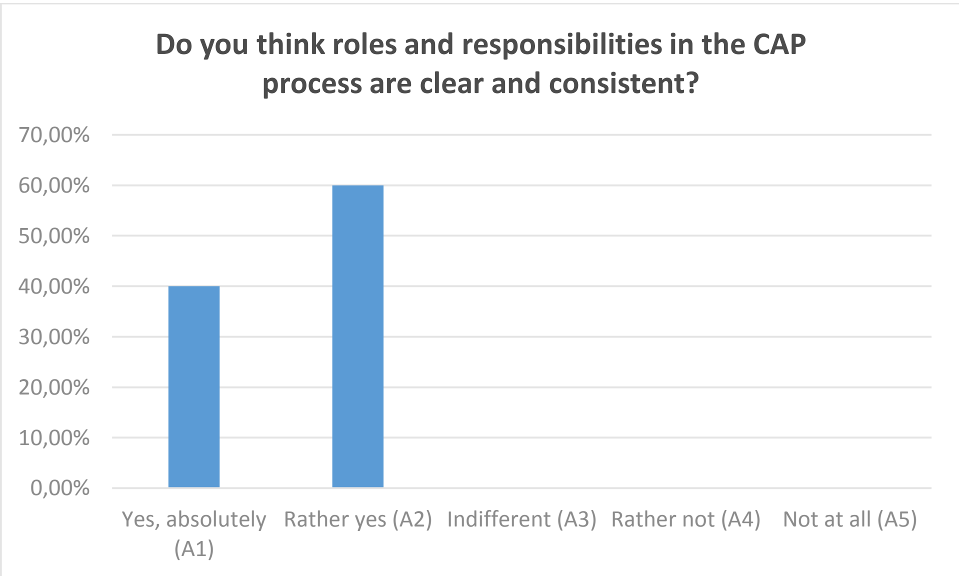


Figure 161 - Answers to query #8 from AU questionnaire

All Flight Dispatchers participating to the questionnaire think that roles and responsibilities in the CAP process are clear and consistent.

- **AU Managers debriefing (WebEx and e-mail)**: AUs mainly think that CAP is an efficient tool and easy to use.

The results show that AUs are satisfied with the CAP tool and process. They indicate that CAP tool is perceived as easy to use and that roles and responsibilities are clear and consistent. It also informs that the majority of AUs thinks that CAP solutions are easy to understand and easy to implement besides CAP process has a positive impact for involved AUs and Flight Dispatchers.

- **Conclusions**:

We conclude from these results that the demonstration exercise has successfully proved that CAP helps AU staff to reduce the time to monitor, analyze, coordinate and implement fine-tuned DCB measures.

6. EX4-OBJ-VLD-04-003 Results

- **FMP questionnaire**:

According to the FMP questionnaire, CAP tool is partly (50% of them) considered easy to use. They are also partly satisfied with CAP. As stated in the FMP manager debriefing summary below, these results are improved at the third iteration of the Live Trial with the updates of the tool.

They consider that the collaborative dimension of CAP is essential for the efficiency of CAP, and that helps knowing the needs of the adjacent ACCs and AUs. Regarding the CDM chat, the FMPs find the general chat with AUs useful, funny, interesting and required. Concerning the CDM chat with other FMPs, they assessed it as useful but not necessary. Some of them also qualified the FMP CDM chat as ‘a loss of time’. Consequently, the CDM chat with AUs has a better value for FMP.

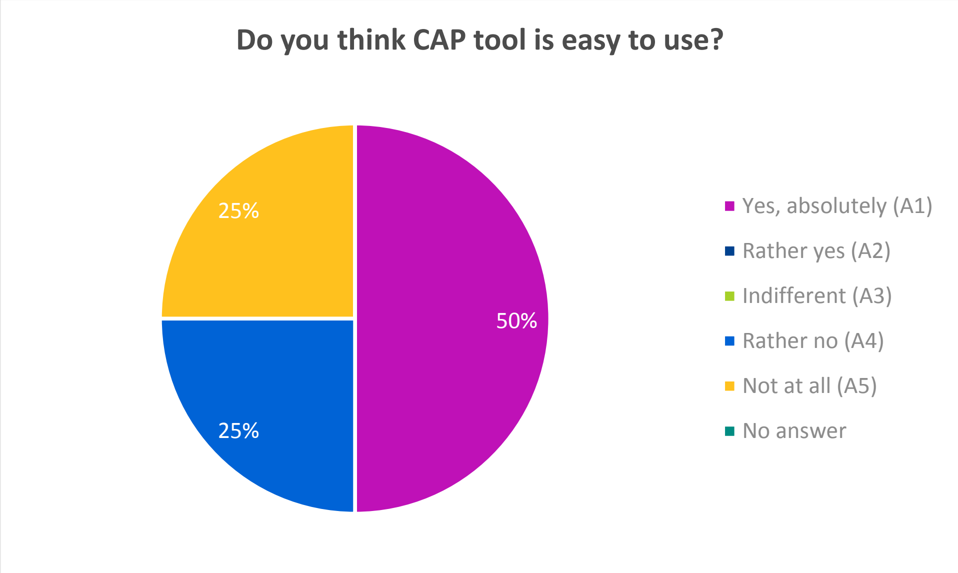


Figure 162 - Query #7 from FMP questionnaire

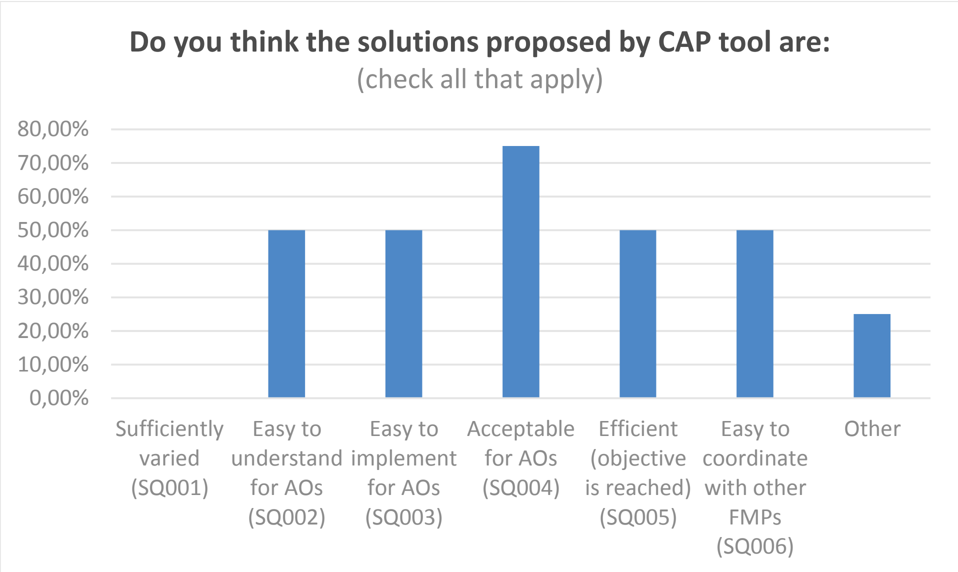


Figure 163 - Query #9 from FMP questionnaire

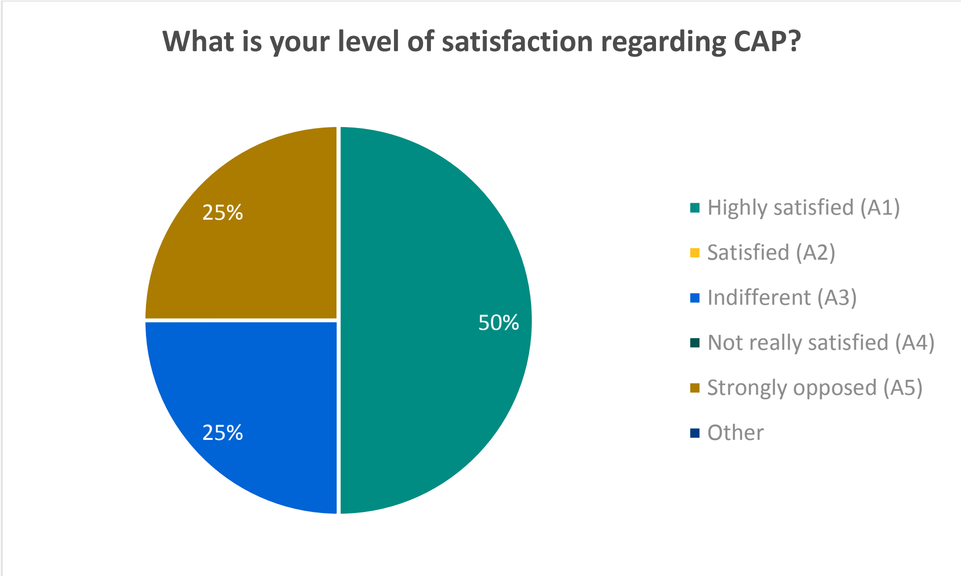


Figure 164 - Query #29 from FMP questionnaire

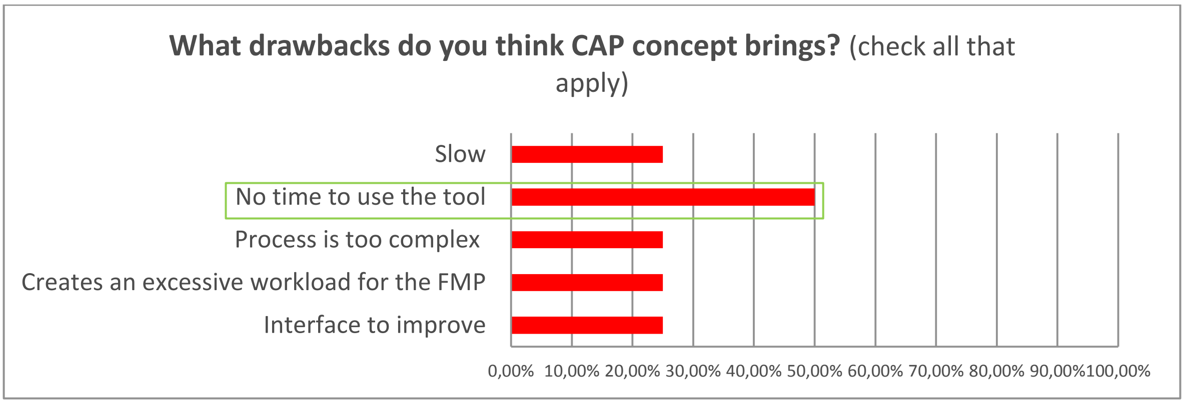


Figure 165 - Query #2 from FMP questionnaire

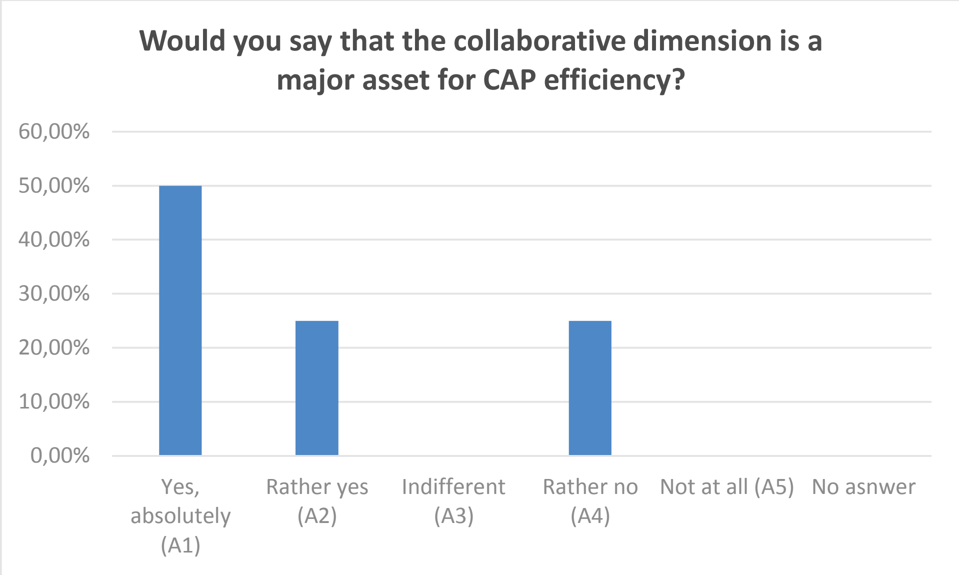


Figure 166 - Query #27 from FMP questionnaire

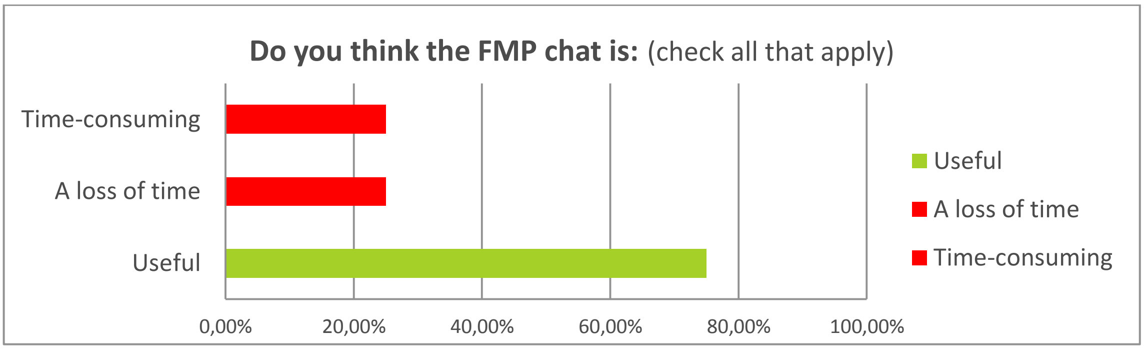


Figure 167 – Query #10 from FMP questionnaire

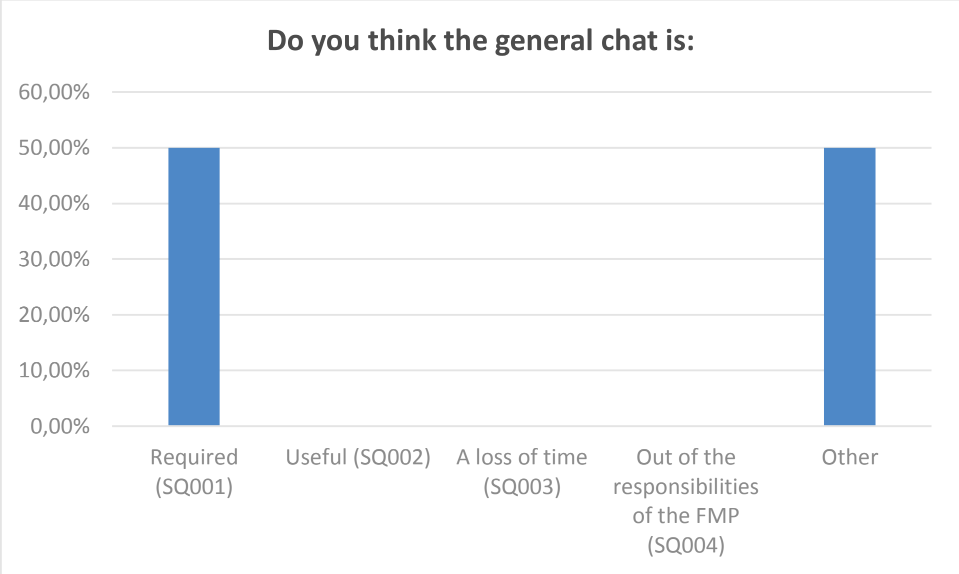


Figure 168 - Query #11 from FMP questionnaire

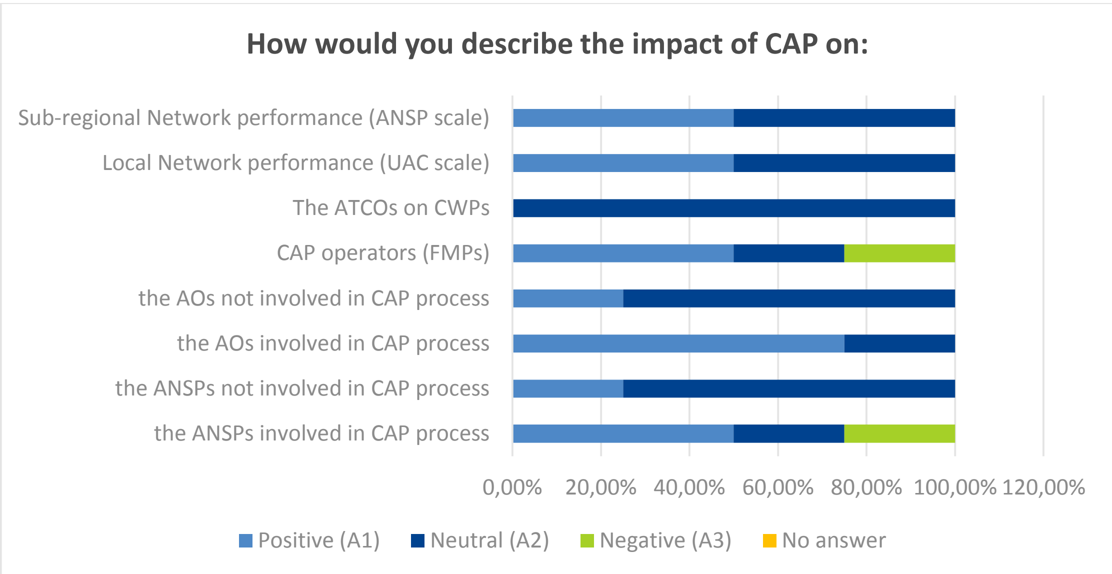


Figure 169 - Query #28a, #28b, #28c, #28d, #28e, #28f, #28g and #28h from FMP questionnaire

- **FMP managers debriefing**:

The new FMP CAP users appreciated the modifications in the tool done for the third iteration, mainly the flexibility of use and the higher quantity of candidates available. Choosing candidates was not a problem that time. Thus, the feeling of loss of time in the selection of candidates reduced on the last iteration, thanks to the improvements made in the tool and also because of the fact that they were more and more familiar and confident with the tool.

However, the new FMP CAP users stated that the CAP process timeframe (around 4h before EOBT/ETO) does not match their working methodology (increased workload). 4h in advance:

- if Traffic Demand significantly exceeds capacity , then they would apply a Scenario
- if there is no big overload (small peak), then they would wait and apply tactical measures at 1h30- 2h before time of entry in the TV if the peak has not disappeared.

For the FMPs that have been using CAP tool for few years, CAP is considered very useful and easy to use. They raised the benefits of CAP process against the implementation of Scenarios (compared to Scenarios, CAP process eases the FMP workload in terms of flight identification and assessment of additional complexity for ATC implementation) and they suggested to the new FMP CAP users to replace Scenarios by CAP process whenever appropriate.

- **Conclusions**:

To set the conclusions, a ponderation of the results from second and third iteration (reminder: corresponding to first and second iteration for new FMP CAP users) was done. More weight was given to results from third iteration, i.e. to the FMP Managers debriefing, to integrate the facts that tool improvements were done based on the feedback provided by FMPs and that the new FMP CAP users were more familiar and experienced with the tool and process.

Most of FMPs consider CAP tool easy to use and flexible. They appreciate the CDM chat, knowing the needs and constraints of the adjacent ACCs and AUs is an added value to solve the DCB issue in a more efficient and coordinated way.

However, when choosing the most appropriate ATFCM measure to solve the DCB issue, the two groups of FMP have different points of view. Several years of usage eases the FMP workload in terms of flight identification and complexity assessment compared to the implementation of a Scenario. On the other hand, the new users think that CAP process does not completely match their working methodology to solve a light traffic peak, they prefer to activate an Scenario or to wait for the peak to either smoothen or rise before taking an action.

7. EX4-OBJ-VLD-05-002 Results

We wanted to prove with Exe#4 Extended CAP Iteration 1 quantitative assessment that the accumulation of ATFM delays in the network is reduced thanks to the application of CAP measures. Find below the data gathered and the conclusions derived from it:

	CAP proposals	CAPped flights	Flights adhering to "CAPped" FPL	CAP proposals acceptance (%)	FPL adherence (%)	Simulation request - SIMEX			S1 - Simulation bfr AU refiling			S2 - Simulation aft AU refiling			Average delay per flight on Simulation (min)		Difference S1-S2 (min)	POST OPS		
						Off-loading TV	Period	Rate	Nb flights	LFExA delays (min)	Total delays (min)	Nb flights	LFExB delays (min)	Total delays (min)	LFExA avg	LFExB avg	LFExA - LFExB	Regulation	RD (flights)	TL (flights)
09/08/2017	3	3	1	100,00	33,33	LFEHYR	10:40-12:20	39	67	518	582	ND	ND	ND	7,73	ND	ND	NO	65	ND
09/08/2017	4	3	2	75,00	66,67	LFEKR	10:00-11:40	30	43	47	157	ND	ND	ND	1,09	ND	ND	NO	47	ND
10/08/2017	2	2	1	100,00	50,00	LFEKD	09:30-10:20	36	28	112	112	16	0	13	4,00	0	112	NO	ND	ND
16/08/2017	13	9	2	69,23	22,22	LFEHYR	09:00-13:00	46	174	880	1514	151	594	1012	5,06	3,93	286	NO	159	148
17/08/2017	9	6	0	66,67	0,00	LFEKN	09:20-13:40	32	141	2167	2654	N/A	N/A	N/A	15,37	N/A	N/A	Yes	137	135
18/08/2017	5	5	4	100,00	80,00	LFEHYR	10:40-10:55	5	13	68	121	8	0	50	5,23	0,00	68	NO	12	10
21/08/2017	6	5	2	83,33	40,00	LFEKN	09:40-13:00	32	107	569	784	93	210	461	5,32	2,26	359	NO	96	96
22/08/2017	10	6	ND	60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NO	ND	ND
23/08/2017	6	6	1	100,00	16,67	LFEHYR	10:00-12:00	42	ND	ND	ND	91	907	972	ND	9,97	ND	NO	93	90
24/08/2017	6	5	1	83,33	20,00	LFEHYR	10:00-12:00	42	78	209	209	68	226	334	2,68	3,32	-17	NO	85	76
25/08/2017	9	8	5	88,89	62,50	LFEHYR	09:00-12:00	42	145	2292	2392	N/A	N/A	N/A	15,81	N/A	N/A	Yes	125	102
28/08/2017	7	2	2	28,57	100,00	LFEHYR	10:20-13:00	42	112	551	961	124	1405	1555	4,92	11,33	-854	NO	124	110
29/08/2017	3	2	2	66,67	100,00	LFEKR	10:20-12:00	32	45	192	251	50	218	525	4,27	4,36	-26	NO	44	55
30/08/2017	7	7	4	100,00	57,14	LFEHYR	10:40-11:29	6	42	965	1028	41	852	997	22,98	20,78	113	NO	40	41
31/08/2017	4	1	1	25,00	100,00	LFEKN	10:20-12:00	29	71	1147	1366	N/A	N/A	N/A	16,15	N/A	N/A	Yes	58	59
01/09/2017	NO CAP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/09/2017	NO CAP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Average	94	70	28	76,45	53,47				1066	9717	12131	642	4412	5919	8,51	6,22	41			

Tableau 1 - Recap of BRY-CLM CAP Live Trial results

The table above shows the data collected during the CAP Live Trial BRY-CLM from 9 August to 4 September 2017 on a daily basis. The orange columns correspond to the analysis of CAP proposals acceptance and FPL adherence. The green columns correspond to the SIMEX requests received from LFEE FMP. The blue columns correspond to the results of the simulation of regulation before and after AU refiling obtained by SIMEX. The data collected in post operations are colored in purple. They correspond to the verification of the activation of regulation in the initially offloaded TV by CAP, the regulated demand (RD) and the traffic load (TL).

Refer to G.1.1 chapter for further information about the methodology used to collect the data from the table.

The results show that, in tactical phase, early morning in the preparation of the morning traffic peaks:

- FMP decided to apply the CAP process on 15 days as a measure to solve a limited traffic peak. The FMP considered CAP usage not appropriate on two days.
- 76,45 % of CAP requests were accepted by AU's and 53,47% of flights were flown as defined in the flight plan.
- 12 out of 15 potential "limited" regulations could be avoided by applying the CAP measure.
- For 14 days, the total delays resulting from the simulations of regulation done before AU flight plan refiling are 9717 min. Subtracting the delays of the days a regulation was actually put in place in the off-loaded TV, the total delays are 4111 min. It can be concluded then that over 12 days, 4111 min of regulation delays were avoided thanks to applying the CAP process.

  These delays are only a "volatile" quantitative value influenced by either additional regulations in the network (MPR or not) potentially cancelled later on, by future regulations in the network which are not taken into account or by the quantity of FPL already filed at the moment of the simulation of regulation. However, it is important to note that the regulation and regulation delays have an impact into the network in form of instability, unpredictability and to the AU's in form of either the cost of delay or the FPL refiling effort.
- Comparing the total delays of simulation of regulation before AU refiling (-4h, -3h before entering into sector) and after AU refiling (-3h, -2h before entering into sector) the difference is low (41 minutes of delay difference). However, if we look at the average simulation of regulation delays per flight, results show that the average delay per flight decreased after AU FPL refiling with a difference of -2,29 min per flight.

We conclude that, thanks to CAP measures applied during 15 out of 17 days of CAP Live trial, the ATM network avoided at least 4111 min of regulation delays and their impact elsewhere besides the average delay per flight decreased 2,29 min after AU FPL refiling.
While the analysis above focuses on the impact of CAP on global ATFCM delays, for all AUs, another key parameter is the ratio for each individual company between the efforts required and the benefits that can be expected, which needs to remain positive to meet their business needs.
In this perspective, Figure 170 shows the number of CAPped flights (flight level capping as a CAP measure) per AU and the number of flights per AU planning to fly through the over-loaded TV between 4h and 3h before entry into sector (caught in simulation of regulation).

The ratio between the effort (i.e. the number of refilings as per CAP proposals) and the benefit (i.e. the number of flights present in the TV that has been off-loaded thanks to CAP) for one single company shows that it is worth participating in CAP, businesswise.

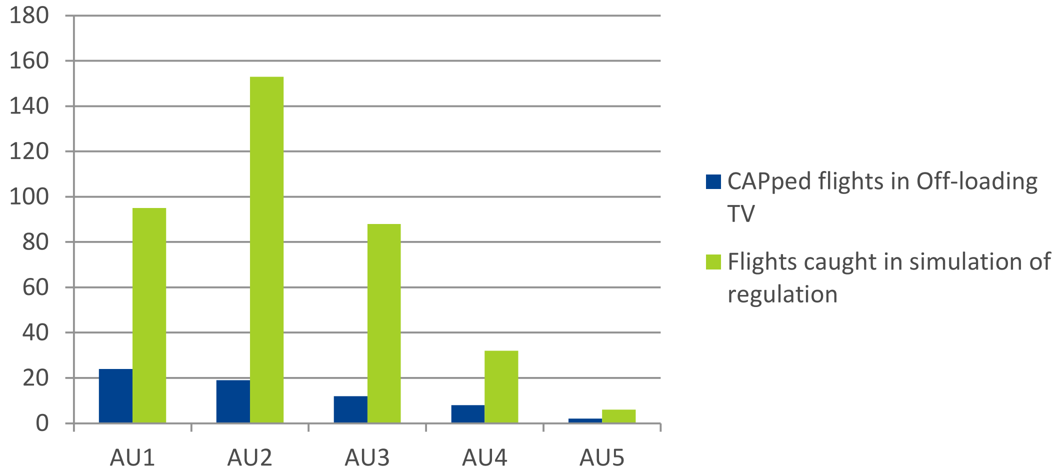


Figure 170 - Ratio between flights caught in simulation of regulation and CAPped flights

- **FMP questionnaire**:

The results show that the totality of FMPs believe CAP helps to reduce the quantity and the strength of the regulations and a 75% of them also think that it helps to reduce the ATFM delays. However only the half of the participants think that CAP promotes the increase of the use of the available capacity.

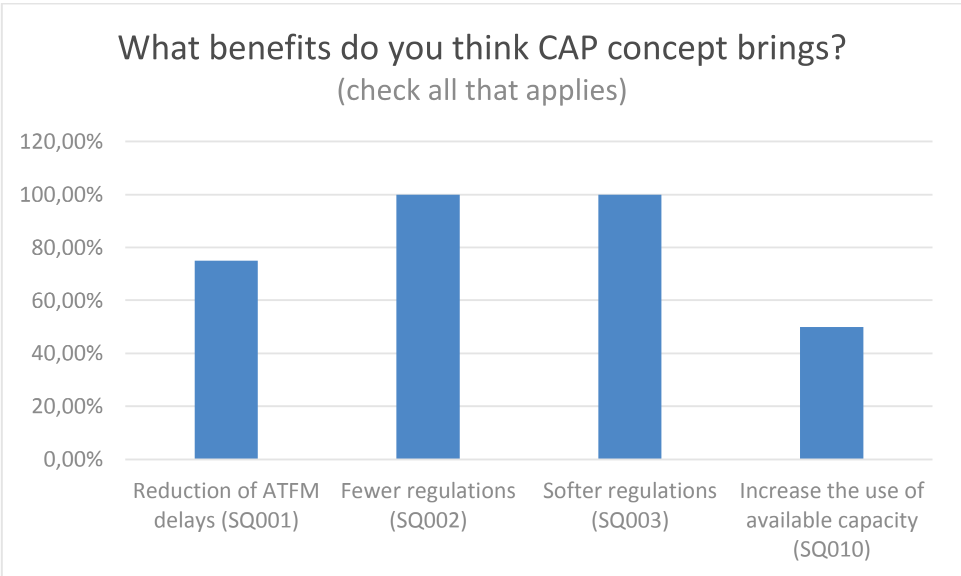
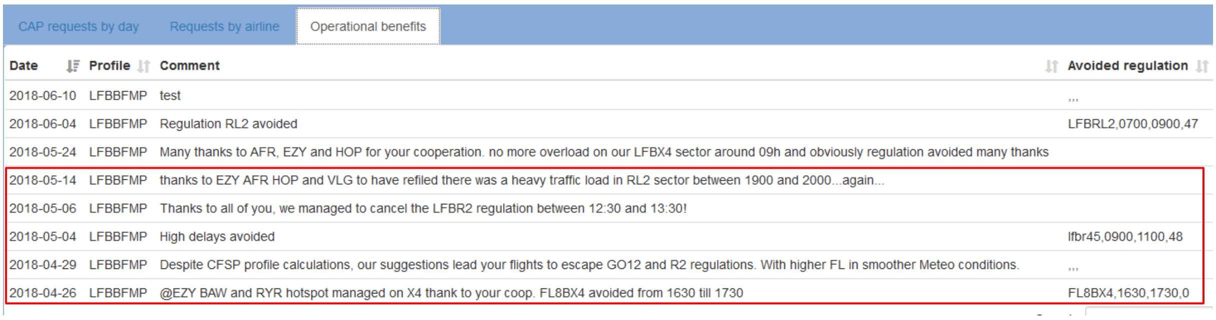


Figure 171 - Queries #1a, #1b, #1c and #1d from FMP questionnaire

- **Operational benefit (FMP feedback)**:

FMP were proposed to fill the operational benefit of the CAP measure during the third iteration of CAP Live Trial. FMPs informed in 5 occasions via the “Operational benefit” button that CAP helped either to manage hotspots or to avoid regulations and high delays.


CAP requests by day | Requests by airline | Operational benefits

Date	Profile	Comment	Avoided regulation
2018-06-10	LFBBFMP	test	,,,
2018-06-04	LFBBFMP	Regulation RL2 avoided	LFBRL2,0700,0900,47
2018-05-24	LFBBFMP	Many thanks to AFR, EZY and HOP for your cooperation. no more overload on our LFBX4 sector around 09h and obviously regulation avoided many thanks	
2018-05-14	LFBBFMP	thanks to EZY AFR HOP and VLG to have refiled there was a heavy traffic load in RL2 sector between 1900 and 2000...again...	
2018-05-06	LFBBFMP	Thanks to all of you, we managed to cancel the LFBR2 regulation between 12:30 and 13:30!	
2018-05-04	LFBBFMP	High delays avoided	lfbr45,0900,1100,48
2018-04-29	LFBBFMP	Despite CFSP profile calculations, our suggestions lead your flights to escape GO12 and R2 regulations. With higher FL in smoother Meteo conditions.	,,,
2018-04-26	LFBBFMP	@EZY BAW and RYR hotspot managed on X4 thank to your coop. FL8BX4 avoided from 1630 till 1730	FL8BX4,1630,1730,0

Figure 172 - Screenshot of Operational benefit list from CAP tool

- **AU questionnaire**:

Results from AU questionnaire show that the majority of AUs (60%) perceive that CAP facilitates the reduction of ATFM delays but they are not so confident (40%) regarding the reduction of the quantity and strength of regulations. They also think, to the same extent (60%), that CAP has a positive impact on the reduction of the number of regulated flights, the reduction of the delays per flight, the use of available capacity and on the Network Performance.

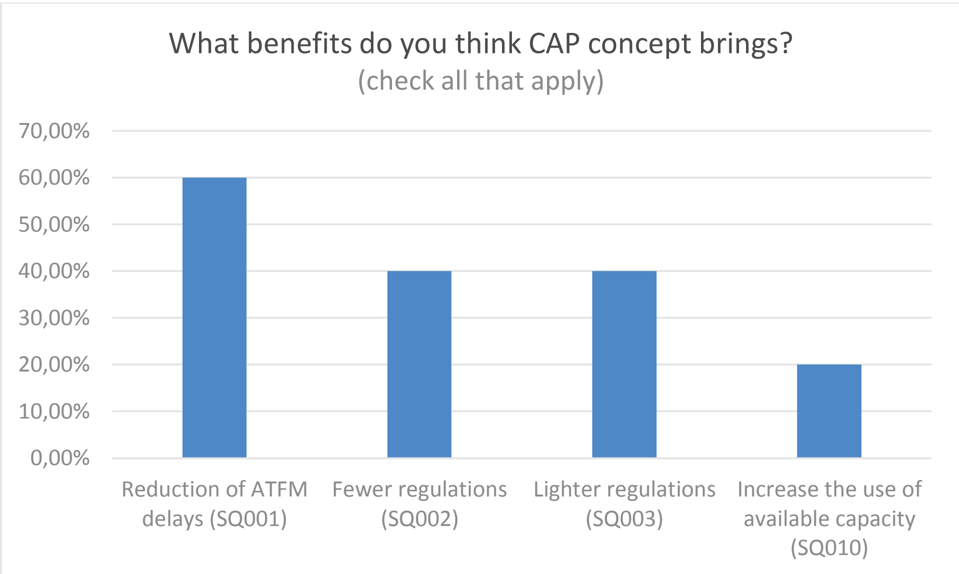


Figure 173 - Queries #1a, #1b, #1c and #1d from AU questionnaire

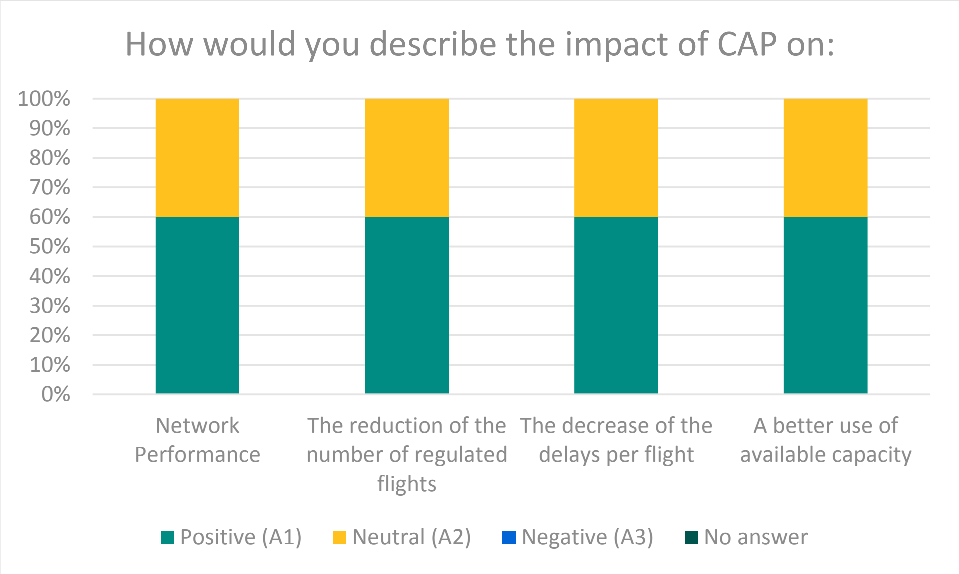


Figure 174 - Queries #4c, #4d, #4g and #4h from AU questionnaire

- **AU Managers debriefing**: They stated that although the proposals were rather less than expected on the third CAP live trial iteration, they could see that regulations and delays were lower than previous months.

- **Conclusion:**

From the quantitative study, the results of the questionnaires and the AU feedback, we conclude that CAP process has a positive impact on the reduction of regulations and ATFM delays of the network.

G.3.3 Unexpected Behaviours/Results

No unexpected behaviours or results occurred.

G.3.4 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

Various factors influenced the representativeness of the different iterations of Extended CAP exercise.

On the second iteration, played at the start of Winter season (October-November), a reduced number of CAP measures were activated due to the habitual drastic decrease of traffic at these dates (few opportunities to created CAP proposals). However, the lack of representativeness was expected and remained compatible with the objective of the iteration that consisted in getting familiar with the new flows for the experienced FMPs in CAP process and getting used to the tool and the process for the new participants.

On the third iteration, played in April and May, the demonstration exercise was influenced by various thunderstorm episodes and the strikes in the neighbouring airspace during the weekends. These operational circumstances did not allow to use the CAP process/tool as initially expected. Note that the CAP measure is not appropriate to solve the DCB issue caused by such non-nominal events.

However, the quantitative analysis performed in Summer season on a major traffic flow allowed to gather sufficient amount of data to draw conclusions on positive effect of CAP regarding ATFCM delays reduction and smoothing regulations.

A lesson learned from this exercise is that Operational managers' contribution and support during the execution of the Live Trials influenced a lot the outcome of it. The active involvement of Operational managers is essential to optimize the level of significance of the results of a Demonstration exercise.

2. Quality of Demonstration Exercise Results

The evaluation was conducted through a qualitative assessment. A tailored questionnaire was submitted to the FMPs and Flight Dispatchers participating to the trials via an online support. Even if the quantity of participants answering the questionnaire was small (answered on a voluntary base), the findings collected were corroborated and completed with the feedback collected from the debriefing sessions.

The evaluation of the reduction of ATFM delays in the network was performed through a quantitative assessment in the first iteration. As described in G.1.1, a manual simulation of regulation targeting a specific CAP Process was performed daily via NM SIMEX function. The simulation result provided the real-time ATFM delay from NM operational system; therefore, collected data can be considered accurate and reliable.

However, results cannot be extrapolated and considered as sufficient to draw general statistics as to how CAP alone impacts the Network because:

- CAP measures cannot be isolated from the general ATFCM context, where the situation (both demand and measures) constantly evolves
- Multiple external parameters influence CAP measures impact, with complicated and multiple interactions, that cannot be identified and quantified precisely.

3. Significance of Demonstration Exercises Results

Final results are compendium of results of the three iterations, based on results obtained from the AU questionnaire, FMP questionnaire, debriefing sessions with FMP managers, debriefing sessions with AU managers, CDM chat analysis or operational benefit button answers. As exposed above, even if the quantity of participants answering the questionnaires was small (answered on a voluntary base), the findings collected were corroborated and completed with the findings collected from the other sources. Thus, results are considered statistically significant.

A.1 Conclusions

Extended CAP Demonstration exercise aimed to demonstrate the benefits for ATM partners, of using fine-tuned measures in the planning phase based on pre-defined flight level capping solutions at strategic phase to solve DCB issues. Joining PJ24 with an existing and already in use concept, the ambition was to extend it to new partners and to assess its benefits in a large-scale demonstration to pave the way towards its standardisation at European level.

From the obtained results, we can conclude that CAP:

- creates an acceptable amount of workload for FMPs,
- improves the situational awareness beyond the ACC boundaries
- and encourages communication and team working between ACCs and airlines that leads to an increase of the transparency and trust between FMPs and Flight Dispatchers.
- The tool is considered easy to use and flexible by most of partners, a factor that contributes to the efficiency to handle DCB.
- Finally, based on the quantitative results and ATM partners perception we can conclude that CAP process has a positive impact on the reduction of regulations and ATFM delays of the network.

A.2 Recommendations

A.2.1 Recommendations for industrialization and deployment

Feedback on Use of B2B Service Semi- Automatic SIMEX:

As the manual simulation of regulation implied real-time requests by human operator, it was considered as very costly for Iteration 1 and not compatible with available resources for the following iterations. To face this limitation and to seize the opportunity to make use of NM B2B Services, DSNA explored the possibility to perform semi-automatic SIMEX simulation of regulation by B2B to gather quantitative results from all CAP flows on the third iteration. This would have allowed the collection of a larger amount of data, hence drastically improving the significance of the results.

- However, despite successful cooperation between NM experts and CAP developer to implement it, a number of limitations has been identified, which made it difficult to adapt to the Demonstration needs in the limited timeframe and available resources, among which: The allocation of one 'simulation slot' (among the two available) needed to be secured, but also limited in time, so as not to disturb other users

- The problem of potentially simultaneous requests from different FMPs (the solution of handling the requests in sequence was considered not satisfying, as the results for the last simulation might be based on outdated NM data)

These findings provide valuable feedback from a first use of the service and its potential developments, and raise interesting prospects for the future use of this functionality by ANSPs in their daily operations.

Experienced CAP users pointed out the benefits of CAP process in combined use with Scenarios (compared to Scenarios, CAP process targets only a few flights in a TV, and not all flights from a flow). During the debriefing sessions with FMP Managers, the opportunity to launch a global discussion analysis of the ATFCM measures catalogue and their combined use was identified. The aim would be to adapt them to current operational needs and performance objectives to best tailor the measure to the nature and granularity of the problem to be solved.

As described in G.2, NM and DSNA identified, during the first iteration of EXE#4, the opportunity to take CAP to a step further towards Network Collaborative Management. So far, coordination between PJ24 PM, NM representatives and DSNA Technical PoC have led to study the technical feasibility of NM B2B messages supporting CAP process. It could be worthwhile to continue this joint development, with the final objective to:

- Standardize and automatize as much as possible the process and interface to limit the additional workload and the costs associated to human and technical resources (for both AUs and ANSPs),

- Give Network Visibility to CAP measures, for better traceability and post operations analysis,

- Provide What-if trajectory functionality to AUs helping to improve traffic predictability, an objective assumed with CAP but no so much perceived like that by the CAP users (EXE4-OBJ-VLD-02-002 Results),

- Secure the slot for AUs refiling according to CAP Proposal, to avoid the 'Late Updater Status', and more generally speaking, any 'double penalty' for the flights.

It could be of interest to include the CFSPs into the discussions to be able to reduce the AU workload when participating to the resolution of DCB issues.

A.2.2 Recommendations on regulation and standardisation initiatives

Not applicable.

Appendix H Demonstration Exercise #05 Report - Sub-Regional Coordination of Fine-tuned Measures

H.1 Summary of the Demonstration Exercise #05 Plan

Exercise #5 involves three ANSP's (Austrocontrol, Croatia Control and SMATSA) that already have signed bilateral coordination processes regarding cross-border STAM measures. This exercise explores system to system communication between local traffic flow managers (FMP positions) in order to take the best decision in configuration and hotspot management. The Exercises will test new system support functions, developed on the ECOSystem platform by ANSP operational experts, aimed at enabling better situational awareness and more responsiveness and impact in the short term ATFCM, from 2-hours to 20 minutes before sector entry time. It aims at the identified gap between ATFCM and ATC, where no dedicated support tools exist today.

The exercise addresses also the impact of weather hazards on flow and FMP decisions, as a continuation of the work done in Toplink LSD. Relevant meteorological information and forecasts (RDT, Jetstream and CAT) are integrated into the HMI which all support better situational awareness.

H.1.1 Exercise description and scope

The major evolution is that all the participating local FMPs are connected via ECOsystem and can exchange information, various STAM requests and what-if's. At the end, the hotspot mitigation measure is sent to Network Manager/EUROCONTROL for implementation, which is simulated in this exercise within the closed Pre-Ops B2B environment. During the Exercise, all the proposed measures will be accepted by the system, and their Network impact will be assessed in post-ops.

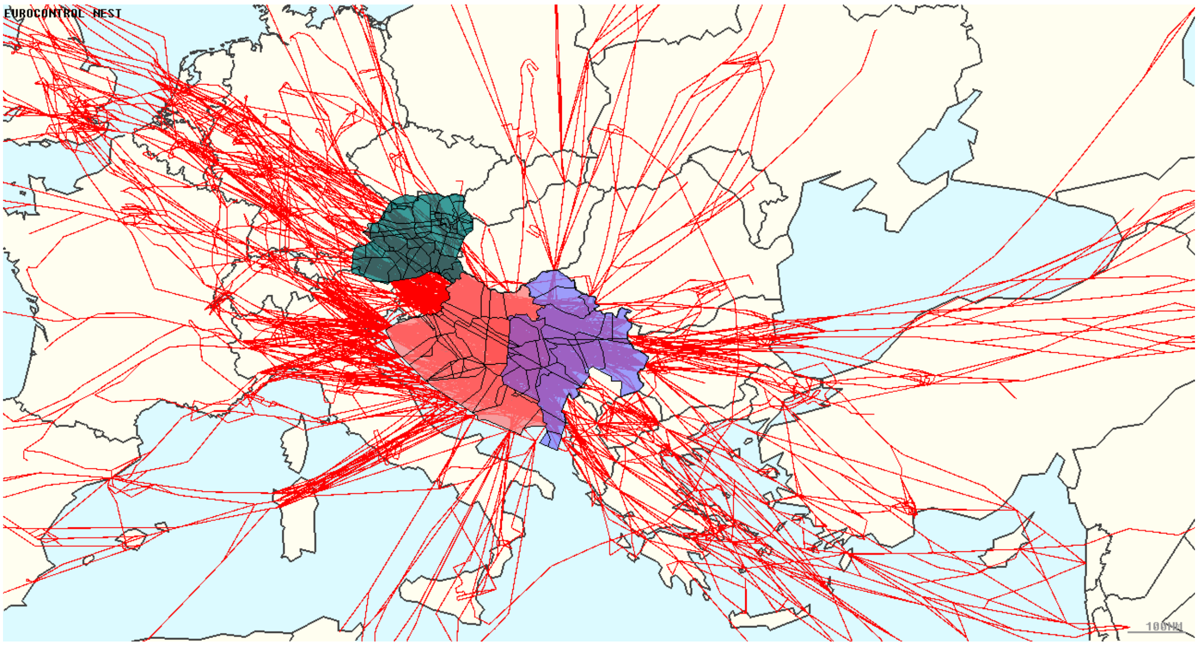


Figure 175 EXE #5 Area is encompassing the AoR of 3 ACC's on the South-East Axis flow

The operational scope is:

- Optimization of airspace resources in a collaborative way between neighbouring ANSPs taking into account currently available capacity, weather, traffic demand, and operational constraints.
- Solve hotspots by using collaborative platform and shared solutions for STAM
- Communicate to NM information from local perspective to complete NM view on local situation

The key demonstration objective is the improvement of capacity in case of adverse weather situation by implementing a common decision making process between local FMP's and regional Network Manager.

The exercise technique is NM B2B Pre-Ops (parallel to Ops) shadow-mode demonstration carried out during a number of predefined days with operational systems from Network Manager and ECOsystem deployed locally in the ANSPs premises.

The exercise took place during 4 iterations on the following dates:

Iteration	TRIAL DATES
1.	31.05.2019 to 02.06.2019
2.	5 - 7 June 2019
3.	17 - 19 June 2019
4.	26 - 28 June 2019

H.1.2 Summary of Demonstration Exercise #05 Demonstration Objectives and success criteria

The key demonstration objective is the improvement of ACC capacity by sharing information and workload across borders. The behaviour of key system players defined as predictability often causes last-minute changes in sector Traffic Load, particularly so in cases of adverse weather, and by implementing a common decision making process between local FMP's and regional Network Manager we want to best align our tactical resources. With current predictability, we need more and better last-minute tools and options to enforce our response to such dynamic change of flows.

EXE5 is carried out by experienced FMP controllers shadowing live operations from the operational FMP position, or another dedicated position. FMP's involved in the demonstration are using ECOSystem to test automated support tool functions in enhancing their influence, reaction time and effect on sector load. Success criteria is based in large part on FMP questionaries' and feedback and post ops analysys of selected measures. Some objectives are assessed also through results of SIMEX and NEST simulations where delay and fuel gains are considered.

H.1.3 Summary of Validation Exercise #05 Demonstration scenarios

Demonstration Exercises scenarios

Reference Scenario(s)

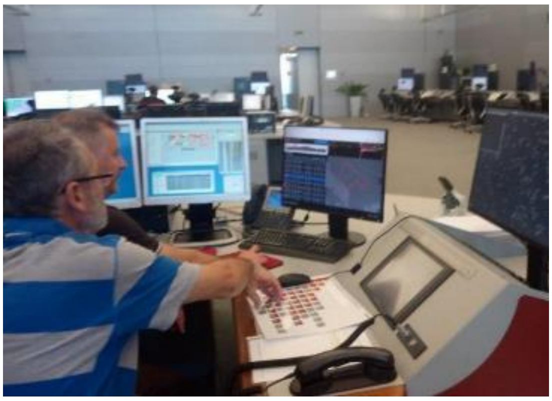
Reference scenario in the 4 iterations of the Demo is real life operational environment, in which the FMP on duty performs his/her tasks using the operationally validated processes and tools, namely CHMI and telephone to make the operational decisions.

