Final Project Report

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Abstract

Project 13.02.03 addresses the topics related to enhanced DCB processes from the strategic to the post-ops phase, in particular DCB in a trajectory management context, dynamic DCB, Network CDM, Airports integration into Network operations, ASM/ATFCM integration and management of critical events. The project validated the SESAR Solutions #17 "Enhanced STAM" and #18 "Calculated take-off time to target times (CTOT to TTA)" which are part of PCP projects under ATM Functionalities AF#4-1 and AF#4-3. The exercises under P13.02.03 also contributed to complete the V3 maturity of the Operational Improvements "Collaborative NOP for Step1" (SESAR Solution #20/PCP AF#4-2) and "Improved Consistency between Airport and ATFCM Planning" (part of Solution #21). In the "Trajectory Based Operations" context, P13.02.03 addressed the Collaborative 4D constraints management concept that paves the way to new concept of Network management mixing classical centralised time-based constraints and local time-based constraints in a collaborative decision making process - including multiple actors such as local DCB actors, Airport and Airspace Users-.

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Acronyms

Acronym	Definition
ACC	Area Control Centre
AIMA	Airport Impact Model Assessment
AMAN	Arrival MANager
ANSP	Air Navigation Service Provider
AOP	Airport Operations Plan
AOT	Airport Operations Team
APOC	Airport Operations Centre
ASM	Airspace Management
APT	Airport
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATSU	Air Traffic Service Unit
AU	Airspace User
B2B	Business-to-Business
CBA	Cost Benefit Analysis
CDM	Collaborative Decision Making
CTOT	Calculated Take-Off Time
DCB	Demand Capacity Balancing
dDCB	Dynamic Demand Capacity Balancing
DS	Data Set
ECAC	European Civil Aviation Conference
E-OCVM	European Operational Concept Validation Methodology
FCM	Flight confirmation message

FMP	Flow Management Position
FO	Flight Object
HMI	Human Machine Interface
HP	Human Performance
INAP	Integrated Network management & ATC Planning
INTEROP	Interoperability Requirements
KPA	Key Performance Area
KPI	Key Performance Indicator
MASSDIV	Massive aircraft Diversion
MTCD	Mid-Term Conflict Detection
NM	Network Manager
NMOC	Network Management Operational Cell
NOP	Network Operations Plan
NWP	Network Working Position
MET	Meteorological
ODSG	ATFCM Operations and Development Sub-Group
OFA	Operational Focus Area
OI	Operational Improvement
OSED	Operational Service and Environment Definition
PCP	Pilot Common Projects
RBT	Reference Business Trajectory
SESAR	The programme which defines the Research and Development activities and Projects for the SJU
SBT	Shared Business Trajectory
SJU	SESAR Joint Undertaking
SPR	Safety and Performance Requirements
STAM	Short-Term ATFCM Measures
SWIM	System Wide Information Management

TRL	Technical Readiness Level
TS	Technical Specifications
TTO/TTA	Target Time Over/ Target Time of Arrival
UDPP	User Driven Prioritisation Process
VALR	Validation Report

1 Project Overview

The main goal of this project was to validate the SESAR dynamic DCB (dDCB) concept. It includes (for "Time Based Operations") the operational description of Advanced Short ATFCM Measures (STAM) and the shift from Calculated Take-off Time to Target Times for ATFCM purposes (CTOT and TTO/TTA). It also addresses (for "Trajectory Based Operations") the first validations of the Collaborative 4D constraints management concept that paves the way to a new concept of Network management, mixing "classical centralised" and "local" time-based constraints, in a collaborative decision making process including multiple actors such as local DCB actors, Airport and Airspace Users.

The following organisations contributed to the project: ALENIA, DFS, DSNA, ENAV, ENAIRE, EUROCONTROL, INDRA, NATS, Leonardo (formerly SELEX), Skyguide.

1.1 Project progress and contribution to the Master Plan

SESAR Project P13.02.03 "Enhanced DCB" was focused mainly on two Operational Improvements within the Time Based Operations context which are the main items of the Optimised ATM network services in the pipeline towards deployment in the ATM Master Plan:

- Advanced Short Term ATFCM Measures: OI DCB-0308 / SESAR Solution #17
- DCB in a Trajectory Management Context: OI DCB-0208 / SESAR Solution #18

In support to other Projects, P13.02.03 also contributed to validate the following other Operational Improvements:

- Collaborative NOP: OI DCB-0103-A / SESAR Solution #20 (P07.06.01)
- Improved Consistency between Airport and ATFCM Planning: OI DCB-0310 / SESAR Solution #21 (P06.03.01)
- Collaborative Airport Planning Interface: AO-0801-A / SESAR Solution #21 (P06.03.01)

Within the Trajectory Based Operations context, P13.02.03 was focused on the following Operational Improvement:

- Collaborative 4D Constraints Management: OI DCB-0209

Advanced Short-Term ATFCM Measures (STAM)

Dynamic DCB shall nominally be restricted to addressing residual overload or complexity problems of limited magnitude. The process to apply dDCB is based on the identification of hotspots. Once identified, hotspots are solved through the application of STAM. The development of STAM consists in an approach to smooth sector workloads by reducing traffic peaks through short-term application of minor ground delays, appropriate flight level capping and exiguous rerouting to a limited number of flights. These measures are capable of reducing the traffic complexity for ATC with minimum curtailing for the airspace users. STAM is based on high-quality data for prediction and accurate traffic analysis and is an important contribution to dDCB. Local STAM have already been developed by some ANSP/ATSU to supplement the use of ground regulations.