The meteorological impact on ACC capacity today is assessed at D-1 and D-day (pre-tact and tact) in which it is largely based on personal best judgement, or reactionary, in which often too late or too heavy. MET-ATFCM Information is not integrated in a system, rather in the person.

All actions and impact to KPI are recorded and available in CHMI.

Solution Scenario(s)

DEMO EXE Environment is run in NM Pre-Ops, and organized as a shadow more operation parallel to real operations, either at the Operational FMP position or any other suitable position in each of 3 participating ACC's.




Picture 1 left . ECOSystem at FMP position in Belgrade ACC Ops Room,

right - meteo briefing during one of the iterations in Zagreb ACC

Pre-ops environment is a copy of real operational environment, run in parallel for the purpose of validation of procedures and conduct of Demonstrations like this one. All actual FPL's and MSG received and exchanged to/from ETFMS are copied to Pre-Ops and are accessible via B2B, and any ATFCM actions and measures taken are made within this closed pre-ops (ECOSystem) environment.

One or two FMP's dedicated to the DEMO EXE 5 are located in ACC Ops room, preferably close but not affecting the operational FMP position. They are shadowing the Operational FMP on duty, and making their own ATFCM actions and decisions within the closed Pre-Ops environment.

It must be stated that ECOSystem is not a validated tool for making operational decisions and they are to be made only in line with existing ATFCM procedures applicable in the 3 ACC's, using CHMI as the only operationally validated source of information.

All actions taken within ECOSystem are recorded, and assessment is done Post-Ops by comparing KPIs with values from CHMI. Various factors are considered like sector traffic load, distances flown/sector occupancy and complexity. To sport post ops assessment, we used snapshots, exported flight lists and flight profiles, TL samples, pictures of current and predicted weather etc.

In this Solution Scenario, meteorological information is integrated with ATFCM in basic form, and new functions were developed by demonstration FMP's and the ECOSystem development team throughout the four iterations.

As described in the DEMOP, plan was to test the concepts and automated functionalities for FMPO. One such concept was to step outside the box and look for Flight Lists of clouds and areas of adverse weather, for the FMP to be able to quickly assess the impact of area of CBs (RDT) by defining the high-risk area in real-time (draw cloud) and by comparing actual and planned trajectories of current and future flights/flows. Significant differences in these trajectories are observed in this Region regularly affecting sector load and causing sudden peaks (hotspots) in Load and Sector Complexity. This functionality in a basic form was added only in the fourth iteration and thus not investigated sufficiently.

H.1.4 Summary of Demonstration Exercise #05 Demonstration Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
EX5-A1	Complexity	Complexity grows with number of flights	Complexity of a particular/any (hotspot) situation is less if the number of flights in that situation is reduced		ENR	Complexity	ATC	complexity reduces with reducing the number of flights	NM ANSPs	High
EX5-A2	Capacity Management	Procedures in place	ATFCM Measures in Pre-Ops are implemented true to CASA Principles		Planning	N/A	PJ24 DEMOP	true	NM ANSPs	Medium
EX5-A3	Observed Traffic	Traffic Characteristics (traffic level)	Observed traffic figures are the actual ones experienced in the involved FMP AoR during the exercise execution days.		All	All	Traffic data from NM systems via B2B	Traffic figures are correct (CIFLO=ECOSystem)	NM ANSPs	Medium
EX5-A4	Network Impact	Network Impact Negligent	Network Impact assessment done Post-Ops by checking affected flights against other measures active during all phases of this flight		All	All	NM	no network impact	NM ANSPs	Medium

Table 41: Demonstration Assumptions overview

H.2 Deviation from the planned activities

During EXE5 Demonstration a few deviations were encountered:

NM not participating in STAM process – Network impact assessed in post-ops. As the Demonstration platform is being developed throughout the EXE5 planning and Demo iterations, not all functionalities were developed to the level which was initially desired. A major drawback from the original plan is the un-ability to send data to NM for approval and action on CTOT of flights. Some other planned functionalities were not available during EXE5 Demo iterations:

Not able to draw CB affected area – this had an impact on use case UC-2.11 Managing Atmospheric/Met impact, as FMPO was not able to quickly assess the volume of impacted flights as desired. Plan was to draw the area of CB's (RDT) in real-time (draw cloud) and then query the system for flights penetrating the area. A basic part of this function (draw polygon) was developed for Iteration 4., but not sufficiently explored.

Complexity module was revised during the four iterations, and the optimal model was decided only for Iteration 4. This prevented the FMP's to manipulate with this functionality to the extent that was originally planned.

Due to unanticipated issues with NM PreOps server minor problems with flight discrepancies were encountered at times, eg. CTOT was not updated for some flights.

LOVV FMP did not participate in the first iteration of EXE#5 (31st May – 2nd June 2019).

H.3 Demonstration Exercise #05 Results

H.3.1 Summary of Demonstration Exercise #05 Demonstration Results

The following table summarizes the demonstration results by objective. Results presented here are a summary of post-ops analysis and conclusions of all the results compiled throughout the four iterations of EXE5.

Demo Objective ID	Demonstration Objective Title	Success Criterion	Sub-operating environment	Exercise Results	Demonstration Objective Status
OBJ-VLD-01-001	EX2-OBJ-VLD-01-001 Acceptable increase in workload for network operations planning actors to apply **COOPANS/SMATSA proposed** enhanced DCB measures to optimally use network capacity	The usage of **COOPANS/SMATSA proposed** enhanced DCB does not have a negative impact on ATM operational staff (NM and ATC) workload	En-route airspace – Medium Complexity	Automation of STAM process had a positive impact on FMP workload and time required to implement a measure	OK
OBJ-VLD-01-004	EX2-OBJ-VLD-01-004 Improved situational/planning awareness for all actors regarding local/network DCB situation and the measures applied **by sharing COOPANS/SMATSA data and actions**	Positive feedback from **COOPANS/SMATSA** regarding DCB transparent process	En-route airspace – Medium Complexity	FMP feedback is positive on the increase of situational awareness. Not a full DCB process was in place, all the proposed STAM measures were processed only locally.	OK
OBJ-VLD-03-002	EX2-OBJ-VLD-03-002 Reduce the extra fuel consumption due to	The cumulated additional fuel consumption over the whole traffic flow overflying a FIR, due	En-route airspace – Medium	NEST calculation shows a positive contribution to fuel reduction, coming from	partially

	COOPANS/SMATSA proposed DCB measures for the whole traffic flow overflying a FIR	to **COOPANS/SMATSA** proposed DCB measures, is reduced.	Complexity	implementation of reduced number of measures.	
OBJ-VLD-04-003	EX2-OBJ-VLD-04-004 Reduction in time for FMP staff to monitor, analyse, coordinate and implement measures to balance demand – capacity **due to FMP efficiency improvements**	Automation resulted in a reduction of time required, and FMP confidence on STAM resolving DCB is increased. Reduced time to achieve the DCB cycle	En-route airspace – Medium Complexity	The time required for general FMP tasks is reduced with better situational awareness from more advanced graphical representation of the situation. Also, time for implementing a STAM measure is reduced.	OK
OBJ-VLD-05-002	EX2-OBJ-VLD-05-002 Reduction of sector (arrival, en-route) delay resulting from **COOPANS/SMATSA proposed measures for** DCB issues by using enhanced DCB and mechanism	The usage of enhanced DCB measures **proposed by COOPANS/SMATSA** reduces sector delay compared to regulations	En-route airspace – Medium Complexity	Some hotspots were solved with STAM which reduced the need for ATFM Regulations. Individual flights when removed from an overload had a positive impact on the level of delay	OK
OBJ-VLD-05-005	EX2-OBJ-VLD-05-005 Mitigate the capacity reduction of a ACC, due to adverse weather	The degradation of FIR or sector capacity, during adverse weather events reducing the available capacity compared to plan, is mitigated by 5 to 15 %, depending on the ANSP	En-route airspace – Medium Complexity	Better informed decision improves efficiency and reduces overall delay	OK

Table 42: Exercise 5 Demonstration Results

1. Results per KPA

SAFETY

Using a more advanced HMI with automated functions for hotspot identification and implementation of STAM measures increases the effects of FMP actions taken. There are additional safety benefits in using complexity indicator for flights and sectors, where the FMP task is to recognize a hotspot in a volume of traffic when it is not obvious. This attitude may even result in a rare regulation request, although unlikely for these hotspots are too short in their existence to be handled by a regulation.

CAPACITY

Capacity of an ACC is positively affected with implementation of fine tuned measures. The magnitude of their effect is currently not extensive, but with automated processes, such targeted measures can significantly reduce sector complexity and improve on ACC capacity. From the feedback it is clear that most FMP's have confidence that the number of STAM measures will increase once their processes are automated.

ENVIRONMENT

Impact to this KPA was not assessed in this exercise.

COST-EFFICIENCY

Impact to this KPA was not assessed in this exercise.

H.3.2 Results impacting regulation and standardisation initiatives

For the benefit of Predictability, it is most important that last filled Flight Plan Trajectory through the concerned sector is known and easily accessible to the ATCO. It has been noted that this is not a requirement within the development or procurement of current ATM systems where such approach would bring clear benefits in better managing the Sector Load. It would also support faster identification of Unintended Flights and enabling taking timely action on them, rather than taking a reactionary action on Flights which belong to the expected Traffic Load within the current configuration.

H.3.3 Analysis of Exercises Results per Demonstration objective

Each participating centre produced own analysis of demonstration results gathered in all four iterations. A summary of results was made and was assessed on debriefing WebEx sessions after each exercise.

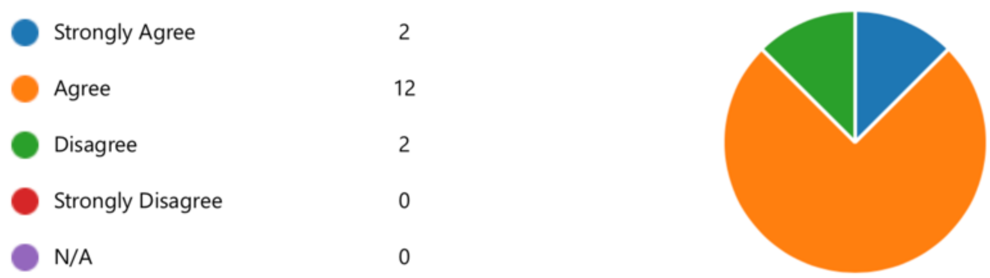
A large amount of data and samples was analised to arrive to these conclusions presented here by each objective:

- Answers to the questionnaires by the FMPs after every iteration
- the feedback of the FMPs during the iterations,
- results of SIMEX simulations of regulations
- CDM chat live discussions between partners during all four EXE5 iterations
- Comparison of results acquired in ECOSystem versus the actual situation on CHMI
- Results of fuel and distances calculation in Post-Ops using NEST
- Conclusions from post-ops WebEx

1. Operational FMP feedback

16 operational FMPs answered the questionnaire to evaluate the different aspects of the demonstration platform and its functions, overall situational awareness and possible operational benefits. The results of the FMP questionnaire are presented here, and the free text feedback was assessed during the post ops after each Iteration.

1. I was able to maintain situational awareness in the monitoring and detection task



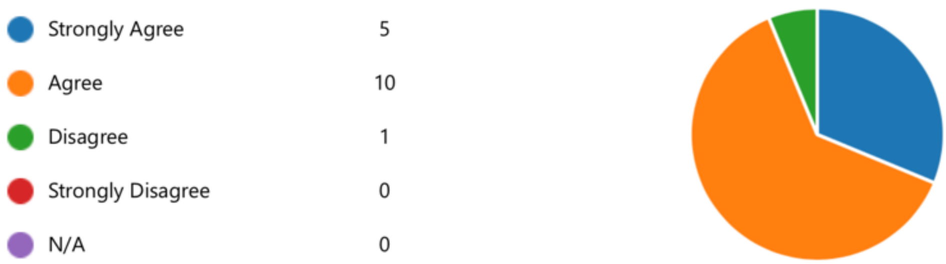
The air situation display feature of ECOsystem is relevant and true, and does not prevent the FMP to keep a close to real time situation awareness

2. The system allowed me to detect hotspots easier, quicker and more accurately than the current NM tool.

The automatic detection of hotspots relies on a good accuracy of the trajectories, and in the time period of 3 hours, the occupancy counts changes are quick and sometimes significant. The answers show that the automatic detection function is good in majority of cases, but still some situations do need a more intelligent way to find a hotspot on occupancy counts.

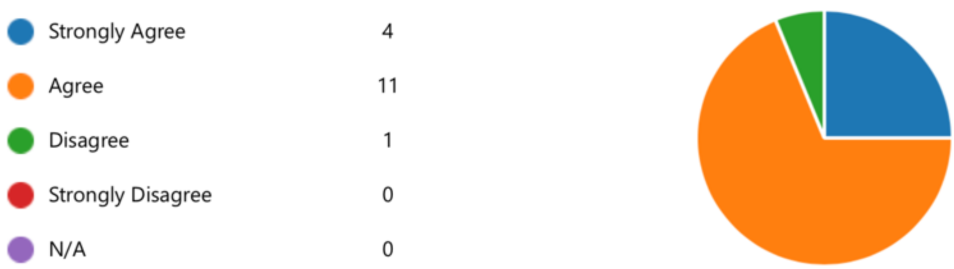
In some cases, as we used a web designed architecture, the refresh rate was not to par with the operational CHMI, and some requests took more time than expected.

3. The workload to detect hotspots was acceptable in the monitoring and detection task



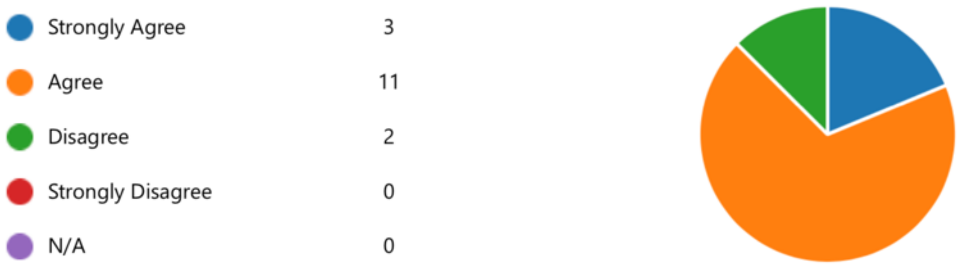
Good result from the feedback showing that the automatic hotspot detection can help a lot the FMP in focusing on resolution rather than on detection.

4. The information needed to detect hotspots was provided by the local tool



ECOsystem offers 3 main views, the air situation display, the sector load view with current view on occupancy count and the sectorization plan view. The mix of different level of information (weather, flight data and occupancy counts) was good to show the maximum of information on a well designed HMI.

5. The tool provided me with information needed to detect a hotspot in a relevant and timely manner.



Same comment as above. The operational FMP's prefer the way this information is laid out to them in the new tool. The timeline view is considered a good way to display the information and to monitor the situation.

6. The tool allowed me to accurately identify underload periods

This is one of the problems of the local tool for now. It was focused on hotspot, and not on what would be characterised as an Optispot in PJ09. The automatic detection of underload period is a topic that needs extra specification and development, and there are some good ideas from FMP's to identify in different color a sector which has spare capacity in which this sector is able to take STAM requests.

7. The workload to analyse hotspots was acceptable in the DCB measures analysis and preparation task

Strongly Agree	3
Agree	10
Disagree	3
Strongly Disagree	0
N/A	0

The feedback of the FMP's again shows good results, showing that the logic of the tool is correct. Here we have to take into account some minor identified performance and refresh issues that may have an impact on the analysis of the hotspots.

8. The information needed to analyse hotspots and prepare DCB measures was provided by the local tool

Strongly Agree	5
Agree	9
Disagree	2
Strongly Disagree	0
N/A	0

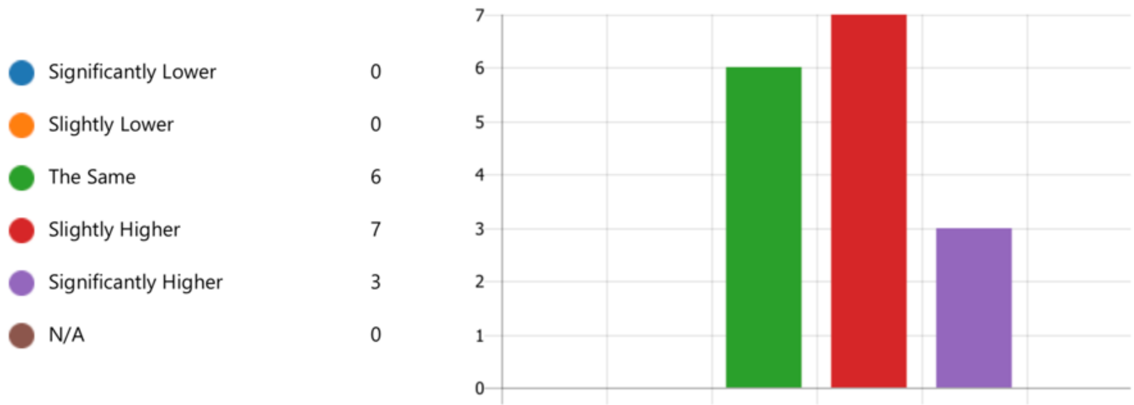
Great majority of FMP's agree or strongly agree that the demo tool has provided all the necessary information to analyze and prepare STAM measures for promulgation.

9. I was able to analyse hotspots in a timely manner in the analysis task

Strongly Agree	3
Agree	11
Disagree	2
Strongly Disagree	0
N/A	0

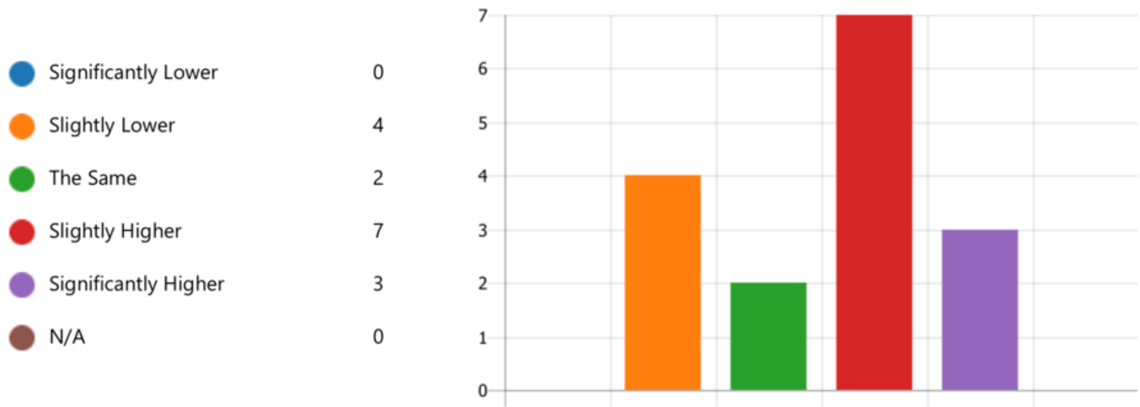
Same as above.

10. When using the new tool, I estimate that the number of hotspots solved by capacity management will be:



Not one FMP thinks that using automated processes will hinder their ability to activate STAM, on the contrary, all of them think the number of STAM requests processed will be greater, proving their confidence in the responsiveness of the demo tool. Capacity management is a key improvement to mitigate some of the delays on the overloaded sectors.

11. With the new tool, my situational awareness was...



The situational awareness is the key in the FMP day to day work. The tool is bringing improvements by showing different information on the same display. Still, some improvements are possible on the UX/UI (User Experience, User Interface) and additional work must be done in continuation to improve this further.

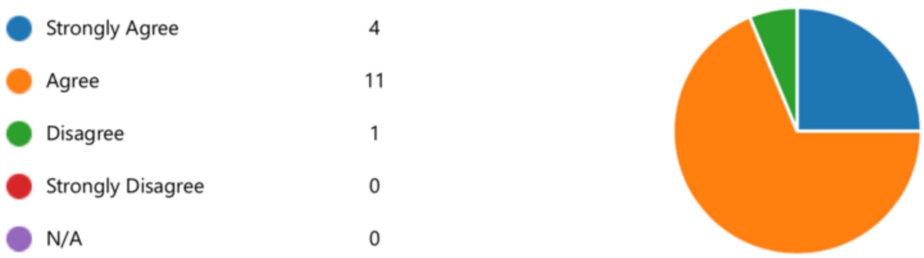
12. The impact on the adjacent airspaces concerned can be assessed and appropriate action taken.

This is clearly a lack on the local tool. The network effect of a measure is not well measured and the what if feature needs a big improvement on the way it displays the impact of a set of measure.

13. The information needed to assess the local impact of the DCB measures proposed to solve the hotspot was provided by the local tool

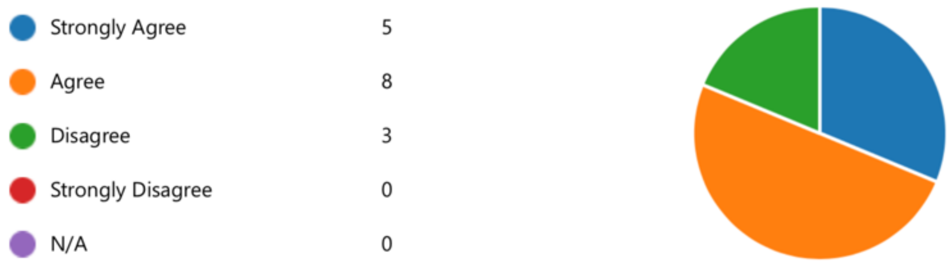
The local impact is well measured, in some case like airborne level cap measure, the precision must be greater, and the effect on adjacent sectors is missing.

14. The method and indicators used for detecting hotspots is clear to me in the detection task



The operation procedure of hotspot detection is clear.

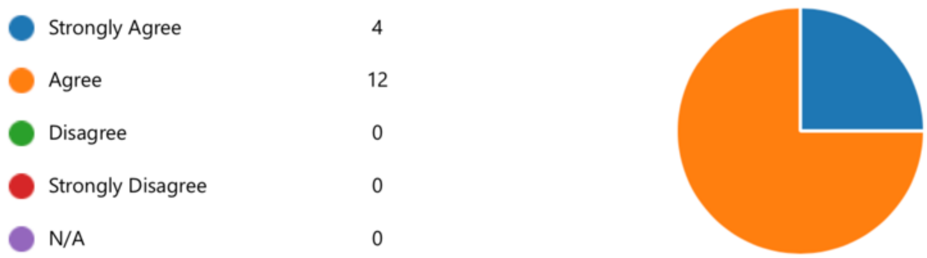
15. The process of declaring a hotspot is clear to me



The operation procedure of hotspot declaration is clear. Even if in PJ24, the hotspot declaration was not really used by NM on the PreOps server.

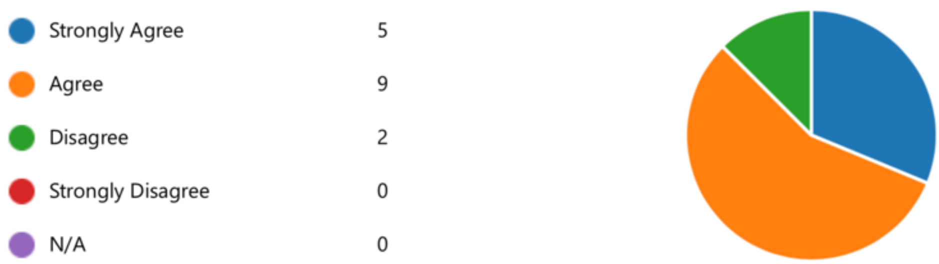
The regional flow management feedback is missing.

16. The method for analysing and preparing DCB measures to solve hotspots is clear to me



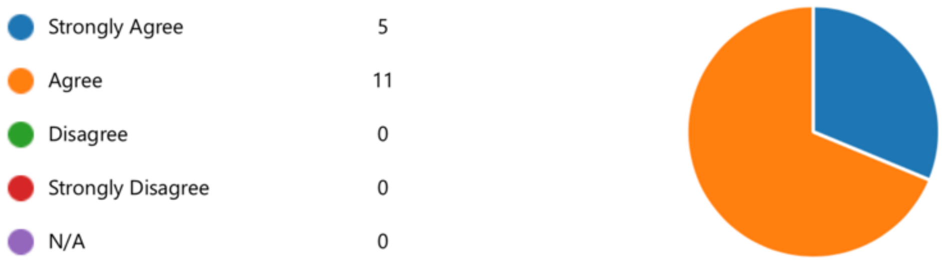
The operation procedure of DCB measure analysis and preparation is clear

17. The method for coordinating DCB measures is clear to me



The operation procedure of DCB measure coordination is clear

18. The method for implementing DCB measures is clear to me



The operation procedure of DCB measure implementation is clear

19. The local tool allowed me to optimise the use of my airspace capacity.

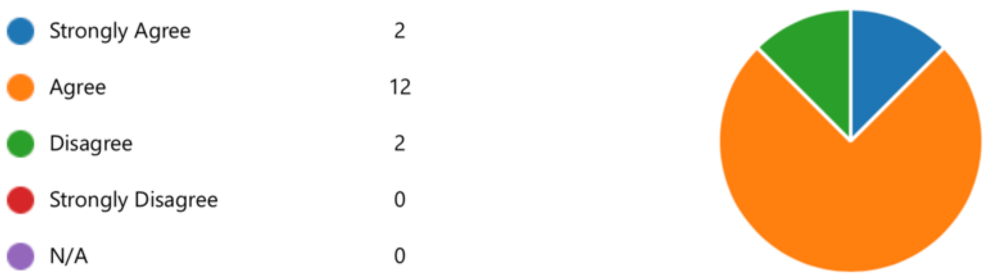
The Airspace Capacity optimization is complex and take time to set up with automatic algorithm. The work on this part is on going, and should be improved through the SESAR Wave 2.

2. EX5-OBJ-VLD-01-001 Results (Acceptable increase in workload

FMPs and ATCOs of the participating ANSPs are familiar with the application of STAM as it is part of normal daily operations.

The increase in FMP workload was only initial, as the participating FMPs quickly became familiar with the ECOSystem functions as they participated in the development of the Demonstration Platform during the preparation phase. The time for taking a consolidated STAM action on a hotspot very quickly became less than with no tool support. Use of the tool proved very efficient as all the details of each request were clearly displayed which made it easy for an FMP to take swift action or decision. Current LoA on STAM (reference doc. STAM implementation in FABCE V1.0), describes that STAM starts with identifying a hotspot and contributing flights and than making the telephone call to the other side, who then assesses the request against a table of STAM criteria. Major elements of this procedure have been integrated into the platform and automated, like hotspot identification, flight selection and assessment of impact on Traffic Load in both the off-load and on-load sectors make it easy to identify an ATFM disturbance, assess the impact and approve (or not) the STAM. From the FMP questionnaire (Q1. – Q3.) it can be observed that great majority of FMP's consider that the workload in the monitoring and detection task has not increased with using the demo platform.

1. I was able to maintain situational awareness in the monitoring and detection task



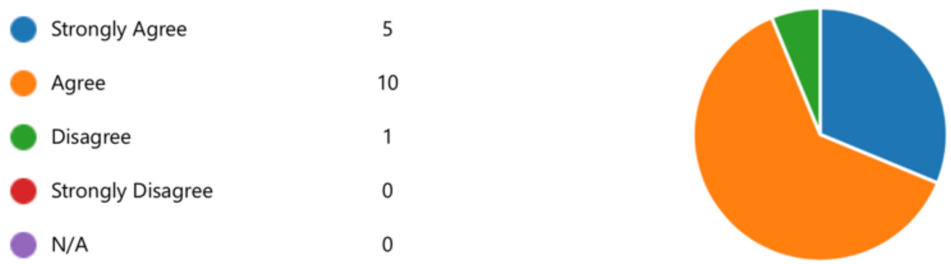
The air situation display feature of ECOsystem is relevant and true, and does not prevent the FMP to keep a close to real time situation awareness

2. The system allowed me to detect hotspots easier, quicker and more accurately than the current NM tool.

The automatic detection of hotspots relies on a good accuracy of the trajectories, and in the time period of 3 hours, the occupancy counts changes are quick and sometimes significant. The answers show that the automatic detection function is good in majority of cases, but still some situations do need a more intelligent way to find a hotspot on occupancy counts.

In some cases, as we used a web designed architecture, the refresh rate was not to par with the operational CHMI, and some requests took more time than expected.

3. The workload to detect hotspots was acceptable in the monitoring and detection task



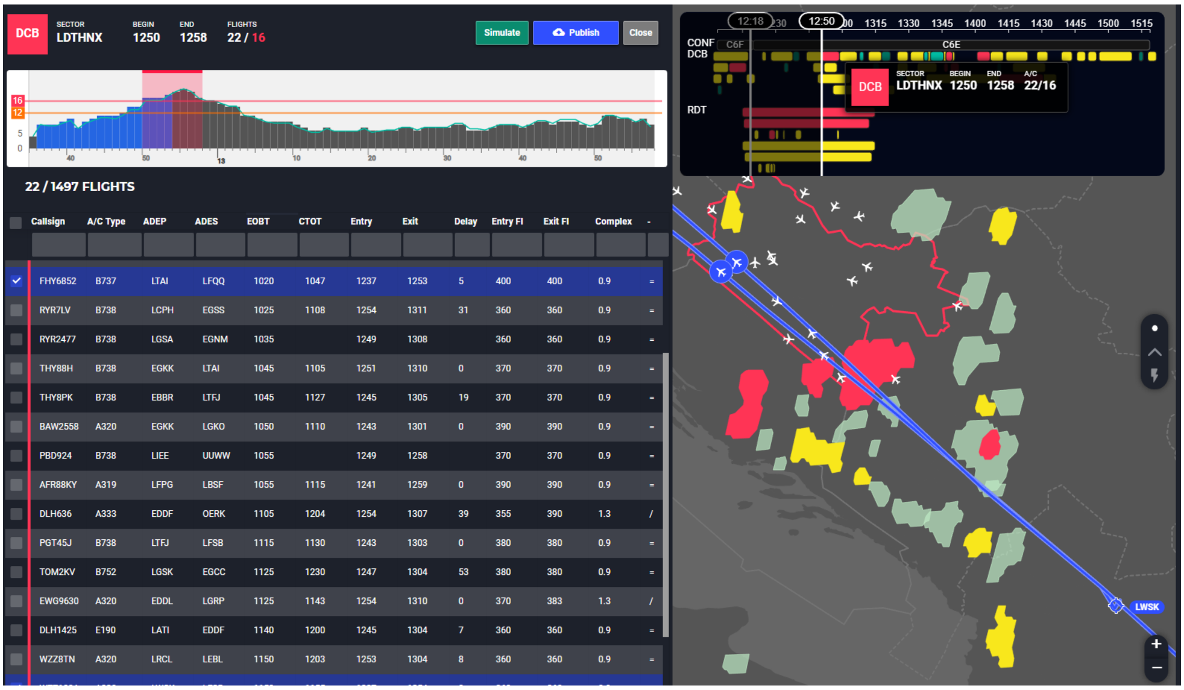
All but one participating FMP's think that workload to detect hotspots was acceptable, and that automatic hotspot detection can enable the FMP to focus on resolution rather than on detection.

3. EX5-OBJ-VLD-01-004 Results (Improved situational/planning awareness for all actors …)

According to the feedback of operational FMP's, the functions which were assessed in the exercise actually helped to improve their situational awareness. Some think there is benefit in integrating and keeping the interaction logic the same as in the existing NM CHMI system (eg. right click on a bar graph to open a flight list of that bar).

Use of the demo platform allowed for an increased situational awareness in some parts of the FMP functions. FMP's think that relevant ATFM information is displayed in an intuitive way, and displayed information increases their knowledge about their own Area or Responsibility, as well as the neighboring AoR which has shown to be increasingly important for an FMP. Apart from Traffic Load graphs, Information is displayed on a Map interface, which is not often used in current operations and existing CHMI due to poor Map response time. The Map integrates well the ATFM functions particularly so as the hotspot is selected, the concerned flights are automatically selected and displayed.

From the feedback it is gathered that automatic hotspot detection is the starting point for a better overall situational awareness, especially for an ACC running configurations with 8-10 sectors where the FMP monitors all of them in parallel (and many more). All the issues throughout the daily-declared configuration are automatically identified as a hotspot and highlighted, which sets the focus on the issues, while the insignificant information is greyed out, but still available.



1 air situation display in ECOSystem

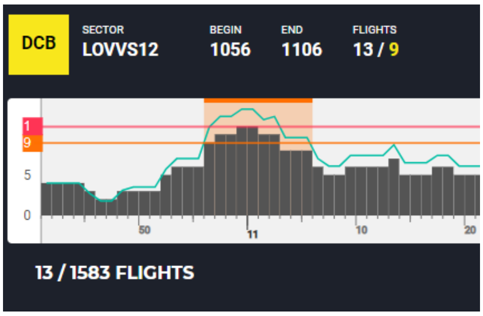
Weather

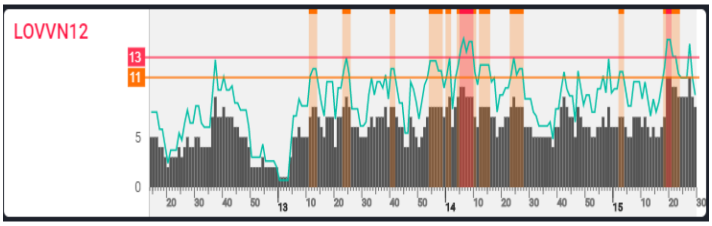
By having a live picture of an oncoming front, or a good forecast of CB forming area in 3h timespan FMP can make well informed predictions of volume of traffic which will potentially circumnavigate such areas. If FMP was able to make a scenario of impact to sector loads in a closed system and exchange such scenarios with other FMPs and NM this could be a part of the INAP process, which was studied in SESAR PJ09, and will hopefully be explored further in SESAR V3. In a future ATM such information will be uploaded to the cockpit and the crew and ATCO will know exactly what they need to do at all times as they will have this information as "planned".

There is also considerable gain in identifying in due time situations with a latent and low number of flights which are all changing their altitude in vertical plane. Such traffic sample is of higher complexity if compared to flight maintaining their level.

Complexity

Additionally ECOsystem provided a complexity representation of the expected traffic load which supported the FMPs in identifying the expected (predicted) complexity inside a hotspot, thus further supported an increase in situational and planning awareness. The complexity was presented as a green line on load bar graphs. This feature is a new concept in all 3 FMP's as none of the participating FMP's have a complexity indication in their centers and daily work. As this functionality was addressed in the second iteration, FMP feedback was gathered and corrections were made to diversify the complexity line away from the pure load values. These corrections on the demo platform came late in iteration 4, were not explored to the extent that was desired.





Due to time constraints on the development of a more extensive complexity model within the demonstration platform, a very simple model was chosen to allow at least for some operational feedback in regard to usability of this information. After several initial considerations, it was decided to go with the following simple increments in flight complexity:

Flight complexity indicator set to:

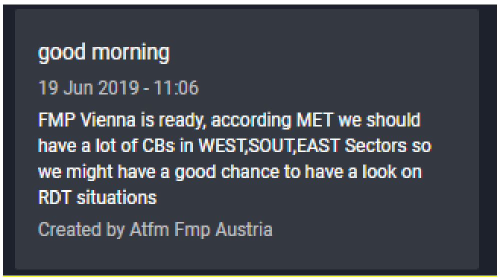
- 0.7 for cruise, level flight through observed sector
- 1.3 for a climb/descend less than 4.000' inside sector
- 1.7 for a climb/descend more than 4.000' inside sector

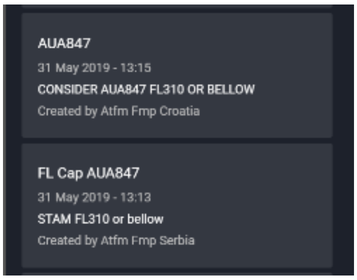
This produced a complexity line which of course depends on traffic load but also on the contextual complexity from the number of vertical transitions in a traffic sample. Similar factors were asked from the developers in regard to flights whose filled trajectories penetrate through RDT's as it is very likely that these are the flights which will ask for radar assistance and approvals for avoiding actions, and whose paths will very likely deviate from the filled profile.

Initial feedback from the FMP's shows that complexity indication is a very welcomed additional safety barrier to pick out situations of high sector workload which are not obvious from the pure representation of traffic load. It was concluded that having such indicators will increase their awareness of situations which may lead to sector overloads, and thus giving them valuable reaction time to undertake offload actions. Reaction to such complexity hotspot may be initiation of a STAM measure, MDI or even a change of configuration.

CDM Platform

Complementary to other system functionalities, a simple exchange of notes and messages between FMP's is available and represents the basis of the CDM exchange process. By connecting local FMP's into a network we unlock a great number of opportunities for collaboration. All STAM requests are sent through this channel, and an alert is also setup to notify the receiving FMP of an incoming message.





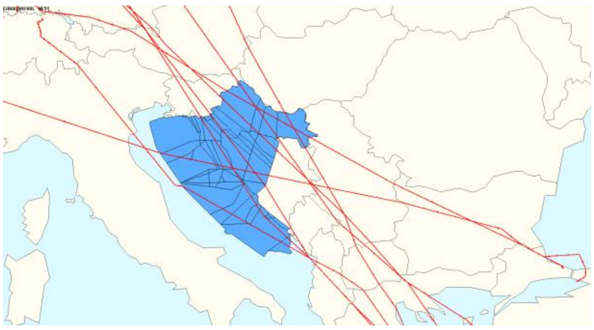
The coordination process is transparent and open, and it follows the steps as already described in LoA as an already existing STAM process signed between the participating ACC's. FMP's consider very important the fact they can very quickly asses the STAM request as all relevant information is presented to them in a very intuitive way. The request is assessed both in the off-load and in on-load sectors so the decision can be quick.

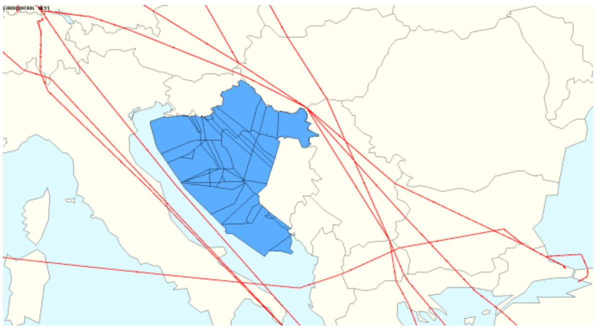
4. EX5-OBJ-VLD-03-002 Results (Reduce the extra fuel consumption due to DCB …)

Reduce the extra fuel consumption due to COOPANS/SMATSA proposed DCB measures for the whole traffic flow overflying a FIR.

By using STAM we can contribute to a reduction in the number ATFM regulations and move even closer to real time events. If informed on time, AO's choose to circumnavigate areas of high delay, which increases fuel consumption due to longer trajectories. By applying targeted and fine tuned measures some regulations can be avoided supporting the shortest route options. Most often this is a win for particular flights located in capacity or complexity hotspots, which makes them selectable for an improvement.

Since real fuel expenditure data is not available a Simulation was made in NEST to support the above claims.





INITIAL		Length / Fuel						DELTA (28.6.vs. 21.6.)	
			21.6.2019			28.6.2019			
Call Sign	City Pair	LENGTH (NM)	FUEL (KG)	CRUISE FL	LENGTH (NM)	FUEL (KG)	CRUISE FL	LENGTH (NM)	FUEL (KG)
AEE3FT	EDDF_LGAV	1.066,05	7.509,42	350	1.089,91	7.617,06	350	23,86	107,64
MSR758	EHAM_HECA	1.802,02	10.107,00	370	1.822,51	10.213,80	370	20,49	106,80
EDW336	LSZH_LGSR	1.041,87	5.760,39	370	1.059,86	6.029,04	350	17,99	268,65
TOM1XE	LGRP_EGCN	1.629,45	9.061,14	380	1.735,08	9.606,19	380	105,63	545,05
THY1UZ	LTFM_LPPR	1.747,34	9.719,86	380	1.768,12	9.975,26	370	20,78	255,40
RYR31CT	EBBR_LCLK	1.624,49	9.222,84	370	1.652,37	9.368,16	370	27,88	145,32

Days 6 (Iteration 2) and 9 (Iteration 3) were compared, where there was not a significant difference in delay through LDZO. On day 6 there were 6 regulations implemented with 6.618 minutes in total, while on day 9 there were 7 regulations and 6.686 minutes of delay.

As real fuel expenditure figures were not available, they were simulated in NEST for both scenarios, one showing trajectories via LDZO and the other outside of LDZO. Actual flights were chosen, which had different trajectories (in/out of LDZO) on these two days most probably for the reasons of delay encountered ENR. To be able to calculate fuel consumption in NEST for an aircraft type on any citypair, we need to run a simulation to achieve the fuel calculation from the 3D trajectory. Wind is not a factor in NEST simulations.

In assessing the results, we are looking at simulated and "potential" fuel saving for each flight as the difference between total trip fuel used on one day (21.06.2019) versus total trip fuel on the other day (28.06.2019). In this case, the potential fuel saving is not a function of reduced mileage multiplied by the fuel consumption per Nautical Mile, but a function of planning the flight on a different 3D route with different airspace restrictions and options which all affect total trip fuel. Also the reduction in Mileage is the difference between total NM one day vs. total NM the other day. The reason why cruise FL's are different on these two days is because of RAD, PTR and other constraints like DELAY encountered in the initially filled FPL.

The results of the fuel calculation show a good potential for fuel saving (on average between 100kg and 230kg of fuel) on an average European citypair.

This all-inclusive approach works also on individual flights once the AOC become part of the CDM process, as having them in the loop will ensure their ever-changing best interests are met as long as airspace capacities are contained.

For the ATEAM perspective the methodology used to compare the trip fuel on a specific flight number identification (ID) from one day to another day due to horizontal STAM measure could not be considered sufficient to identify the Airlines benefit; the two flights could have very different performance parameters, could be affected by many factors that should be considered and normalized before obtaining the delta fuel such as normalized weight, due to differences in passengers, cargo, (ZFW), different aircraft performance, different Flight Level, last updated wind component, Cost Index, other possible restriction due to the adjacent sector getting congested etc.

Therefore the savings obtained between day1 and day2 are not consistent since they have been not normalized for some of the above mentioned parameters (ZFW and aircraft performance factor are normalized).

The simulation provides nevertheless an interesting indication through the planned horizontal trajectory looking at the different distance in NM, the Flight Level due to possible ATC sector restrictions such as RAD and others factors.

5. EX5-OBJ-VLD-04-003 Results (Reduction in time for FMP staff to monitor, analyze …)

In most ACC's in ECAC, these processes rely on the FMP to dig deep to look for candidate flights, and then to use the telephone to exchange information and initiate STAM requests. Some more automated processes have recently been setup, like the DSNA CAP Process (in EXE 4) which has automated main parts of the STAM process and has involved other interested parties.

Having automated processes for hotspot ID and basic CDM exchange through a simple message exchange has shown a great increase in confidence of operational FMP in their ability to really manage the sector load. The results of the FMP questionaries' show a reduction of time to carry out their regular duties to monitor and analyze the oncoming traffic and choose the optimal configuration.

From the FMP feedback it is also clear they like the proven functions which are simple like opening a flight list from a Load Bar with a right click.

It is interesting how some operational FMP's consider the incoming message alarm a very important function in the FMP position as the tasks of this position have significantly evolved from the odd telephone coordination. Since time is of crucial importance in ATM they want their attention to be grabbed by an incoming STAM request, as the FMP's use multiple screens to perform their tasks.

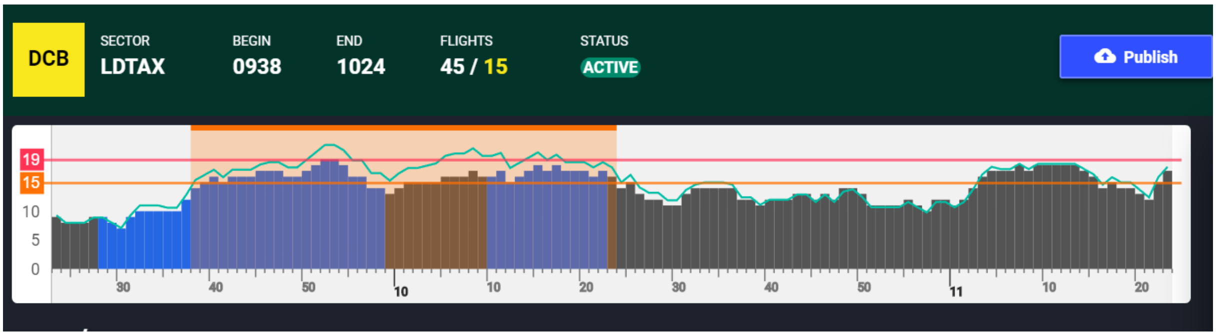
6. EX5-OBJ-VLD-05-002 Results (Reduction of sector delay resulting from DCB issues …)

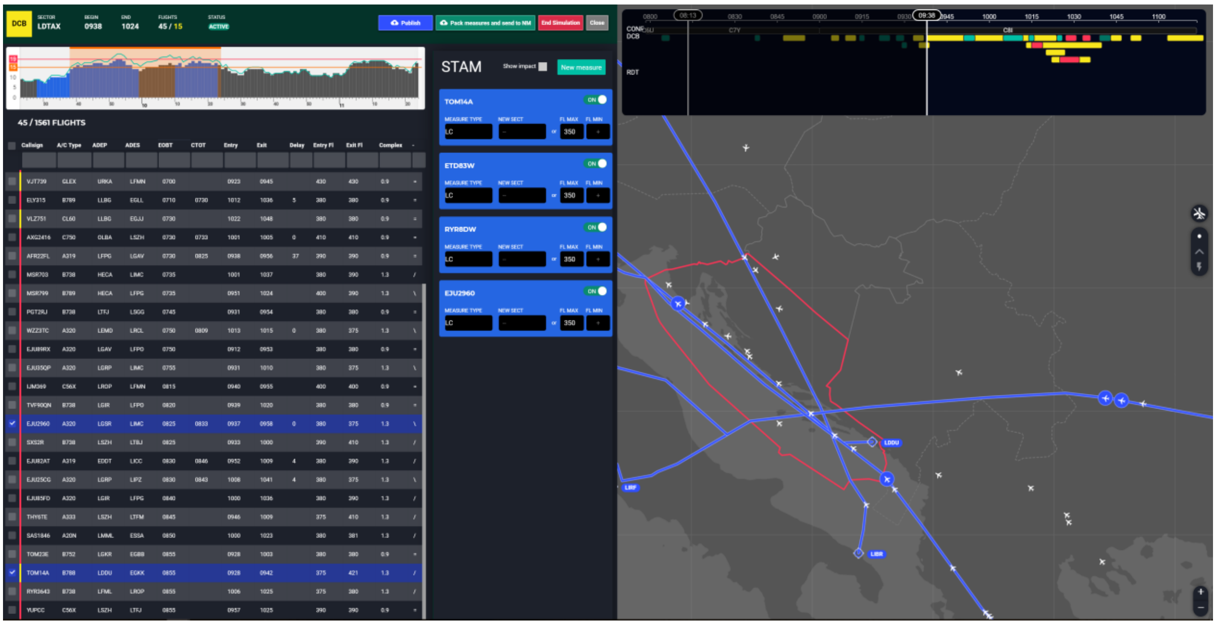
Reduction of sector (arrival, en-route) delay resulting from COOPANS/SMATSA proposed measures for DCB issues by using enhanced DCB and mechanism

By implementing better last minute tools and processes, we can better manage the impact of FMP actions on sector load. Most sectors in EU have a defined buffer on capacity to mitigate unintended flights entering their AoR. With having more efficient and better last minute options, these buffers can be reduced, which is exactly what happened with the implementation of STAM processes in FABCE arena.

Very often, the same result can be achieved by re-arranging flights in sector in coordination with neighboring FMP, in which case there is no ATFM delay involved. It is a simple short operational agreement put in place instead of a regulation. By developing new and operational short term processes like STAM, MDI etc., we increase our chances of impacting sector loads in a positive way and most importantly – on time.

In the following example from 27.06.2019, LDTAX has a high workload period lasting over 40 minutes. Situation is assessed and four candidate flights are identified for reducing their entry level out of LDTAX sector.

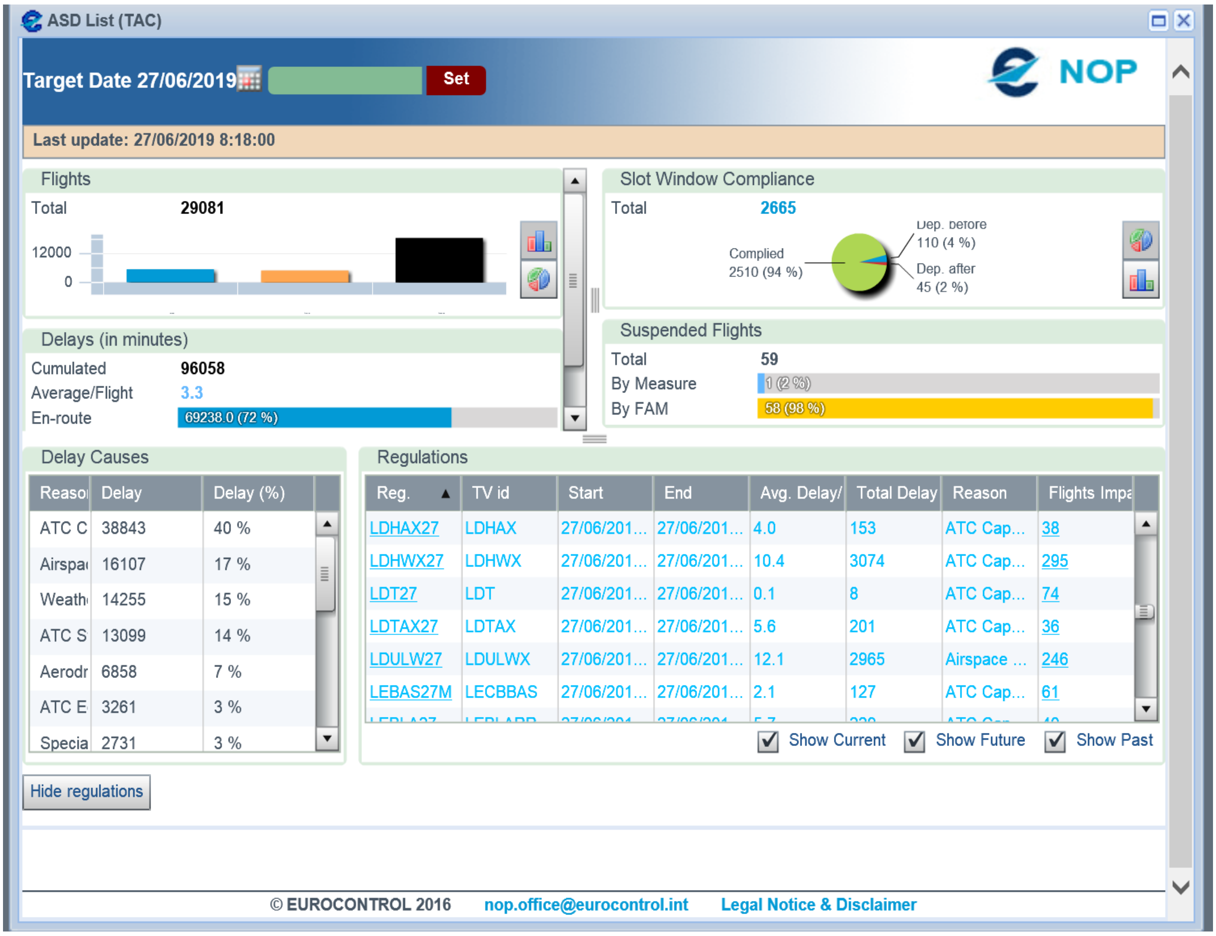




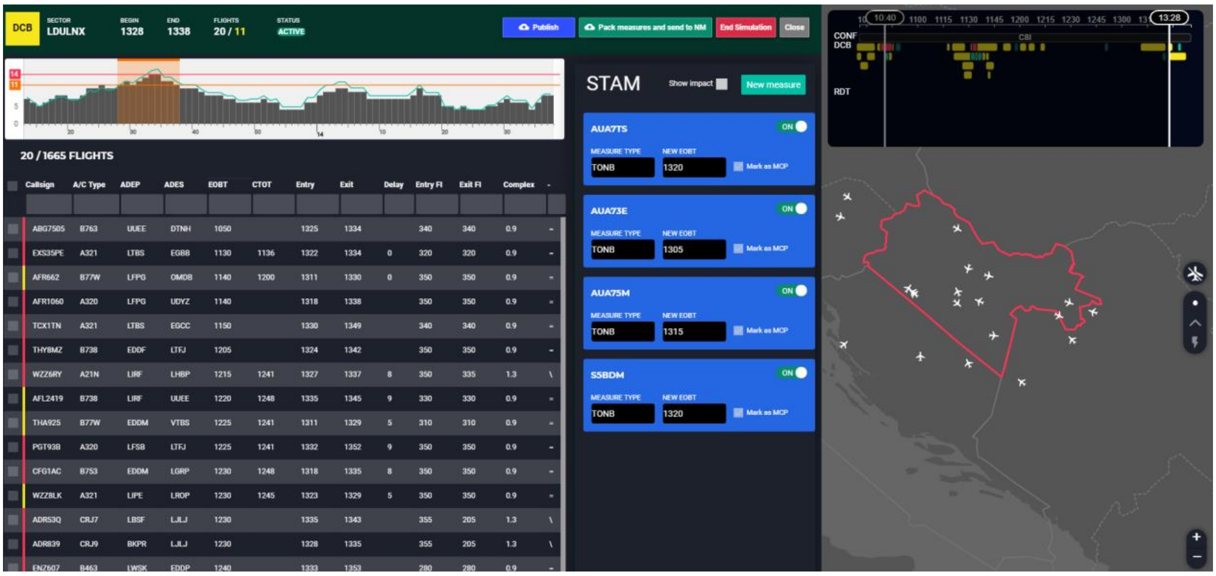
By using the Demo tool the FMP was able to remove four flights out of the peak on LDTAX, and a regulation was avoided. This regulation was applied in SIMEX produced a total delay of 201 minutes, which were saved in this particular situation.

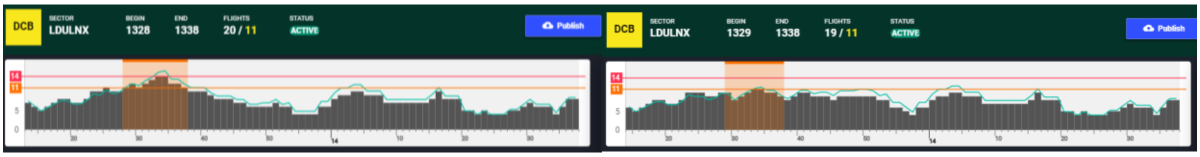
LDTAX	9:40	10:40	37+1	avg.delay	total delay	flights impacted

LDTAX27	LDTAX	27/06/201...	27/06/201...	5.6	201	ATC Cap...	36



In another example, a hotspot on LDULNX is solved by implementing TONB STAM on four flights. A regulation on this hotspot is simulated in SIMEX which captures 25 flights and cause 107 minutes of delay. It seems very inefficient regulate 25 flights with the current ATFM methods where re-arranging four of them in a fine tuned targeted measure achieves the same desired effect.





LDULNX27	LDULNX	27/06/2019 13:20	27/06/2019 14:00	4.7	117	ATC Capacity	25

From these observations and SIMEX results, we can see that if an FMP is equipped with an automated solution can he can undertake more and faster actions than with no tool support.

Another quick win for both the ANSP and the AO is in the following situation:

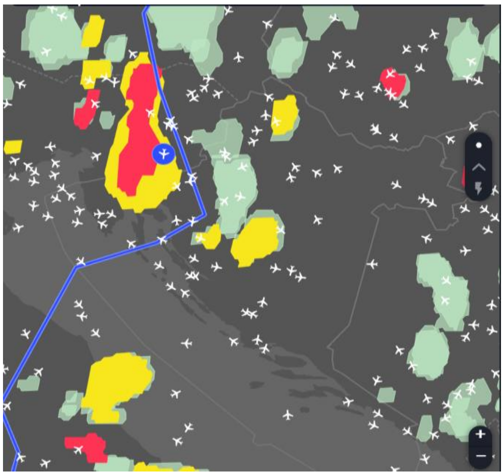
The flight is part of the hotspot on LDTHNX, and is captured by a regulation on LDULNX, and has a delay of 25min. The FMP checks the latest update on sector load and finds that he can improve this flight in regulation on LDULNX. By removing the delay, the flight is also removed from the hotspot on LDTHNX.

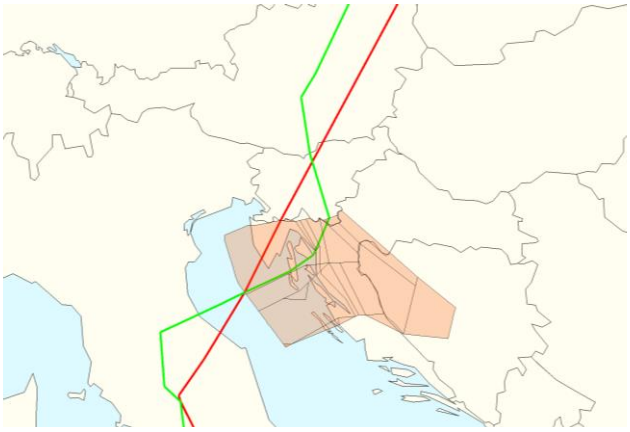
This is a win-win situation for both the ATC and AO as the delay is saved both ways. An automated tool to support easy and quick identification of such instances by the operational FMP will enable significant savings for the airlines.

7. EX5-OBJ-VLD-05-005 Results (Mitigate the capacity reduction of a FIR , due to adverse weather …)

Mitigate the capacity reduction of a FIR, due to adverse weather

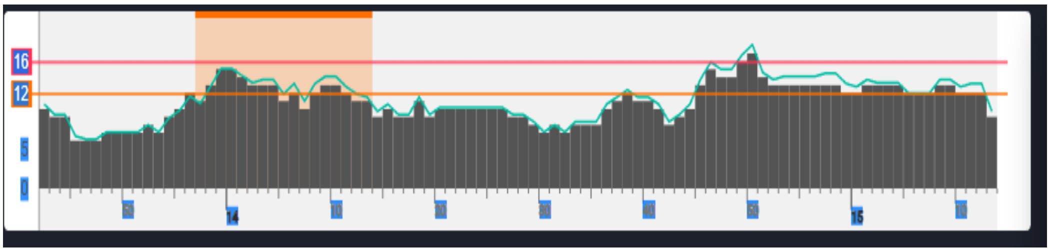
The first obvious difference to existing tools is the fact that meteorological information is integrated with, and displayed on the same screen with ATFM information. By observing flights behavior it was concluded that complexity indicator should be observed as being increased for flights penetrating areas of RDT, and this was requested from the development team. This functionality has been added only in the last Iteration 4 and not explored enough.



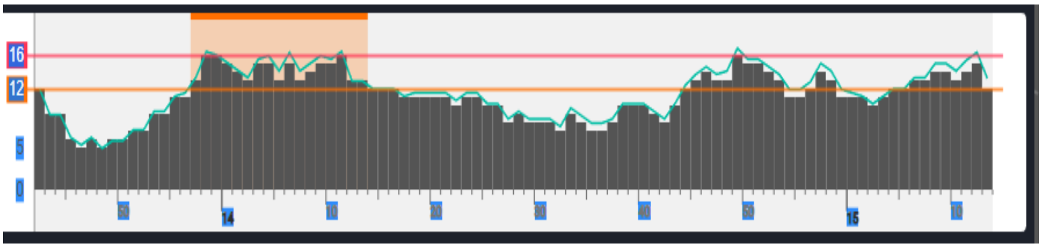


In the example above, RYR2YR's trajectory (19.06.2019) was affected by adverse weather which covers the area depicted on the map in yellow and red color. The red area represents an area of RDT's where CB's are already formed and present a safety obstruction, and the flight takes a longer path through Zagreb LDTWX sector. This in turn increases sector occupancy for this flight.

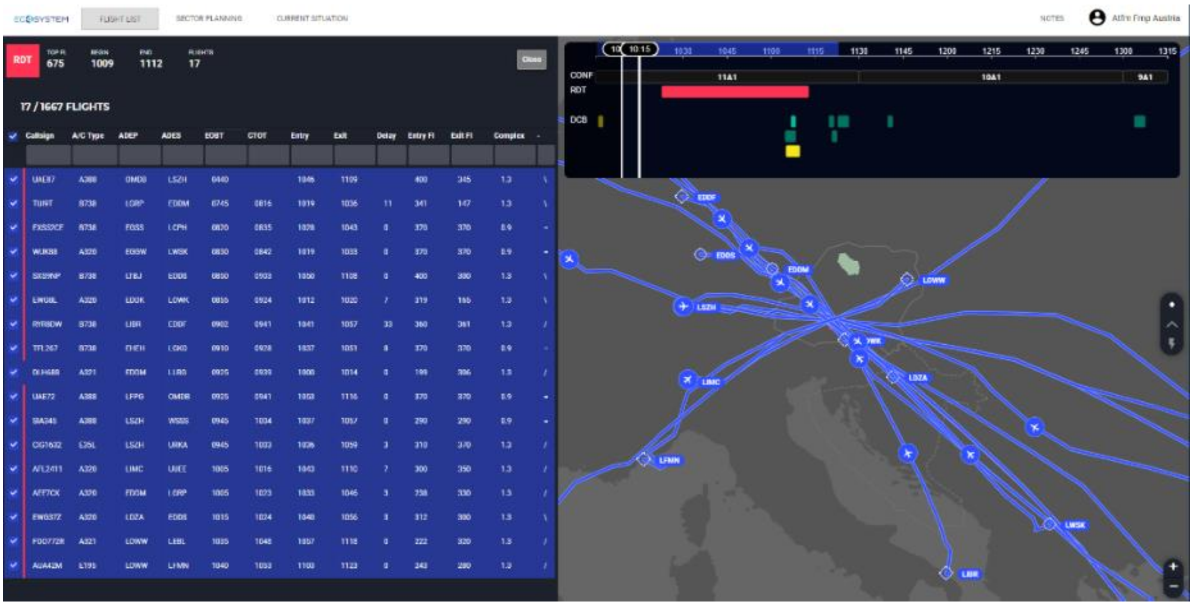
Based on MET information, an FMP can create a scenario in which he adds proposed avoiding trajectory for all concerned flights to the sector load and choses another configuration to optimize the efficiency of ACC configuration and total capacity of the ACC.



Before RYR2YR enters the sector LDTW, a hotspot can be observed around 14:00 UTC

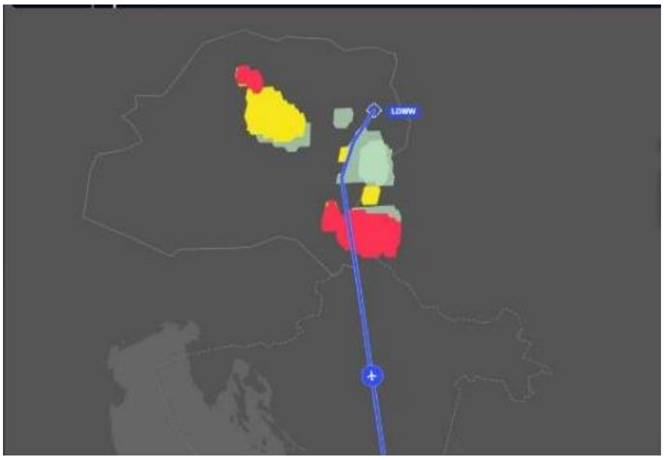


Once RYR2YR enters the sector, she is flying a longer route to avoid the area of RDT. This in turn increases sector occupancy time and is likely to qualify as an OTMV overload. By observing the current weather and actual trajectories, the FMP is able to predict such scenario is able to take the necessary ATFM action.



The following 2 screenshots for LOVVS15 from 27th June 2019 show the impact of a particular RDT on the planned and actual flight path of one particular aircraft which also impacted the LHCC and LDZO FIRs:

Screenshot #1 shows the planned trajectory:



Screenshot #2 shows the actual trajectory in retrospect:

From the pictures above it is easy to understand how the meteorological situation may impact sector loads, and cause uncertainty in sectors where this flight is not planned. The argument that there is always space for another quickly becomes invalidated as in complex meteo situations this is never only one flight, as complete flows are encompassed by weather. Some sector overloads connected with CB avoiding amount to over 50% of sector capacity in normal circumstances, which makes a clear conclusion of their severity and impact. FMP will never be able to mitigate all those flights, but at least having good awareness of the situation greatly improves the chances of making the right decision.

H.3.4 Unexpected Behaviours/Results

It was observed that although an area has been marked as RED as in the examples above, there were still some flight going through it and not circumnavigating. In reality, pilots often choose a path between particular clouds as they are equipped with a weather radar system and see a safe passage. Considering the accuracy of weather forecast and models today, the MET providers will only indicate an area where the conditions are likely for a Cumulonimbus (CB) cloud to propagate. Further increasing the granularity of MET data will have a positive effect on the quality of forecasts of sector load changes.

H.3.5 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

The exercise was conducted within the NM B2B pre-ops environment. The following screenshots from ECO system and NM CHMI show a comparison of Occupancy TL (Traffic Load) for the same sector that were taken on 5th June 2019.

2 left: CHMI at 08:49 UTC and right: ECO system at 08:50 UTC

By comparing the Load graphs of the generic, operationally validated CHMI and the Demonstration platform, it can be concluded that the Demo platform is not showing the exact figures as in the CHMI. This difference was concluded to be marginal, and not affecting the results of the exercise. It was concluded that the focus is on the possible benefits of automating the STAM process, as well as getting a more complete insight of the oncoming flows.

Being a shadow-mode demonstration, all the requested measures were approved for the argument of testing and training. It is also fair to say that all the message exchanges were expected and there was very little time wasted in waiting for an answer. All the actions were quick and positive, which in reality is often not the case, and there are more inefficiencies within the same process.

Significance of these exercises is great in the sense that demos like this drive the development of local tools and indicate directions worth exploring. Hence COOPANS decision to continue to pursue advanced ATFM solutions in the gap between ATC and ATFCM as a lot of efficiency can be fine-tuned in this area.

2. Quality of Demonstration Exercise Results

This demo is run in pre-ops and the results of measures are simulated in a closed pre-ops environment. As such, all proposed measures were implemented and effects of such measures were always on the positive side. In real life, the real impact will be lower as some measures are denied, as well as in some odd situations a STAM measure may worsen the situation due to sudden last minute changes in demand driven by less than optimal predictability of the current NM system.

Quality of the EXE results is a function of FMP actions where having experienced FMP take part in Demo ensures their actions are operationally relevant and efficient. According to FMP feedback, overall results of the Demonstration are considered positive as processes that were tested allowed an FMP to quickly identify a hotspot and make positive impact on sector load by actual “delegation of workload” across the border to sectors and ACC’s which have spare capacity in these short timeslots. Such CDM actions increase the efficiency of local ACC’s and their interface, thus directly contributing to overall efficiency of the Network.

Decision time in these operational STAM procedure is set to minimum 20minutes before sector ENTRY time to complete the action before the exchange of flight data between two ACC centres takes place (at 12min prior ENTRY=ESTimate).

The results of SIMEX and NEST simulations used in this EXE are considered to be more an indication of a trend rather than a real theoretical value, although these applications are operationally used at many ANSP’s as validated tools for analysis and planning.

3. Significance of Demonstration Exercises Results

This demonstration was originally planned as an operational live-trial with the involvement of NM and airspace users would definitely be of more significance but as the plan was developed a number of issues that were encountered steered the demonstration into the shadow mode operations. This was an iterative process, and decisions were made as the limitations of the exercise became apparent. In the end, it was decided to carry out the shadow mode and to test the FMP to FMP coordination and collaboration, as well as to test some of the interesting new functions for possible future COOPANS development and deployment. In this regard the results of FMP feedback is valued as an expert opinion, and improvement processes are normally built on such

Significance is great in having an impact on the way of thinking of operational FMP's and enabling them to feel more comfortable and take the more proactive approach. Their capacities are increased and they already feel comfortable with cross border procedures which are not yet operationally implemented.

H.4 Conclusions

From the four iterations the following conclusions were made:

Use of the demo platform increased the situational awareness of the FMP. It has also allowed for a reduction in response to a hotspot, as well as an increase in impact to sector load. The platform only allows the FMP to identify flights and propose actions, but still it is the ATCO who must make the final corrections in trajectories and deliver the flights as requested. It is exactly the aim of these processes to enable them for quick wins when the time allows and when there is spare capacity in the adjacent sector. For efficiency of such operations, the initial request filter (FMP criteria for STAM promulgation) must be very clear and simple.

There are significant gains in automation support for traffic load density management as already addressed by SESAR OI step CM-0101 which is also the predecessor of traffic complexity tools. Ecosystem platform is one example solution which gives an insight into how automating load management enables new victories in flow management and airspace capacity and throughput. Such processes also develop closer relations and rapport among the operational people across borders as they gain on and experience the benefits of such concept. Implement Local Traffic Complexity tools and procedures Implement Local Traffic Complexity tools and procedures

Use of the platform allowed for basic insight into sector complexity, and this indicator was developed throughout the four iterations. Complexity indication will help to identify peaks in traffic when they are not obvious, and will thus directly contribute to safety. Requirement to implement mplement Local Traffic Complexity tools and procedures mplement Local Traffic Complexity tools and procedureslocal traffic complexity tools and procedures by end of 2021, as described in ESSIP FCM-06 of the SES and also in ICAO GANP will drive additional safety enhancements in sector load management and prediction. Enhanced Flow Performance through Network Operational Planning

COOPANS Improvement Group (CIG) is looking for a tool to cover all these and many more requirements and improve on efficiency by developing the extended ATCO planner or multisector planner function. Lessons from this demonstration exercise will be presented to the CIG Group for possible further investigation and future operational deployment of some of them which are considered by the FMP's taking part in this demonstration as potentially most productive.

Using the platform has shortened the response time and increased the impact of an FMP in carrying out his/her operational duties.

From the FMP feedback it is clear that operational FMP's consider the tool as an improvement in their function. To support this claim, majority of them think that the number of STAM requests will be higher, or even significantly higher when using the tool, compared to today's manual process.

Development of the MET functions should be investigated further. The "Cloud Flight List" function was not available in the Demo platform as planned, so the possible benefits could not be investigated in full. Still, the integration of MET and ATFM data has shown a rise in confidence of the FMP's to implement STAM measures at short notice. The granularity of MET data needs to be improved because the scenarios which are built from this data directly rely on the accuracy of meteorological information.

In regard to complexity indication, this feature was added only for Iteration 4, in which the FMP's only started to become familiar with it.

H.5 Recommendations

H.5.1 Recommendations for industrialization and deployment

It is clear that automated processes can assist the operational FMP in their tasks, and increase the capacity of this position into the extended planner of multisector planner tasks. This ATFM platform enabling such processes needs to be connected with the local ATM system to enable direct distribution of STAM compliant request to the ATCO concerned. In any future ATFM system and software solution, it will be necessary to merge both some of the proven functions of the generic CHMI, and the newly developed functions as described here.

This session of PJ24 was very interesting from an operational point of view, but is was also a good technical validation for several topics:

- Provide ATFM as a service: All the trials were conducted on an instance of ECOsystem ATFM through Internet.
- According to cyber security principle, the tool was accessible through a web page running in google Chrome application. This is very important to test the principle of web application development in the context of a highly secured and protected operational environment.

- Link with SWIM PJ18.04a and PJ18.04b services: during PJ24 trials, THALES used the platform to validate the SWIM services defined by PJ18.04:
  - Meteo service: a local weather data provider connected to the platform through the SWIM service Meteo
  - Local NOTAM distribution: a local NOTAM server was connected to the platform through the NOTAM SWIM Services.

H.5.2 Recommendations on regulation and standardisation initiatives

During the preparation of the demonstration activities, it has come to the attention that not all ATM systems display accurately the information on exact trajectory filled through their AoR. We consider it would be of benefit to predictability if this information was easily available to all ATCO's. In reality, ATCO's "drive" their sector sequence in which the actually filled FL is often mistaken with maximum RFL enroute. As the efficiency improvements of future ATM system rely on better FPL adherence and implementation of 4D business trajectory we must make sure that all the key players are equipped with all the important information as otherwise we will not achieve the efficiency that we are after.

Appendix I Demonstration Exercise #06 Enhanced Coordination of STAM (ENAIRE)

I.1 Summary of the Demonstration Exercise #06 Plan

Exercise #06 work plan included four iterations using different tools to address the Use Cases under study, namely UC2.2, UC2.4 (including UC2.5) and UC2.8. Table 43 below provides a summary of the activities executed as part of EXE#06.

IT #	VALIDATION TECHNIQUE	TOOL USED	UC(S) ADDRESSED	SCOPE	SCHEDULE
1&2	Live Trial	CAP Tool (DSNA)	UC2.4 & UC2.5	LECM & LFBB	Q4 2017 Q2 2018
3	Technical Verification	iACM (INDRA)	UC2.2	LECM	Q2 2019
4	Shadow Mode	PLANTA (Eurocontrol)	UC2.2 & UC2.8	LECM LECB	Q2 2019

Table 43: Summary of activities under the scope of EXE#06

In a more graphical way, Figure 176 shows the relationship between tools used and UCs address in each iteration.

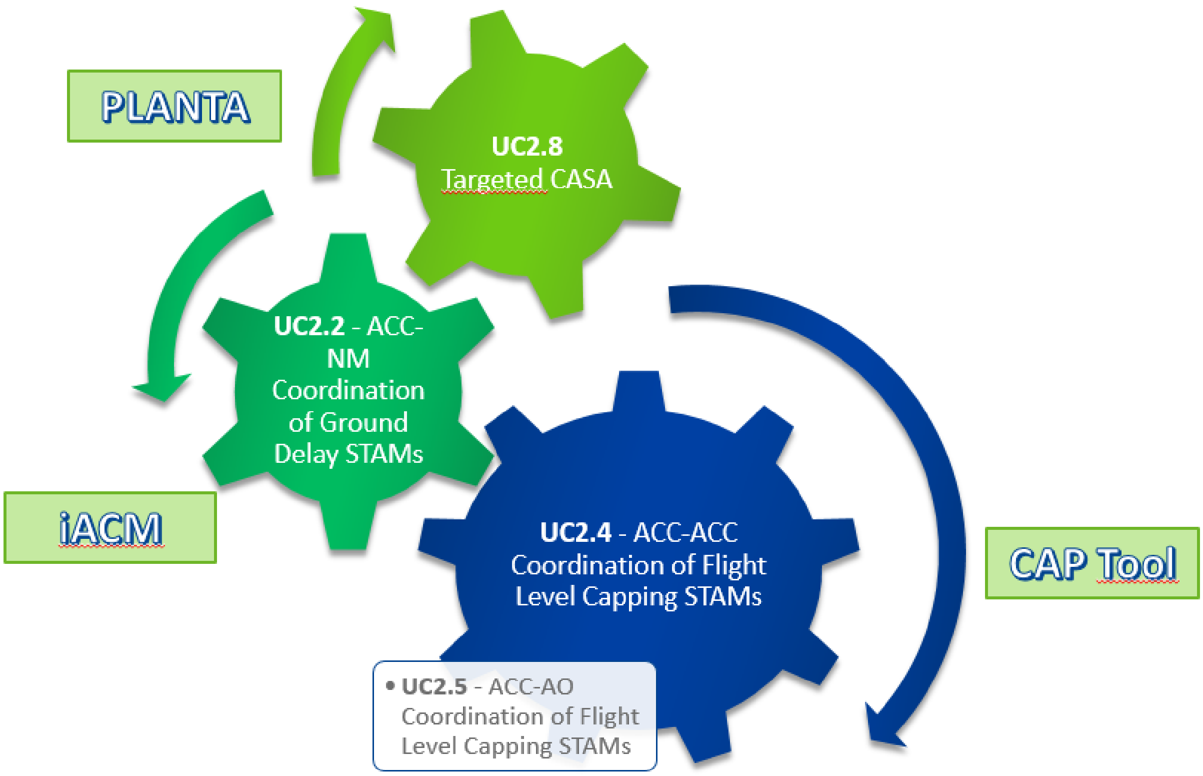


Figure 176: EXE#6 UCs/Tools relationship

Details regarding iterations 1&2 with the CAP tool are described in **Error! Reference source not found.** Summary of the Demonstration Exercise #06 Plan.

Iteration #3 was degraded to a technical verification. ENAIRE PJ24 team participated during one day in the technical tests to check the B2B connections required to notify hotspots and coordinate Ground Delay measures. Results against demonstration objectives are not gathered due to the kind of activity.

Iteration #4 with PLANTA is describe in section I.1.1 below.

SAFETY Aspects

It is important to note that for the three iterations, coordination between ENAIRE/CRIDA PJ24 team and ENAIRE Safety group was put in place. AESA, the Spanish National Authority, was informed by ENAIRE of the execution of this exercise, including scope, operational concept, objectives, dates of execution and impact on real operations. AESA acknowledged the reception of the arguments without providing counter-arguments.

I.1.1 Exercise description and scope

EXE#6 iteration #4 aim was to solve two main ENAIRE needs. On the one hand, ENAIRE wanted to test the efficiency of Flow Regulations (known as Targeted CASA) vs. General CASA Regulations in LECB, while on the other hand, there was a need to prove the benefits of applying Ground Delay measures with Mandatory Cherry Picking in LECM.

1. UC2.8 Targeted CASA in LECB

PLANTA

It is foreseen a big increase of traffic in the ECAC area in 2019 summer. Due to the traffic characteristics in LECB, ENAIRE is looking for new solutions that could accommodate the expected demand. Expected demand in LECB for summer 2019 is over the capacity and consequently a DCB process will be requested. Targeted CASA regulations is a DCB measure that could allow to mitigate the impact of current CASA regulations and thus to reduce the number of minutes of delay at Traffic Volume and Network level and the number of flights affected by the measures applied.

ENAIRE LECB Operational Staff have identified the flows in LECB ACC where Targeted CASA regulations could provide bigger benefits and requested to Eurocontrol PLANTA Team to integrate the new TVs in PLANTA. They are listed below:

CURRENT TV	NEW TARGETED FLOWS ID	TARGETED FLOWS DESCRIPTION	NEW NEGATIVE TV
LECBO1	LECBG1EV	Sector including evolution traffic	LECBG1ES – Exclude flows included in G1EV
LECBCCC	LECBCCEV	Include traffic arrival to	LECBCCES – Exclude traffic to LEPA

CURRENT TV	NEW TARGETED FLOWS ID	TARGETED FLOWS DESCRIPTION	NEW NEGATIVE TV
		LEPA and LEIB	and LEIB
LECBVNI	LECBVNEV	Include traffic arrival to LEPA	LECBVNES – Exclude traffic to LEPA
LECBMNI	LCBMNAS	Flow via LUMAS	LECBMNEX – Exclude all three flows
	LECBMNOS	Flow via OSPOK	
	LECBMNMU	Flow via MUREN	
LECBBAS	LECBBAEV	Include traffic arrival to LEIB	LECBBAES – Exclude traffic arrival to LEIB and destination DAAG
	LECBBAAG	Include traffic destination DAAG	
LECBLVL	LECBLBLA	Include LEBL Arrivals	LECBLVES – Exclude all four flows
	LECBLBLD	Include LEBL Departures	
	LECBLVIB	Include LEIB Arrivals and LEIB Departures	
	LECBLVAL	Include LEAL Arrivals	

Table 44: EXE#6 Targeted CASA Flows definition

Eurocontrol included new traffic volumes identified in the corresponding AIRAC cycle that were available in PLANTA during the exercises.

Figure 177 shows a summary of the process followed by LECB FMP during the exercise execution.

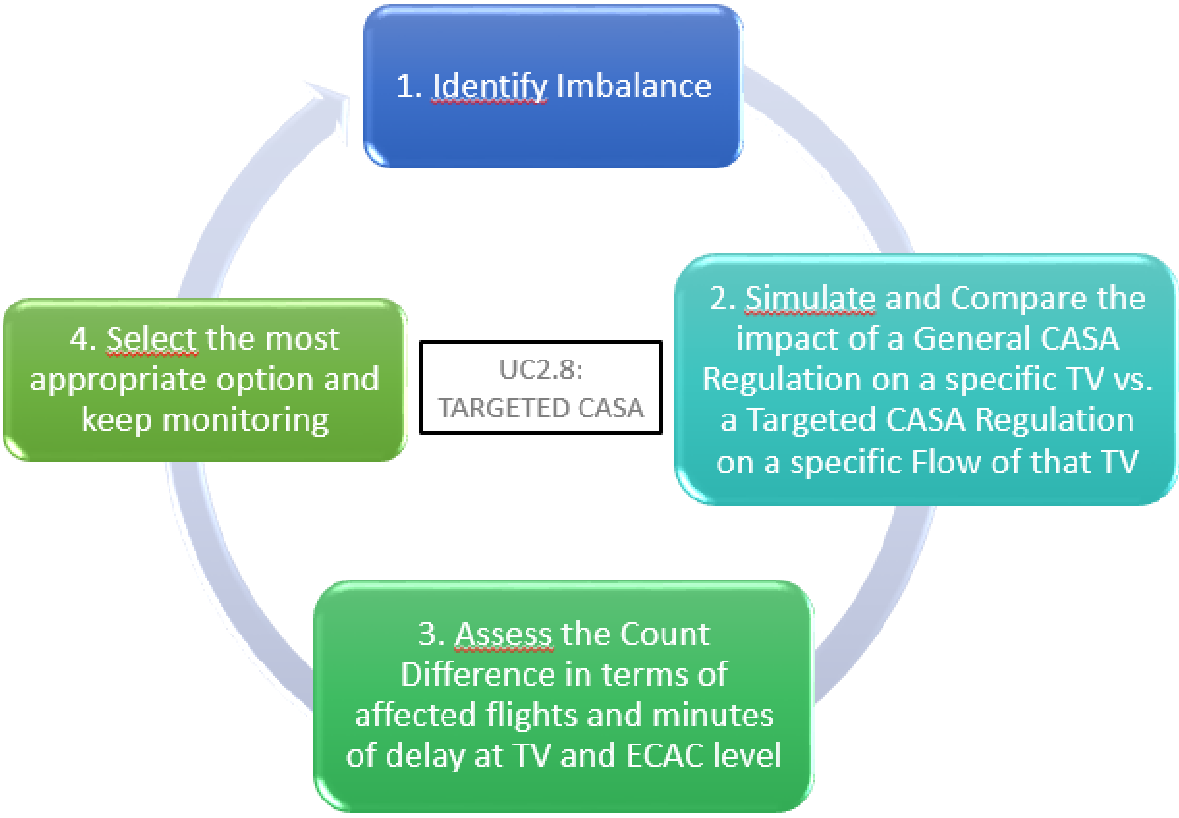


Figure 177: UC2.8 Summary of Operational Flow

1. Identify Imbalance

PLANTA HMI – ACC Monitor view easily allows LECB FMP to identify imbalances thanks to the colour code defined. The imbalance will provide guidance to the FMP in order to find the most appropriate Targeted CASA. Figure 178 shows the graphical identification of a hotspot in PLANTA.

Figure 178: PLANTA HMI - Imbalance identification

2. Simulate and compare the impact of a General CASA and Targeted CASA Regulation

As result of PJ24 work, PLANTA includes a functionality to compare the impact of a General CASA Regulation in the TV selected vs. the impact of a Targeted CASA Regulation in the selected Flows being a sub-part of the main TV. FMP could select rate, window width and period before launching the simulation process. The tool provides feedback in terms of number of affected flights, total and average delay in both simulation (General CASA vs. Targeted CASA). Figure 179 shows the Targeted Regulation Comparison screen.

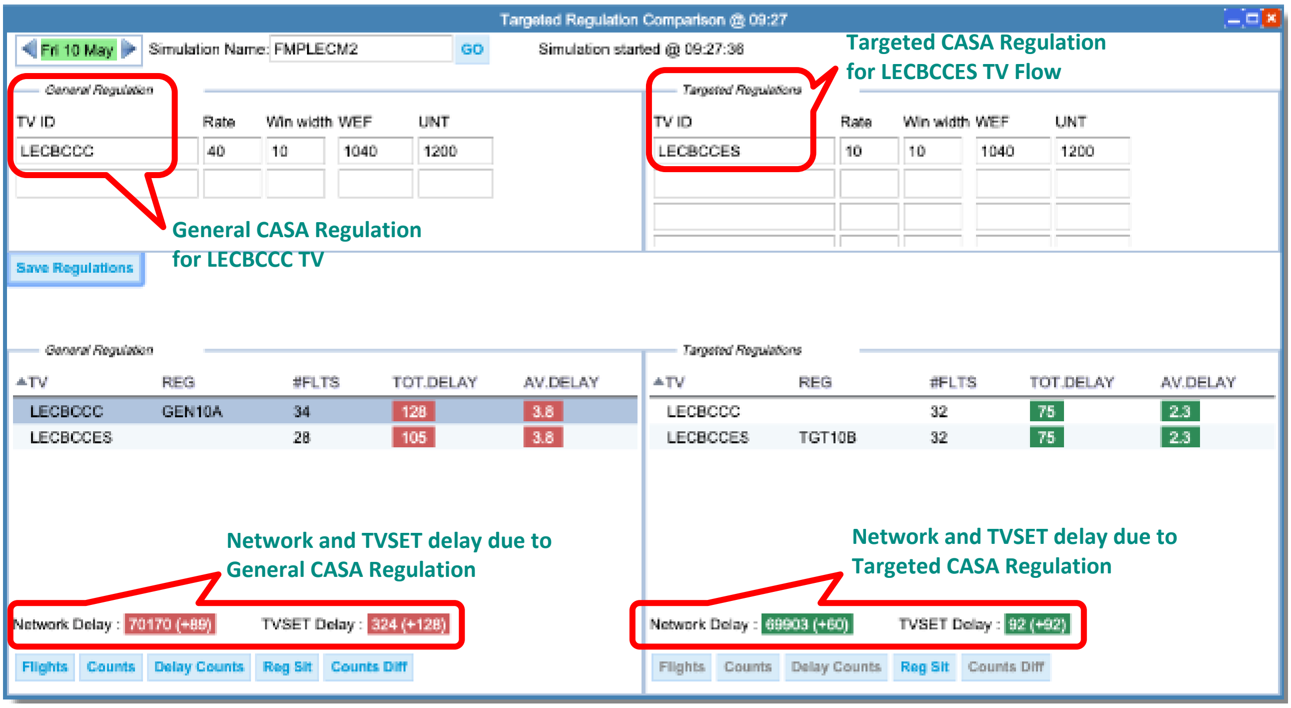


Figure 179: Targeted Regulation Comparison

3. Assess the Counts Difference

Once the results of the simulation are available, PLANTA indicates which one is better in terms of performance. Results highlighted in green are the better ones as indicated in Figure 179. In addition to that initial assessment, FMPs could process the details to assess if the simulation results are enough to solve the imbalance identified. Simulation results are shown using Entry Counts and Occupancy Counts. FMPs can modify the rates of both complexity indicators. Figure 180 shows the counts difference between the CASA Regulation and the Targeted Regulations simulation in terms of Entry Counts.

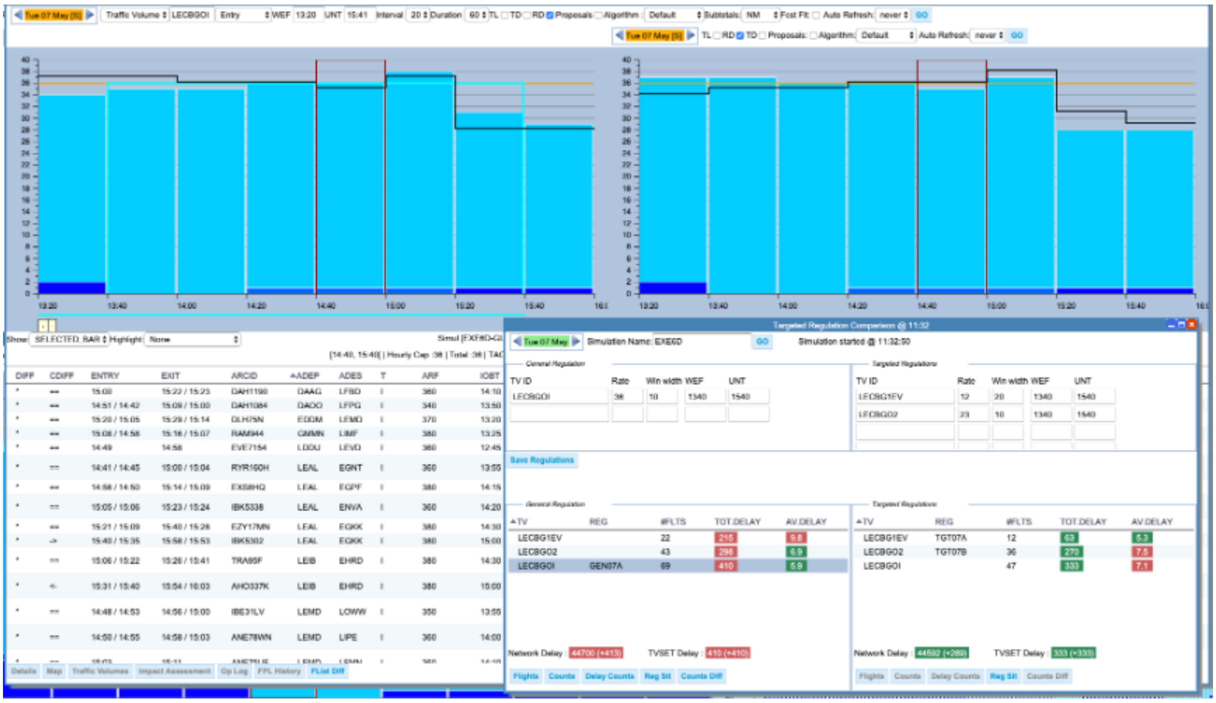


Figure 180: Counts difference after simulation

4. Select the most appropriate measure and keep monitoring

Results of the simulation were exported to facilitate the post-analysis.

In real operations, once the most appropriate Targeted CASA measure has been selected, the FMP should implement it. Due to the design of the tool and the demonstrations limitations, during the exercise the direct implementation of the measure was not possible in real operations.

2. UC2.2 Ground Delay with MCP in LECM

PLANTA

ENAIRE would like to go a step further in the resolution of imbalances by the application of Ground Delay with Mandatory Cherry Picking in the Spanish airspace. Savings of delay on affected flights are expected by the application of those measures. In addition, thanks to the what-if tool included in PLANTA, the FMP could identify the most appropriate flights to apply the GD and could assess how many minutes of delay should be applied to each of them could solve the imbalance.

Despite that the demonstration was performed during weekdays in May, when traffic in LECM is not really high enough to consider the implementation of regulations, PLANTA allows to adjust the Capacity thresholds to "force" imbalances requiring FMPs' actions.

Anyhow, the FMP looked at the demand and identified hotspots where Ground Delay measures were requested. The operational process followed by the FMP is described in Figure 181.

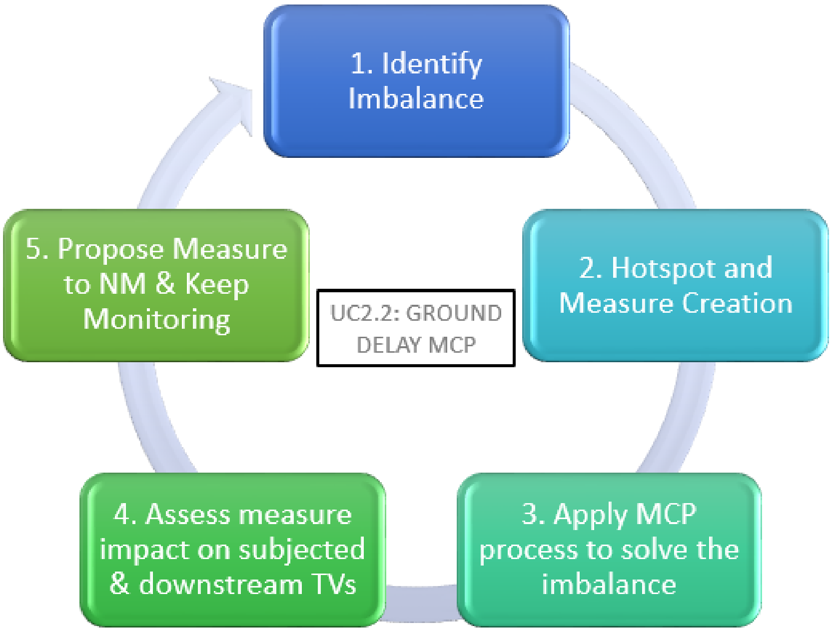


Figure 181: UC2.2 Summary of the Operational Flow

1 & 2 – Identify Imbalance, Hotspot and Measure Creation

PLANTA HMI – ACC Monitor view easily allows LECM FMP to identify imbalances thanks to the colour code defined. Once the imbalance is identified, the FMP could create and notify the associated hotspot to the NM via B2B Figure 182 shows how a hotspot is represented in the HMI.

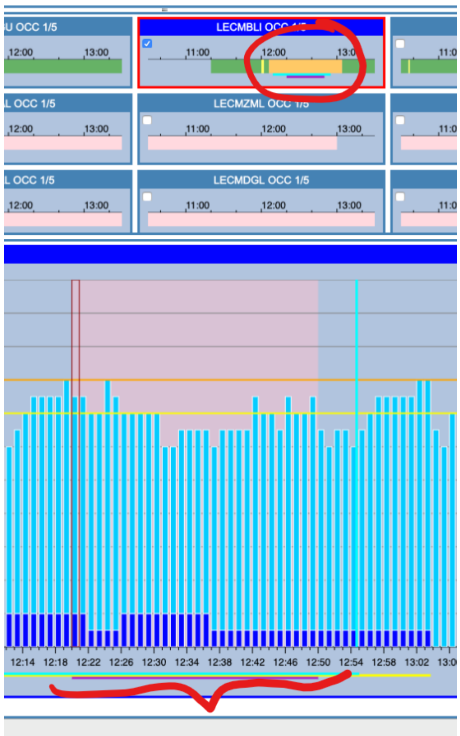


Figure 182: Hotspot Creation

3. Apply MCP process to solve the imbalance

When there was an imbalance in a sector identified by the FMP, he created the associated hotspot and drafted the measure. The next step was to identify the most appropriate flights to be included in the measure. The FMP usually followed a set of criteria based on his experience, e.g. select the flights at the end of the period of the hotspot to be able to move them to the next period, select flights not affected by other constraint, flights that are still on ground, etc.

FMP made use of the multiple filters available in the tool. To support the identification of the better flights to apply the MCP, FMP selected to show flights in hotspot highlighting those eligible for MCP. Once the filter was done, he chose the flights according to his expertise. One of the principles for Spanish FMPs is that it is better to apply little delay to more flights that a big delay to few flights.

Figure 183 shows the result of the MCP process. On the top of the figure, the highlighted flights are shown while in the bottom part, the graph indicates the imbalance. The purple mark in each of the bars indicates how the bars would be modified in case the selected flights are removed from the bars. On the bottom-right part, the flights selected are listed and ready for the next step, assessment of the measure impact based on the minutes of delay applied to each flight.

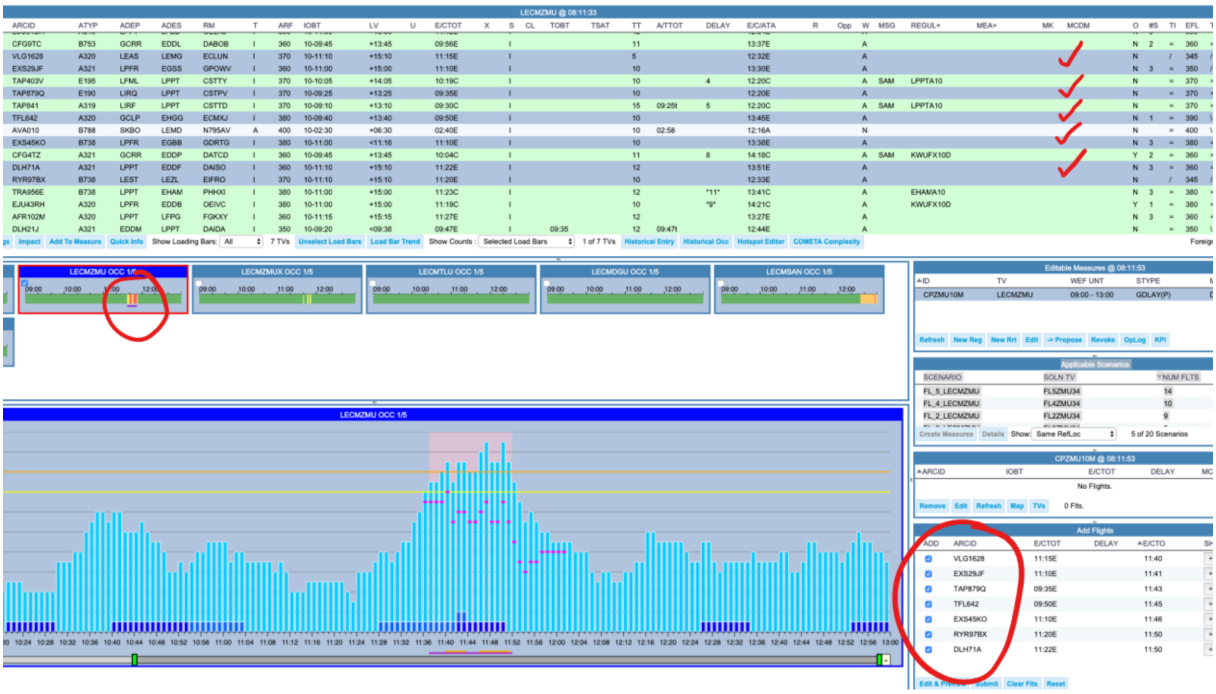


Figure 183: MCP process to solve the imbalance

4. Assess measure impact

During the next step, the FMP assesses what would be the minimum number of minutes of delay that could solve the imbalance. The what-if tool embedded in PLANTA allows the FMP to “play” in order to find the best option. Graphical representation supports the process.

Figure 184 shows the impact assessment of the Ground Delay measure. In the graph, bars height varies depending on the flights removed from them (in green) or the flights added (in red). In the flights box, the minutes of delay applied to each of the selected flights are indicated.

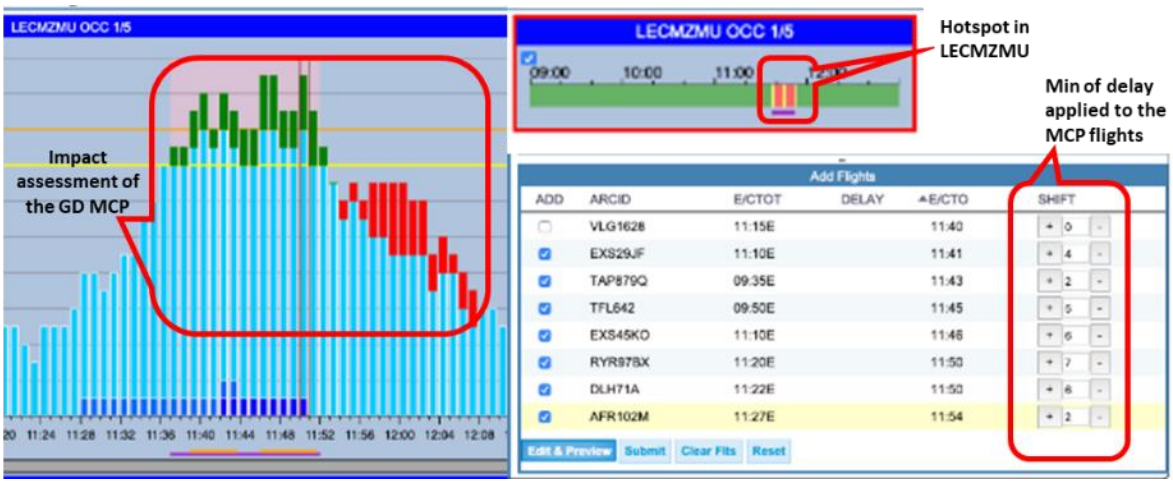


Figure 184: Assessment of the impact of Ground Delay

Once the most appropriate option is chosen, flights with delay are added to the “measure box” created on the first step. Then the impact of that delay is shown in the downstream sectors before the implementation of the measure.

5. Propose Measure to NM & Keep Monitoring

The final step is to Propose the measure to NM. This process is done within PLANTA via B2B. Once the NM receives the proposed measure, they analyse the measure and its impact at network level. If it is OK, the measure is implemented. The process could be monitored by the FMP as the measure status changes from DRAFT → PROPOSED → COORDINATED → IMPLEMENTED.

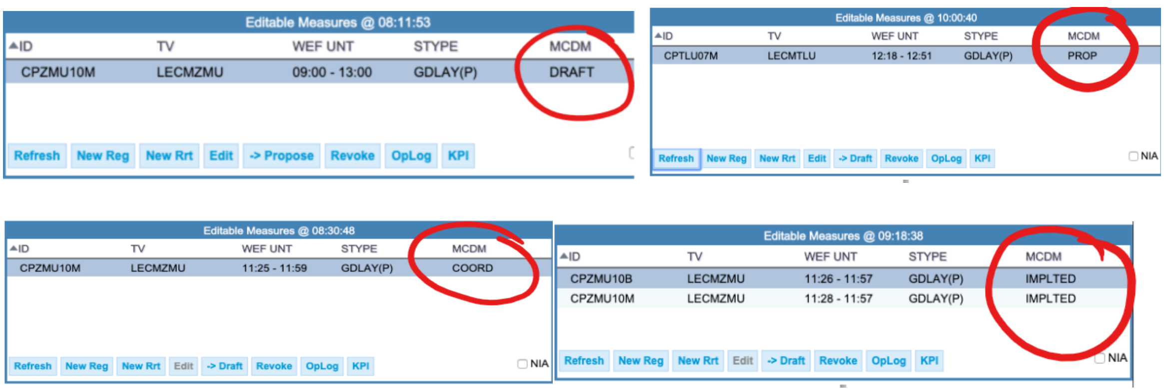


Figure 185: Ground Delay with MCP measure statuses

The technical Verification in iteration#3 with iACM addressed also UC2.2. In this case, the objective was to test the B2Bs are correctly working to be able to detect an imbalance, create and notify a hotspot and assess and create a Ground Delay with MCP measure. No qualitative or quantitative results were gathered as result of the verification tests.

iACM

The technical Verification in iteration#3 with iACM addressed also UC2.2. In this case, the objective was to test the B2Bs are correctly working to be able to detect an imbalance, create and notify a hotspot and assess and create a Ground Delay with MCP measure. No qualitative or quantitative results for validation objectives were gathered as result of the verification tests.

The verification tests were carried out at INDRA premises and ENAIRE PJ24 team participated during one day in the technical tests to check the B2B connections.

This use case area includes workflows required for ANSP FMPs to automatically coordinate ground delay STAMs (i.e. MCP) with NM NMOC. The NMOC would perform a network impact assessment before approving the regulation request. The NM SAT-X platform would be used for the coordination (B2B service) mechanism and to distribute the resulting flight planning updates across the network.

In this case, the general operating method for MCP Ground Delay application is through Regulation Proposal Service.

1. The system creates/updates a Regulation Proposal for all day.
2. The selected flights with Ground Delay measure will be submitted to the proposed regulation, adding/removing flights to/from it.
3. NM will coordinate the regulation performing an impact assessment with the affected flights.
4. NM will update the flight plan with a new CTOT and regulation applied.

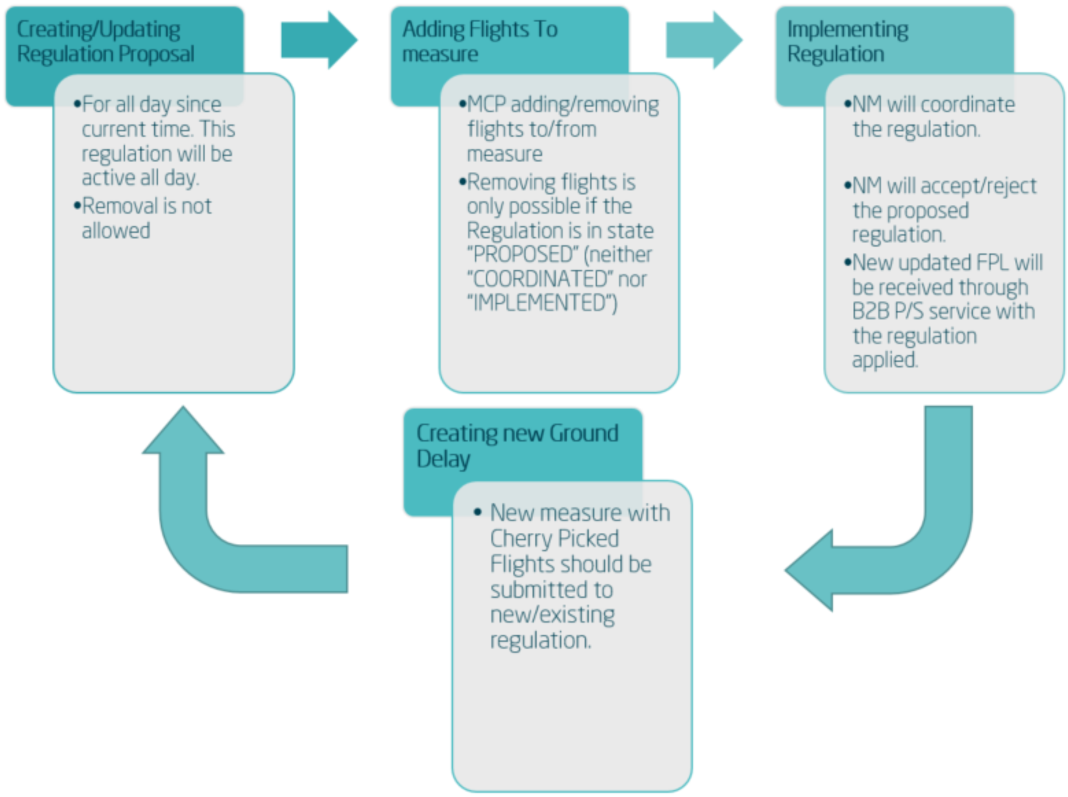


Figure 186. iACM Operating Method

Regarding the FMP procedure in iACM, the steps are the following:

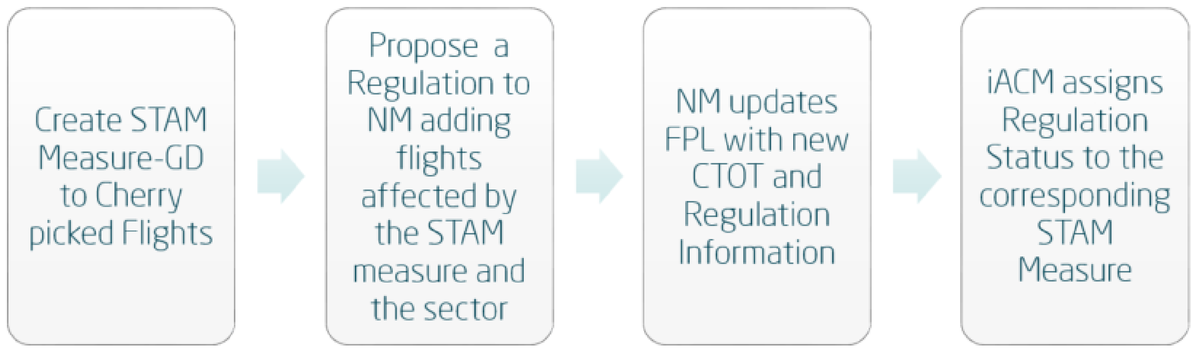


Figure 187: iACM Ground Delay Operating Procedure

1. Imbalance detection and Hotspot creation.

In the summary area, the FMP is able to perform a quick analysis of the Network, identifying the current imbalances in the AoR with a specific colour code. These imbalances are candidates to become a Hotspot if the FMP considers it. For this purpose, it is available the option to create a Hotspot for each sector notifying it to NM or update an existing one.

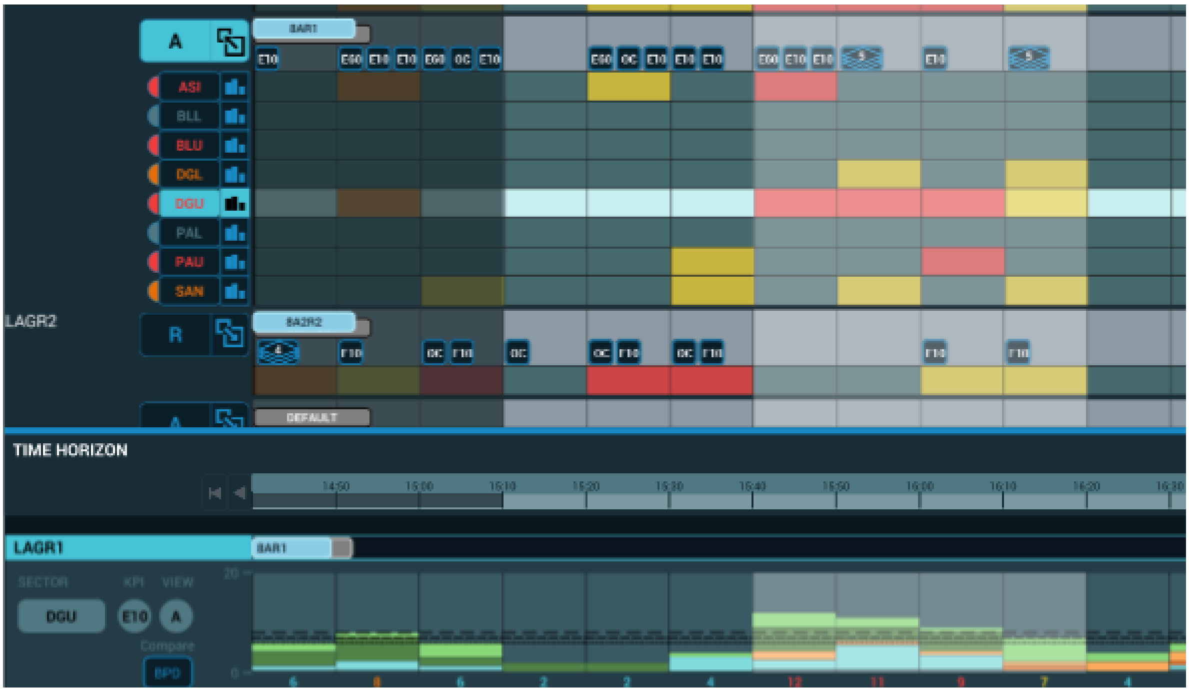


Figure 188: iACM Imbalance detection in the summary area

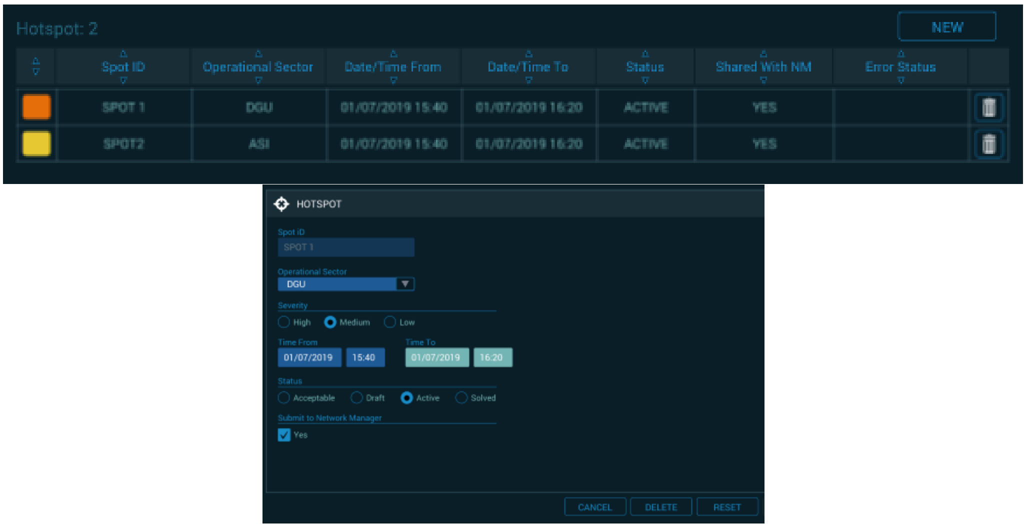


Figure 189: Hotspot List and Hotspot creation/update

2. MCP Imbalance Resolution

Once the hotspot is notified, the next step is select the most appropriate flights to be included in the regulation based on the FMP expert judgement. Each Ground Delay Measure (TONB in iACM terminology) could be applied for flights with the same departure airport. In this case, the same delay will be associated to them. The system allows the user to perform several measures associated to the same airpace/sector. iACM will send to NM all the proposed flights eventhough they are linked to different measures.

“Sandbox” view shall be opened as it is the working area of the tool.

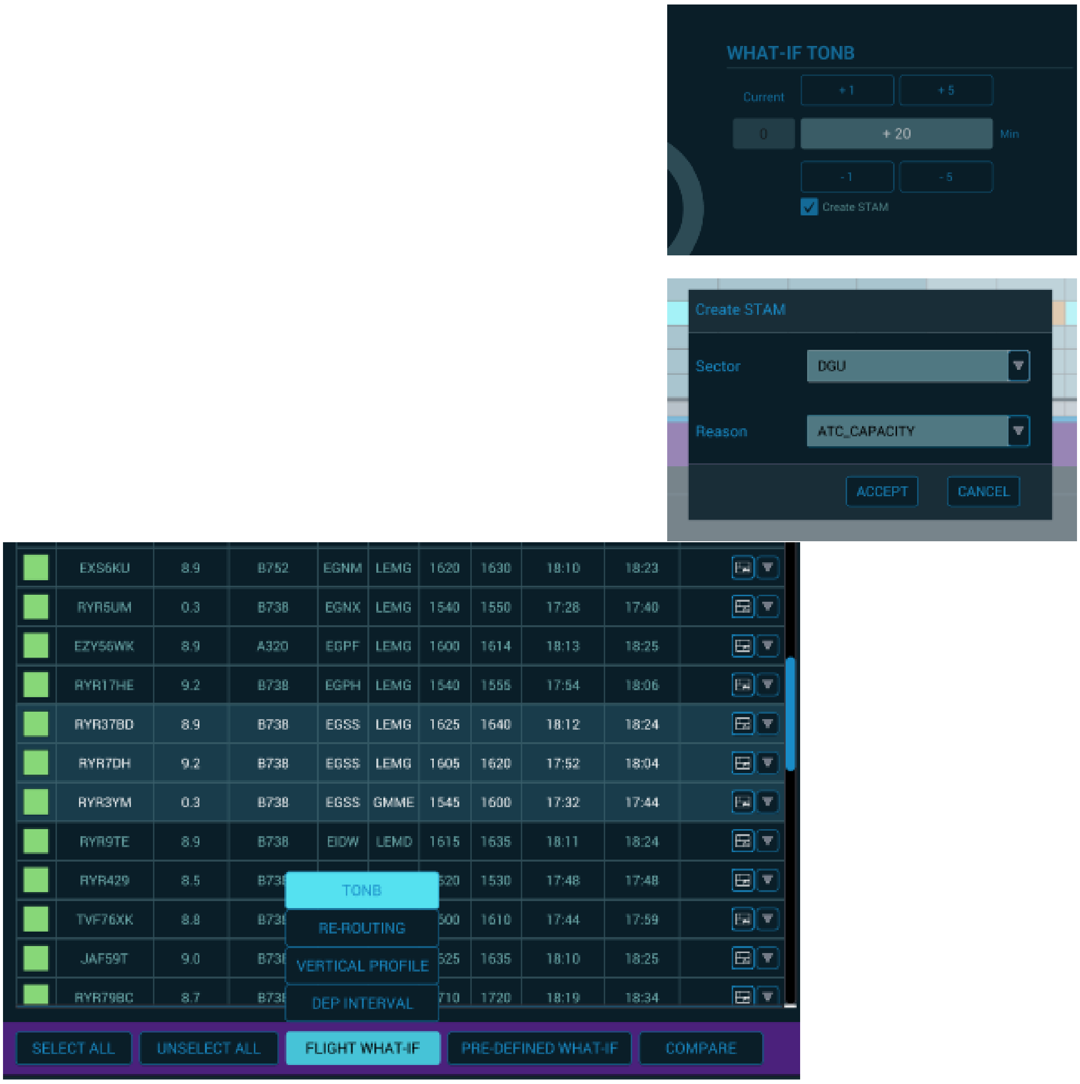


Figure 190: iACM Ground Delay measure application

The affected sector and the reason for application should be filled for the Regulation Proposal Service

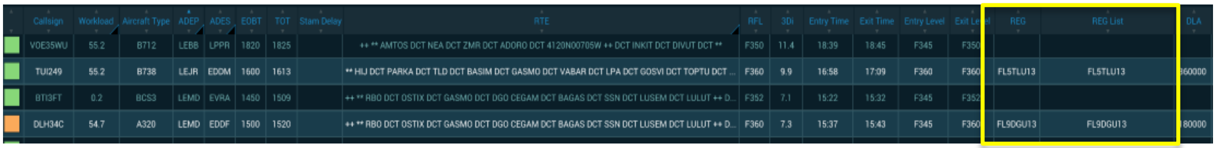
The regulation remains stored locally in a draft state as well as the associated ground delay measures until FMP decides to notify NM both the regulation and the regulated flights.

The next step is initiate the negotiation with NM once FMP is ready. For this purpose, the “LAUNCH STAM” option shall be selected and the stored regulation will be submitted remaining in “DRAFT” state in the NM system. After the regulation creation/update iACM will automatically add the flights changing the status of the regulation to “PROPOSED”. Afterward, the NM is ready to assess the regulation, changing the state to “COORDINATED”. Once Impact assessment work is performed, the result is accept or reject the measures changing to “IMPLEMENTED”/”INTERRUPTED” status accordingly.

Figure 191: Launch negotiation iACM-NM

3. Asses Measure impact

Once the NM implements the regulation, a new flight plan of the measure is expected to be received with the updated CTOT and the name of the regulation that affects each flight (and other active regulations of the network).



Callsign	Workload	Aircraft Type	ADEP	ADES	EOBT	TOT	Stam Delay	RTE	RFL	3Di	Entry Time	Exit Time	Entry Level	Exit Level	REG	REG List	DLA
VOE35WU	55.2	B712	LEBB	LPPR	1820	1825		++ ** AMTOS DCT NEA DCT ZMR DCT ADORO DCT 4120N00705W ++ DCT INKIT DCT DIVUT DCT **	F350	11.4	18:39	18:45	F345	F350			
TUI249	55.2	B738	LEJR	EDDM	1600	1613		** HIJ DCT PARKA DCT TLD DCT BASIM DCT GASMO DCT VABAR DCT LPA DCT GOSVI DCT TOPTU DCT ...	F360	9.9	16:58	17:09	F360	F360	FL5TLU13	FL5TLU13	360000
BTI3FT	0.2	BCS3	LEMD	EVRA	1450	1509		++ ** RBO DCT OSTIX DCT GASMO DCT DGO CEGAM DCT BAGAS DCT SSN DCT LUSEM DCT LULUT ++ D...	F352	7.1	15:22	15:32	F345	F352			
DLH34C	54.7	A320	LEMD	EDDF	1500	1520		++ ** RBO DCT OSTIX DCT GASMO DCT DGO CEGAM DCT BAGAS DCT SSN DCT LUSEM DCT LULUT ++ D...	F360	7.3	15:37	15:43	F345	F360	FL9DGU13	FL9DGU13	180000

Figure 192: iACM Extended Flight List

If a measure has been implemented by NM, the icons change the colour to blue in iACM HMI.

In order to continue solving the imbalances of the network, the FMP could add new flights to the regulation creating new Ground delay measures. The system will send these new flights, avoiding the ones that have already been regulated (the blue ones). The histograms may show the result of application, both in the “Agreed View”-“Raw View” and “Sandbox View”.

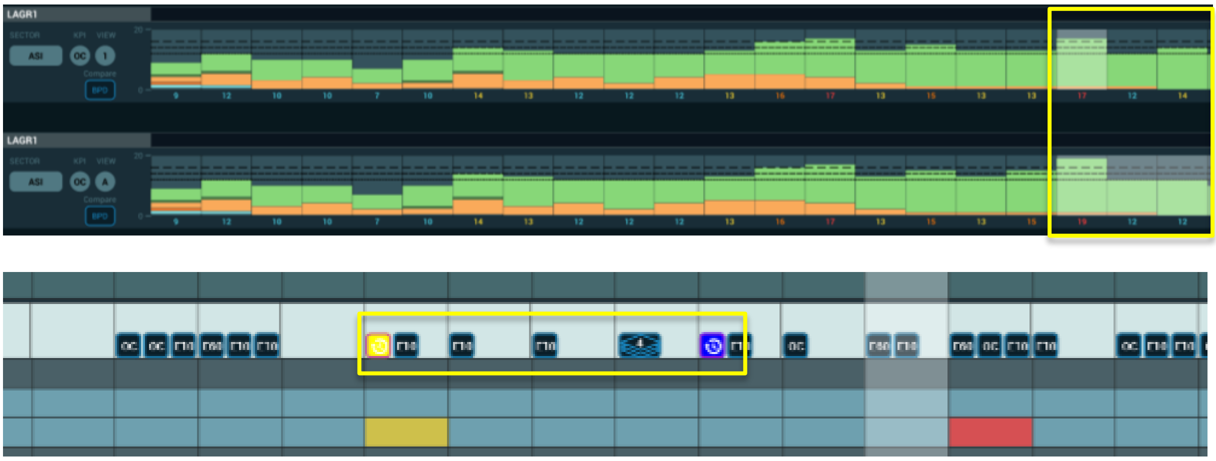


Figure 193: Ground Delay assessment-Histograms/Summary Area

The tool provides the option to remove measures. In this case, this is only possible in the following cases:

- If the measures are stored locally.
- If the regulation is in state “PROPOSED” in the NM system.

In case of a measure is under reviewing by NM “COORDINATED” or it is already accepted “IMPLEMENTED” status, it is not possible to remove that flights from the regulation.

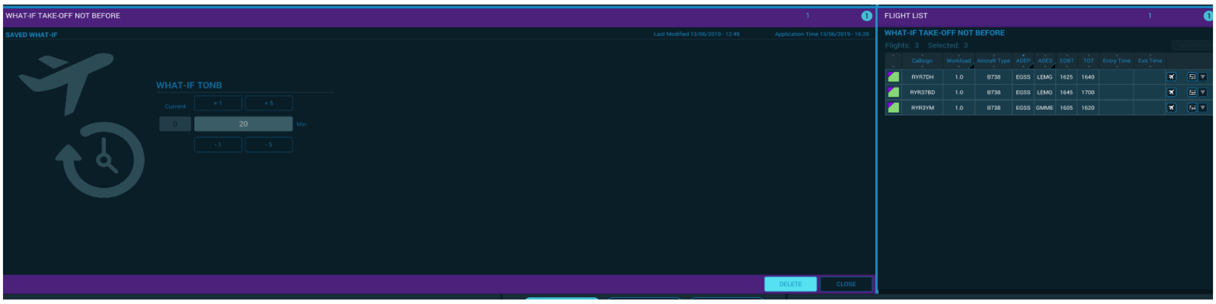


Figure 194: Applied Ground Delay Information

In I.3.5 this process is showed deeply.

I.1.2 Summary of Demonstration Exercise #06 Demonstration Objectives and success criteria

Table 45 summarises the demonstration objectives linked to EXE#6, together with their success criteria.

Demonstration Objective (as in section 5.3)	Demonstration Success criteria (as in section 5.3)	Coverage and comments on the coverage of Demonstration objectives (as in section 5.3)	Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria
OBJ-VLD-01-004	CRT-VLD-01-004	**Partially covered**: Exercise 6 activities form part of overall network cooperative processes and **STAMs** contribute therefore partially to the objective as described.	**EX6-OBJ- VLD-01-004A** Demonstrate the added value of using local tools to support the analysis and preparation of STAM	**EX6- CRT-VLD-01-004A** The level of situational awareness of the FMP increases with the inclusion of local tools in the analysis of STAM
			EX6-OBJ- VLD-01-004B Demonstrate the added value of using local tools to support the coordination of STAM	**EX6- CRT-VLD-01-004B** The level of situational awareness of the FMP increases with the inclusion of local tools in the coordination of STAM
			EX6-OBJ- VLD-01-004C Demonstrate the processes and procedures related to the integration of local and network dynamic DCB processes are clear and consistent	**EX6- CRT-VLD-01-004C** All the actors involved confirm the STAM operating methods are clear and consistent.
			EX6-OBJ- VLD-01-004D Demonstrate that the roles and responsibilities of human actors related to the integration of local and network dynamic DCB processes are clear and consistent.	**EX6- CRT-VLD-01-004D** The concerned actors confirm the roles and responsibilities are clear and consistent.
OBJ-VLD-02-002	CRT-VLD-02-002	**Partially covered**: Exercise 6 activities form part of overall network cooperative processes and **STAMs** contribute therefore partially to the objective as described.	**EX6-OBJ-VLD-02-002** Demonstrate an improvement on predictability thanks to the use of local tools (including what-if)	**EX6-CRT-VLD-02-002** The number of regulated and affected flights decrease. Reactionary delays are reduced.

Demonstration Objective (as in section 5.3)	Demonstration Success criteria (as in section 5.3)	Coverage and comments on the coverage of Demonstration objectives (as in section 5.3)	Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria
OBJ-VLD-03-002	CRT-VLD-03-002	Partially covered: Exercise 6 activities form part of overall network cooperative processes and **STAMs** contribute therefore partially to the objective as described.	**EX6-OBJ-VLD-03-002** Demonstrate the optimization of fuel consumption thanks to the use of what-if for local network performance tools	**EX6-CRT-VLD-03-002** Reduction in fuel consumption and CO2 emissions induced by STAMs.
OBJ-VLD-04-003	CRT-VLD-04-003	Partially covered: Exercise 6 activities form part of overall network cooperative processes and **STAMs** contribute therefore partially to the objective as described.	**EX6-OBJ-VLD-04-003** Demonstrate an improvement in cost-efficiency for ANSPs due to the reduction in time for FMP staff to monitor, analyze and coordinate measures to DCB	**EX6-CRT-VLD-04-003** FMP confidence on STAM to resolve Demand Capacity Imbalance increase. FMP workload is not increased.
OBJ-VLD-05-002	CRT-VLD-05-002	Partially covered: Exercise 6 activities form part of overall network cooperative processes and **STAMs** contribute therefore partially to the objective as described.	**EX6-OBJ-VLD-05-002** Increase the use of available capacity through a better management of extra capacity and use of under-loaded period.	**EX6-CRT-VLD-05-002** Delay per flight is reduced Reduction of less under-loaded period when STAM is applied.

Table 45: Exercise #6 - Enhanced Coordination of STAM Demonstration Objectives.

I.1.3 Summary of Validation Exercise #06 Demonstration scenarios

See **Error! Reference source not found.** Summary of Validation Exercises #04 Demonstration scenarios. The Scenarios applied in this demonstration are the ones defined for EXE#04 Iteration 2/3.

Table 46 provides a description of the scenario used in the demonstration activity with DSNA. A joint exercise was performed (being the first iteration of the DEMO with the CAP Tool for ENAIRE and the second iteration for DSNA).

In the first iteration, run in October-November 2017, Madrid and Bordeaux ACCs were involved. Same ACCs were involved in the second iteration, run in April-May 2018.

SCN-EX6-002	
Scope of the Demonstration Exercise	Coordination of STAM Flight Level Capping between two ACCs from different ANSPs: ENAIRE and DSNA. The ENAIRE FMP (in Madrid ACC) coordinates with the corresponding FMP in the involved French ACC (Bordeaux) the implementation of

SCN-EX6-002	
	Level Capping in specific flights to minimize possible complex situations. **UC2.4** – ACC-ACC Coordination of STAM Flight Level Capping
Validation Objectives	EX6-OBJ- VLD-01-004A EX6-OBJ- VLD-01-004B EX6-OBJ- VLD-01-004C EX6-OBJ- VLD-01-004D EX6-OBJ-VLD-02-002 EX6-OBJ-VLD-03-002 EX6-OBJ-VLD-04-003 EX6-OBJ-VLD-05-002
Operational Context	<u>Airspace Information</u> The operational context for the demonstration activity corresponds to Madrid ACC boundary sectors and the corresponding sectors in the French side. Free Route is not applicable.
	<u>Airport Information</u> N/A
	<u>Traffic information</u> Regular traffic for a typical autumn/spring day in Madrid ACC. High complexity and peaks are not expected.
	<u>Variants</u> N/A
Key Roles	FMP acts mainly in Medium to short term, sharing with NM the airspace configuration management through the CDM framework. In the same time window, he/she leads the DCB processes for the ACC, monitors the situation at local level, and anticipates hotspots and workload issues. Network Manager in medium and short term will collaborate with the FMP to approve the proposed STAM if there is not impact on the network performance.
Assumptions	Same as in section I.1.4

Table 46: SCN-EX6-002 Description – UC2.4

Iteration #4 was run during four full days in May (7th-10th of May). The tool used was PLANTA and two different Spanish ACCs were involved: LECM addressing UC2.2 linked to SCN-001 and LECB addressing UC2.8, linked to SCN-003. Both scenarios are described below in Table 47 and Table 48.

SCN-EX6-001	
Scope of the Demonstration	Shadow Mode. Coordination of Ground Delay STAM between ENAIRE/FMPs and the NM/NMOC. The Madrid FMP will coordinate with NM the proposed STAM Ground

SCN-EX6-001	
Exercise	Delay with MCP measures to solve a potential complex situation. **UC2.2** - ACC-NM Coordination of Ground Delay STAMs
Validation Objectives	EX6-OBJ- VLD-01-004A EX6-OBJ- VLD-01-004B EX6-OBJ- VLD-01-004C EX6-OBJ- VLD-01-004D EX6-OBJ-VLD-02-002 EX6-OBJ-VLD-04-003 EX6-OBJ-VLD-05-002
Operational Context	<u>Airspace Information</u> The operational context for the demonstration activity will correspond to the airspace within Madrid ACC, where the impact of the DCB measure (in this case STAM Ground Delay (MCP)) will be analysed. Free Route is not applicable.
	<u>Airport Information</u> Airports would be informed on the flights affected by the STAM Ground Delay measure.
	<u>Traffic information</u> Regular traffic for a typical May day in Madrid ACC.
	<u>Variants</u> This scenario was addressed in Iteration 3 and 4, using iACM (for verification purposes only) and PLANTA respectively. Due to the validation technique, there was a risk of having few or none possibilities of Ground Delay application. In that's the cases, PLANTA allowed the FMP to reduce capacity thresholds in the TV so generate complexity situations.
Key Roles	FMP acts mainly in Medium to Short term, sharing with NM the airspace configuration management through the CDM framework. In the same time window, he/she leads the DCB processes for the ACC and monitors the situation at local level anticipating hotspots and workload issues. Network Manager in medium and short term will collaborate with the FMP to approve the proposed Ground Delay STAM if there is not impact on the network performance.
Assumptions	Same as in section I.1.4

Table 47: SCN-EX6-001 Description – UC2.2

SCN-EX6-003	
Scope of the Demonstration	Shadow Mode. Coordination of CASA regulations, that are limited to specific flows, with NM. Flows are described for specific TV in LECB (see Table 44). ENAIRE FMP (belonging to Barcelona ACC) will coordinate with NM via B2B the implementation

SCN-EX6-003	
Exercise	of specific flows regulation in order to minimize the impact of a general CASA regulation. **UC2.8** – ACC-NM Coordination of flows regulations (Targeted CASA)
Validation Objectives	EX6-OBJ- VLD-01-004A EX6-OBJ- VLD-01-004B EX6-OBJ- VLD-01-004C EX6-OBJ- VLD-01-004D EX6-OBJ-VLD-02-002 EX6-OBJ-VLD-04-003 EX6-OBJ-VLD-05-002
Operational Context	Airspace Information The operational context for the demonstration activity will correspond Barcelona ACC traffic volumes where specific flows subjected to be regulated have been defined. Free Route is not applicable.
	Airport Information N/A
	Traffic information Regular traffic for a typical Spring (May) day in Barcelona ACC.
	Variants N/A
Key Roles	FMP acts mainly in Medium to Short term, sharing with NM the airspace configuration management through the CDM framework. In the same time window, he/she leads the DCB processes for the ACC and monitors the situation at local level anticipating hotspots and workload issues. Network Manager in medium and short term will collaborate with the FMP to approve the proposed flow regulation if there is an acceptable impact on the network performance.
Assumptions	Same as in section I.1.4

Table 48: SCN-EX6-003 Description – UC2.8

I.1.4 Summary of Demonstration Exercise #06 Demonstration Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
EX6-A1	STAMs – Capacity Management	Procedures in place	Airspace configuration is supposed to have been optimized through capacity management measures so as the detected hotspot can only be solved through demand management measures.	N/A	Planning Phase	N/A	PJ24 DEMOP	N/A	PJ24 - ENAIRE	Medium
EX6-A2	Observed Traffic	Traffic Characteristics (traffic level)	Observed traffic figures are the actual ones experienced in the involved FMP AoR during the exercise execution days.	N/A	N/A	All	Traffic data from local and NM systems	Depending on the traffic volume of study.	PJ24 - ENAIRE	High

Table 49: Demonstration Assumptions overview

I.2 Deviation from the planned activities

Only one deviation from planned activities:

Dev-1: Iteration #3 with iACM was degraded to a Technical Verification, due to the prototype maturity at the moment of executing the trial.

I.3 Demonstration Exercise #06 Results

I.3.1 Summary of Demonstration Exercise #06 Demonstration Results

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results – It#1&2	Exercise Results – It#4	Demonstration Objective Status
EX6-OBJ-VLD-01-004A	Demonstrate the added value of using local tools to support the analysis and preparation of STAM	EX6-CRT-VLD-01-004A	The level of situational awareness of the FMP increases with the inclusion of local tools in the analysis of STAM	The results show that the situational awareness was equal or better as it is now. (See I.3.21)	When analysing STAMs, the results regarding UC2.2 showed that the situational awareness is greater than current situation (100%). On UC2.8 the results were positive as well (88%).	OK
EX6-OBJ-VLD-01-004B	Demonstrate the added value of using local tools to support the coordination of STAM	EX6-CRT-VLD-01-004B	The level of situational awareness of the FMP increases with the inclusion of local tools in the coordination of STAM	The situational awareness increases for both FMPs and AUs. (See I.3.22 and F.3.3.3)	All FMPs strongly agreed that there was an increase of the situational awareness when using the local tool in the coordination of STAM for UC2.2. Regarding UC2.8, 75% of FMPs largely agreed that there was an increase of situational awareness when coordinating a STAM measure using the tool.	OK
EX6-OBJ-VLD-01-004C	Demonstrate the processes and procedures related to the integration of local and network dynamic DCB processes are clear and consistent	EX6-CRT-VLD-01-004C	All the actors involved confirm the STAM operating methods are clear and consistent	The feedback received by the FMPs shows CAP Tool processes and Procedures were in	The feedback received by the FMPs shows PLANTA processes and procedures both were in line with the operating methods for UC2.2 as well as clear and consistent. For UC2.8, half of the FMPs strongly agreed that the processes and procedures were clear	OK

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results – It#1&2	Exercise Results – It#4	Demonstration Objective Status
				line with the operating methods. (See I.3.23)	and consistent; the rest of FMPs showed a neutral feedback.	
EX6-OBJ-VLD-01-004D	Demonstrate that the roles and responsibilities of human actors related to the integration of local and network dynamic DCB processes are clear and consistent	EX6-CRT-VLD-01-004D	The concerned actors confirm the roles and responsibilities are clear and consistent	The feedback from the FMPs involved were mainly positive regarding the roles and responsibilities. (See I.3.24) I.3.21	Regarding the roles and responsibilities for UC2.2 and UC2.8, the feedback obtained from the FMPs involved was highly positive.	OK
EX6-OBJ-VLD-02-002	Demonstrate an improvement on predictability thanks to the use of local tools (including what-if)	EX6-CRT-VLD-02-002	The number of regulated and affected flights decrease	The feedback obtained regarding regulated flights were positive: mainly there was a decrease regarding the number of regulations declared once using CAP. (See I.3.25)	The number of regulated and affected flights relevantly decreased in both UC2.2 and UC2.8.	Partially OK
			Reactionary delays are reduced		The reduction of reactionary delays could not be measured in the fourth iteration of the exercise; no conclusions on this matter will be provided	

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results – It#1&2	Exercise Results – It#4	Demonstration Objective Status
EX6-OBJ-VLD-03-002	Demonstrate the optimisation of fuel consumption thanks to the use of what-if for local network performance tools	EX6-CRT-VLD-03-002	Reduction in fuel consumption and CO2 emissions induced by STAMs	No negative impact can be measured regarding fuel consumption in Iteration #1. Results from iteration #2 indicated that the trade-off between the impact on fuel and the benefits obtained using the Tool is acceptable. (See I.3.26)	Not applicable for any of the use cases in the fourth iteration of the exercise as no route changes were proposed.	OK
EX6-OBJ-VLD-04-003	Demonstrate an improvement in cost-efficiency for ANSPs due to the reduction in time for FMP staff to monitor, analyse and coordinate measures to DCB	EX6-CRT-VLD-04-003	FMP confidence on STAM to resolve Demand Capacity Imbalance increase	The results show that because of the tool, the workload, stress level, etc. are incremented for the FMPs not familiar with the tool. However, the FMPS highlighted that the benefits obtained make	FMPs confidence on STAM to resolve the Demand Capacity Imbalance was highly positive for UC2.8. Regarding UC2.2, FMPs answers reflected also a very positive position towards the confidence in the tool.	OK
			FMP workload is not increased		As for workload, the answers were very similar. In UC2.2 all FMPs share a positive view and agreed that the workload was acceptable and did not impact on its other tasks. For UC2.8, there was also a positive feedback from FMPs regarding the workload affection.	

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Exercise Results – It#1&2	Exercise Results – It#4	Demonstration Objective Status
				acceptable this increment. (See I.3.27)		
EX6-OBJ-VLD-05-002	Increase the use of available capacity through a better management of extra capacity and use of under-loaded period	EX6-CRT-VLD-05-002	Delay per flight is reduced	The preliminary results show a positive impact on delay per flight and decrease in the under-loaded period thus a further analysis should be needed with the following iterations. (See I.3.28)	For UC2.8, there is an average decrease in the delay per regulated flight around 9.6% when comparing to a General CASA regulation scenario. In addition, there is a relevant reduction in total delay (31%). For the UC2.2 this objective could not be calculated as there is no Reference Scenario to compare with.	**OK** (further results for UC2.2 should complement this assessment)
			Reduction of less under-loaded period when STAM is applied		For UC2.8, when implementing a Targeted CASA regulation, the under-loaded periods (i.e. differences between peaks and off-peak hours) were successfully smoothed. For the UC2.2 this objective cannot be calculated as there is no Reference Scenario to compare to.	

Table 50: Exercise #6 Demonstration Results

1. Results per KPA

In this sub section and according to the current description of EXE#06 in D1.1 Demonstration Plan (DEMOP) a preliminary identification of potential impacts on each KPA/KPI has been described. Anyhow as PJ24 is a VLD the results obtained during the trials will not contribute to the Validation Targets identified by PJ.19-04 thus there will be an alignment with the metrics already defined. As the exercise is planned through a cycle of 3 Iterations the data to be collected in the following iterations will have an impact in the KPA/KPI, so the contents in it should be understood as an iterative process.

Currently PJ19.4 D4.1 Performance Framework guidance material supports and guides the identification of KPA/KPI. Following this guidance an alignment with the OBJ defined for this EXE #06 allows to identify the KPA/KPI affected as follows: PUN1, PRED1, HP1.1 and FEFF.

An overall result per KPA is included in Table 51. Details of the results are provided in sections I.3.2, I.3.3 and I.3.4.

KPA	Objective ID	KPA result
SAF	EX6-OBJ-VLD-01-004A/B/C/D	Regarding situational awareness, results demonstrate an increase when using the tool. In addition, the coordination of STAM has been stablished more easily. The feedback obtained from FMPs determine processes and procedures as clear and in line with the operating methods. Roles and Responsibilities as clear and consistent were positive too.
PRD	EX6-OBJ-VLD-02-002	The number of regulated and affected flights decrease when a Targeted CASA regulation has been implemented. The reduction of reactionary delays could not be measured, so no conclusions on this matter can be provided.
CEFF	EX6-OBJ-VLD-04-003	FMPs confidence on STAM to resolve the Demand Capacity Imbalance was positive. As for workload, all FMPs shared a positive view and agreed that the workload was acceptable and did not impact any other tasks.
CAP	EX6-OBJ-VLD-05-002	For UC2.8, in 2 out of 5 cases, a reduction in the delay per flight is accomplished. Considering the average value, there is a

		decrease in the delay per flight of 9.6%. As well, it can be said that the under-loaded periods tend to disappear and the differences between peaks and off-peak hours tend to be smoother. For the UC2.2 this objective could not be calculated as there was no Reference Scenario to compare with.

Table 51: EXE#6 Results per KPA

2. Results impacting regulation and standardisation initiatives

N/A

I.3.2 Analysis of Exercises Results per Demonstration objective of the first iteration – CAP Tool (Q4 2017)

UC2.4 – Level Capping

This section presents the qualitative analysis of the results obtained from the questionnaires answered by the FMPs who have used the CAP tool during the trial integrated with the results of the briefing and debriefing sessions hold with them.

Table 52 provides the coverage of the objectives and associates success criteria by the topics included in the questionnaire completed by the FMP.

Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria	Questionnaire items addressing the Objective
EX6-OBJ- VLD-01-004A Demonstrate the added value of using local tools to support the analysis and preparation of STAM	**EX6- CRT-VLD-01-004A** The level of situational awareness of the FMP increases with the inclusion of local tools in the analysis of STAM	Question 05 (h, i, j) and 24 (c, e, f) (See 1)
EX6-OBJ- VLD-01-004B Demonstrate the added value of using local tools to support the coordination of STAM	**EX6- CRT-VLD-01-004B** The level of situational awareness of the FMP increases with the inclusion of local tools in the coordination of STAM	Question 05 (h, i, j) and 24 (e) (See 2)
EX6-OBJ- VLD-01-004C Demonstrate the processes and procedures related to the integration of local and network dynamic DCB processes are clear and consistent	**EX6- CRT-VLD-01-004C** All the actors involved confirm the STAM operating methods are clear and consistent.	Question 04 (See 3)

Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria	Questionnaire items addressing the Objective
EX6-OBJ- VLD-01-004D Demonstrate that the roles and responsibilities of human actors related to the integration of local and network dynamic DCB processes are clear and consistent.	**EX6- CRT-VLD-01-004D** The concerned actors confirm the roles and responsibilities are clear and consistent.	Question 21 (See 4)
EX6-OBJ-VLD-02-002 Demonstrate an improvement on predictability thanks to the use of local tools (including what-if)	**EX6-CRT-VLD-02-002** The number of regulated and affected flights decrease. Reactionary delays are reduced.	Question 05 (a, b, c, d, e, f, l) and 28 (i, j, l, m) (See 5)
EX6-OBJ-VLD-03-002 Demonstrate the optimization of fuel consumption thanks to the use of what-if for local network performance tools	**EX6-CRT-VLD-03-002** Reduction in fuel consumption and CO2 emissions induced by STAMs.	Question 28 (See 6)
EX6-OBJ-VLD-04-003 Demonstrate an improvement in cost-efficiency for ANSPs due to the reduction in time for FMP staff to monitor, analyze and coordinate measures to DCB	**EX6-CRT-VLD-04-003** FMP confidence on STAM to resolve Demand Capacity Imbalance increase. FMP workload is not increased.	Question 17, 18, 19, 20, 22, 23 and 28 (m) (See 7)
EX6-OBJ-VLD-05-002 Increase the use of available capacity through a better management of extra capacity and use of under-loaded period.	**EX6-CRT-VLD-05-002** Delay per flight is reduced Reduction of less under-loaded period when STAM is applied.	Question 28 (See 8)

Table 52: Coverage of the questions regarding the OBJ and success criteria

1. EX6-OBJ-VLD-01-004A Results

Questions 05 and 24 from the questionnaire refer to this Demonstration Objective.

All the answers of the FMPs are represented in the following graphics:

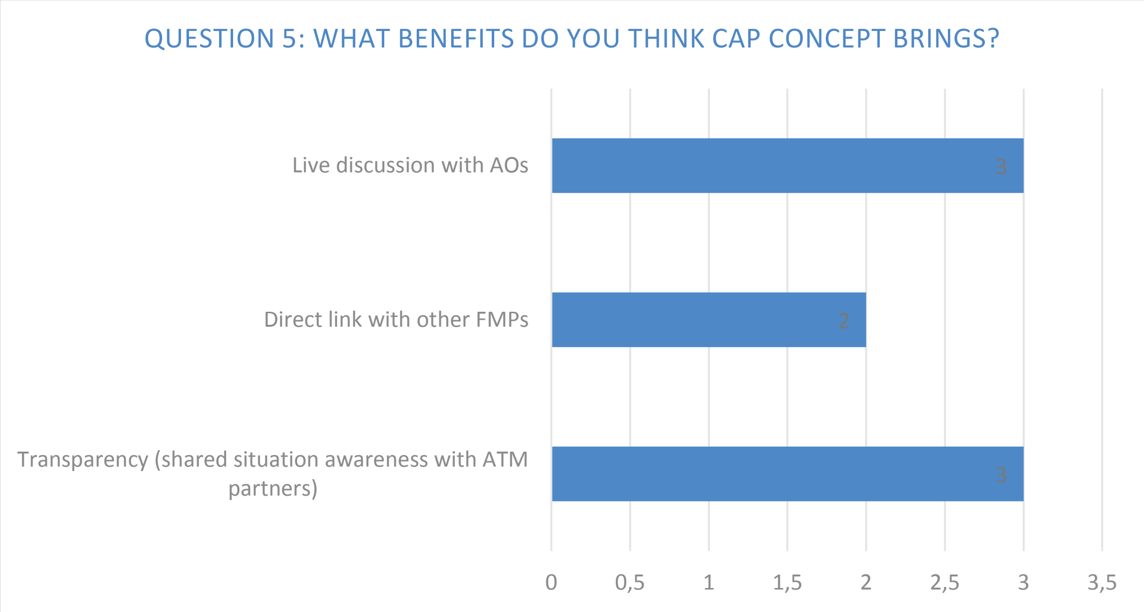


Figure 195: Answers to questions 05. h), 05. i) and 05. j)

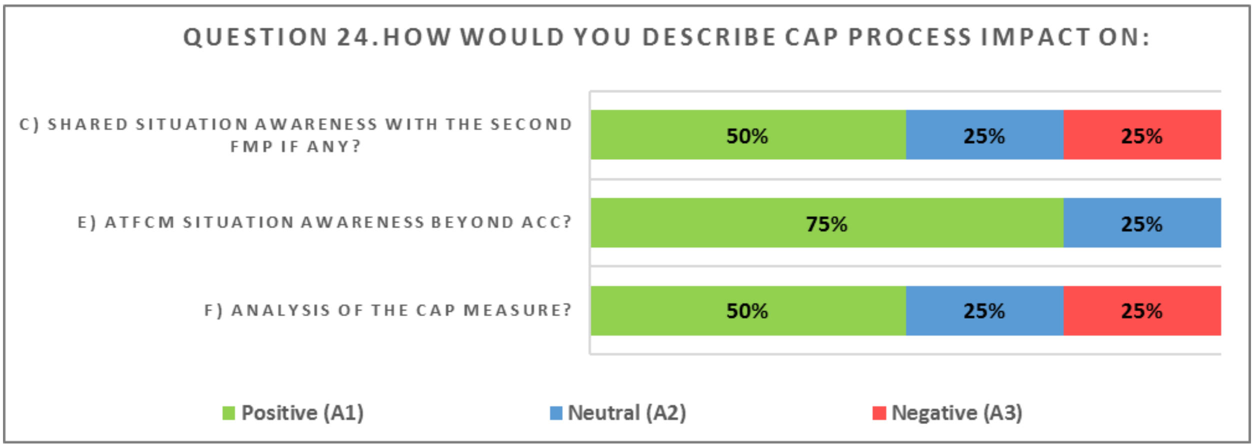


Figure 196: Answers to questions 24. c), 24. e) and 24. f)

The results show that the answers were mostly positive and to a lesser extent, neutral.

2. EX6-OBJ-VLD-01-004B Results

Questions 05 and 24 from the questionnaire refer to this Demonstration Objective.

All the answers of the FMPs are represented in the following graphics:

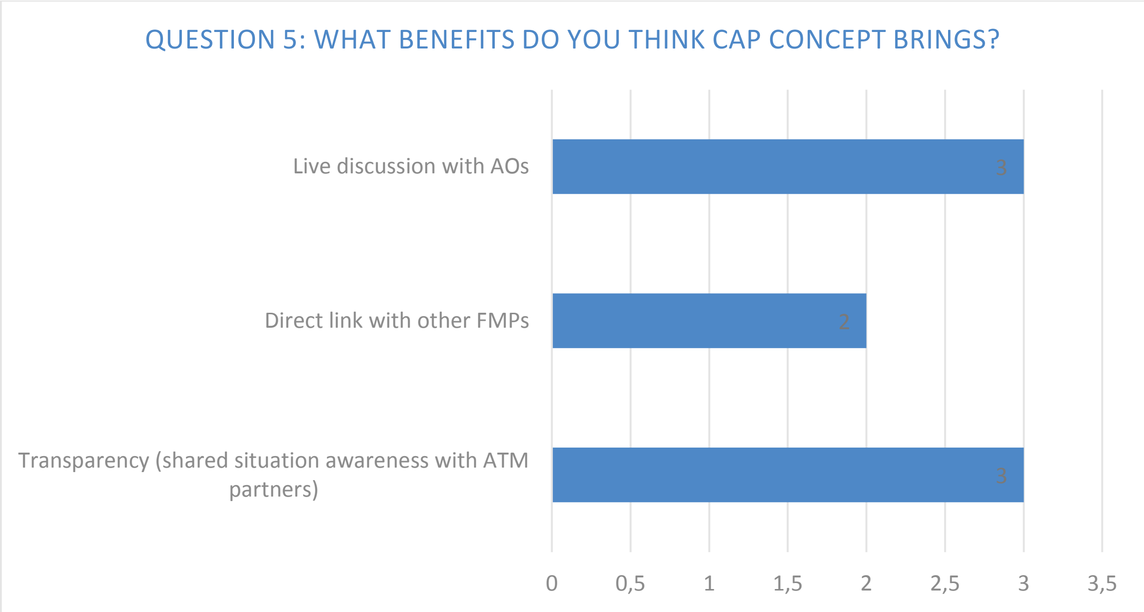


Figure 197: Answers to questions 05. h), 05. i) and 05. j)

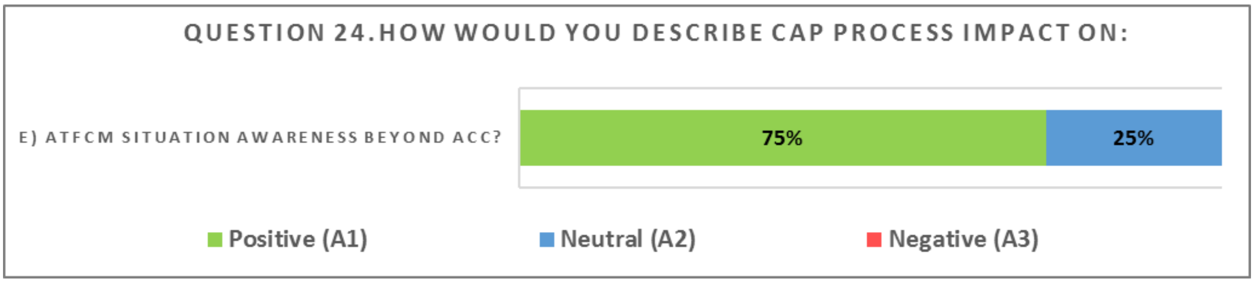


Figure 198: Answers to question 24. e)

The situation awareness increases but further data are needed to have a better understanding of the situation regarding transparency and involvement of the AUs.

3. EX6-OBJ-VLD-01-004C Results

Question 04 from the questionnaire refers to this Demonstration Objective.

All the answers of the FMPs are represented in the following graphic:

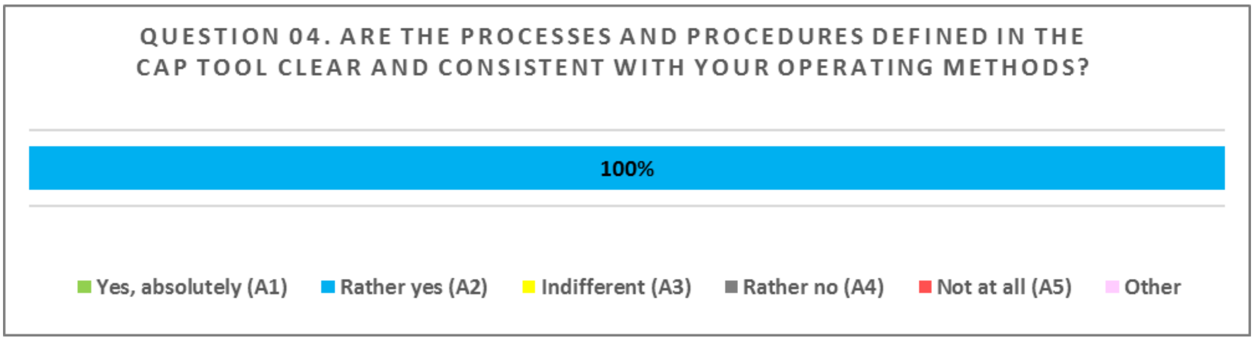


Figure 199: Answers to question 04

The feedback received by the FMPs shows CAP Tool processes and Procedures were in line with the operating methods.

4. EX6-OBJ-VLD-01-004D Results

Question 21 from the questionnaire refers to this Demonstration Objective.

All the answers of the FMPs are represented in the following graphic:

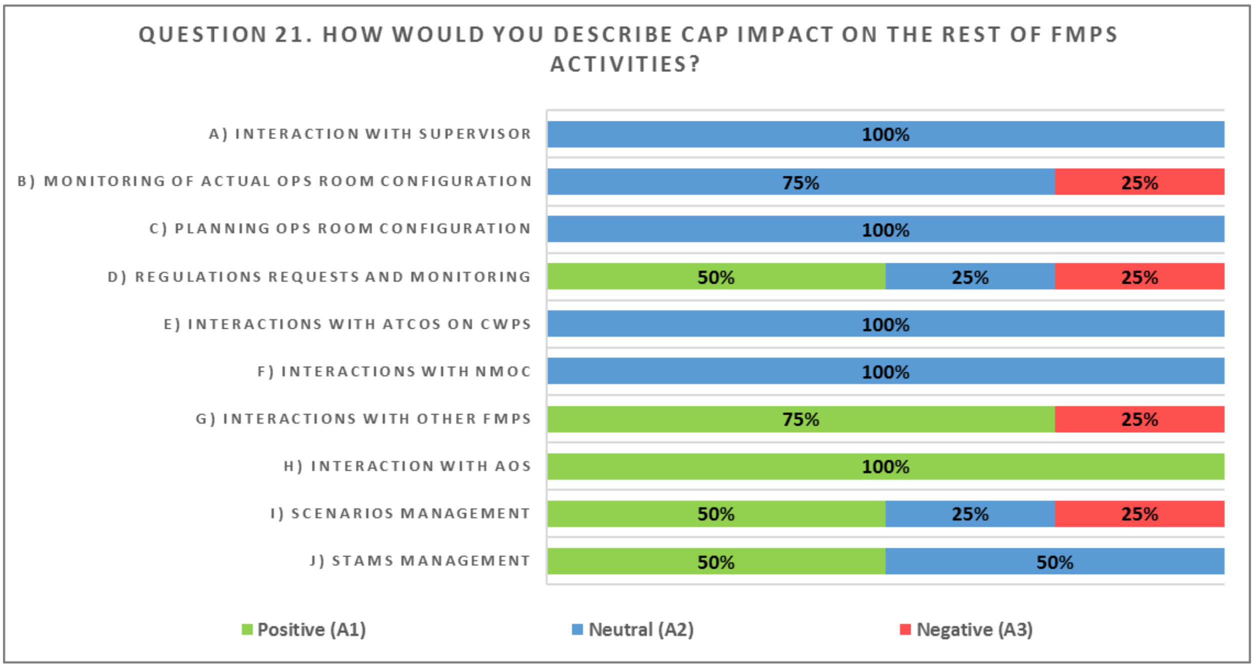


Figure 200: Answers to question 21

The final analysis with the results obtained show that the FMPs rather suffer any impact on their current activities or to a lesser extent, the impact was positive.

5. EX6-OBJ-VLD-02-002 Results

Questions 05 and 28 from the questionnaire refer to this Demonstration Objective.

All the answers of the FMPs are represented in the following graphics:

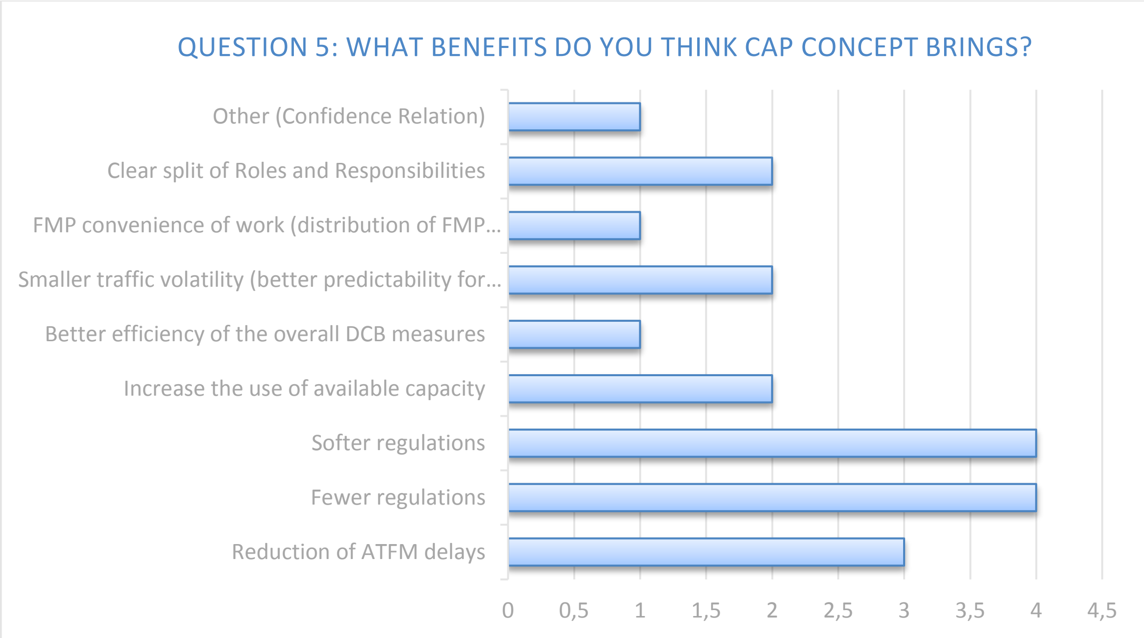
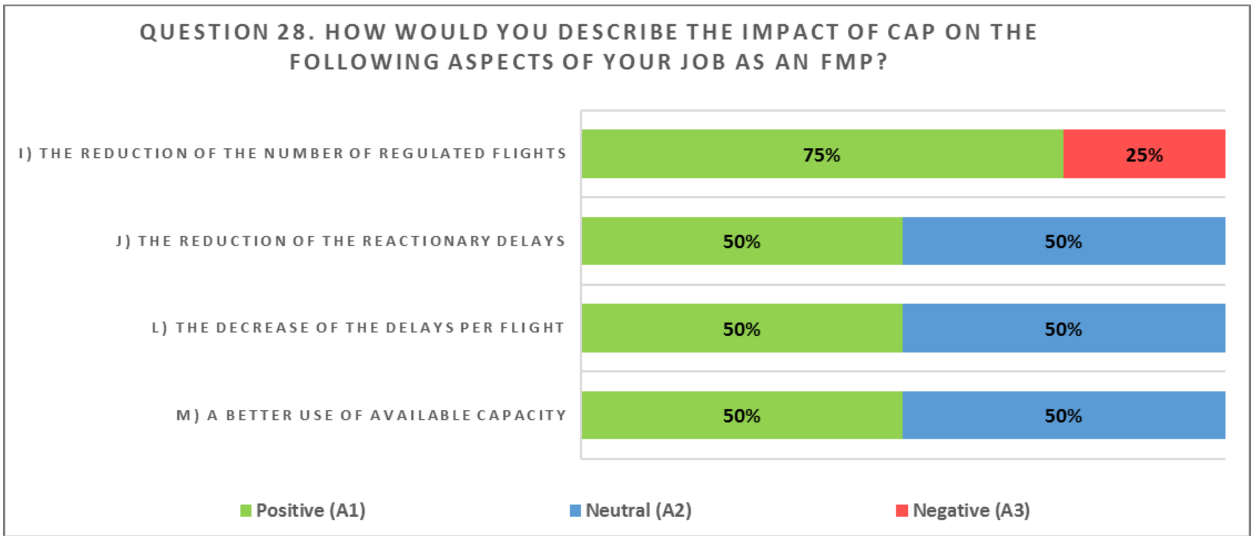


Figure 201: Answers to questions 5. a), 5. b), 5. c), 5. d), 5. e), 5. f), 5. l)



YOU CAN DETAIL ANY ITEM BELOW IF YOU WISH:"*A LEVEL CAP CONSUMES MORE FUEL*".

Figure 202: Answers to question 28. i), 28. j), 28. l), 28. m)

The results show that answers were neutral and positive regarding the different impacts of CAP and there were a decrease regarding the number of regulation declared once using CAP.

6. EX6-OBJ-VLD-03-002 Results

Question 28 from the questionnaire refers to this Demonstration Objective.

All the answers of the FMPs are represented in the following graphic:

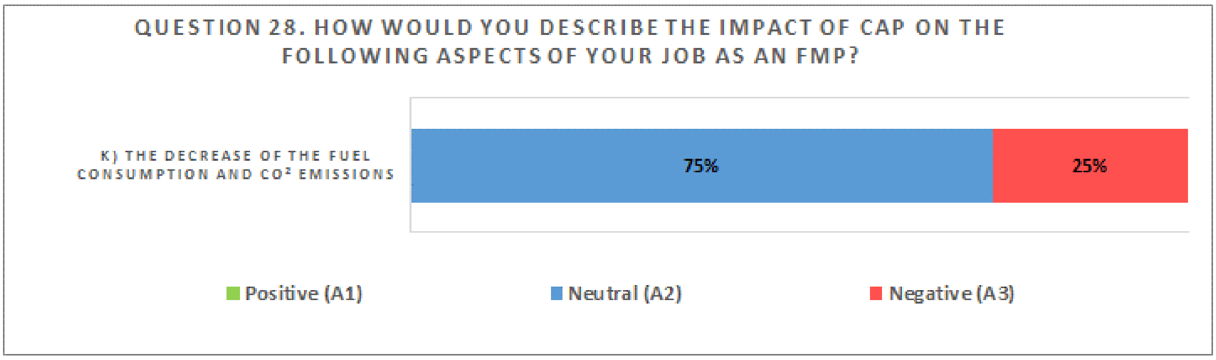


Figure 203: Answers to question 28

The results show that answers were mostly neutral and to a lesser extent, negative. No negative impact can be measured regarding fuel consumption with the data gathered.

7. EX6-OBJ-VLD-04-003 Results

Questions 17, 18, 19, 20, 22, 23 and 28 from the questionnaire refer to this Demonstration Objective.

The remaining answers of the FMPs are represented in the following graphics:

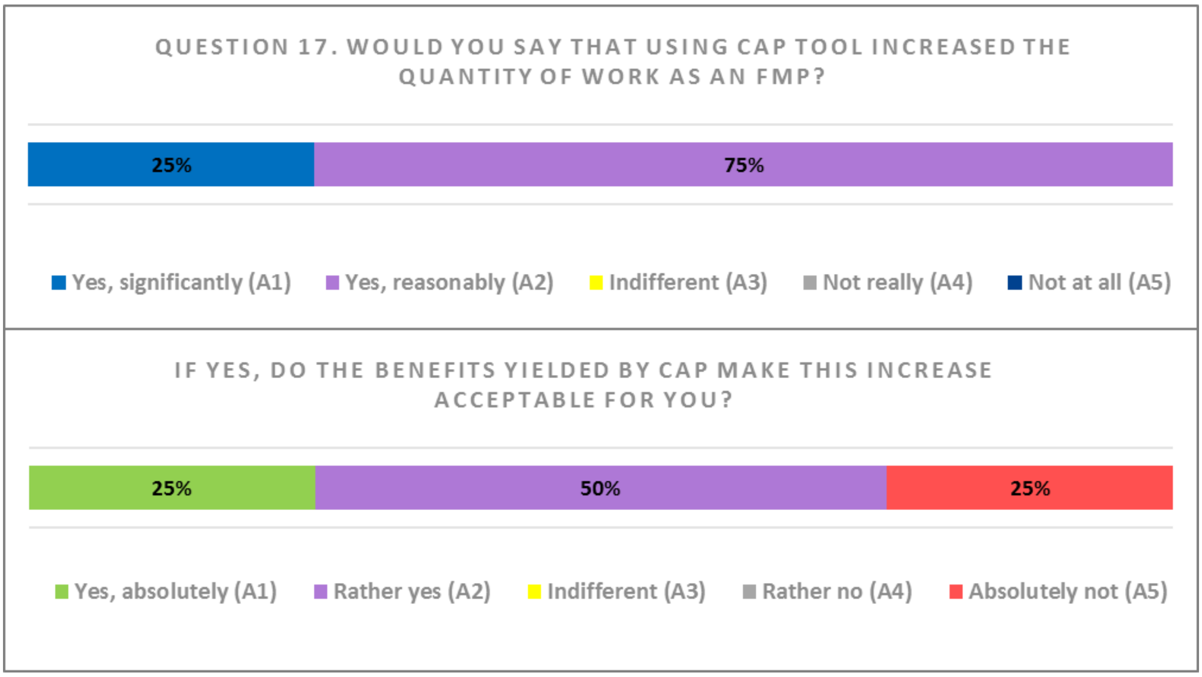


Figure 204: Answers to question 17

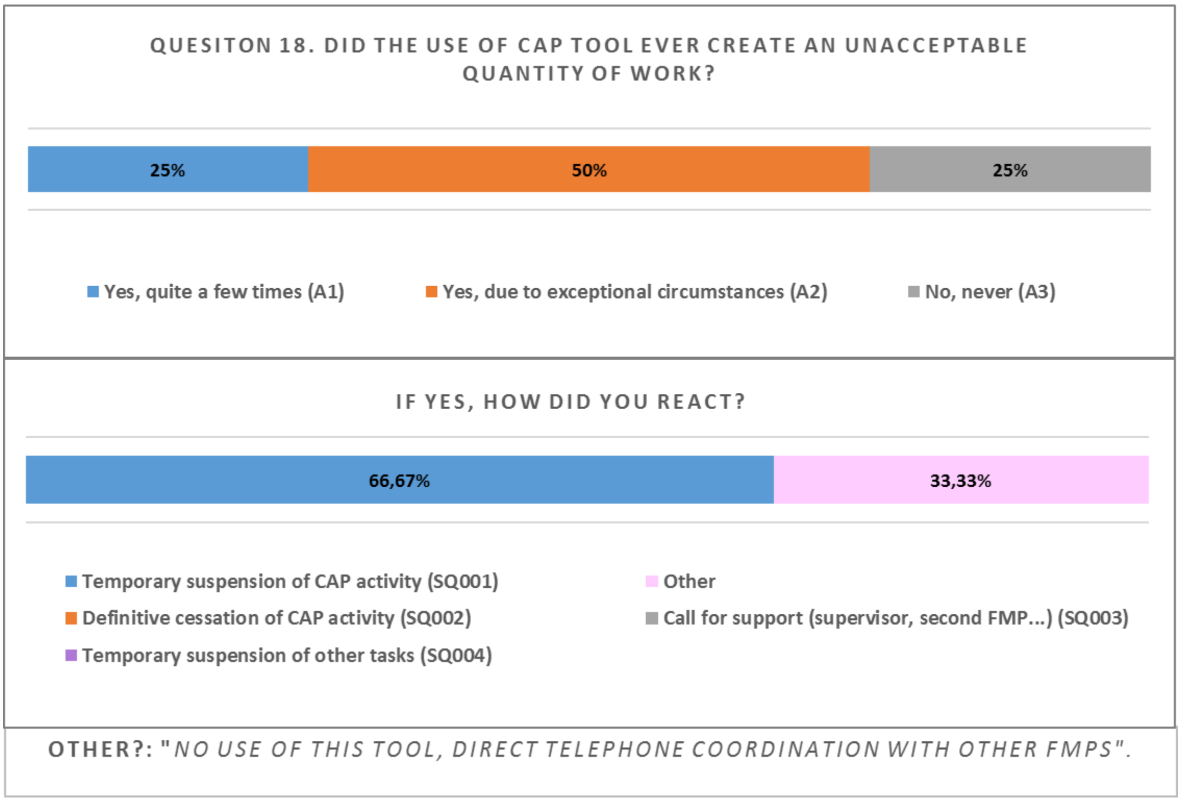


Figure 205: Answers to question 18

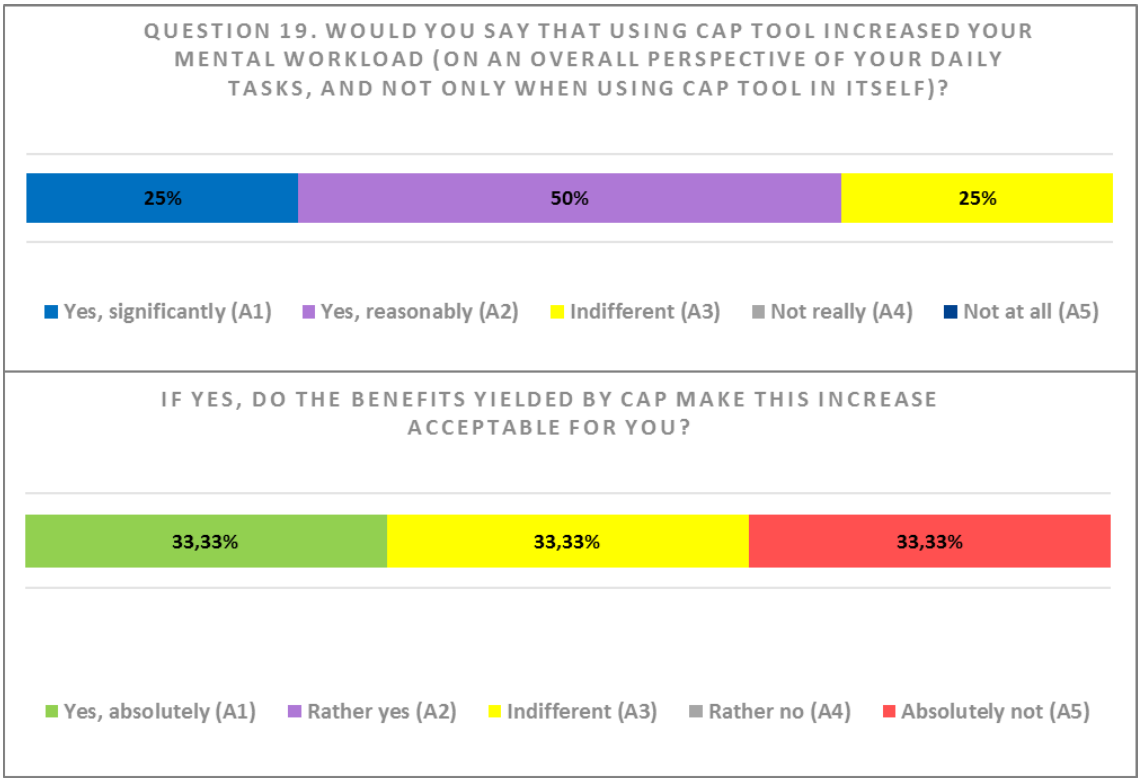
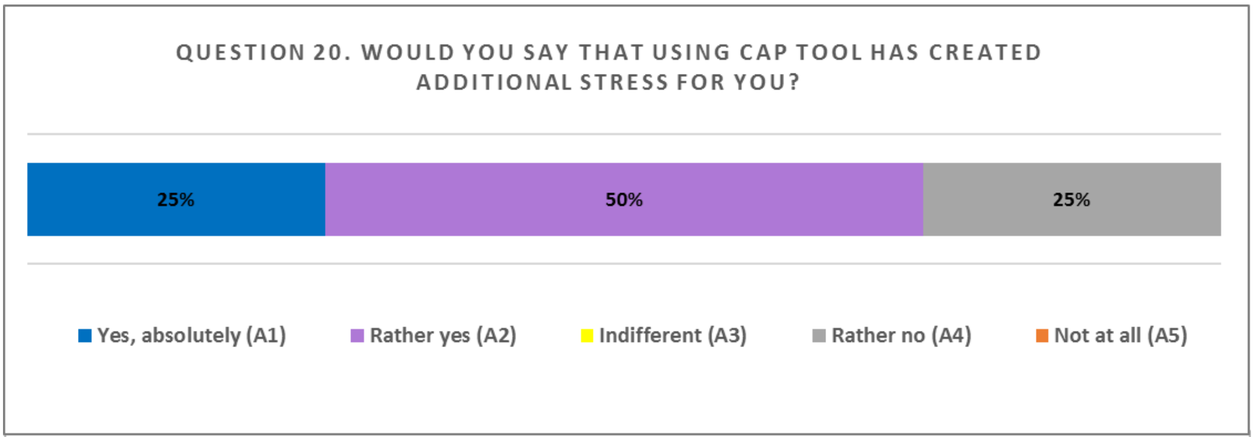


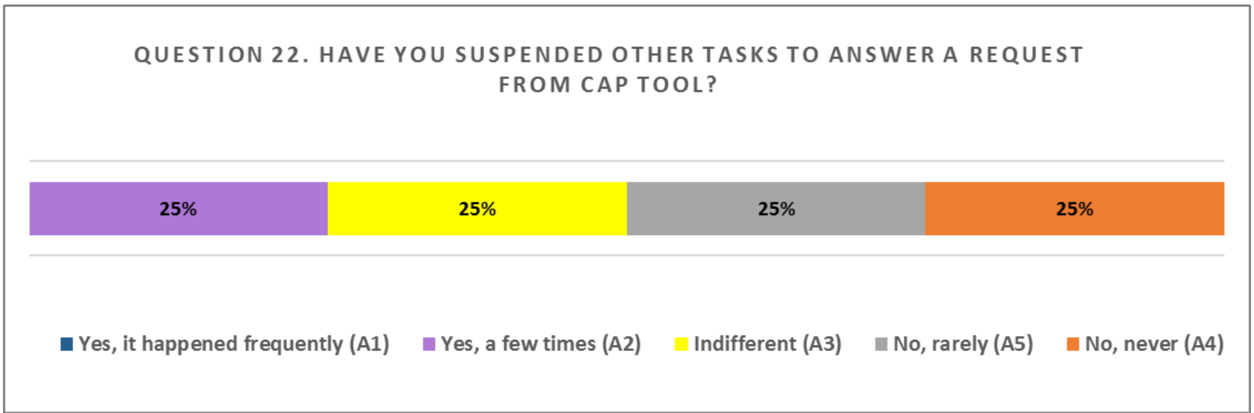
Figure 206: Answers to question 19



WHY?

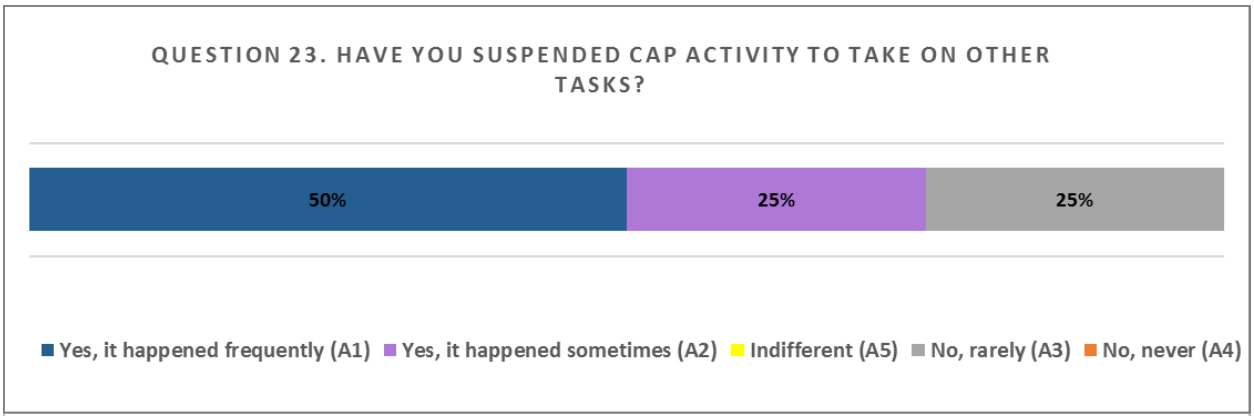
1. **RATHER YES:** "*IT'S A NEW PROCESS*".
2. **RATHER YES:** "*TIME CONSUMING*".
3. **YES, ABSOLUTELY:** "*ALREADY MENTIONED, DIFFICULT TO MONITOR AND SLOW. IT HAS NOT BEEN USEFUL FOR ME. WHEN I NEEDED IT AND WHEN I TALKED TO OTHER FMPS, IT HAS BEEN COORDINATED VIA PHONE*".

Figure 207: Answers to question 20



IF YES, WHAT TASKS?: "*MONITORING*".

Figure 208: Answers to question 22



IF YES, WHAT TASKS?

1. "THE MONITORING OF THE ROOM HAS TO BE IN REAL TIME".
2. "MONITORING".
3. "MONITOR THE CHMI, APPLY SCENARIOS, REGULATIONS, COORDINATE WITH OTHER FMPS BY TELEPHONE, INFORM SUPERVISORS AND ROOM MANAGER OF OPERATIONAL INCIDENTS AND ACTIONS TO BE TAKEN, UPDATE CONFIGURATIONS, ETC".

Figure 209: Answers to question 23

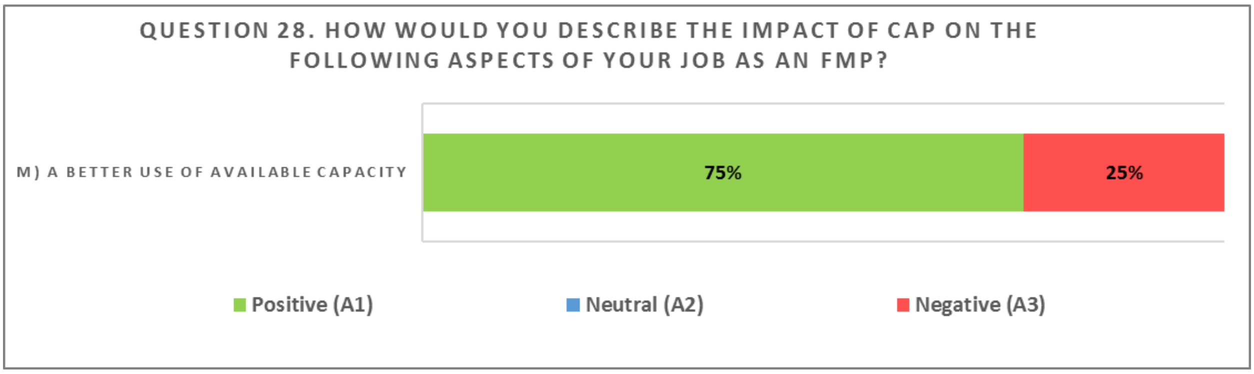


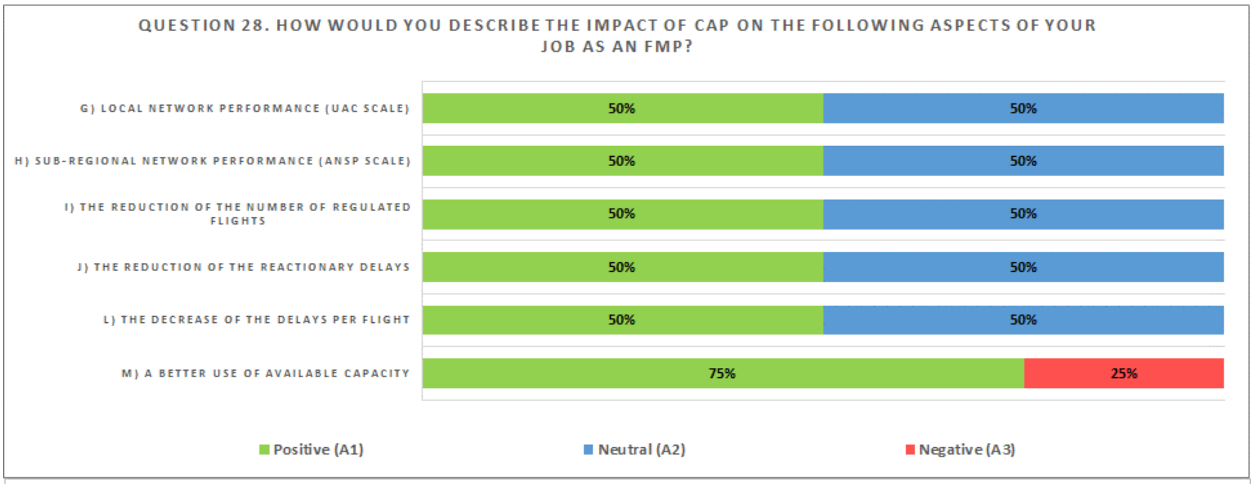
Figure 210: Answers to question 28. m)

The results show that because of the tool, the workload, stress level, etc. are incremented at least for the FMP not used to work with it. However, survey respondents indicated that the obtained benefits make acceptable this increment.

8. EX6-OBJ-VLD-05-002 Results

Question 28 from the questionnaire refers to this Demonstration Objective.

All the answers of the FMPs are represented in the following graphic:



YOU CAN DETAIL ANY ITEM BELOW IF YOU WISH: *"A LEVEL CAP CONSUMES MORE FUEL".*

Figure 211: Answers to question 28

The results show that answers were neutral and positive.

I.3.3 Analysis of Exercises Results per Demonstration objective of the second iteration – CAP Tool (Q2 2018)

UC2.4 – Level Capping

This section presents the qualitative analysis of the results obtained from the questionnaires answered by AUs who have used the CAP tool during the trial integrated with the results of the briefing and debriefing sessions hold with them. No additional questionnaires were filled by the FMPs in the second iteration so the results at FMP level remain the same as in section F.3.2.

It is of special interest the results shown in section 6 regarding the fuel efficiency analysis.

Table 53 provides the coverage of the objectives and associates success criteria by the topics included in the questionnaire completed by the AUs and FMPs, as well as the feedback get from them by email and debriefing sessions.

Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria	Questionnaire items addressing the Objective
EX6-OBJ- VLD-01-004A Demonstrate the added value of using local tools to support the analysis and preparation of STAM.	**EX6- CRT-VLD-01-004A** The level of situational awareness of the FMP increases with the inclusion of local tools in the analysis of STAM.	**FMPs:** Question 05 (h, i and j) and 24 (c, e and f) (See I.3.21)
EX6-OBJ- VLD-01-004B Demonstrate the added value of using local tools to support the coordination of STAM.	**EX6- CRT-VLD-01-004B** The level of situational awareness of the FMP increases with the inclusion of local tools in the coordination of STAM.	**FMPs:** Question 05 (h, i and j) and 24 (e) (See I.3.22)

Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria	Questionnaire items addressing the Objective
EX6-OBJ- VLD-01-004C Demonstrate the processes and procedures related to the integration of local and network dynamic DCB processes are clear and consistent.	**EX6- CRT-VLD-01-004C** All the actors involved confirm the STAM operating methods are clear and consistent.	**AUs:** Question 07 **FMPs:** Question 04 (See I.3.23)
EX6-OBJ- VLD-01-004D Demonstrate that the roles and responsibilities of human actors related to the integration of local and network dynamic DCB processes are clear and consistent.	**EX6- CRT-VLD-01-004D** The concerned actors confirm the roles and responsibilities are clear and consistent.	**AUs:** Question 08 **FMPs:** Question 21 (See I.3.24)
EX6-OBJ-VLD-02-002 Demonstrate an improvement on predictability thanks to the use of local tools (including what-if).	**EX6-CRT-VLD-02-002** The number of regulated and affected flights decrease. Reactionary delays are reduced.	**AUs:** Question 01 (a, b, c, d, e and f) and 04 (d, g and h) **FMPs:** Question 05 (a, b, c, d, e, f and l) and 28 (i, j, l and m) (See I.3.25)
EX6-OBJ-VLD-03-002 Demonstrate the optimization of fuel consumption thanks to the use of what-if for local network performance tools.	**EX6-CRT-VLD-03-002** Reduction in fuel consumption and CO2 emissions induced by STAMs.	**AUs:** Question 04 (f) **FMPs:** Question 28 (See I.3.26)
EX6-OBJ-VLD-04-003 Demonstrate an improvement in cost-efficiency for ANSPs due to the reduction in time for FMP staff to monitor, analyse and coordinate measures to DCB.	**EX6-CRT-VLD-04-003** FMP confidence on STAM to resolve Demand Capacity Imbalance increase. FMP workload is not increased.	**FMPs:** Question 17, 18, 19, 20, 22, 23 and 28 (m) (See I.3.27)
EX6-OBJ-VLD-05-002 Increase the use of available capacity through a better management of extra capacity and use of under-loaded period.	**EX6-CRT-VLD-05-002** Delay per flight is reduced Reduction of less under-loaded period when STAM is applied.	**AUs:** Question 04 (d, g and h) **FMPs:** Question 28 (g, h, I, j, l and m) (See I.3.28)

Table 53: Coverage of the questions regarding the OBJ and success criteria

1. EX6-OBJ-VLD-01-004A Results

Same results as in F.3.2.1

2. EX6-OBJ-VLD-01-004B Results

Same results as in F.3.2.2

3. EX6-OBJ-VLD-01-004C Results

- **AUs:**

Question 07 from the questionnaire refers to this Demonstration Objective.

All the answers of the AUs are represented in the following graphic:

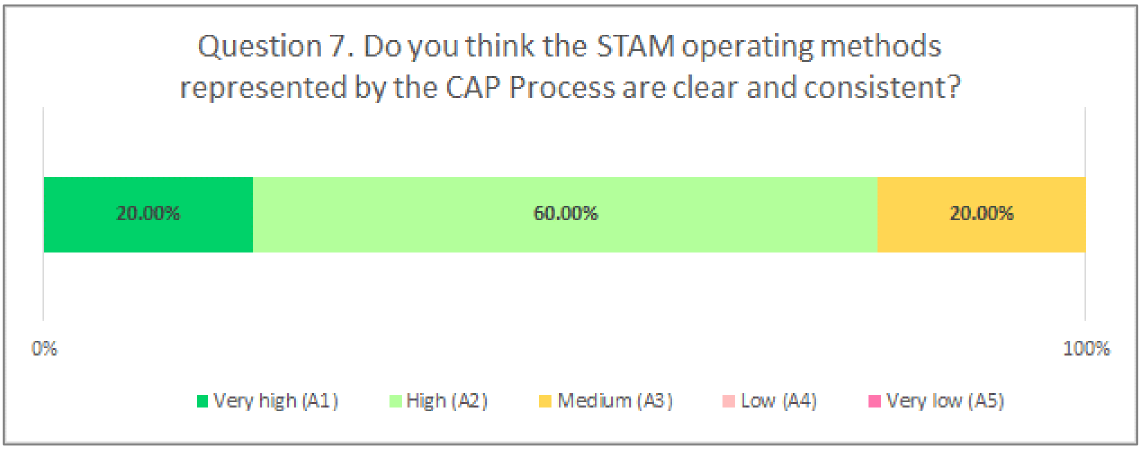


Figure 212: Answers to question 07.

The feedback received by the AUs shows CAP Tool processes and Procedures were in line with the operating methods. In addition, the AUs describe the tool as intuitive and easy to use. They found the information that the Chat box provides clear and easy to understand.

4. EX6-OBJ-VLD-01-004D Results

- **AUs:**

Question 08 from the questionnaire refers to this Demonstration Objective.

All the answers of the AUs are represented in the following graphic:

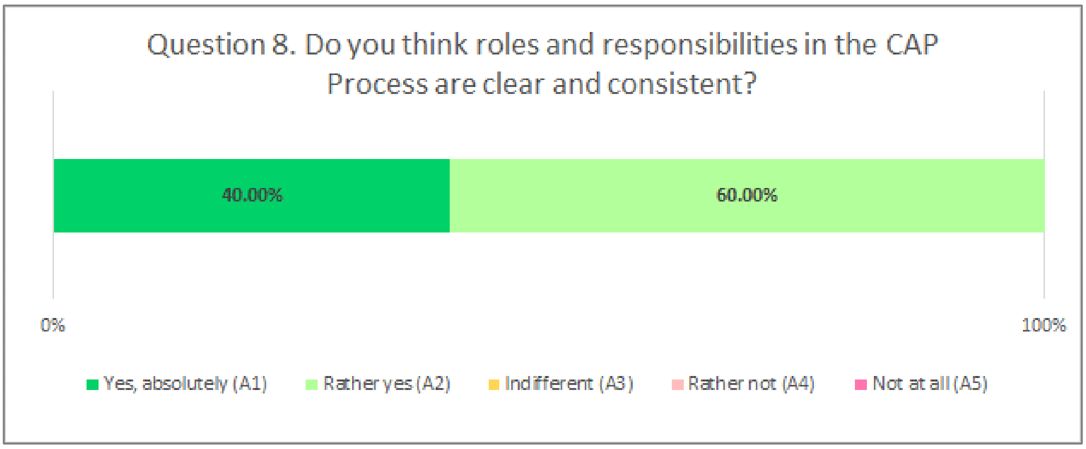


Figure 213: Answers to question 8.

The final analysis with the results obtained show that the AUs rather suffer any impact on their current activities or to a lesser extent, the impact was positive.

5. EX6-OBJ-VLD-02-002 Results

- **AUs:**

Questions 01 (a, b, c, d, e and f) and 04 (d, g and h), from the questionnaire refer to this Demonstration Objective.

All the answers of the AUs are represented in the following graphics:

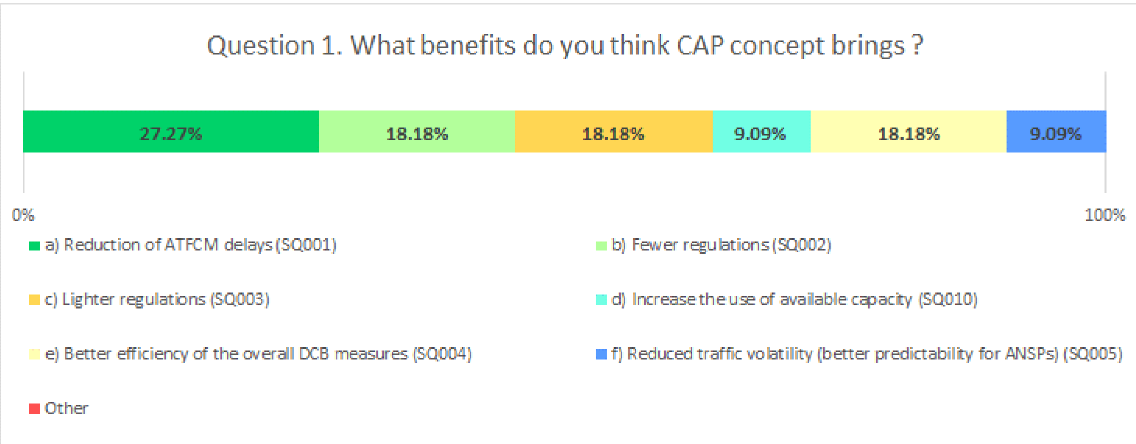


Figure 214: Answers to question 1 (a, b, c, d, e and f).

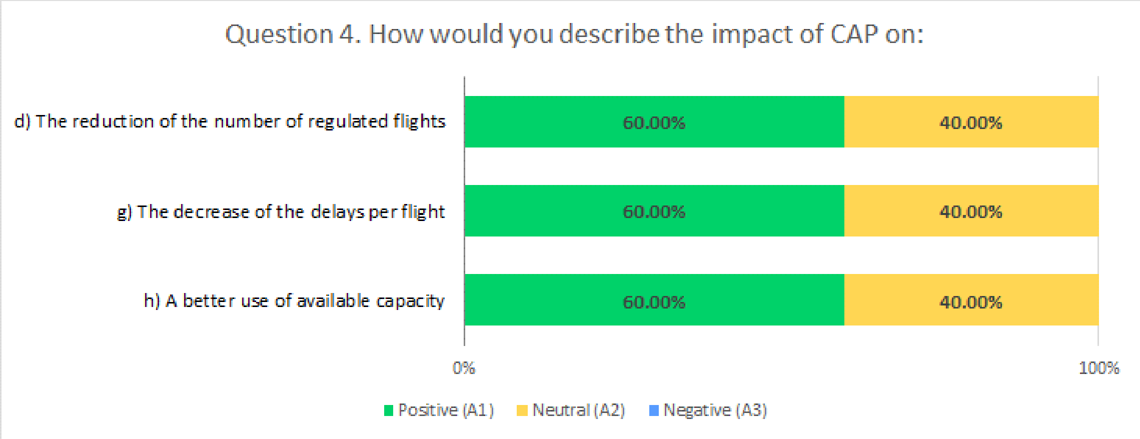


Figure 215: Answers to questions 4 (d, g and h).

The results show that answers were positive regarding the different impacts of CAP and the number of regulation declared once using CAP. There have been neutral answers because the CAP tool has not been used every day during the trial (due to the characteristics of the traffic flow).

6. EX6-OBJ-VLD-03-002 Results

- **AUs:**

Question 04 (f) from the questionnaire refers to this Demonstration Objective.

All the answers of the AUs are represented in the following graphic:

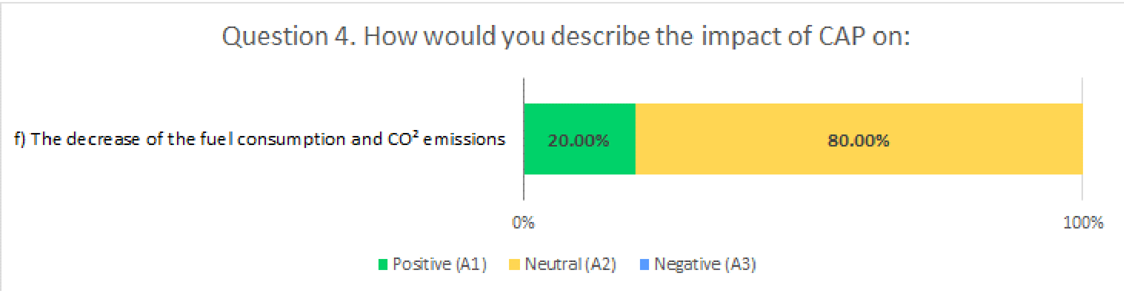


Figure 216: Answers to question 04 (f).

AUs consider that the impact of CAP was mainly positive and neutral.

- **FMPs:**

Question 28 from the questionnaire refers to this Demonstration Objective.

All the answers of the FMPs are represented in the following graphic:

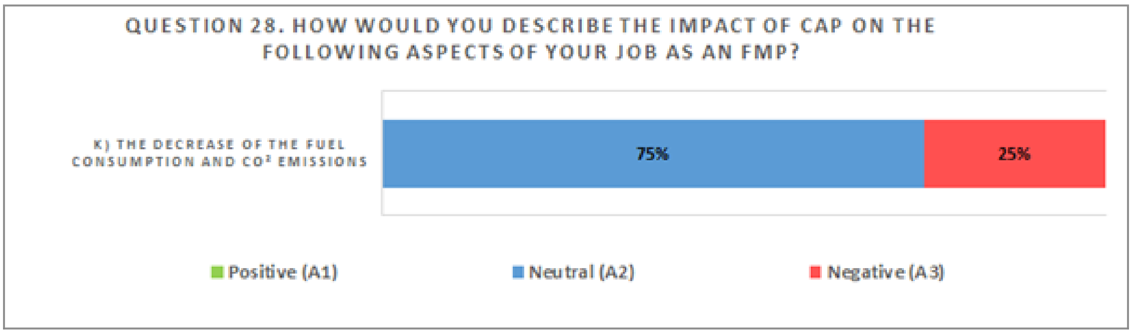
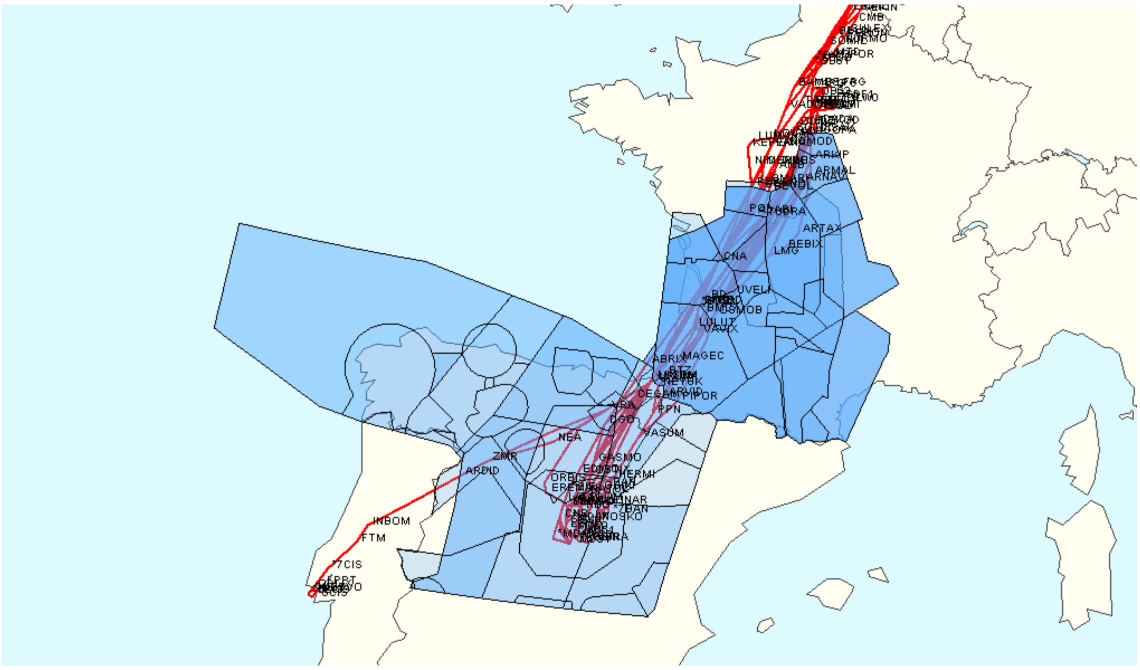


Figure 217: Answers to question 28.

The results show that answers were mostly neutral.

Additionally, with the data obtained during the trial, the following results regarding Fuel Consumption and CO2 emissions have been obtained:

The aim of this analysis is to assess the impact in fuel consumption due to the implementation of STAM measures, focusing on the traffic Flow between LFBB and LECM. The study covers the period from 06:00 until 18:00, where the STAM measures were applied.



- Traffic:

The CAP tool provided a list of the elected flights to which the STAM measure was proposed for the period from 23/04/18 to 20/05/18. From all the days under study only 3 of them implemented STAM measures in the LECM-LFBB flow (24, 26 of April and 05 of May) in charge of the Spanish FMP. For comparison purposes, only the affected city pairs per day have been considered for the analysis.

- Data Considerations:

On the 24th of April, there were 4 flights affected by STAM measures in the Flow LECM-LFBB, including the city pairs LEMD-EHAM, LEMD-LFPO and LFBD-LPPT. For the same day, a wider analysis was also made considering the same city pairs (23 flights, including the previous ones)

On 26th of April, 22 flights were affected by STAM measures, from which only 4 had an impact in fuel consumption within the Flow LECM-LFBB. The city pairs analysed are LEMD-EHAM, LEMD-LFPO and LFOB-LEMD. For the same day, the affected city pairs gather 38 flights (including the previous ones)

On the 5th of May, 27 flights were impacted by STAM measures, from which only 2 were gathered by the Flow LECM-LFBB. The city pairs included are LEMD_EBBR and LEMD_LFPG. 15 flights made the same Origin/Destination (O/D) for that day.

- Calculations:

Fuel consumption and CO2 emissions have been calculated through the AEM model available in NEST tool, by comparing the estimated fuel consumption in the FPL (M1) and the actual ones (M3[12]).

Fuel Consumption INITIAL vs ACTUAL

The methodology used to compare the Initial planned fuel vs the Actual fuel burn is affected by many factors that should be considered and normalized before to obtain the delta fuel such as normalized weight (ZFW, Discretionary fuel), tactical directs (DCT) segments requested and flown by pilot, actual usage of flaps, last updated wind component, actual speed and so on.

Therefore the horizontal trajectories between "solution" (M3 model) and "reference" (M1 model) are not here normalized for the above mentioned parameters;

Furthermore It has not been verified whether the "solution" trajectory actually applied the refiled level-cap.

Said that, the following analysis is nevertheless interesting and provide an indication through the horizontal trajectory looking at the actual fuel burn.

Results such as fuel/CO2 savings (from Figure 220) could come as the results of the missing normalization process.

[12] M1 and M3 files obtained from the DDR repository via NEST.

The level-cap procedure is not a measure proposed to Airlines to save fuel and it is neither the main purpose. The main purpose keep sating on Demand and Capacity balance.

For the ATEAM perspective the “AD-HOC Air France FUEL Assessment”, in the following pages, provide a more supported analysis.

This graphic below shows the total fuel burnt for the traffic captured within the flow LECM-LFBB in the period of study. It can be observed that in the actual trajectories the fuel consumption was slightly higher than in the FPL trajectories.

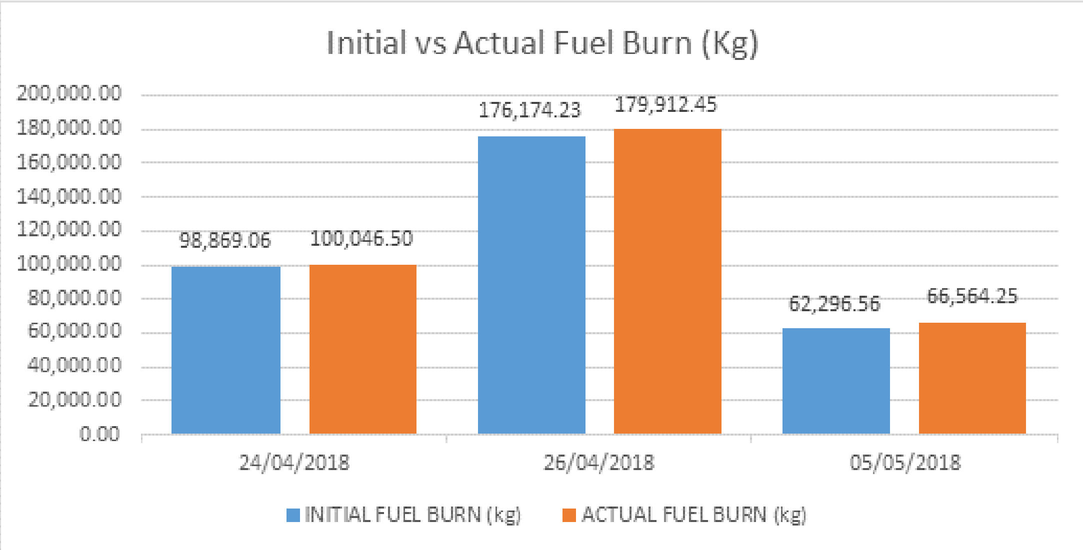


Figure 218. Initial vs Actual Fuel Burn (Kg).

When analysing more in detail the flights affected by STAM measures, it can be appreciated that the fuel consumption of the actual trajectory is higher on the 5th of May, while at 24th and 26th the fuel consumption is a bit lower than in the FPL trajectory

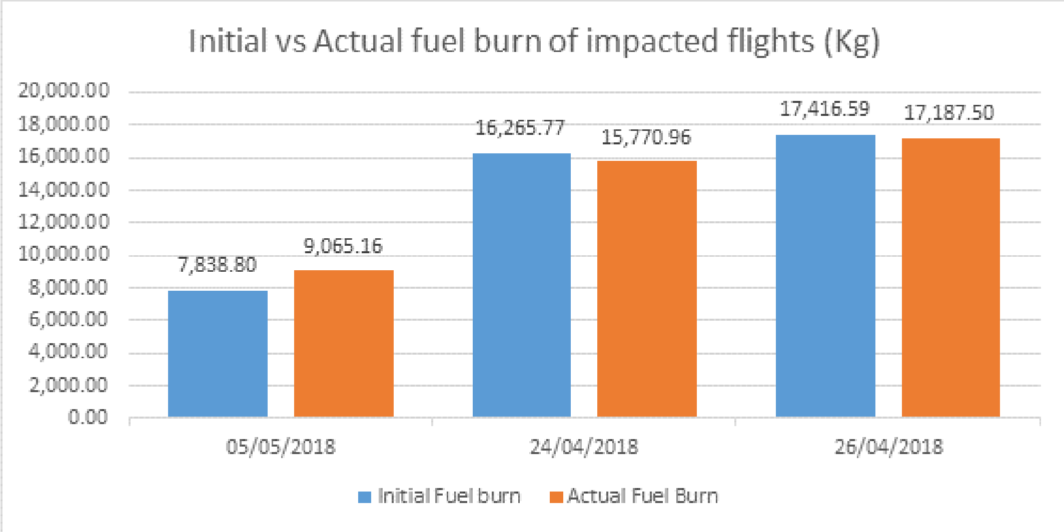


Figure 219. Initial vs Actual fuel burn of impacted flights (Kg).

When analysing the impact of the fuel burn of each traffic sample, we can observe that at some cases there are flights that save some fuel while others burnt more fuel than initially planned.

- Extra/Saved fuel burn:

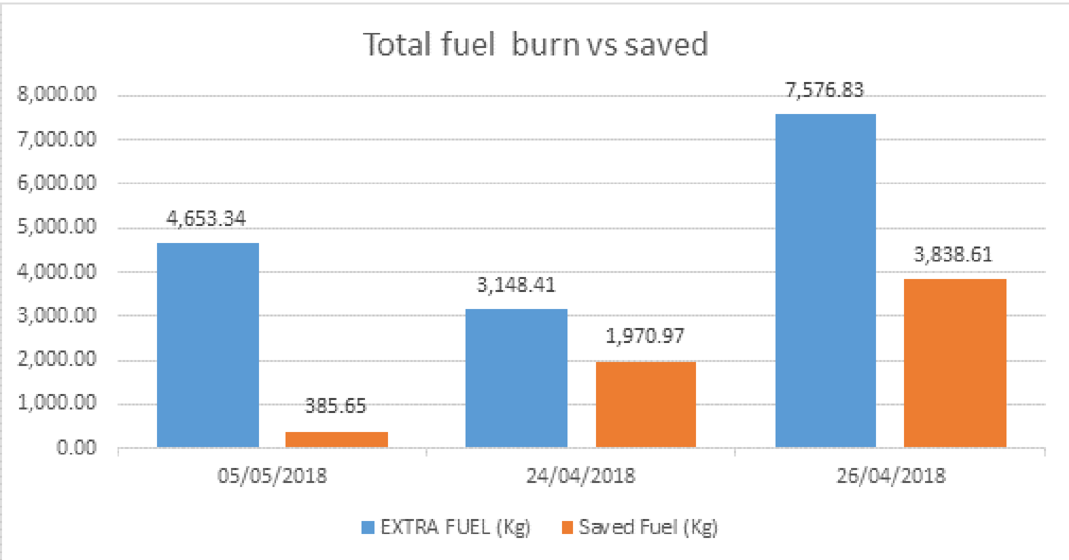


Figure 220. Total fuel burn vs saved.

On the 24th of April, 23 flights were captured in the traffic flow LECM-LFBB. 13 of them increased the fuel consumption against their FPL an average of 242,185 kg of fuel, while 10 of them reduced this consumption an average of 197,097 kg. The extra fuel burn goes from a maximum of 688,500 kg until a minimum of 36,460 kg. On the other hand, the flights which reduce their fuel consumption against their planned trajectory saved a maximum of 670,66 kg and a minimum of 22,94 kg of fuel.

On the 26th of April, 38 flights were captured in the traffic flow LECM-LFBB. 18 of them increased the fuel consumption against their FPL an average of 420,94 kg of fuel, while 20 of them reduced it an average of 191,93 kg. The extra fuel consumption goes from a maximum of 3313,92 kg until a minimum of 25,75 kg. Meanwhile, the flights which reduce their fuel consumption against their planned trajectory goes from a maximum of 453,91 kg until a minimum of 46,35 kg of fuel.

On the 5th of May, only 15 flights were captured in the traffic flow LECM-LFBB. 12 of them increased the fuel consumption against their FPL an average of 387,778 kg of fuel, while 3 of them reduced it an average of 128,55 kg. The extra fuel consumption goes from a maximum of 1164,290 kg until a minimum of 39,230 kg. In the meantime, the flights which reduce their fuel consumption against their planned trajectory save a maximum of 212,57 kg and a minimum of 24,87 kg of fuel.

Going more into detail, the fuel consumption of the impacted flights with STAM measures were analysed with the following results:

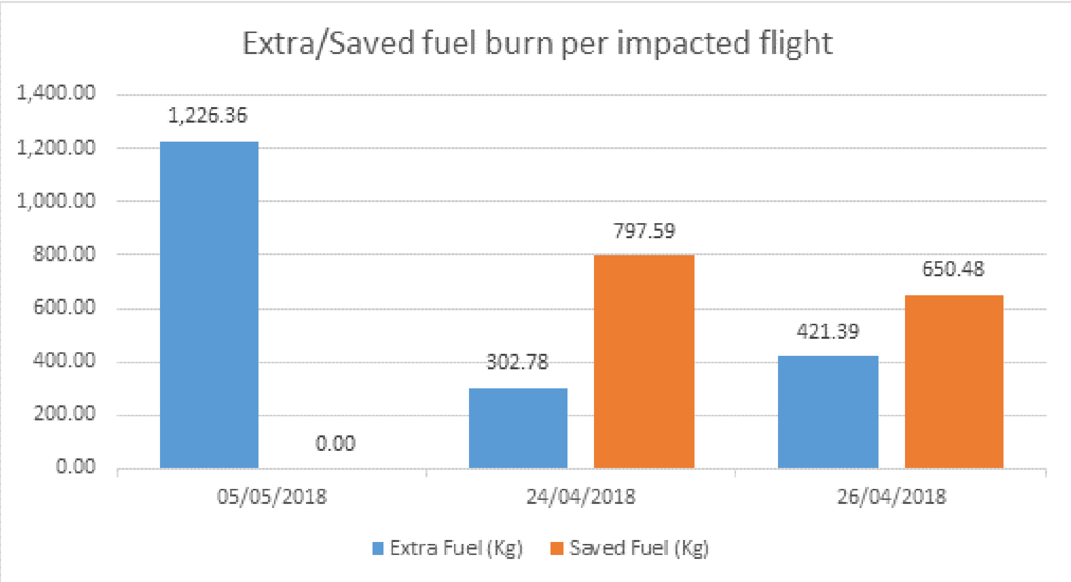


Figure 221. Extra/Saved fuel burn per impacted flight.

It can be observed that despite of the STAM measures applied on the 24 and 26 of April, some impacted flights saved fuel when comparing the FPL trajectory against the actual one.

On the 24th of April there were 4 flights impacted by STAM measures within the flow LECM-LFBB, from which, 2 of them increased the fuel consumption against their planed trajectory in a maximum of 250,490 kg and a minimum of 44,290 kg of fuel in the city pairs LEMD-EHAM and LEMD-LFPO. On the other hand, the other two flights reduced the fuel burnt regarding their FPL in 126,93 kg and 670,660 kg of fuel in the city pairs LEMD-LFPO and LFBD-LPPT.

On the 26th of April, there were also 4 flights impacted by STAM measures within the flow LECM-LFBB, from which only 1 increased the fuel consumption in 421,390 kg compared to the planed trajectory in the city pair LEMD-EHAM. Meanwhile, 3 of them reduced the fuel consumption in 96,890 kg, 102,980 kg and 450,610 kg of fuel respectively in the city pairs LEMD-LFPO, LFPG-LEMD and LFOB_LEMD.

Finally, on the 5th of May, there were only two flights affected by STAM measures within the flow under study. They show an increase in the fuel consumption of 62,07 kg of fuel in the city pair LEMD-EBBR and 1164,29 kg of fuel in the city pair LEMD-LFPG.

- CO2 Emissions:

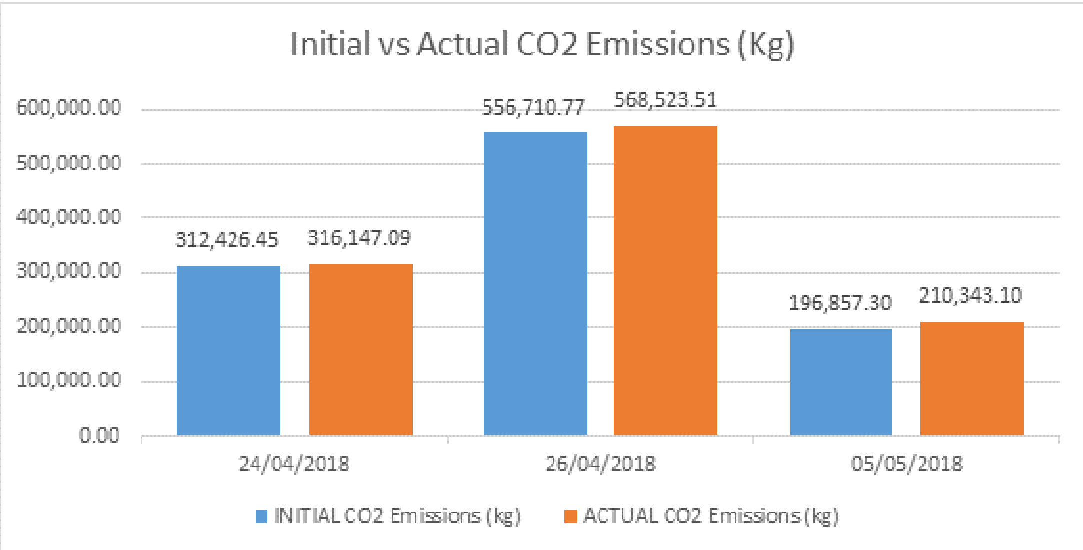


Figure 222. Initial vs Actual CO2 Emissions (Kg).

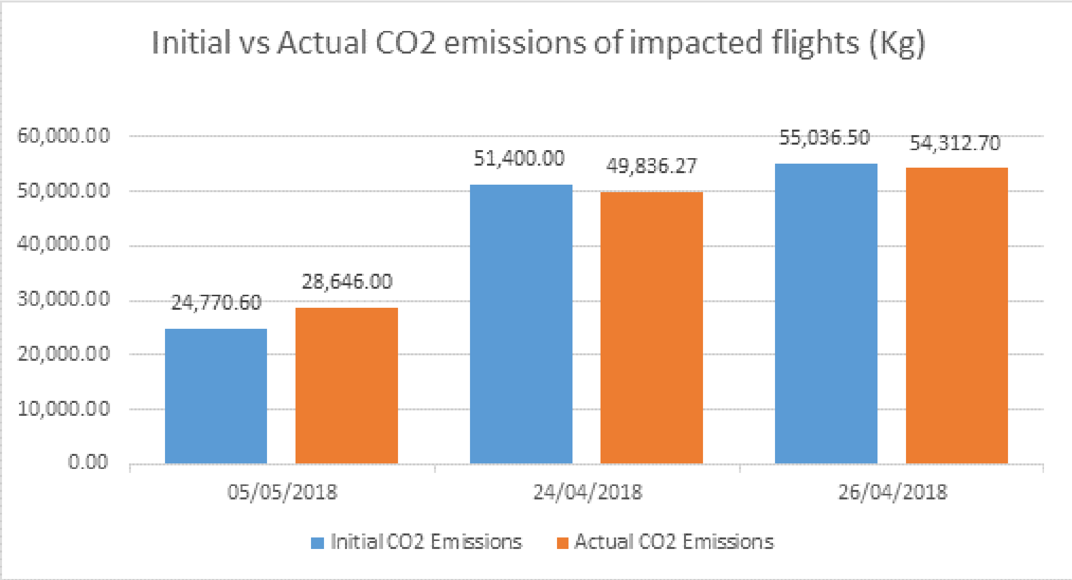


Figure 223. Initial vs Actual CO2 emissions of impacted flights (Kg).

- Extra/Saved CO2 emissions:

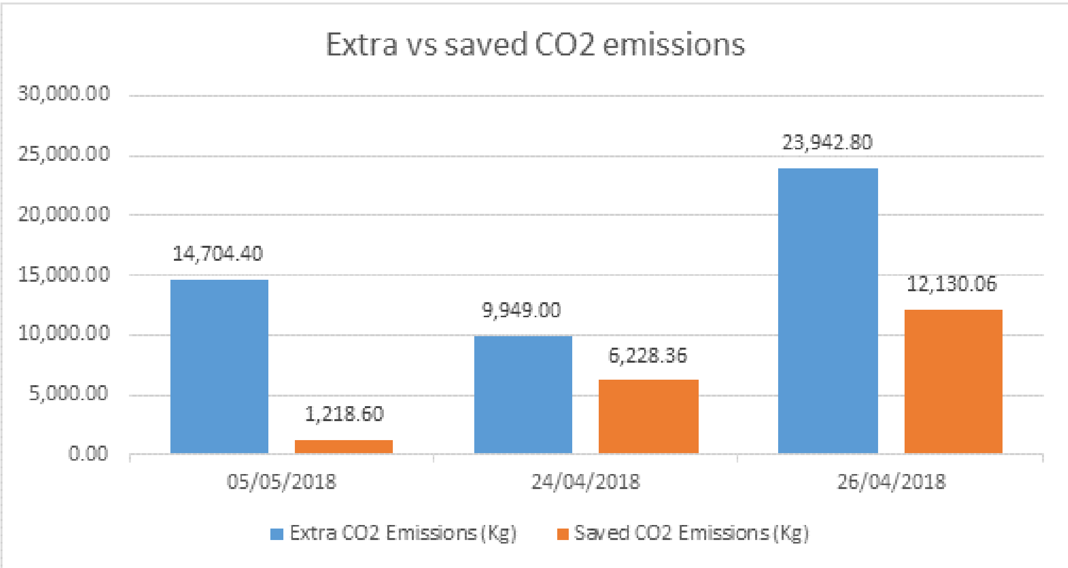


Figure 224. Extra vs saved CO2 emissions.

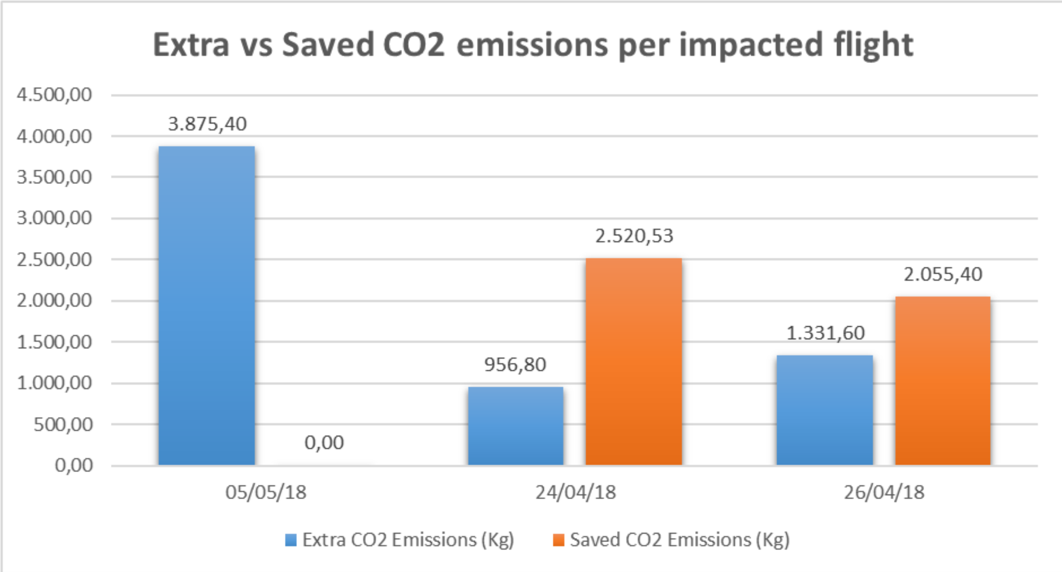


Figure 225. Extra vs Saved CO2 emissions per impacted flight (Kg).

- Fuel consumption and emissions per Origin/Destination (O/D):

From the previous graphics, it was detected that depending on the city-pair, the fuel consumption could increase or decrease, the following figures show the cases where there was a saving or an extra fuel consumption compared to the FPL trajectory.

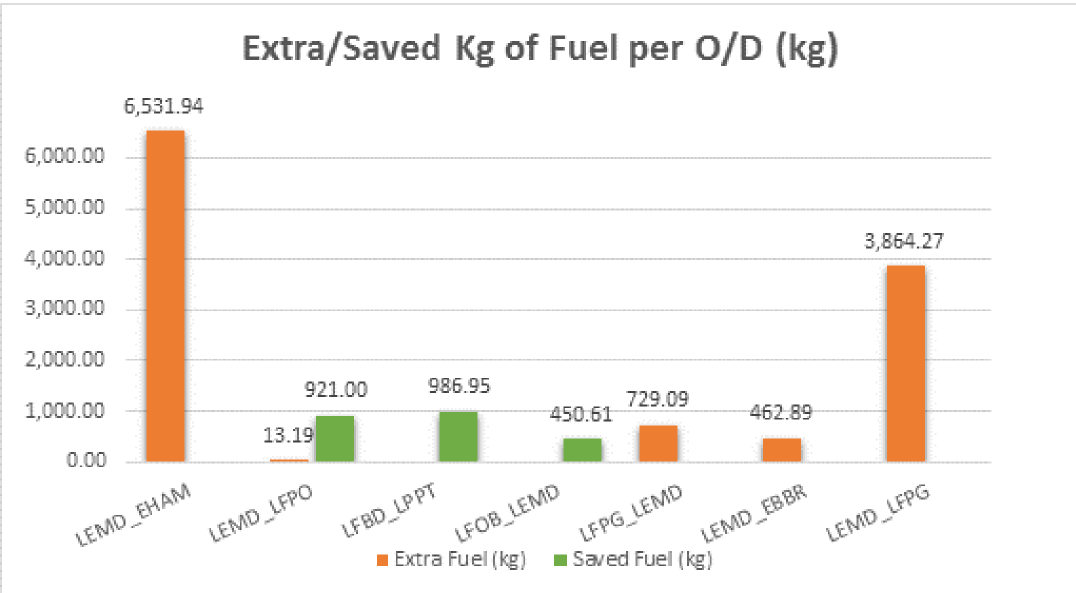


Figure 226. Extra/Saved Kg of Fuel per O/D (kg).

It can be observed that the O/D LEMD_EHAM and LEMD_LFPG gather most of the extra fuel burnt of all the traffic analysed.

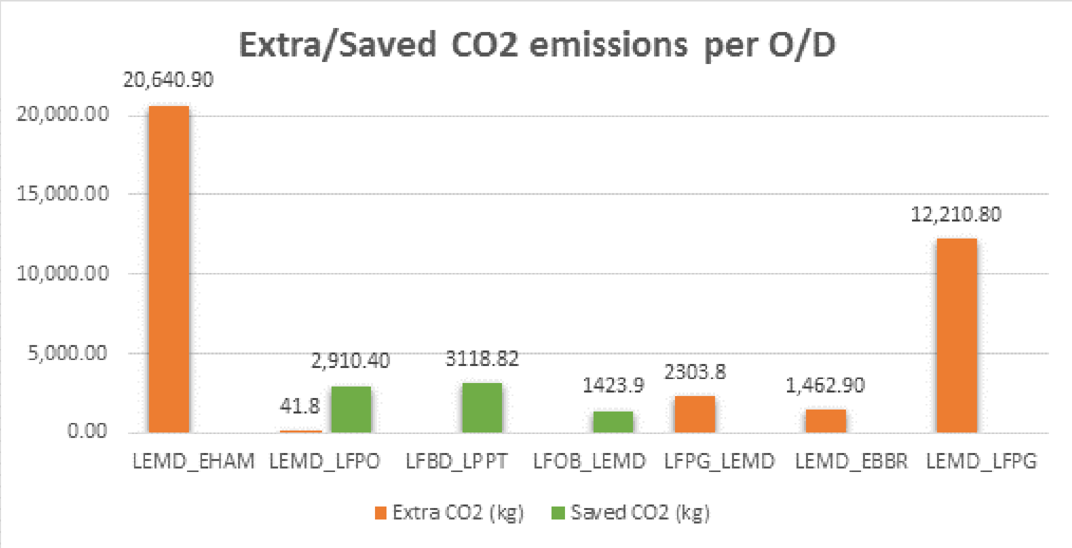


Figure 227. Extra/Saved CO2 emissions per O/D.

- Representativeness:

O/D	Flights per O/D	Impacted flights per O/D
LEMD-EHAM	19	2
LEMD-LFPO	25	3
LFBD-LPPT	3	1
LFOB-LEMD	1	1
LFPG-LEMD	13	1
LEMD-EBBR	5	1
LEMD-LFPG	10	1

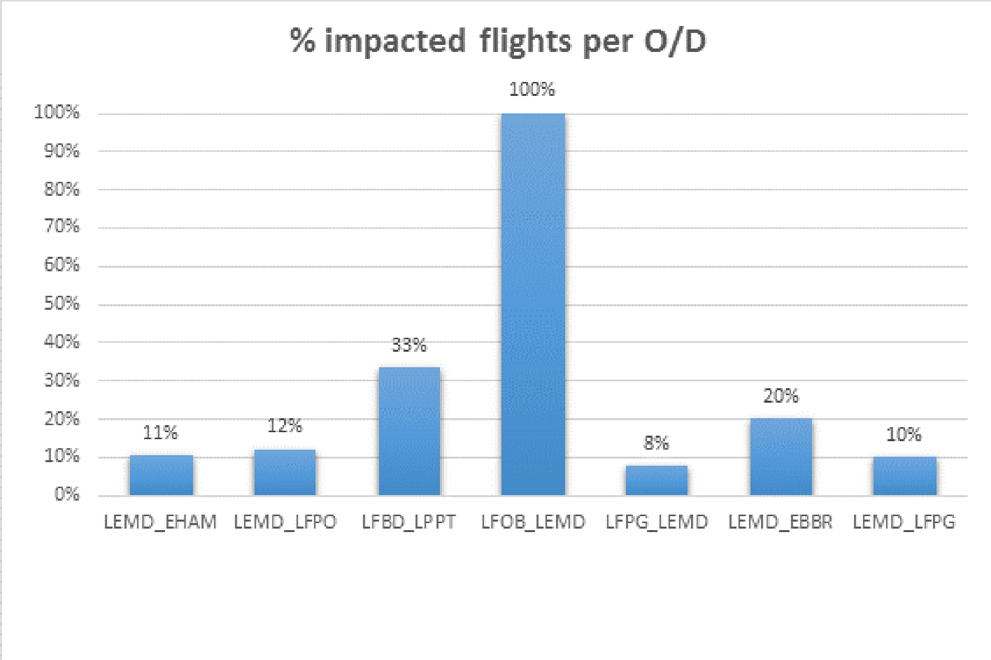


Figure 228. % impacted flights per O/D.

Depending on the O/D the percentage of flights, consuming extra fuel or saving fuel varies in the following proportion.

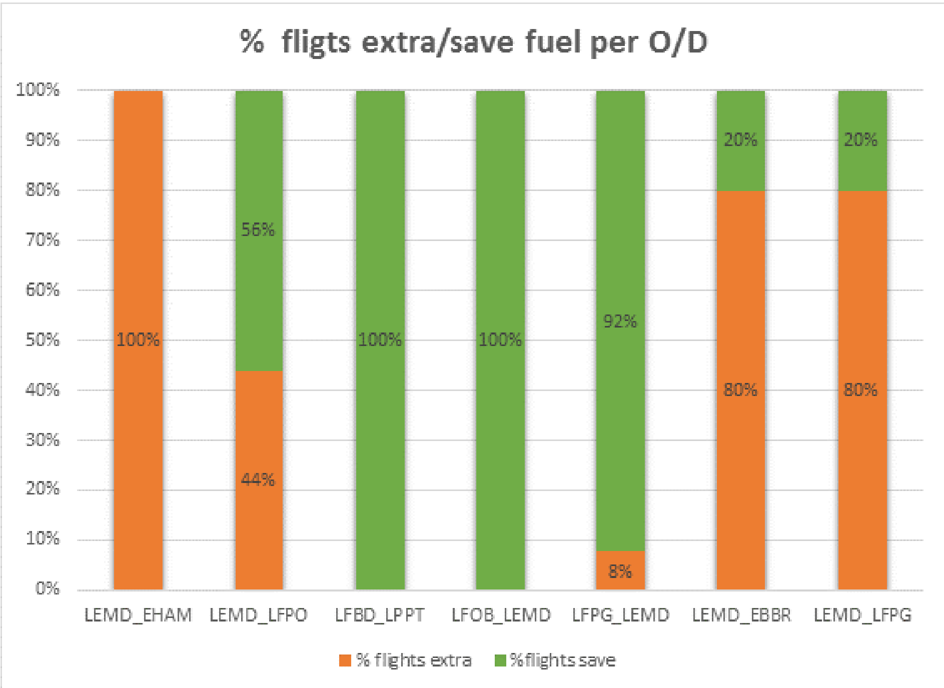


Figure 229. % flights extra/save fuel per O/D.

AD-HOC AIR FRANCE FUEL ASSESSMENT

For AFR flights with CAP constraints, it has been extracted the archived flight briefs before and after CAP for 25 flights between April and September 2018.

From these sample there were taken the "trip fuel" requested by the CFPS.

Results:

The trip fuel increase for flying at lower levels than optimum is of "a few tens of kilograms".

- The maximum amount was +87 kg
- The minimum amount was +9 kg
- The average amount is +29,0 kg

In percentage, the average is around 2% extra fuel on a medium-haul flight.

All concerned flights are on A320-family (A319, A320, A321).

(There has been one case of an extreme impact: for a flight refiled at FL290 instead of FL330, the headwinds in the lower level were much stronger than in the higher level. This required 330 kg of additional fuel, or 12%. There has been one single long haul flight for which a CAP proposal has been applied (an Airbus A330). Given the very large amount of trip fuel, the impact in percentage is tiny. In absolute value, it was +20kg. The averages above are calculated excluding these two outliers.)

In no cases was the fuel consumption in the new flight plan less than the original flight plan.

Notice that this impact was considered "quite low", and very acceptable if it allows to avoid regulations and minutes of delay.

It would be very useful to have an estimate of the "avoided regulations" thanks to the CAP measures.

Air France is convinced that the balance is certainly in favour of CAP.

Concerning the reliability of the Trip Fuel calculated by Air France CFPS, the "Fuel Efficiency" teams did a lot of observations on these, and it was verified that when the flown trajectory and profile are close to the planned ones, then the actual fuel used is very close to the calculated trip fuel.

So it is considered that "calculated trip fuel" is a good number for the comparison "before and after CAP", (although it is known that very often the pilots have to fly "different from planned").

7. EX6-OBJ-VLD-04-003 Results

Same results as F3.2.7

8. EX6-OBJ-VLD-05-002 Results

- **AUs:**

Question 04 (d, g and h) from the questionnaire refers to this Demonstration Objective.

All the answers of the AUs are represented in the following graphic:

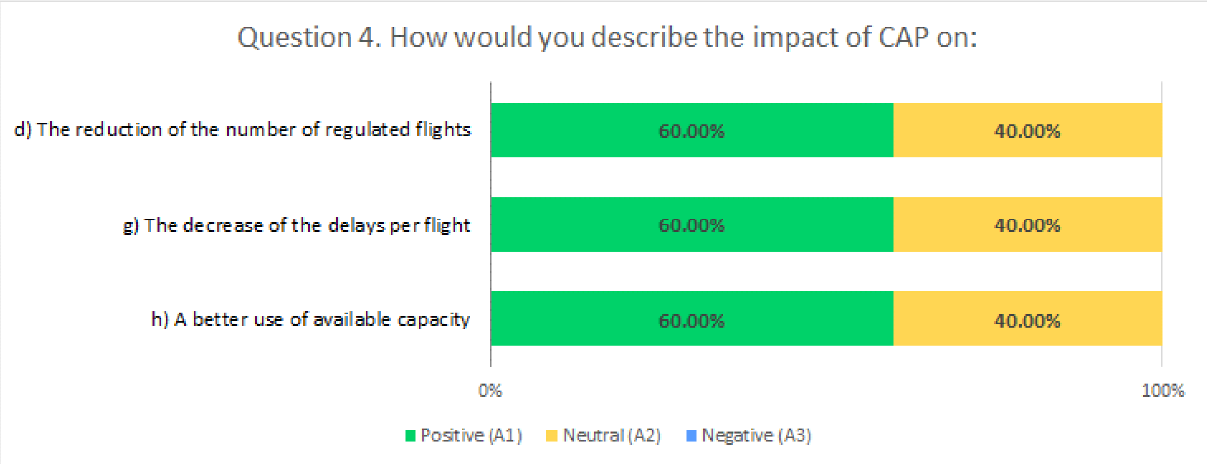


Figure 230: Answers to question 4 (d, g and h).

The effect of CAP was mainly positive and neutral. In addition, the AUs noticed that regulations and delays were lower than previous months.

I.3.4 Analysis of Exercises Results per Demonstration objective of the four iteration – PLANTA (Q2 2019)

This section presents the qualitative analysis of the results obtained from the questionnaires answered by FMPs who have used the PLANTA tool during the trial integrated with the results of the briefing and debriefing sessions hold with them.

Error! Reference source not found. provides the coverage of the objectives and associates success criteria by the topics included in the questionnaire completed by FMPs, as well as the feedback got from them during the debriefing sessions.

Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria	Questionnaire items addressing the Objective

Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria	Questionnaire items addressing the Objective
EX6-OBJ- VLD-01-004A Demonstrate the added value of using local tools to support the analysis and preparation of STAM.	**EX6- CRT-VLD-01-004A** The level of situational awareness of the FMP increases with the inclusion of local tools in the analysis of STAM.	**FMPs:** **Question 01:** maintenance of situational awareness in the analysis of imbalances based on traffic flows. **Question 02:** maintenance of situational awareness in the preparation of Targeted CASA regulations.
EX6-OBJ- VLD-01-004B Demonstrate the added value of using local tools to support the coordination of STAM.	**EX6- CRT-VLD-01-004B** The level of situational awareness of the FMP increases with the inclusion of local tools in the coordination of STAM.	**FMPs:** **Question 03:** confidence in PLANTA for the coordination of STAM.
EX6-OBJ- VLD-01-004C Demonstrate the processes and procedures related to the integration of local and network dynamic DCB processes are clear and consistent.	**EX6- CRT-VLD-01-004C** All the actors involved confirm the STAM operating methods are clear and consistent.	**FMPs:** **Question 04:** procedures and processes clear and consistent.
EX6-OBJ- VLD-01-004D Demonstrate that the roles and responsibilities of human actors related to the integration of local and network dynamic DCB processes are clear and consistent.	**EX6- CRT-VLD-01-004D** The concerned actors confirm the roles and responsibilities are clear and consistent.	**FMPs:** **Question 05:** the role in the coordination phase is clear.
EX6-OBJ-VLD-02-002 Demonstrate an improvement on predictability thanks to the use of local tools (including what-if).	**EX6-CRT-VLD-02-002** The number of regulated and affected flights decrease. Reactionary delays are reduced.	For both cases under study (UC2.2 and UC2.8), a decrease in the number of regulated and affected flights has been measured. Reactionary delays reduction is not measured in any of the use cases (UC2.2 and UC2.8).
EX6-OBJ-VLD-03-002 Demonstrate the optimization of fuel consumption thanks to the use of what-if for local network performance tools.	**EX6-CRT-VLD-03-002** Reduction in fuel consumption and CO2 emissions induced by STAMs.	Questions regarding Fuel consumption and CO_2 emissions induced by STAMs were not part of the fourth iteration of the exercise.
EX6-OBJ-VLD-04-003 Demonstrate an improvement in cost-efficiency for ANSPs due to the reduction in time for FMP staff to monitor, analyse and coordinate measures to DCB.	**EX6-CRT-VLD-04-003** FMP confidence on STAM to resolve Demand Capacity Imbalance increase. FMP workload is not increased.	**FMPs:** **Question 06:** confidence that the STAM will resolve the imbalance. **Question 07:** workload to implement STAM acceptable.

Demonstration Exercise 6 Objectives	Demonstration Exercise 6 Success criteria	Questionnaire items addressing the Objective
EX6-OBJ-VLD-05-002 Increase the use of available capacity through a better management of extra capacity and use of under-loaded period.	**EX6-CRT-VLD-05-002** Delay per flight is reduced Reduction of less under-loaded period when STAM is applied.	For UC2.2, to analyse the possible reduction in delay per flight and the impact of stablishing a General CASA regulation, in order to obtain a reference scenario, a simulation with NEST (taking into account the initial trajectory) was carried out. However, the results were not good enough so as to determine the objective. Therefore, no results on this matter will be commented.

Table 54: Coverage of the questions regarding the OBJ and success criteria

UC2.2 – Ground Delay with MCP

The results of the questionnaires answered by the FMPs demonstrate the benefit of the concept. The following figures show the results for UC2.2 regarding Ground Delay Cherry Picking, applied in Madrid ACC.

1. EXE6-OBJ-VLD-01-004A Results

Regarding the process to determine if a STAM is required, FMPs were able to maintain situational awareness through the analysis of traffic as well as the preparation of STAM (Ground delay Cherry Picking).

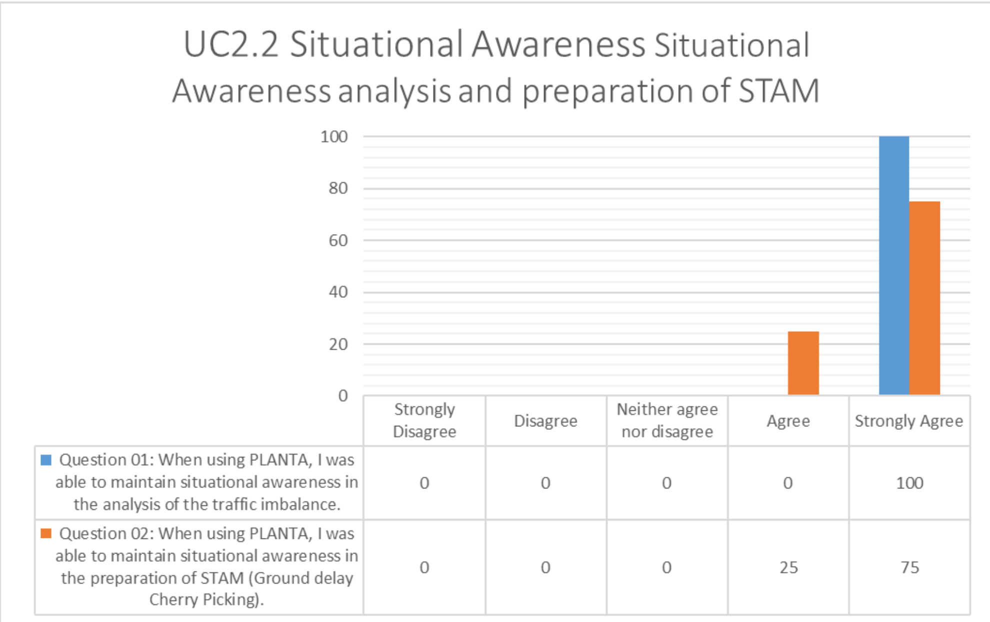


Figure 231: UC2.2 SA analysis and preparation of STAM.

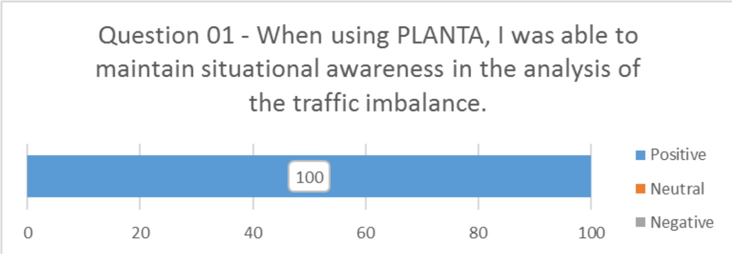


Figure 232: UC2.2 Question 01 – SA analysis.

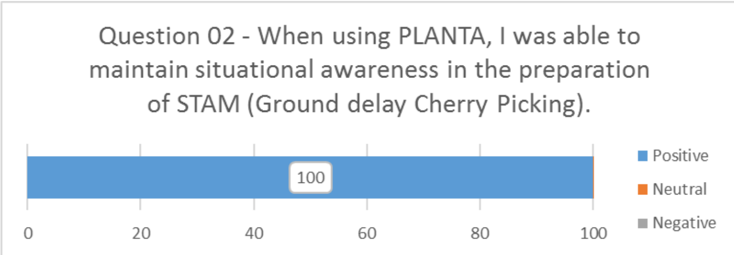


Figure 233: UC2.2 Question 02 – SA preparation.

2. EXE6-OBJ-VLD-01-004B Results

All FMPs felt confident when using PLANTA as an assistance to coordinate the designed Ground Delay Cherry Picking procedure.

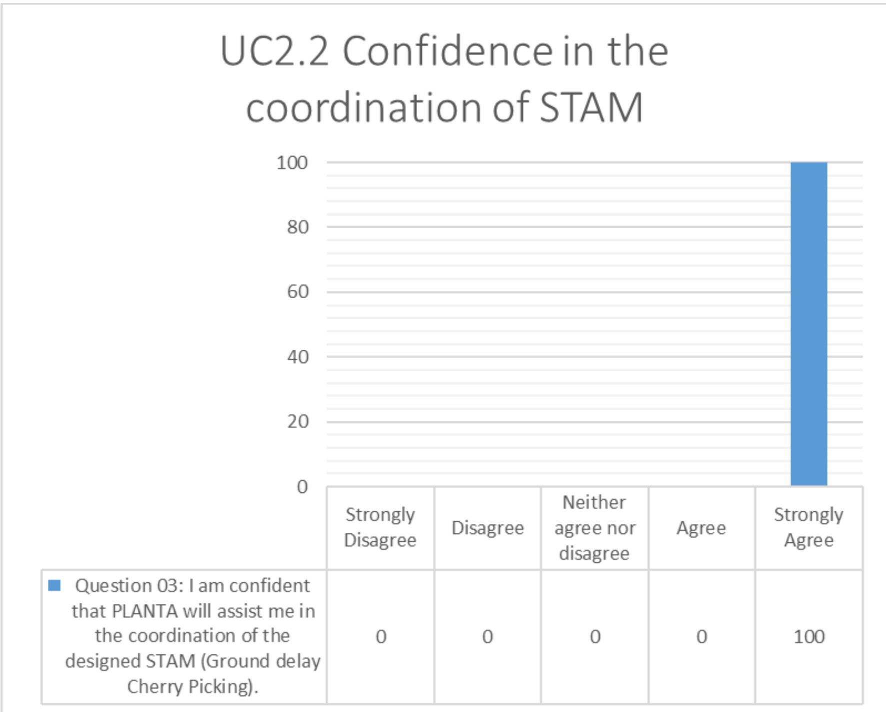


Figure 234: UC2.2 Confidence coordination of STAM.

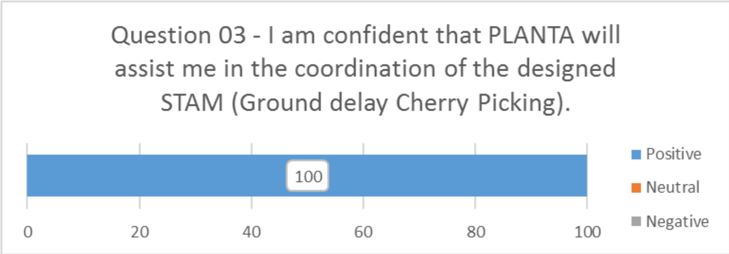


Figure 235: UC2.2 Question 03 – Confidence coordination of STAM.

3. EXE6-OBJ-VLD-01-004C Results

The processes and procedures have been clearly collected in the tool. FMPs confirmed its consistency as well as the support PLANTA provided when presenting the information in a visual and intuitive manner.

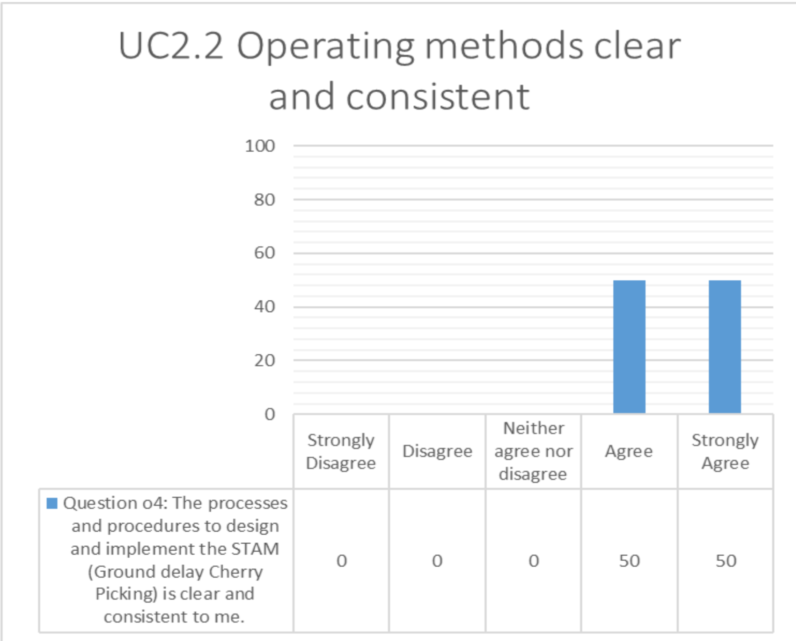


Figure 236: UC2.2 Operating methods clear and consistent.

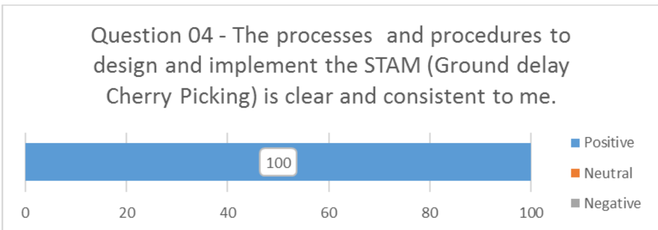


Figure 237: UC2.2 Question 04 – Operating methods.

4. EXE6-OBJ-VLD-01-004D Results

Regarding roles and responsibilities, the integration of the processes and procedures in PLANTA reflected perfectly the organizational sequence to be followed, being clear and consistent in every moment the areas of responsibility of each role.

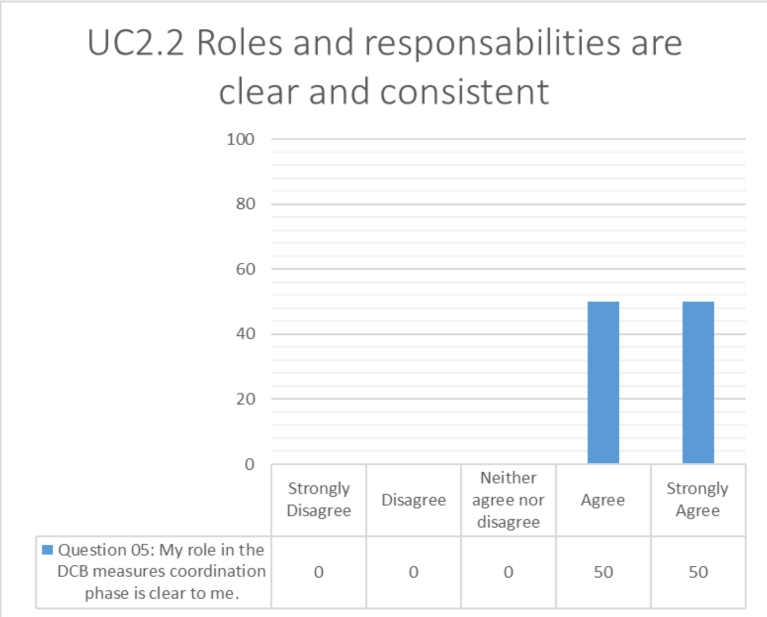


Figure 238: UC2.2 Roles and Responsibilities clear and consistent.

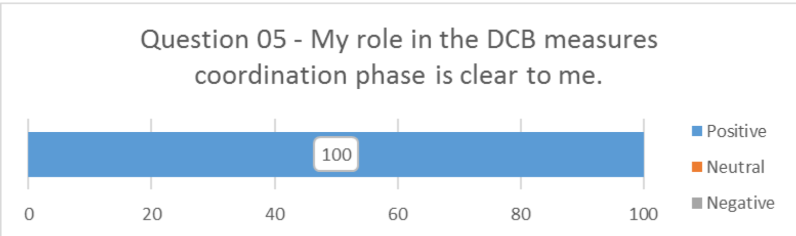


Figure 239: UC2.2 Question 04 – Roles and Responsibilities.

5. EXE6-OBJ-VLD-02-002 Results

During the trials, Ground Delay with MCP resulted successful in order to reduce the number of regulated and affected flights. Different tests were done each day by the FMP in order to find the most appropriate solution to accommodate capacity and demand. Important to note that due to the low demand, most of the days the FMP needed to reduce the OMTV to force the imbalance. Below, the processes to apply GD with MCP followed during the trial days was described.

- **Ground Delay with MCP - 07th May 2019**

During this day of execution up to two trials were carried out.

Trials	Decisions made	Execution	Conclusions

Trial 1	Demand was under the OTMV for the area of study and thus, the OCC threshold was manually reduced in order to force the existence of a Demand Capacity imbalance. .	The regulation was implemented more than 3 hours in advance.	Ground Delay with MCP was successfully executed.
Trial 2		The regulation was implemented and then, due to the B2B configuration, the measure disappeared from the Editable Measure box. As situation evolved, FMP would like to refine the regulation to solve better the DCB imbalance, but it was not possible	Ground Delay with MCP was executed. Nevertheless, if "Edit" option would have worked properly the measure could have resulted more effective.

Table 55: Summary execution 07th May 2019

Despite of having executed two trials, only the first one recorded a measurable result.

Regarding Trial 1, the number of flights regulated (i.e. MCP) was seven while the total of flights which would have been affected by the standard regulation (i.e. CASA) was twenty-one.

TVSET	Regulated flights (CASA)	Regulated flights (MCP)	Difference
LECMFMP	21	7	14 (66.7%)

Table 56: Number of flights regulated with Ground Delay with MCP. Trial 1.

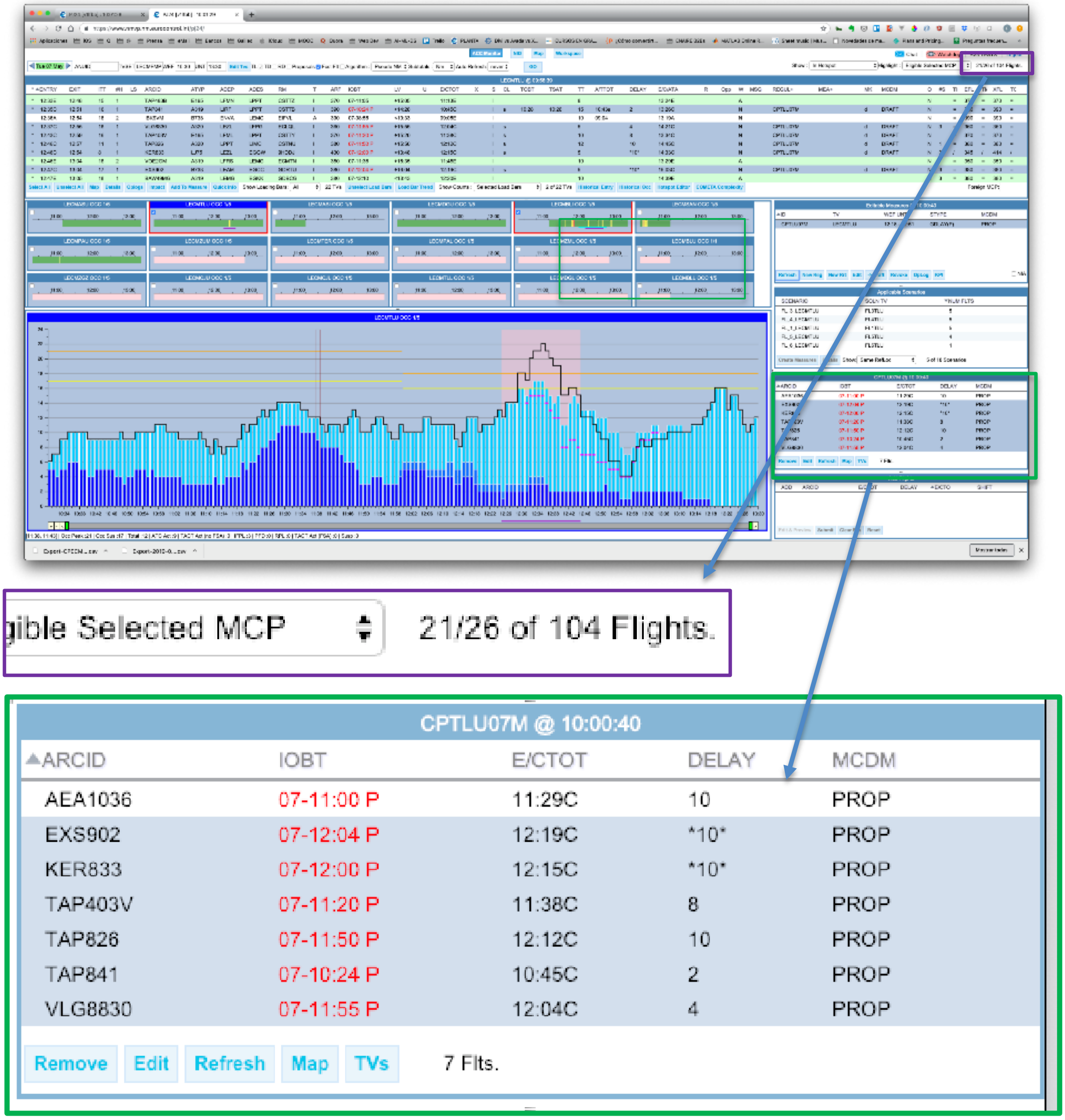


Figure 240. Trial 1: implementation with Ground Delay with MCP.

- **Ground Delay with MCP - 08th May 2019**

During the second day of execution up to two trials were carried out. The following table explains the main characteristics.

Trials	Decisions made	Execution	Conclusions
Trial 1	Demand was under the OTMV for the area of study and thus, the OCC threshold was manually reduced in order to force the existence of a Demand Capacity imbalance.	The selected hotspot included two hours.	Ground Delay with MCP was not finally applied.
Trial 2	Demand was under the OTMV for the area of study and thus, the OCC threshold was manually reduced in order to force the existence of a Demand Capacity imbalance.	The selected hotspot included just 8 minutes.	Ground Delay with MCP was successfully executed.

Table 57: Summary execution 08th May 2019

Regarding to Trial 1, during the execution, one of the affected flights showed an error message because it had been affected by another regulation during the period. After checking it, the Ground Delay with MCP was not longer needed (due to traffic updates) and therefore, it was cancelled.

Regarding Trial 2, the number of flights regulated (i.e. MCP) was five while the total of flights which would have been affected by the standard regulation (i.e. CASA) was nineteen.

TVSET	Total flights (CASA)	Regulated flights (MCP)	Difference
LECMFMP	19	5	13 (73.7%)

Table 58. Number of flights regulated with Ground Delay with MCP. Trial 2.

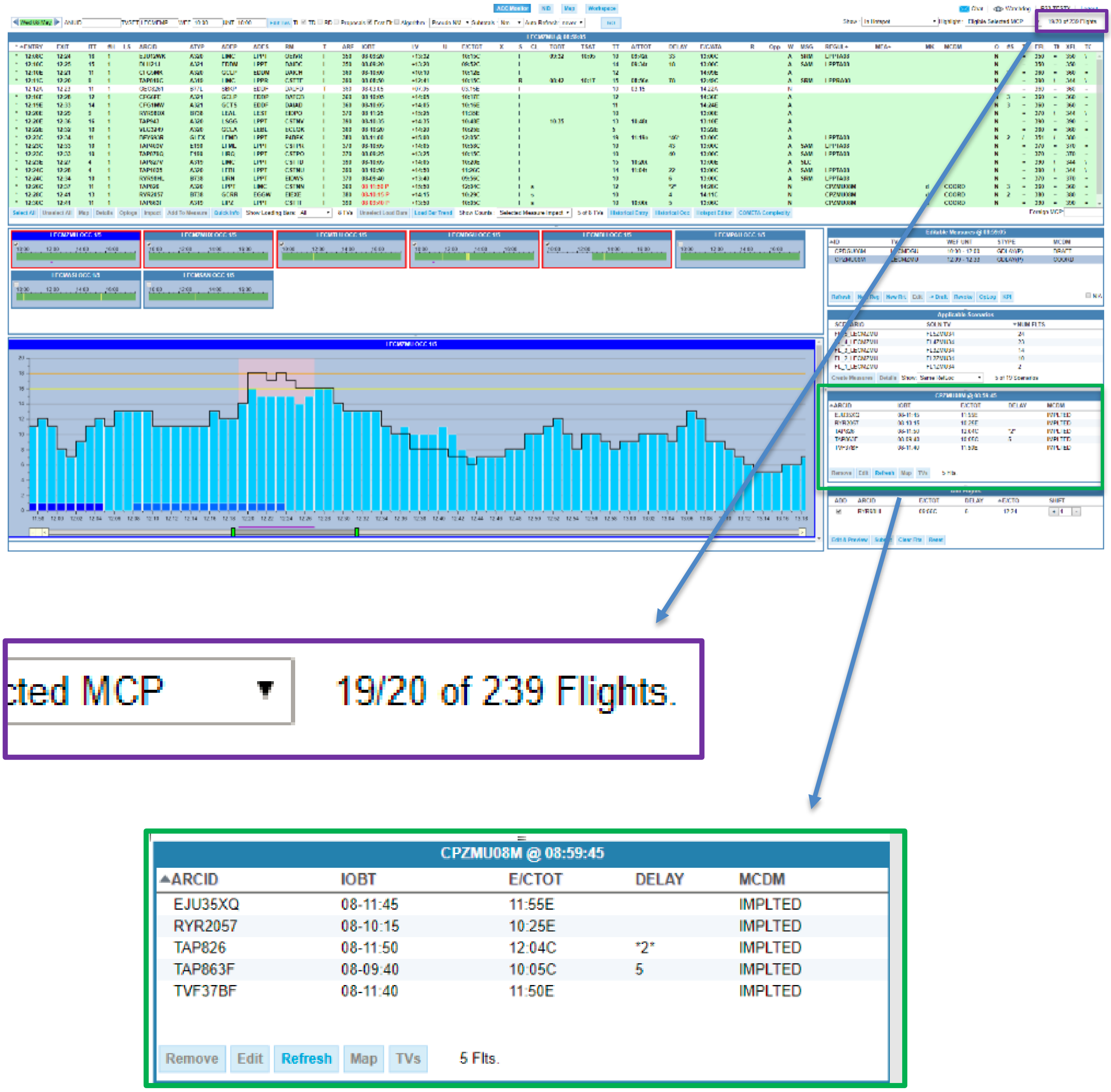


Figure 241. Example of the implementation with Ground Delay with MCP.

- **Ground Delay with MCP - 09th May 2019**

During this day of execution up to two trials were carried out. However, it was a very difficult day marked by the industrial action taking place in France. Several sectors presented peaks in occupancy as well as entries where most flights were already regulated due to the industrial action.

Trials	Decisions made	Execution	Conclusions

Trials	Decisions made	Execution	Conclusions
Trial 1	Flights where another regulation had not affected were identified. However, the delay caused by PLANTA produced more network delay than expected.	Since the ASU sector was over the peak in EC and OCC, mostly all the north-south flights were affected by other regulations.	Ground Delay with MCP did not provide any benefit.
Trial 2	A different scenario was created in order to find flights with not regulations affecting them before.	Since the ASU sector was over the peak in EC and OCC, mostly all of the north-south flights were affected by another regulations.	Ground Delay with MCP did not provide any benefit.

Table 59: Summary execution 09th May 2019

The results of these trials are not taken into account for the demonstration of the success criteria due influence of the industrial action that took place on France.

- **Ground Delay with MCP - 10th May 2019**

During the last day of execution up to three trials were carried out. The following table explains the main characteristics.

Trials	Decisions made	Execution	Conclusions
Trial 1	Demand was under the OTMV for the area of study and thus, the OCC threshold was manually reduced in order to force the existence of a Demand Capacity imbalance.	The selected hotspot length was 15 minutes. However, while the approval was being sent, another peak appeared. The regulation was modified, and two extra flights were added.	Ground Delay with MCP was successfully executed.
Trial 2	Demand was under the OTMV for the area of study and thus, the OCC threshold was manually reduced in order to force the existence of a Demand Capacity imbalance.	A message with an error appeared.	Ground Delay with MCP was not implemented.
Trial 3	A different scenario was created in order to find flights without applicable regulations.	Everything worked correctly and there was no need to update the affected flights.	Ground Delay with MCP was successfully executed.

Table 60: Summary execution 10th May 2019

Although one of the trials was not successful, the result was recorded before the implementation failure. Therefore, three results from this day were obtained.

Regarding Trial 1, the number of flights regulated (i.e. MCP) was seven while the total of flights which would have been affected by the standard regulation (i.e. CASA) was twenty-six.

TVSET	Scenario	Total flights (CASA)	Regulated flights (MCP)	Difference
LECMFMP	LECMZMU	26	7	19 (73.1%)

Table 61: Number of flights regulated with Ground Delay with MCP. Trial 1.

Regarding Trial 2, the number of flights regulated (i.e. MCP) was six while the total of flights which would have been affected by the standard regulation (i.e. CASA) was nineteen.

TVSET	Scenario	Total flights (CASA)	Regulated flights (MCP)	Difference
LECMFMP	LECMZMU	19	6	13 (68.4%)

Table 62: Number of flights regulated with Ground Delay with MCP. Trial 2.

Regarding Trial 3, the number of flights regulated (i.e. MCP) was six while the total of flights which would have been affected by the standard regulation (i.e. CASA) was twenty-seven.

TVSET	Scenario	Total flights (CASA)	Regulated flights (MCP)	Difference
LECMFMP	LECMTLU	27	6	21 (77.8%)

Table 63: Number of flights regulated with Ground Delay with MCP. Trial 3.

As is denoted in the results, a large reduction in the number of regulated and affected flights was showed in all of the trials.

6. EXE6-OBJ-VLD-04-003 Results

The confidence of FMPs in the CASA regulation to be able to solve the Demand and Capacity imbalance is very positive.

Concerning workload, FMPs have shared that the workload experienced during the implementation of the STAM was acceptable and did not interfered in any other of their tasks.

Nevertheless, it has been suggested during the debriefings that a possible improvement would be the automation of the initial flight selection and even a proposal of the delay required for each flight to lower the peak. This is because to perfectly adjust the measure to the imbalance, some estimations need to be done, which might be time consuming in some occasions. However, all FMPs concurred in the potential of the tool and its intuitive and visual use.

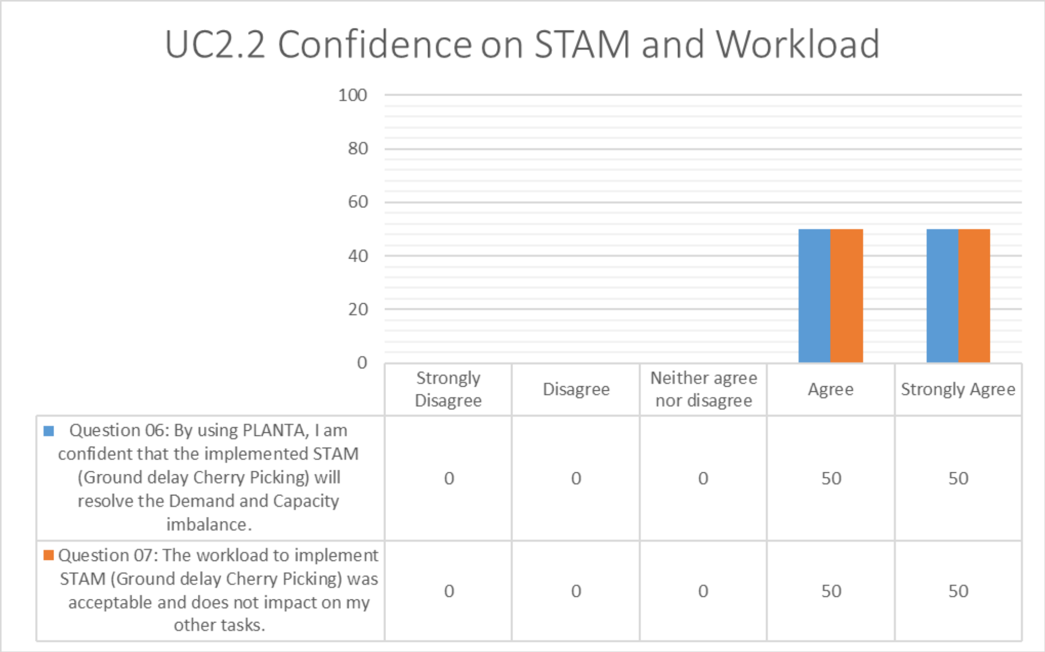


Figure 242: UC2.2 Confidence on STAM.

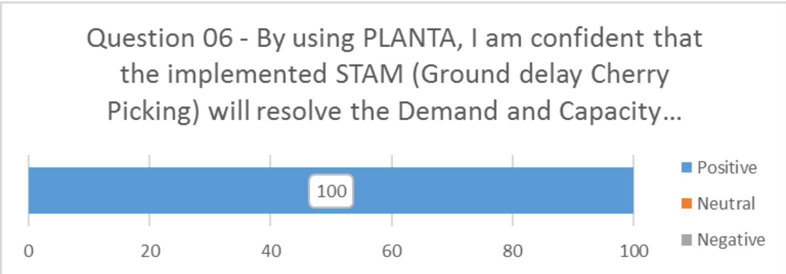


Figure 243: UC2.2 Question 06 – Confidence on STAM.

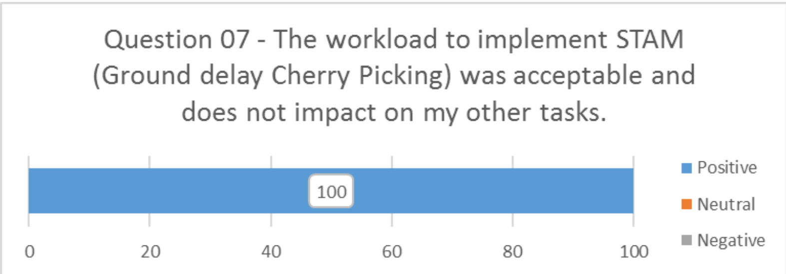


Figure 244: UC2.2 Question 07 – Workload to implement STAM.

7. EX6-OBJ-VLD-05-002 Results

The reduction of delay per flight cannot be measured for this use case due to the lack of a Reference Scenario to compare with. Therefore, for this objective there will be no results on this matter.

The same occurs with the reduction of less under loaded periods when STAM is applied. Simulation of CASA regulation were not planned during the execution of the exercise so there is no information of what would have happened if a General CASA regulation would have been stablished instead of Ground Delay with MCP.

UC2.8 – Targeted CASA

The results of the questionnaires answered by the FMPs demonstrate a benefit from using PLANTA tool. In the following figures can be seen the results from UC2.8 regarding traffic flows, applied in Barcelona ACC.

8. EXE6-OBJ-VLD-01-004A Results

The situational awareness of the FMPs was increased with the inclusion of PLANTA in the analysis previous to the implementation of a Targeted CASA Regulation.

As for the preparation of the STAM, it was also detected a positive result since it allowed the FMPs to test different options. This helped and guided them in the decision-making process to finally implement the best possible measure possible, knowing beforehand the expected consequences.

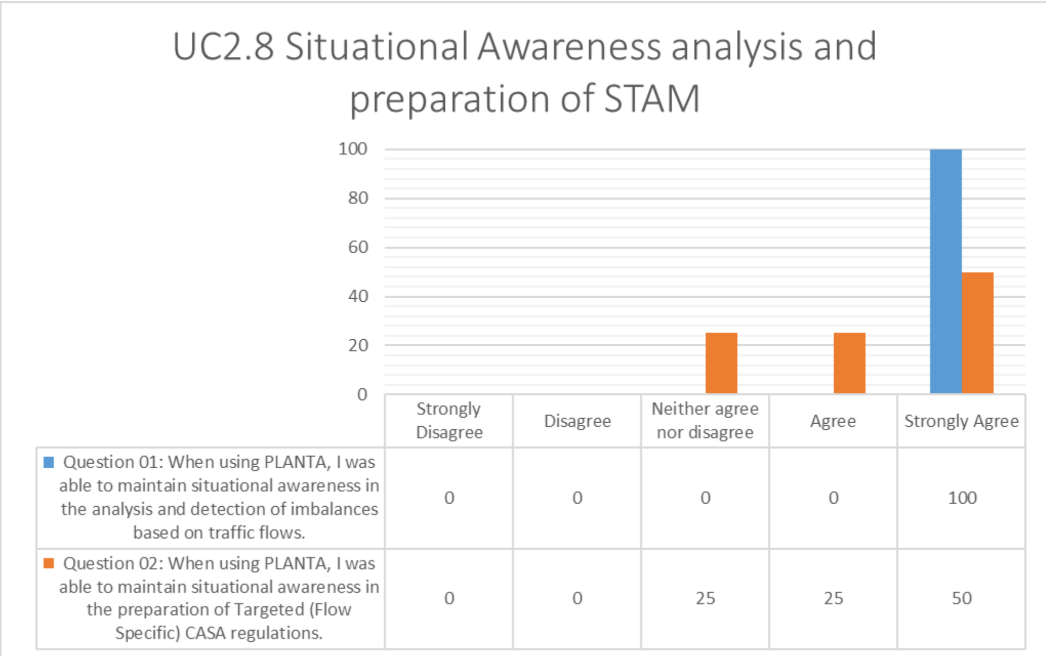


Figure 245: UC2.8 SA analysis and preparation of STAM.

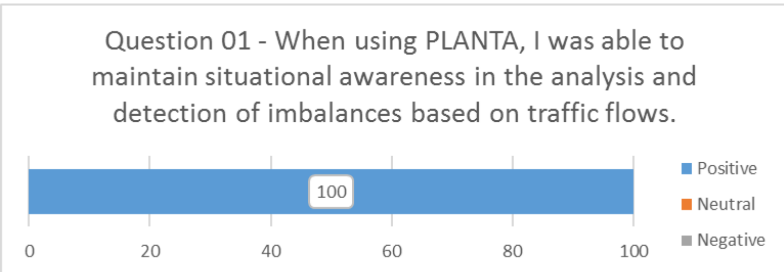


Figure 246: UC2.8 Question 01 – SA analysis.

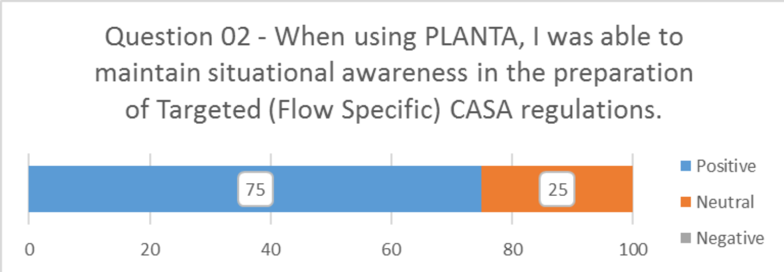


Figure 247: UC2.8 Question 02 – SA preparation.

9. EXE6-OBJ-VLD-01-004B Results

Broadly speaking, the vast majority of the FMPs felt confident when using PLANTA as a support in the coordination of STAM.

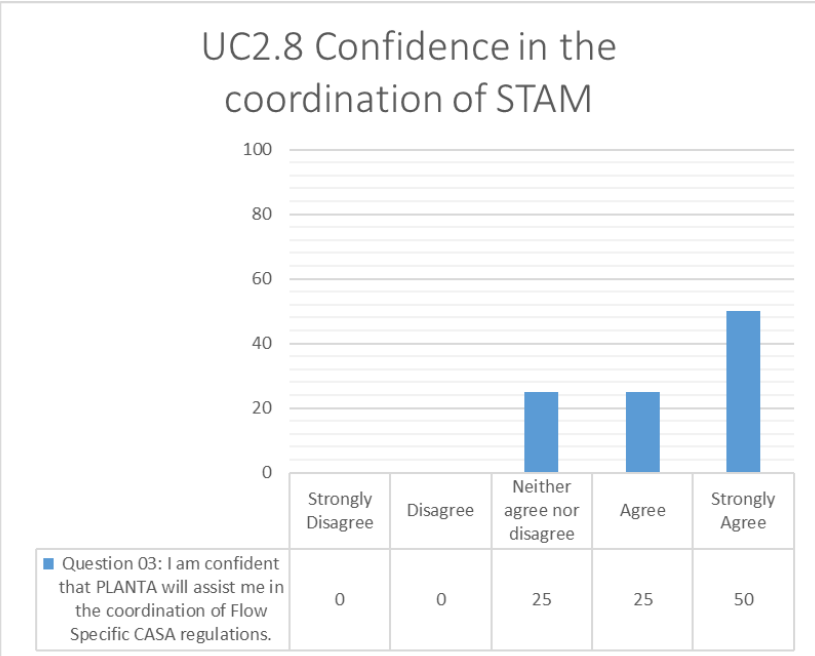


Figure 248: UC2.8 SA coordination of STAM.

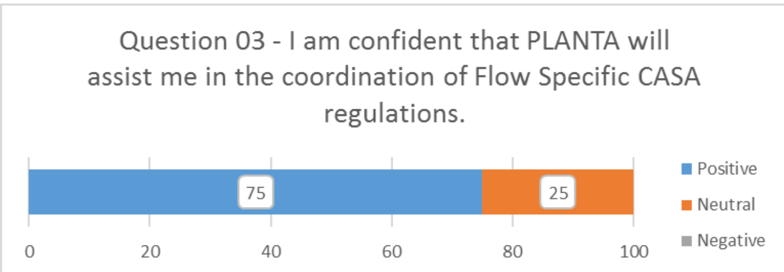


Figure 249: UC2.8 Question 03 – SA coordination.

10. EXE6-OBJ-VLD-01-004C Results

Regarding the clarity and consistency of operating methods gathered in the tool, the FMPs view is neutral or positive.

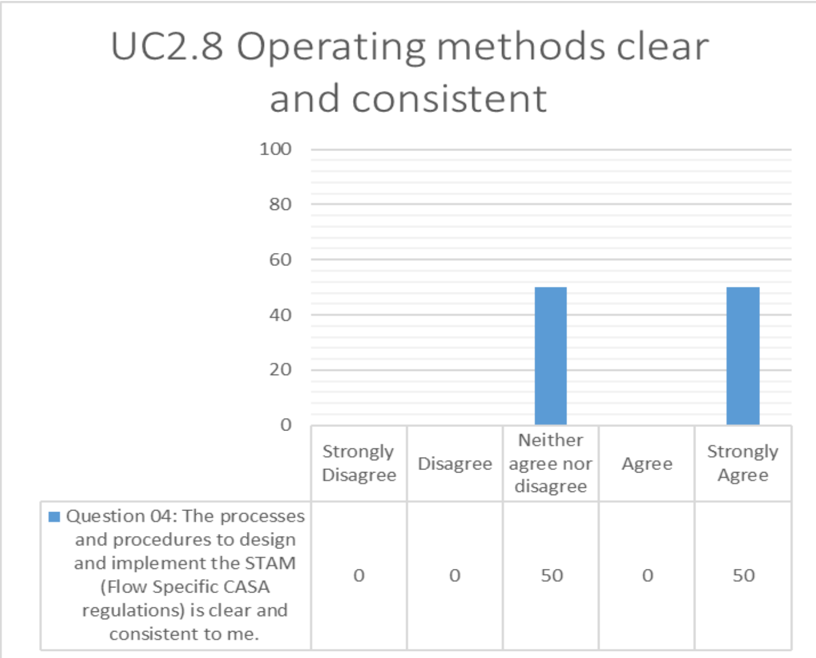


Figure 250: UC2.8 Operating methods clear and consistent.

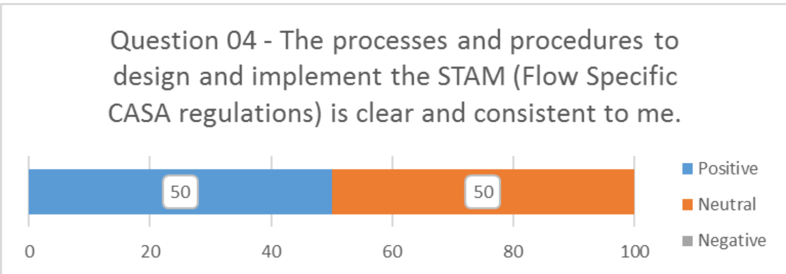


Figure 251: UC2.8 Question 04 – Operating methods.

11. EXE6-OBJ-VLD-01-004D Results

The roles and responsibilities were clear and consistent in the integration of processes in PLANTA according to all FMPs.

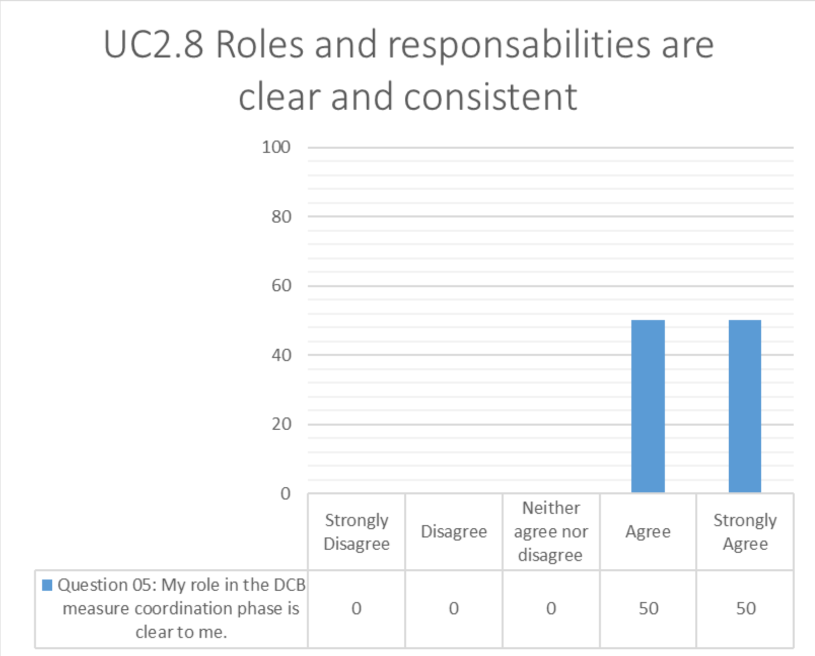


Figure 252: UC2.8 Roles and Responsibilities clear and consistent.

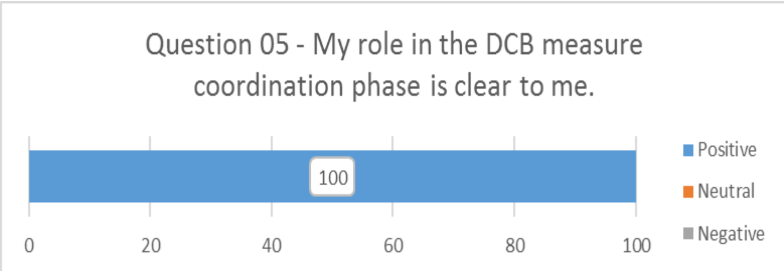


Figure 253: UC2.8 Question 04 – Roles and Responsibilities.

12. EXE6-OBJ-VLD-02-002 Results

As commented before, the reduction of reactionary delays could not be measured for any of the use cases in the fourth iteration of the exercise. Then, no conclusions on this matter are provided.

Regarding UC2.8, the number of regulated and affected flights is analysed for each day of execution:

- **Targeted CASA - 07th May 2019**

During this day of execution up to four trials were carried out. However, some issues, mainly related to the definition of the TVs, made impossible to reach a reliable conclusion in two out of four.

Trials	Decisions made	Execution	Conclusions

Trials	Decisions made	Execution	Conclusions
Trial 1	TV GO1 & GO2 were merged to try to make the peak higher in order to need a targeted CASA regulation.	A problem was identified related to the hour when the Targeted CASA was activated. Probably too close to the departure time to be implemented properly.	Targeted CASA simulation did not work well.
Trial 2	The capacity of TV MED was reduced from 42 to 34 in order to create a peak and try a targeted CASA regulation.	A problem with the definition of the TV was encountered.	Targeted CASA simulation did not work due to the problem with the TV definition. [13]
Trial 3	The capacity of TV MED was reduced to force a peak.	The Targeted CASA regulation was implemented for MNAS and MNMU between 11:40-13:40h UTC. The peak was not resolved completely although it provided better results than general regulation.	Targeted CASA simulation accomplished.
Trial 4	Demand and Capacity imbalance had been identified in GOI.	Several options were applied to try to reduce the peak. However, the best results were achieved with a regulation of GO2 with a rate of 23 between 13:40 -15:40h UTC. The results obtained are very similar to the general regulation due to the absence of a high number of flows.	Targeted CASA simulation accomplished.

Table 64: Summary execution 07th May 2019

The results taken into account for the demonstration are obtained from the successful trials.

Regarding the number of regulated and affected flights with the targeted CASA regulation for the third trial, there has been a reduction of **8 flights (12%)** being regulated in comparison with General CASA regulation.

TV	Regulation	Flights	Total Delay	Average Delay
LECBMNI	GEN07A	67	67	1

Table 65: REF: General CASA Regulation Analysis – Trial 3

TV	Regulation	Flights	Total Delay	Average Delay

[13] The issue was clarified and solved during the day after coordination between ECTL and ENAIRE teams.

TV	Regulation	Flights	Total Delay	Average Delay
LECBMNAS	TGT07D	51	36	0.7
LECBMNMU	TGT07C	8	31	3.9

Table 66: SOL: Targeted CASA Regulation Analysis – Trial 3

Regarding the number of regulated and affected flights with the targeted CASA regulation for the fourth trial, there has been a reduction of **9 flights (26%)** being regulated in comparison with General CASA regulation.

TV	Regulation	Flights	Total Delay	Average Delay
LECBGOI	GEN07A	34	60	1.8

Table 67: REF: General CASA Regulation Analysis - Trial 4

TV	Regulation	Flights	Total Delay	Average Delay
LECBG1EV	TGT07A	10	48	4.8
LECBGO2	TGT07B	15	0	0

Table 68: SOL: Targeted CASA Regulation Analysis – Trial 4

- **Targeted CASA - 08th May 2019**

During this day of execution up to three trials were carried out. In the following table, are explained the main characteristics.

Trials	Decisions made	Execution	Conclusions
Trial 1	The Central sector had a peak that was corrected by a regulation in LECBCCEV. Sector GO had an occupancy peak but it was not reflected on entries. In order to not exceed occupancy, a Targeted CASA regulation was evaluated.	A Targeted CASA regulation was applied to LECBCCEV with rate 18 between 10:00 - 11:20h UTC, where the arrivals of LEPA and LEIB were removed. In order to reduce occupancies in Sector GO two regulations were evaluated. First, on LECBG12 with rate 40 between 10:00 – 11:00h UTC. Second, on LECBG1EV with rate 33 same period of time as mentioned earlier.	After some tests, the best option was considered a Targeted CASA regulation applied in LECBG1EV with rate 28 between 10:00 – 11:00h UTC.
Trial 2	The objective was to regulate the predecessor sector of GO in order to see the impact on this one and if possible, to solve the peak with less delay and affected flights.	After trying several combinations of rates the occupancy peaks remained the same.	There was no impact in regulating the predecessor sector to solve the peak identified in the occupancies of GO.

Trials	Decisions made	Execution	Conclusions
			No targeted CASA regulation was implemented.
Trial 3	The central sector had a little peak in entries.	Several combinations were evaluated. First, regulating LECBCCC with rate 43 between 09:20 – 10:20h UTC. Second, LECBCCEV with rate 18 in the same period.	The targeted CASA regulation was implemented, successfully reducing the identified peak.

Table 69: Summary execution 08th May 2019

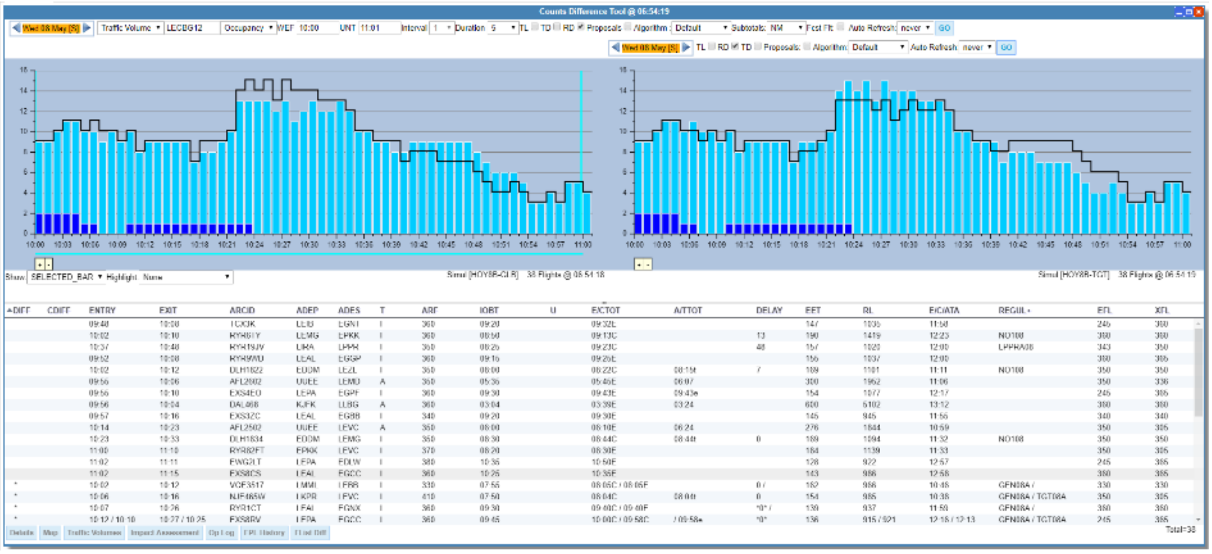


Figure 254: UC2.8 Example of occupancies LECBG12 after implementing Targeted CASA regulation.

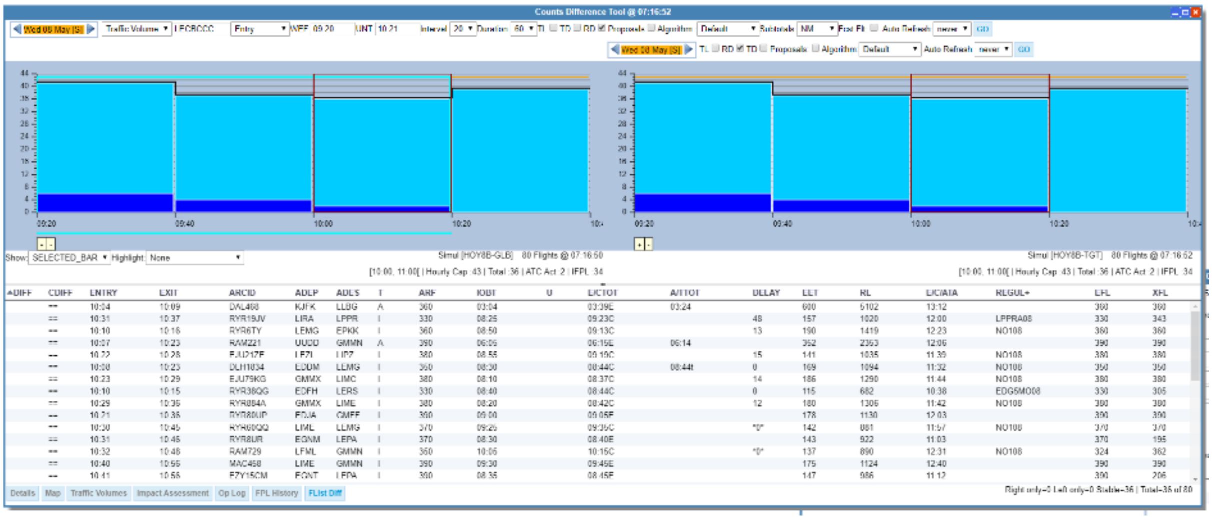


Figure 255: UC2.8 Example of entries LECBCCC after implementing Targeted CASA regulation

The results taken into account for the demonstration of the success criteria are obtained from the most successful trial.

Regarding the number of regulated and affected flights with the first targeted CASA regulation implemented, there has been a reduction of **6 flights (26%)** being regulated in comparison with General CASA regulation.

TV	Regulation	Flights	Total Delay	Average Delay
LECBG12	GEN08A	23	20	0.9

Table 70: REF: General CASA Regulation Analysis – Trial 1

TV	Regulation	Flights	Total Delay	Average Delay
LECBG1EV	TGT08A	17	4	0.2

Table 71: SOL: Targeted CASA Regulation Analysis – Trial 1

Regarding the number of regulated and affected flights with the third targeted CASA regulation implemented, there has been a reduction of **12 flights (46%)** being regulated in comparison with General CASA regulation.

TV	Regulation	Flights	Total Delay	Average Delay
LECBCCC	GEN08C	26	22	0.8

Table 72: REF: General CASA Regulation Analysis – Trial 3

TV	Regulation	Flights	Total Delay	Average Delay
LECBCCEV	TGT08E	14	11	0.8

Table 73: SOL: Targeted CASA Regulation Analysis – Trial 3

- **Targeted CASA - 09th May 2019**

During this day of execution up to three trials were carried out. However, it was a very difficult day marked by the industrial action taking place in France. Several sectors presented peaks in occupancy as well as entries where most flights were already regulated due to the industrial action.

Trials	Decisions made	Execution	Conclusions
Trial 1	Several peaks in occupancies and entries in sectors GO23, VERSO and CENTRAL.	A regulation in LECBVNEV was evaluated with rate 20 between 11:50 -13:10h UTC.	The results obtained were not reliable due to the influence of the industrial action on the traffic.
Trial 2	A peak in entries and occupancies of the central sector was detected.	A targeted CASA regulation was applied with rate 43 between 11:40 – 12:40h UTC to regulate the flow of the negative sector LECBCCES.	The results obtained were positive. Less delays was accomplished with the Targeted CASA regulation.

Trials	Decisions made	Execution	Conclusions
Trial 3	LECBMNI had a peak in occupancies as well as entries.	It was regulated by flows LECBMNI and LECBMNAS, rate 42, 14:40 – 16:20h UTC.	The results obtained were very promising. The delay was reduced by the regulation of flows. However, the peak did not disappear because the regulation only captured a few flights (free from regulation due to industrial action).

Table 74: Summary execution 09th May 2019

The results of these trials are not taken into account for the demonstration of the success criteria due influence of the industrial action that took place on France.

- **Targeted CASA - 10th May 2019**

During this day of execution, two trials were carried out. However, some instability on PLANTA system marked the first part of the day.

Trials	Decisions made	Execution	Conclusions
Trial 1	The load of traffic was very low so the capacity of TV Med was reduced in order to regulate.	A targeted CASA regulation was applied to LECBMNAS with rate 31 between 13:00 – 15:00h UTC. The other traffic flows did not have a high load.	The measure applied did not solve the peak and the system provides and "error" every time the parameters of the measure were adjusted. Trial not considered for the analysis.
Trial 2	Same occurred to the central sector, its capacity was reduced to 40 to be able to regulate.	Several regulations were evaluated: ▪ LECBCCC, rate 40, window with 10, 10:40 – 11:40h UTC. ▪ LECBCCEV, rate 6, window with 6, 10:40 – 11:40h UTC. ▪ LECBCCES, rate 40, window with 10, 10:40 – 11:40h UTC.	In this situation, the result was negative for the targeted CASA regulation, not being able to reduce the delay induced by the general regulation.

Table 75: Summary execution 10th May 2019

Regarding the number of regulated and affected flights with the targeted CASA regulation, there has been a reduction of **5 flights (11%)** being regulated in comparison with General CASA regulation.

TV	Regulation	Flights	Total Delay	Average Delay
LECBMNI	GEN10A	45	512	11.4

Table 76: REF: General CASA Regulation Analysis – Trial 2

TV	Regulation	Flights	Total Delay	Average Delay
LECBMNAS	TGT10A	32	460	14.4
LECBMNMU	TGT10B	4	17	4.3
LECBMNOS	TGT10E	4	19	4.8

Table 77: SOL: Targeted CASA Regulation Analysis - Trial 2

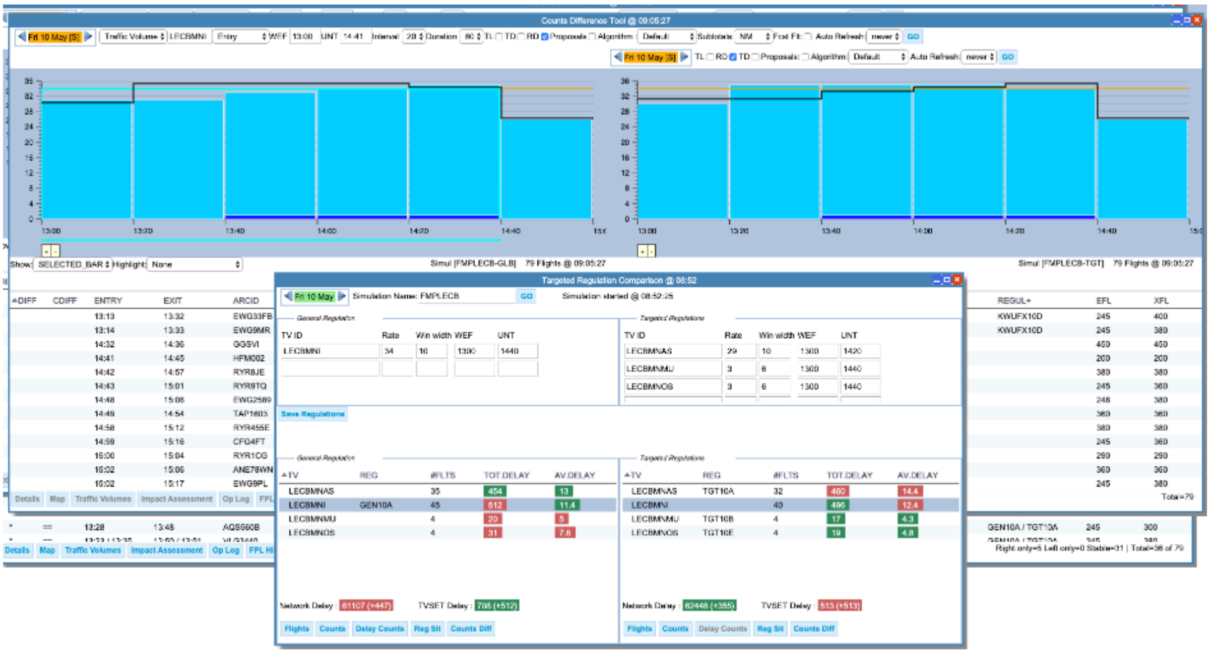


Figure 256: UC2.8 Example of Targeted CASA regulation results

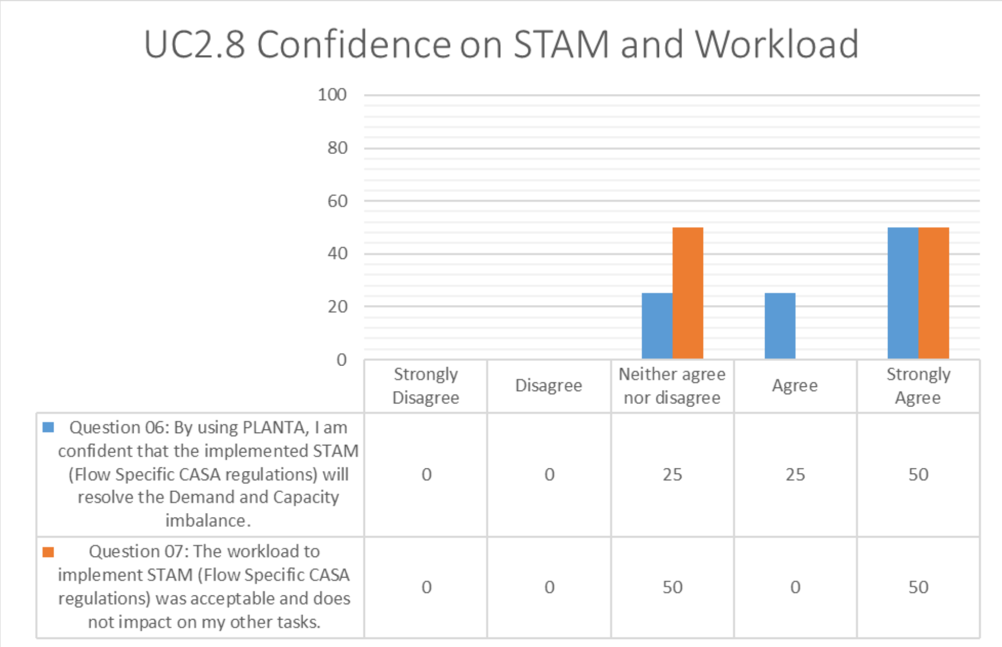
13. EXE6-OBJ-VLD-04-003 Results

In relation with the improvement in cost-efficiency for ANSPs due to the reduction in time for FMP staff to monitor, analyse and coordinate measures, the average of answers from the FMPs is positive.

For UC2.8, as it can be seen in the figures below, the confidence in the CASA regulation to be able to solve the Demand and Capacity imbalance is high.

On the other hand, the question related to the workload experienced in the implementation of the STAM, the FMPs answers varied between a neutral position and a positive one.

It has been mentioned during the debriefings that the workload could be very high, depending on the number of options and combinations available for the FMP to evaluate and finally decide. This exercise of trial and error could require too much time for the FMP to find the best option. Although this issue might be overcome with more experience in the use and familiarity of PLANTA.



	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Question 06: By using PLANTA, I am confident that the implemented STAM (Flow Specific CASA regulations) will resolve the Demand and Capacity imbalance.	0	0	25	25	50
Question 07: The workload to implement STAM (Flow Specific CASA regulations) was acceptable and does not impact on my other tasks.	0	0	50	0	50

Figure 257: UC2.8 Confidence on STAM.

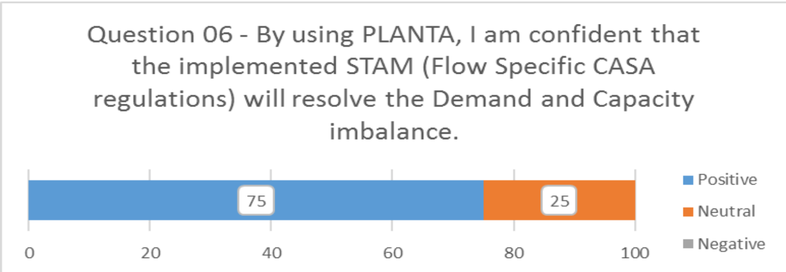


Figure 258: UC2.8 Question 06 – Confidence on STAM.

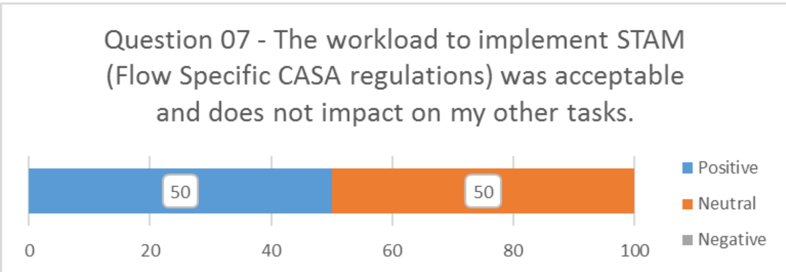


Figure 259: UC2.8 Question 07 – Workload to implement STAM.

14. EXE6-OBJ-VLD-05-002 Results

The delay per flight is analysed for each day of execution:

- **Targeted CASA - 07th May 2019**

During this day of execution, there were two successful trials as indicated in [12]. The data is summarised in the following table. Reference scenario refers to the ones where a General CASA regulation was implemented whereas Solution scenario refers to those where the Targeted CASA regulation was established.

Trial	Scenarios	TV	Regulation	Flights	Total Delay	Average Delay	Delay per flight
TRIAL 3	Reference	LECBMNI	GEN07A	67	67	1	14% of increment in the delay per flight registered with the Targeted CASA regulation.
	Solution	LECBMNAS	TGT07D	51	36	0.7	
	Solution	LECBMNMU	TGT07C	8	31	3.9	

Table 78: Trial 3 – Delay analysis

Trial	Scenarios	TV	Regulation	Flights	Total Delay	Average Delay	Delay per flight
TRIAL 4	Reference	LECBGOI	GEN07A	34	60	1.8	9% of increment in the delay per flight registered with the Targeted CASA regulation.
	Solution	LECBG1EV	TGT07A	10	48	4.8	
	Solution	LECBGO2	TGT07B	15	0	0	

Table 79: Trial 4 – Delay analysis

Regarding the average delay per flight with the targeted CASA regulation during the 7th of May execution, there has been an **increase of 12%** with respect to the reference scenario. This figure is calculated as the mean of all the successful trials. This increase is induced by the important reduction of regulated flights that leads to a slight increment of the delay each regulated flight has to manage.

- **Targeted CASA - 08th May 2019**

During this day of execution, there were two successful trials as indicated in [12].

Trial	Scenarios	TV	Regulation	Flights	Total Delay	Average Delay	Delay per flight
TRIAL 1	Reference	LECBG12	GEN08A	23	20	0.9	73% of reduction in the delay per flight registered with the Targeted CASA regulation.
	Solution	LECBG1EV	TGT08A	17	4	0.2	

Table 80: Trial 1 – Delay analysis

Trial	Scenarios	TV	Regulation	Flights	Total Delay	Average Delay	Delay per flight
TRIAL 3	Reference	LECBCCC	GEN08C	26	22	0.8	7% of reduction in the delay per flight registered with the Targeted CASA regulation.
	Solution	LECBCCEV	TGT08E	14	11	0.8	

Table 81: Trial 3 – Delay analysis

Regarding the delay per flight with the targeted CASA regulation there has been a **decrease of 40%** with respect to the reference scenario. This figure is calculated as the mean of all the successful trials. This decrease is induced by the important reduction of the number of regulated flights as well as its associated delay.

- **Targeted CASA - 09th May 2019**

As was mentioned in point 12 of this section, the results of the trials from the day 9th of May are not taken into account for the demonstration of the success criteria due to the influence of the industrial action that took place on France.

- **Targeted CASA - 10th May 2019**

During this day of execution, there was one successful trial as was mentioned above in this section.

Trial	Scenarios	TV	Regulation	Flights	Total Delay	Average Delay	Delay per flight
TRIAL 2	Reference	LECBMNI	GEN10A	45	512	11.4	9% of increment in the delay per flight registered with the Targeted CASA regulation.
	Solution	LECBMNAS	TGT10A	32	460	14.4	
	Solution	LECBMNMU	TGT10B	4	17	4.3	
	Solution	LECBMNOS	TGT10E	4	19	4.8	

Table 82: Trial 2 – Delay analysis

Regarding the delay per flight with the targeted CASA regulation there has been an **increase of 9%** with respect to the reference scenario. This figure is calculated as the mean of all the successful trials. This increase is induced by the important reduction of regulated flights that leads to a slight increment of the delay each regulated flight has to manage.

To sum up in **2 out of 5 cases, a reduction in the total delay per flight is accomplished**. Moreover, if the **average delay value** is considered, there is a **decrease** in the delay per flight of **9.6%** when comparing to a General CASA regulation scenario.

As to the reduction of less under-loaded period when STAM is applied, the figures below represent how the occupancy or the entry counts of the sector under evaluation move when the STAM is in action.

On the left graph, the blue columns represent the occupancy or entry counts of the General CASA regulation in which the black line represents the occupancy or entry counts of the Targeted CASA regulation. The right graph works conversely.

- **Targeted CASA - 07th May 2019**

From one of the trials of 7th of May it can be seen how the under-loaded periods between 11:40 - 12:00 and 13:00 - 13:320 have more traffic when the STAM is applied. Therefore, the load of traffic presents an equitable distribution throughout the hours with more demand.

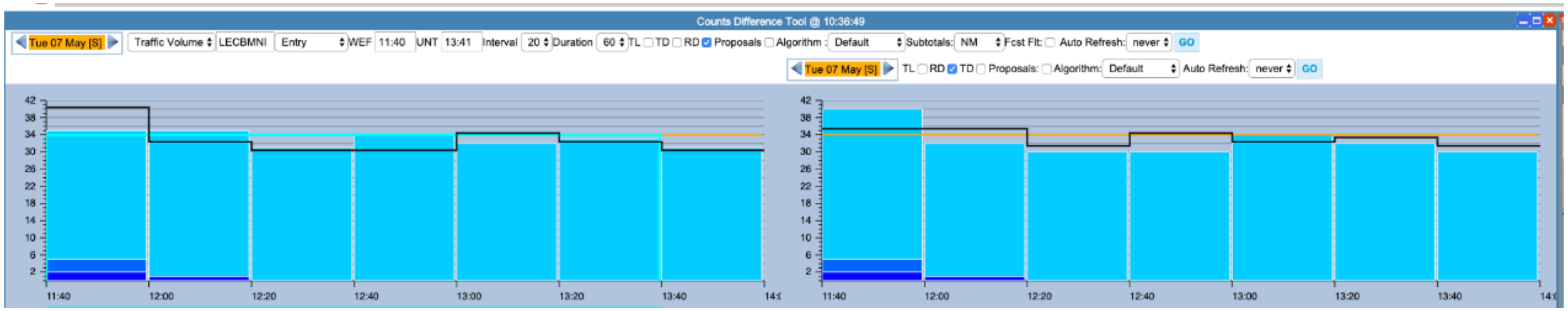


Figure 260: Example of entry counts – Trial 07th May.

- **Targeted CASA - 08th May 2019**

The image below corresponds to another trial.

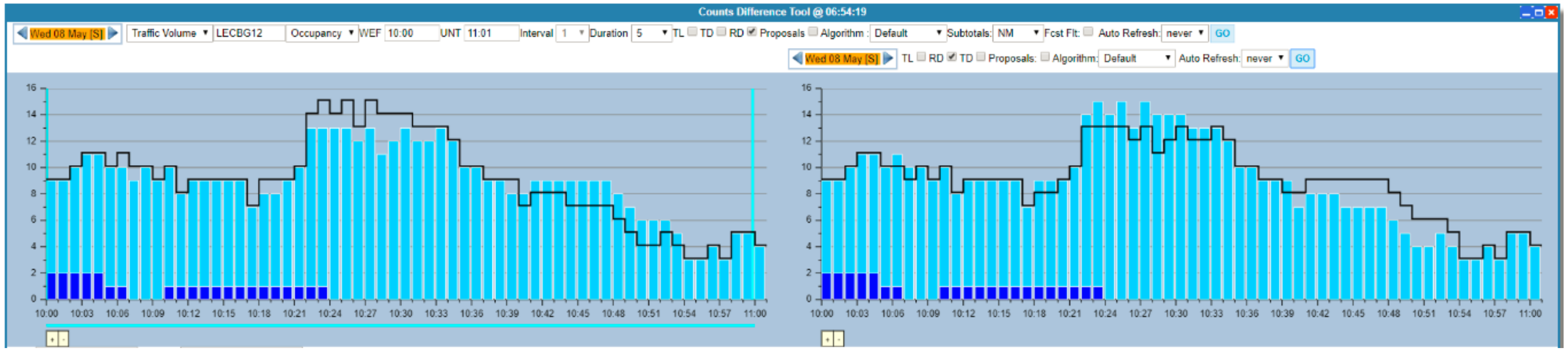


Figure 261: Example of occupancy counts – Trial 08th May.

In this particular case, the Targeted CASA regulation did not provide any benefit regarding the General CASA regulation. For this reason, a General CASA regulation would have been implemented. The peak was even more pronounced after the Targeted CASA regulation was established. The differences between the peak and the under-loaded periods became even sharper.

- **Targeted CASA - 10th May 2019**

From one of the trials of 10th of May, it can be seen how the under-loaded periods between 13:20 - 14:20 have more traffic when the STAM is applied. Therefore, the load of traffic presents an equitable distribution throughout the hours with more demand.

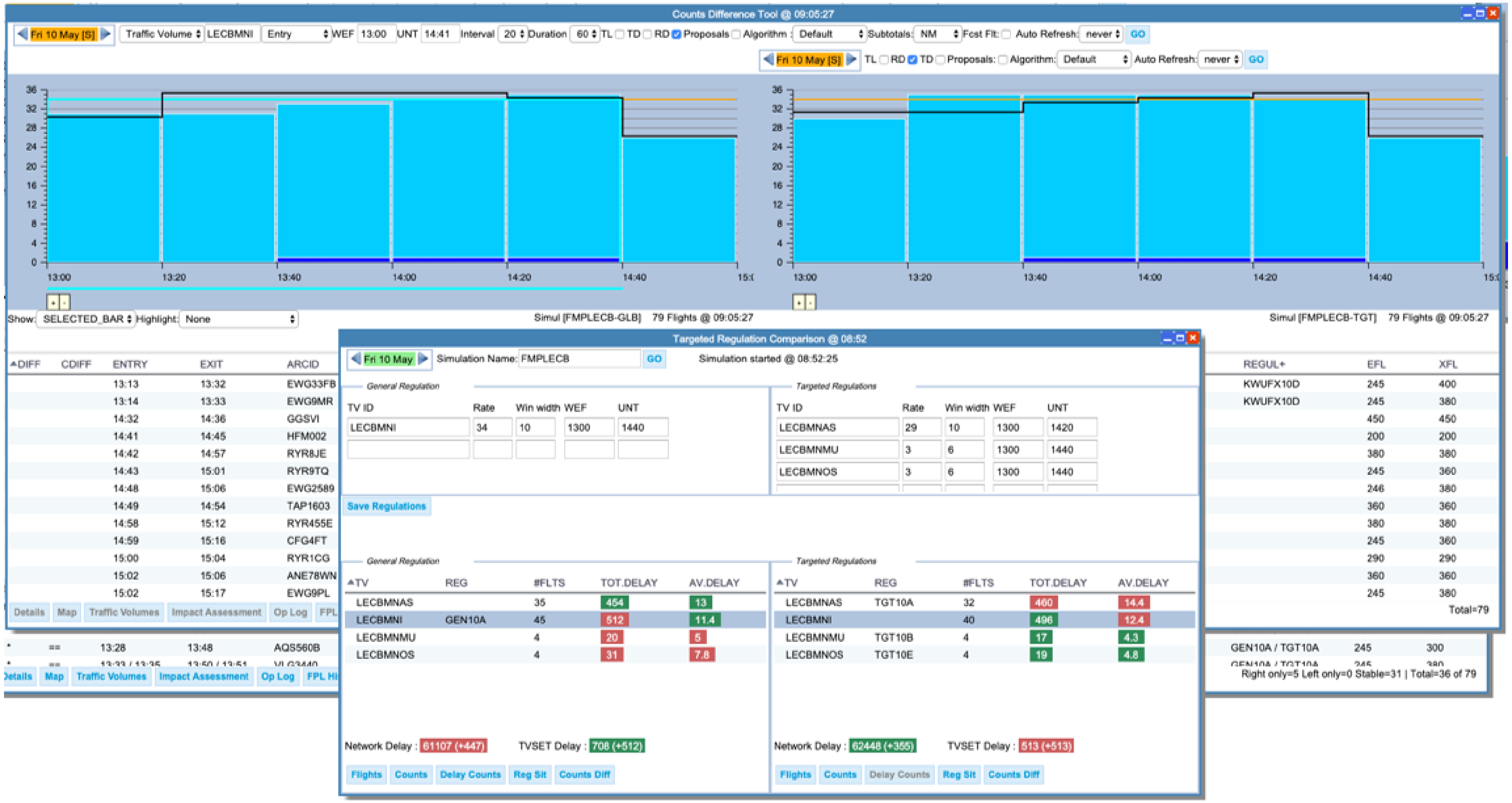


Figure 262: Example of entry counts – Trial 10th May.

Here there are other examples from trials of 10th of May where the distribution of occupancy counts is more equitable with the implementation of the Targeted CASA regulation.

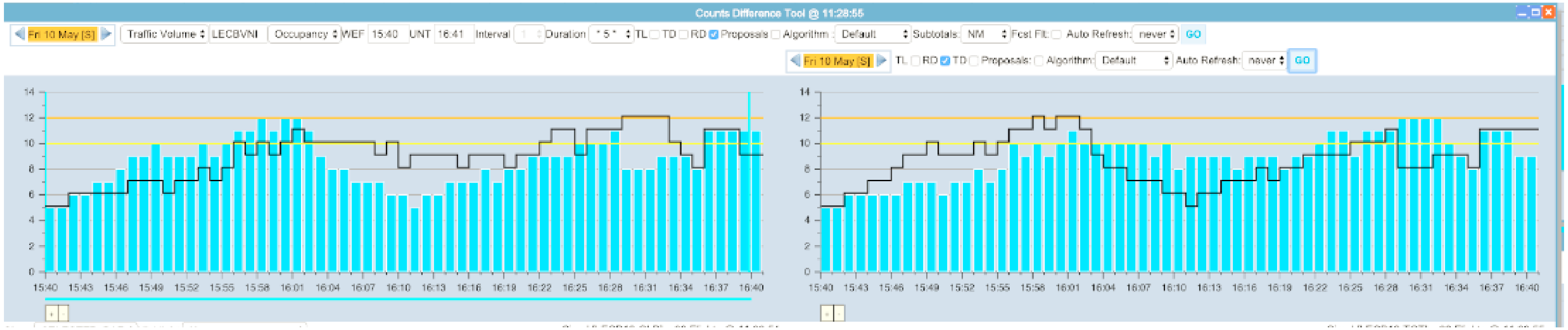


Figure 263: Example of occupancy counts – Trial 10th May.

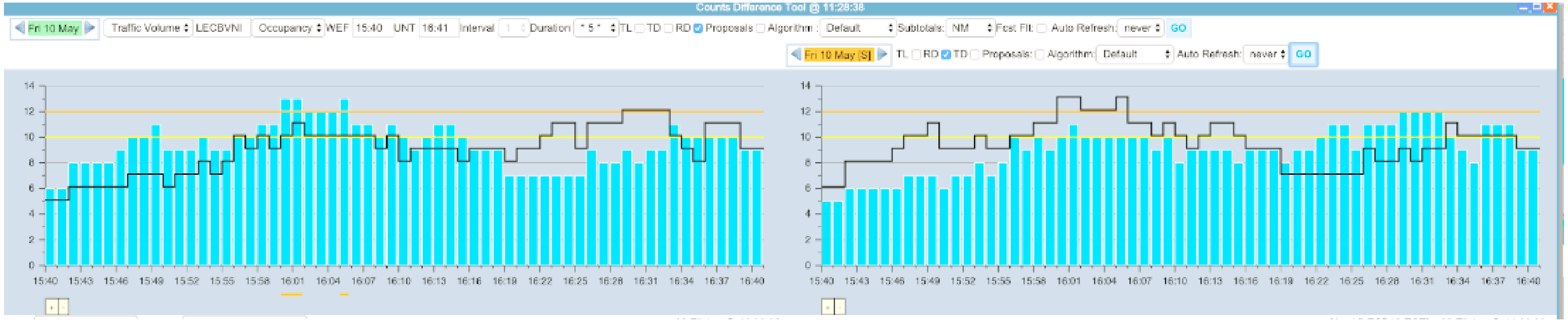


Figure 264: Example of occupancy counts – Trial 10th May.

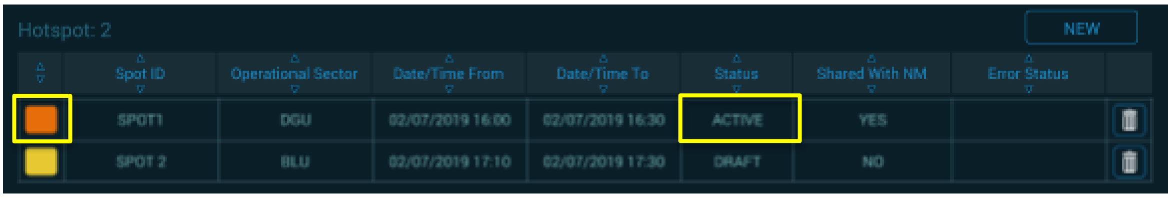
As a conclusion, it can be said that when implementing a Targeted CASA regulation, the under-loaded periods tend to disappear and the differences between peaks and off-peak hours tend to be smoother.

I.3.5 Technical Verification Results of iACM

As iteration #3 was degraded to a technical verification, the main purpose of this section is to demonstrate the success in the automatic connection with NM through B2B service for the communication of Hotspots and MCP Ground Delay measures, and without taking into account the validation objectives in the qualitative or quantitative way for UC2.2.

Hotspot Creation

In the following Figure, it is presented the table where Hotspots are listed. One of the columns stands for the status of the B2B connection to NM "Shared with NM". If the hotspot was notified to NM, with the consequent positive reply, a text "YES" will appear in this column. If the connection is not available or there are an overlap with other hotspots already stored in the NM platform (same operational sector and overlap in time), a warning with a yellow triangle will appear in the "Error Status" column. A negative answer "NO" will also be presented in the previous column notifying that the Hotspot has not been shared with NM.


Hotspot: 2
NEW

	Spot ID	Operational Sector	Date/Time From	Date/Time To	Status	Shared With NM	Error Status	
	SPOT1	DGU	02/07/2019 16:00	02/07/2019 16:30	ACTIVE	YES		
	SPOT 2	BLU	02/07/2019 17:10	02/07/2019 17:30	DRAFT	NO		

Figure 265: iACM Hotspot List

The NM reply is automatic and it contains the following attributes:


```
<item>
    <hotspotId>
        <applicabilityPeriod>
            <wef>2019-07-02 16:00</wef>
            <unt>2019-07-02 16:30</unt>
        </applicabilityPeriod>
        <trafficVolume>LECMDGU</trafficVolume>
        <duration>0010</duration>
    </hotspotId>
    <severity>LOW</severity>
    <status>SOLVED</status>
    <remark>New hotspot</remark>
    <trafficVolumeDescription>DOMINGO UPPER</trafficVolumeDescription>
</item>
```


Figure 266: iACM-NM Hotspot notification Reply log

The system also allows the FMP to update the status/severity of the Hotspot, in this case the SPOT1 has changed the colour of the severity and the current status to SOLVED:

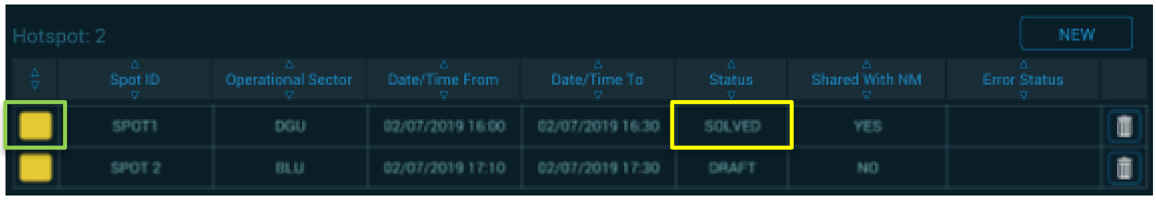


Figure 267: iACM Hotspot Update

As the communication with NM is immediate, the reply of each hotspot takes approximately 0,25 seconds.

MCP Ground delay application

Once a Hotspot is identified, the FMP could solve the problem applying MCP ground delay measures. In this example, the FMP selects two flights and applies 20 minutes delay. It is possible to observe in the histograms below the change in occupancy counts.

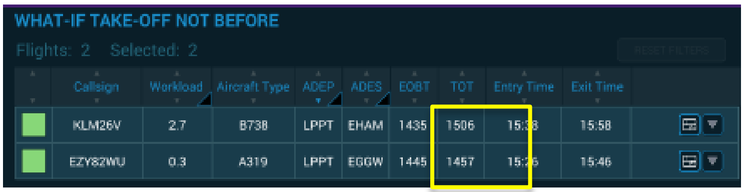


Figure 268: Flights measured before Ground Delay iACM

Figure 269: 20 Minutes Delay application iACM

Figure 270: Flights measures after Ground Delay iACM

In the flight list the what-if measure is presented with a specific icon and purple triangle at the top left corner of the flight status information as in the image above.

Histograms View (Agreed View and Sandbox View): The real situation is the second one (Agreed View) and the first one is the “Sandbox Working Area”. The selected peak has been reduced in two occupancy counts and increased 20 minutes later.

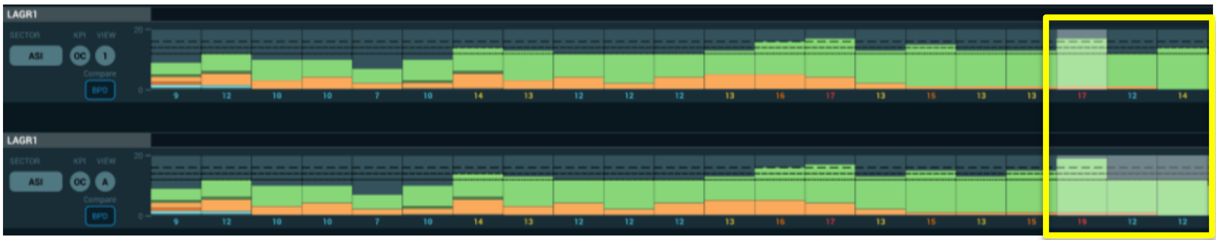


Figure 271: Histograms View (Agreed and Sandbox View)

The FMP has the decision to start the negotiation with NM, for this purpose “LAUNCH STAM” button is available. The system will request for a new Regulation Proposal (if it doesn’t exist) from the moment of application until the end of the day.


```
    <proposal>
        <applicability>
            <wef>2019-07-02 10:15</wef>
            <unt>2019-07-02 23:59</unt>
        </applicability>
        <measureCherryPicked>true</measureCherryPicked>
        <subType>GROUND_DELAY</subType>
        <regulationId>ECMASI02</regulationId>
        <reason>ATC_CAPACITY</reason>
        <location>
            <id>LECMASI</id>
        </location>
        <remark>STAM Measure</remark>
        <updateCapacityRequired>false</updateCapacityRequired>
        <updateTVActivationRequired>false</updateTVActivationRequired>
        <kind>RegulationProposalWithProposalFlights</kind>
        <action>CREATION</action>
    </proposal>
</RegulationProposalFilingRequest>
```


Figure 272: RegulationProposalFilingRequest Log iACM

The status of the regulation should be in “DRAFT” in order to add proposed flights to it.


```
    <requestReceptionTime>2019-07-02 10:18:57</requestReceptionTime>
    <requestId>B2B_CUR:4876</requestId>
    <sendTime>2019-07-02 10:18:58</sendTime>
    <status>OK</status>
    <data>
        <planTransferred>true</planTransferred>
        <planCutOffReached>true</planCutOffReached>
        <dataset>
            <type>OPERATIONAL</type>
        </dataset>
        <proposals>
            <item>
                <dataId>004530000050062</dataId>
                <regulationId>ECMASI02</regulationId>
                <kind>RegulationProposalWithProposalFlights</kind>
                <action>CREATION</action>
                <approvalState>UNKNOWN</approvalState>
                <mcdmState>DRAFT</mcdmState>
                <regulationState>APPLIED</regulationState>
            </item>
        </proposals>
    </data>
/RegulationProposalListReply>
```


Figure 273: DRAFT state Regulation Proposal Log iACM

Afterwards, the system is ready to add the concerned flights with calculating new CTOT to regulation created through *AddFlightsToMeasureRequest*. The *reply* from NM platform is the information of flights added to regulation and their new CTO and CTOT.

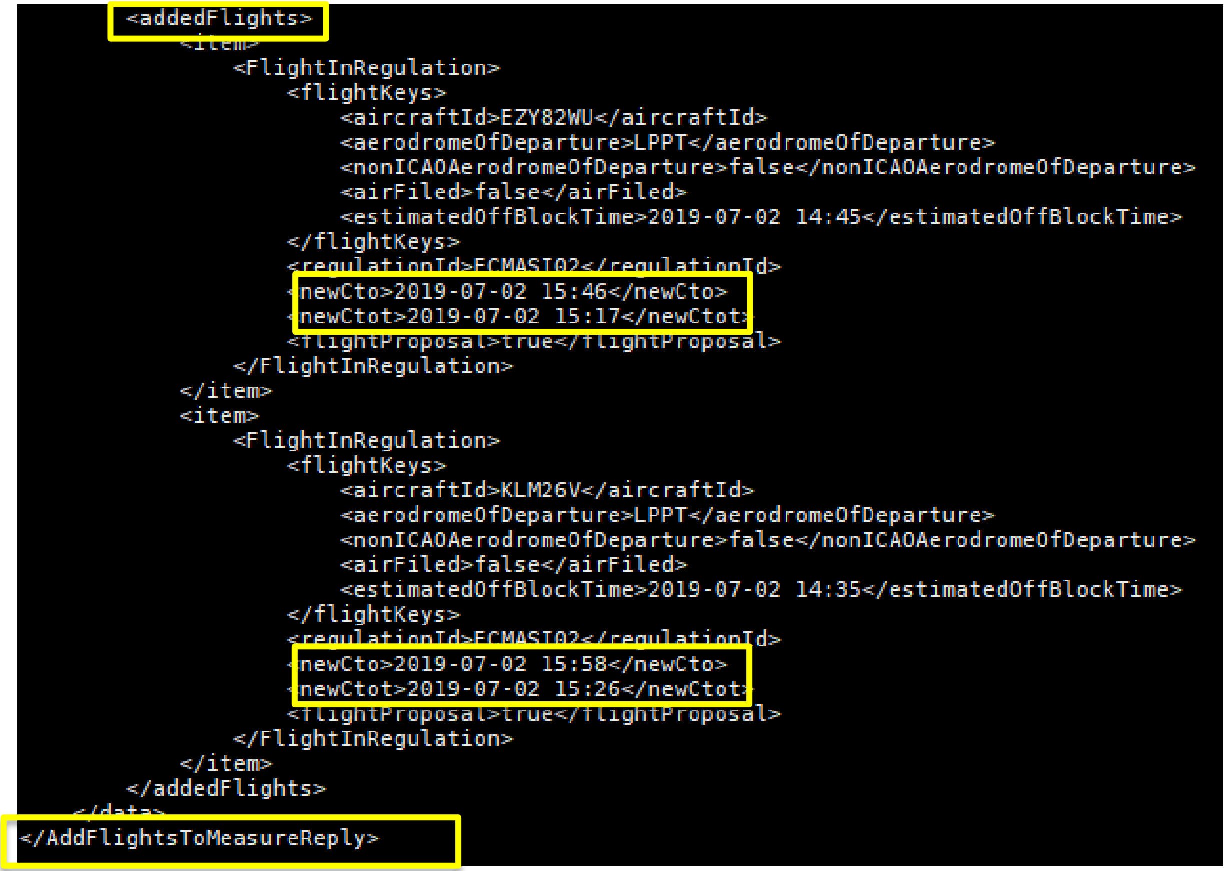


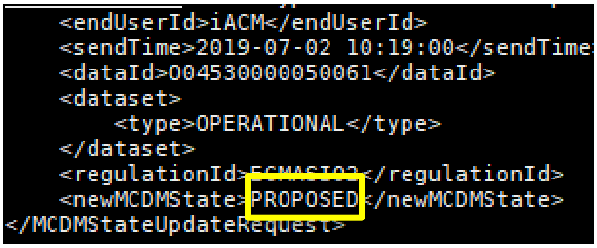
Figure 274: AddFlightsToMeasureReply Log iACM

The system automatically requests change the status for the regulation through *MCDMStateUpdateRequest* from “DRAFT” to “PROPOSED”. Once the flights have been added and the regulation is in this state, NM should assess the proposed measures and accept/reject the regulation.

In iACM HMI, a “Pop-up” window will appear notifying that the negotiation has been started if everything goes well or the cause of the failure if the regulation has been rejected automatically by NM system.

There are several statuses of NM under consideration by iACM:

- **DRAFT**: Needed to add/Remove flights to/from Measure.
- **PROPOSED**: it is a pending status, with the proposed list of flights.



```
    <endUserId>iACM</endUserId>
    <sendTime>2019-07-02 10:19:00</sendTime
    <dataId>004530000050061</dataId>
    <dataset>
        <type>OPERATIONAL</type>
    </dataset>
    <regulationId>ECMASI02</regulationId>
    <newMCDMState>PROPOSED</newMCDMState>
</MCDMStateUpdateRequest>
```


Figure 275: PROPOSED mcdmState Log iACM

- **COORDINATED**: the regulation is under review by NM.

```
        <proposals>
            <item>
                <dataId>004530000050548</dataId>
                <regulationId>ECMASI02</regulationId>
                <kind>RegulationProposalWithProposalFlights</kind>
                <action>CREATION</action>
                <approvalState>ACKNOWLEDGED</approvalState>
                <mcdmState>COORDINATED</mcdmState>
                <regulationState>APPLIED</regulationState>
            </item>
        </proposals>
    </data>
</RegulationProposalListReply>
```


Figure 276: COORDINATED mcdmState Log iACM

- **IMPLEMENTED**: After NM review, the regulation is accepted.

```
        <proposals>
            <item>
                <dataId>004530000050563</dataId>
                <regulationId>ECMASI02</regulationId>
                <kind>RegulationProposalWithProposalFlights</kind>
                <action>CREATION</action>
                <approvalState>APPROVED</approvalState>
                <mcdmState>IMPLEMENTED</mcdmState>
                <regulationState>APPLIED</regulationState>
            </item>
        </proposals>
    </data>
</RegulationProposalListReply>
```


Figure 277: IMPLEMENTED mcdmState Log iACM

- **INTERRUPTED**: NM decides to cancel the regulation.

```
        <proposals>
            <item>
                <dataId>004520000049298</dataId>
                <regulationId>ECMDGU06</regulationId>
                <kind>RegulationProposalWithProposalFlights</kind>
                <action>CREATION</action>
                <approvalState>REJECTED</approvalState>
                <mcdmState>INTERRUPTED</mcdmState>
                <regulationState>APPLIED</regulationState>
            </item>
        </proposals>
    </data>
</RegulationProposalListReply>
```


Figure 278: INTERRUPTED mcdmState Log iACM

In order to maintain the permanent communication with NM platform and check the status information, iACM requests the status information of the regulations every 10 seconds.

In HMI, each Ground delay measure is presented as an icon with a specific colour. It stands for the status of the measure.

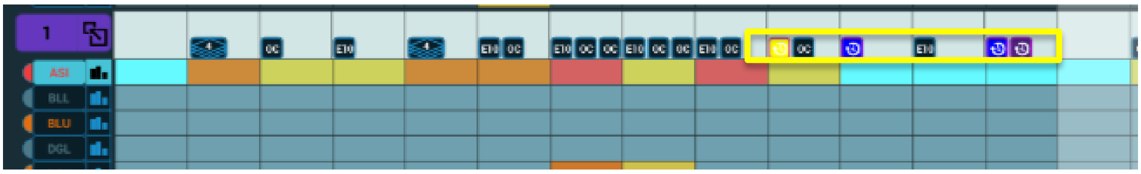


Figure 279: Ground Delay HMI representation iACM

- **Purple**: Local measure, no shared with NM
- **Yellow**: Local measure prepared to be shared with NM as well as PROPOSED status of the regulation.
- **Blue**: The measure is in state IMPLEMENTED by NM.

If a Ground Delay measure has been implemented by NM, a new flight plan with the name of the regulation will be received. It will be shown also in the Agreed View, with an updated CTOT. The Extended flight list shows all the regulations applied to the flight and the most penalizing in other column.

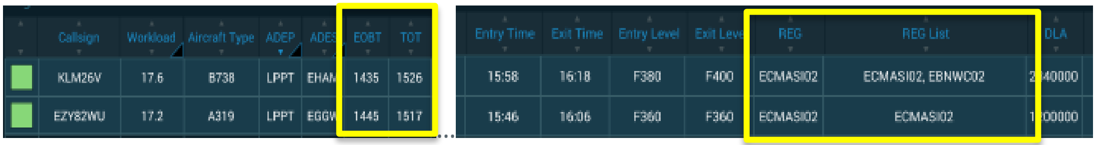


Figure 280: Regulation List in the Extended Flight List iACM

The FMP could add flights to the already existing regulation creating new Ground Delay measures and starting negotiations with NM. In these terms, iACM will avoid to send existing implemented measures.

I.3.6 Unexpected Behaviours/Results

On 9th of May, there was a general strike in France, including Air Traffic Controllers. The consequences of that strike was that 9th of May was the day with the biggest delay recorded in 2019. Due to the geographical situation of Madrid and Barcelona ACCs and their borders with French Airspaces, most of the traffic arriving or departing from LECM and LECB airports was regulated. As consequence, there were no or very few opportunities to apply Targeted CASA regulations or to apply Ground Delays. Traffic was smooth enough so the FMPs and ATCOs could deal with it.

Most of the work done or results gathered that day was of no interest for the global results of the exercise.

In addition, during the first part of the trial executed on the 10th of May, PLANTA functionality seemed to be downgraded.

I.3.7 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

CAP Tool

We experience some limitations regarding the number of situations to use the CAP tool. During most of the days of the live trial, traffic demand was not high enough and in the cases it was, there was a need for regulation. This is why the application of the CAP Tool was quite limited during the two months of trials. In addition, Spanish FMPs were not really familiarised with the tool. They indicated that the CAP Tool have a high potential to solve minor imbalances in the future, but in combination with current CHMI and thus with the NM.

On the other hand, Spanish airlines involved in iteration 1&2 with the CAP tool, clearly showed their interest in the tool and in fact, they have continued worked with it.

Regarding traffic representativeness and scenarios, there was not limitation as the demonstration was a live trial. All the validation objectives could be covered and the FMPs actively contribute to the debriefing sessions and completed the questionnaires proposed.

PLANTA

The most important limitation was the low level of traffic. When addressing UC2.2, the FMPs had to reduce sometimes the OTMV of the sectors of study to be able to generate imbalances. However, this was not a problem to demonstrate that the concept works and the tool facilitated its application.

During the first day, the FMPs experienced some issues when trying to apply a Targeted CASA in MED Sector, as the TV including the flow via LUMAS was not correctly defined. This issue was solved, and it worked perfectly during the rest of the execution days.

Another limitation was to determine the right timing (i.e. how much time in advance) to apply a measure in order to obtain the desired effect. . According to FMPs' experience, any measure applied less than 1h 30' in advance, will not have the desired impact.

The PLANTA iteration was designed as a shadow mode demonstration, as PLANTA is a research tool connected to SAT-X or Pre-OPS testing platforms. As consequence, the measures were not really implemented in OPS. This allowed the FMP to gain insight on the possibilities available in PLANTA to solve imbalances with a minor impact than current CASA regulations and Scenarios.

iACM

The biggest limitation was to select a set of flights which satisfy the regulation features. The most common failure of adding flights to the regulation was that they were not regulated by it. This is because the Spanish Airspace adaptation in iACM is not enough mature in terms of constraint lines/operating procedures, with the result that the trajectory was somewhat different in both platforms.

Another limitation was related to SAT-X platform that allows only 5 regulations per day for all Madrid ACC. In addition to that, only 1 regulation could be under Review by NM. Due to this, the tests were restricted.

2. Quality of Demonstration Exercise Results

During the three iterations, ENAIRE dedicated up to one week of the exercise to training, and provided the participants training material such as working methods, user guides and concept presentations. FMPs participants also had the chance to try the platforms in advance and any doubt was coordinated in advance with DSNA or Eurocontrol respectively.

The FMPs involved in the exercise were committed with the execution and expressed their interest in the concepts and tools used.

In the case of the CAP Tool exercise, it was really important the involvement of the Airspace Users as part of the DCB decisions. They have had the possibility to assess and accept/reject the proposal from the FMP. Which was key in the process is that it was based on trust between the ATM stakeholders.

Regarding the PLANTA Exercise, FMPs Manager and Head of Operations and Flow of ENAIRE assisted to the execution providing their feedback and identifying the potential use of a local tool to solve some of the future issues the ANSPs will face.

Data to analyse the results was gathered by means of questionnaires to the FMPs and AUs (in the case of the CAP Tool) to collect qualitative feedback and by means of logs and recordings on CAP Tool and making use of the exporting capabilities in PLANTA.

3. Significance of Demonstration Exercises Results

Significance of Demonstration Exercise Results is categorised as high. The length of the two iterations performed with the CAP Tool was of one month each one. During that month, the CAP Tool was displayed in a screen close to the CHMI position. During those two months, many FMPs used it making the results more objective. Airlines participated also during the two months. The length of the exercise was agreed by the ENAIRE/DSNA PJ24 teams with the support of the LECM and LFFB FMP Managers.

In the case of the PLANTA iteration, two ENAIRE FMPs familiarised with LECM and LECB airspaces participated in the trial. Due to the availability limitations of the FMPs the extension of the trial was four days. PLANTA allows the FMPs to customize the OTMV for the sectors of study, so although the duration of the trial was limited to four days, the FMPs could test the two UCs addressed.

I.4 Conclusions

Exercise 6 includes different demonstration activities using different techniques. Two live trials, followed by a Shadow Mode and a Technical Verification, were performed in order to bring the “Enhanced Coordination of STAMs” concept into real operations. The concept was validated in SESAR1 and thus, the objective of this exercise is to demonstrate it can be brought into operations by means of some of the tools (e.g. CAP Tool, iACM) and the B2B services developed to that aim. In the PLANTA Tool case, it is a prototype developed for R&D. PLANTA also uses the B2B services developed by NM to bring the abovementioned concepts into operations. EXE#6 presents additional added value as three ATFCM tools have been tested by the Spanish FMPs to address the different UCs included in this exercise. FMPs were able to identify the best practices from each iteration, tools and B2B services to continue working towards the process implementation.

UC2.4 – Level Capping

In general, the results obtained at the end of the UC2.4 iterations were positive. Despite the feedback from the FMP’s participants was subjective, there was some difference among how comfortable they felt with the new Processes and Procedures associated to the UC and the supporting tool. FMP’s feedback is considered twofold regarding the process/methods and the tools, although ultimately interdependent.

- For some of the FMPs there’s a need to get used to the tool thus the general feeling was beneficial and useful for their work and more over they find this tool totally helpful for autumn and spring, low peak seasons.
- The number of airlines involved were limited so it was difficult to obtain a clear benefit when using the tool.
- A scenario is usually preferred by the FMPs with limited experience with the CAP tool, as they are sure the issue would be solved. On the other hand, CAP tool-experienced FMPs thought that CAP measures are, sometimes, more efficient (capturing the needed number of flights to solve the issue) and it creates much less workload for neighbouring impacted ACCs.
- For FMPs with limited experience with the CAP Tool, the phone call is much better and quick.

- The feedback provided by the FMPs who already know the tool was that this process has helped to avoid regulations and helped the airlines participating in the CAP.
- There were not many opportunities where the CAP Tool could be used due to the amount of traffic, during weekdays with big peaks and during the weekend low. These aspects affected the analysis of the fuel consumption only done in three days of the expected month.
- Fuel consumption has not a negative impact in the global use of the tool. There are particular flights that present an increase of Fuel comparing with the planned flight plan but looking at its daily consumptions there's no increase.
- Increasing the number of AU involved in the process, the results of the second iteration seems to be more realistic. However, feedback was obtained just from the four new Spanish airlines involved in the exercise.

UC2.2 – Ground Delay with MCP

Ground delay with MCP UC has resulted in great interest from ENAIRE's FMPs and Flow Division. The application of GD with MCP could improve the situation experienced in some TVs, mainly during the summer season, by decreasing the number of affected flights by a regulation as well as the total number of minutes of delay. ENAIRE would like to continue working on this thread and using the approach showed in PLANTA to be able to address this UC.

As a technical verification, iteration 3 did not have neither quantitative nor qualitative results in terms of validation objectives. For this reason, only tangible conclusions related to iACM System could be exposed here.

- iACM functionality to create a Hotspot and MCP Ground delay measure using Proposal Regulation Service has been successfully verified. The communication with NM SAT-X platform was performed without errors, always receiving the request/reply in both sides. There were not lost messages nor corrupted data.
- The new flight plans with an updated CTOT were received successfully, displaying the most recent information in the Agreed View- Real View.
- iACM helps FMP to select a set of flights that could be regulated with Ground Delay measure instead of regulating all flights in an operational sector. In this case, the total Delay is decreased accordingly.

UC2.8 – Targeted CASA

Targeted CASA UC allowed ENAIRE's FMPs to perform some tests using a different ATFCM measure to solve imbalances in specific flows defined beforehand according to the TV flow characterisation. PLANTA supported the FMPs to implement that concept that was initially defined for some Spanish TVs. Despite the traffic level during the trial did not allow the implementation of many Targeted CASA regulations, the FMPs agreed on the potential added value of the Targeted CASA measures to solve imbalances decreasing the impact (mainly in number of affected flights, minutes of delay and knock-on effect) of the current General CASA Regulations.

The following conclusions applied to the results of the 4th iteration of EXE#6 were UC2.2 and UC2.8 were addressed. Feedback from FMPs is also summarised in the following list.

- The possibility to show status, what-if assessments and results using different complexity indicators such as EC or OCC and with different rates is definitively well received from the operational staff.
- PLANTA allowed FMPs to increase their situational awareness when trying different combinations in order to stablish the better solution for each situation. In addition, using B2B coordination services to propose measures instead of the phone proved that a more fluent communication with NM is possible.
- FMPs agreed that the operating methods were clear, consistent and well reflected in the tool. PLANTA offered a visual and intuitive layout of the "entry counts", while performing what-if assessments, that assisted FMPs when designing a measure.
- The precision of the data shown on HMI helped FMPs to adjust each measure in order to decrease both the number of affected and regulated flights and the average delay per regulated flight. In addition, the global delay was reduced in both use cases with the use of PLANTA.
- FMPs felt confident when using PLANTA and exposed that it improved their traffic monitoring and decision-making processes. Moreover, the workload experienced during the trials was successfully acceptable.

I.5 Recommendations

I.5.1 Recommendations for industrialization and deployment

Following the same approach as in the Conclusions section, this chapter is split per UC addressed during the different exercise iterations. Again, recommendations are formulated summarising the FMPs' feedback linking the concepts and the tools that support them for the concept implementation.

UC2.4 – Level Capping

- From a Spanish point of view, there is a need to increase the number of AU involved in the process and the flows where to apply the CAP Process.
- A need of further training with the CAP Tool was detected for those FMPs not used to it.
- More opportunities to use the tool are needed to give more feedback on the benefits shown by it.

- For the purpose of improving the quality of the results in fuel burn and CO_2 emissions, it is recommended for next iteration to compare the planned flight (before CAP - M1 DDR), and also the updated planned flight (after CAP) (M1’ DDR). During iterations 1 and 2, this M1’ did not exist in DDR, and for that reason, it was not possible to do that comparison that would have enriched the representativeness of the results and the conclusions. Nevertheless, since in the future, NOP will be also involved, it would be a good opportunity to incorporate also that metric (i.e. M1’) in the results assessment.

UC2.2 - Ground Delay with MCP

- Regarding the Ground Delay with MCP process:
  - to develop an algorithm to select flights and minutes of delay, once the imbalance period is selected.
  - to develop an algorithm to propose a hotspot time interval to speed up the what-if design process.

  Note: ATCOs and FMPs could support this process by developing criteria to do that.

- The HMI should provide more awareness to FMP of the different states of measures. If something went wrong in the process, it should be clear the reason of failure and where is it.
- The operational procedures of the Spanish airspace should be the included in both Systems (NM platform and iACM) with enough maturity in order to predict a similar trajectory.
- It is important to maintain the awareness of the flights that have been regulated with a ground delay measure.

UC2.8 – Targeted CASA

- Right after starting a simulation, - an initial best-guess value for Rate and Window Width should be automatically provided by default. Then the FMP could test different values if needed.
- FMPs suggested that once a measure is implemented it should remain clearly visible for monitoring purposes. While monitoring afterwards, the FMPs may detect the need to update it, e.g. the flights in it, the number of minutes allocated to them, etc.

I.5.2 Recommendations on regulation and standardisation initiatives

N/A

Appendix J Security Assessment Report (SecAR)

Not applicable.

The required security assessment activities have been performed following existing operational implementation processes and procedures at local and network level as part of normal quality management systems, involving safety supervisory authorities at national level and EASA at network level where required.

Appendix K Human Performance Assessment Report (HPAR)

Not applicable.

The required human performance assessment activities have been performed following existing operational implementation processes and procedures at local and network level as part of normal quality management systems.

Appendix L VLD progress towards TRL-7

See 5 Conclusions and recommendations of the document.