ATFCM Measures relying on improved predictability, together with automated tools for network view hotspot detection and for the promulgation and implementation of STAM enable ANSPs to adopt and improve the tactical capacity management procedures used to optimise traffic throughput. These tools connect local and regional network management function level for situation awareness, information sharing and CDM. Collaborative decision making process (CDM) comes into play as the various actors discuss the situation and agree on the best solution (measure). Today, it no longer makes sense to systematically apply regulations when demand does not significantly exceed available capacity and when traffic can be predicted with a higher level of granularity and accuracy. However, regulations shall still be used in resolving major imbalances.

Proving this hypothesis was the main objective of the validation activities. Validation was structured around five goals:

- Demonstrating the optimisation of traffic throughput using STAM,
- The use of automated support tools for hotspot identification and for the promulgation and the implementation of STAM,
- The interconnection of local and regional tools,
- The use of advanced ATFCM measures based on STAM deployment,
- The improved predictability of operations.

These goals allowed to demonstrate the feasibility of the application of advanced ATFCM measures based on STAM deployment, the potential increases in capacity (both in En-route and the TMA) and the reduction of adverse impact on Airspace User Operations through the application of SESAR solution #17.

DCB in a Trajectory Management Context (CTOT and TTA/TTO)

P13.02.03 strongly contributed to validate this SESAR Solution which aims at complementing departure regulations, CASA regulations - i.e. calculated take-off time (CTOT) -, with the dissemination of locally-generated target times, over the hotspot. Each airport collaborates with terminal area control to develop its own strategy to optimise the traffic flow in and outbound the airport. Strategies are likely to take into account the consistency of flight plans with seasonally-allocated airport slots, arrival route and runway allocation, or gate and connection management. The principle is based on the dissemination of the TTO (Target Time Over) & TTA (Target Time on Arrival) by the Network Manager to the concerned actors to create a common awareness between Pilot and ATM service providers for the adherence to this Target Time. Consequently, the Target Time is continuously monitored during the execution phase to detect deviation and (if needed) revising the Target Time to fit with the DCB plan execution. This collaborative process contributes to a more coherent approach to demand regulation, which is expected to result in a reduced number of reactionary delays thereby benefitting passengers and airlines, as well as the network. The solution provides more flexibility to the Airspace Users allowing them to adjust their flight profile (with new flight performance) whilst maintaining the TTO & TTA; thus, allowing them to adapt the CTOT to their preference.

Adherence to TTA/TTO by Airspace Users and ATC was a feature of the original concept, which was removed during the project life-cycle given the lack of consensus on the Target Time Management concept, notably with regards to:

- The intervention of pilots and controllers during the flight execution phase to adhere to target times;
- The status of target time (i.e. mandatory, discretionary, for information purposes);
- The invalid assumption that the ETO in the FMS is always close to the ETO in the ground system, since this is strongly impacted by the extent to which data-link capabilities are deployed (for EPP).

In consequence, the maturity assessment of the related Operational Improvement (DCB-0208) considers issues related to TTA/TTO adherence as "acceptable issues".

To validate at a large scale the concept with a staged approach, several exercises have been performed complemented by two Large Scale Demonstrations FAIRSTREAM and iStream. They allowed to:

- Assess the concept of TTA for managing arrival congestion (combined use with CTOT).
- Assess the operational feasibility including the possible role and responsibilities of the different actors (ATCOs, local DCB actor, NM...).
- Assess the technical feasibility (ground and on-board systems).
- Assess the performance benefits.

The last validation exercise (VP-749) covered the Target Time Management and AOP-NOP Integration in a collaborative effort between 3 Operational Focus Areas:

- Enhanced ATFCM Processes focusing on the validation aspects related to OI Step DCB-0208, and well primarily on Target Time Management as a local DCB solution.
- Network Operations Planning focusing on the validation aspects related to OI Step DCB-0103-A and well primarily on the integration of multiple AOP's with the NOP.
- Airport Operations Management focusing on the validation aspects related to OI Steps DCB-0310 and AO-0801-A and well primarily on the benefits of AOP/NOP Integration from an airport perspective.

The AOP/NOP Integration, delivering increased predictability, is a key enabler for the Target Time Management concept.

Collaborative NOP

As the Network Operations Plan is the result of all operational processes linked to Network Management from the long-term planning phase to the post-ops phase, the validation of the OI DCB-0103-A, under the responsibility of P07.06.01, has been performed through exercises from the different primary projects such as P07.06.02, P07.05.04 and P13.02.03. P13.02.03 contributed to this validation through a set of 5 exercises.

A dedicated process, relying on the NOP, has been elaborated by P13.02.03 to optimise the management of a massive diversion for a major European airport or set of airports in case of unusual and unexpected situation. The process, referred to as "MassDiv" for Massive Aircraft Diversion, involves all partners concerned by the diversion (ATSUs, airports, airlines, the Network Manager). It relies on tool-sharing information among the actors and supports collaborative decision processes to identify the best option to divert aircrafts and to prepare the recovery after the end of the non-nominal situation. This information will then be updated during the execution of the diversions to reflect as accurately as possible the remaining parking stands available. The process will also increase the visibility in terms of aircraft localisation to anticipate the recovery once the unusual situation is over. Exercise VP-772 allowed to validate the HMI definition through a mock-up and to measure performance gains.

Another topic addressed by P13.02.03 is the AOP/NOP integration supported by the data exchange update between the Airport Operations Plan (AOP) and the Network Operations Plan (NOP) in order to have a common, coherent and consistent plan for all airport and Network Manager Functions stakeholders. The enhancement of the airport arrivals process is proposed through the management of a Target Time of Arrival (TTA) allocation. In case of regulation for the arrival, a proper use of the TTA information will allow the airport to move from the reactive management to the proactive management by feeding back with new messages to the Network Manager with the TTA impact on the airport.

This arrival monitoring and airport impact assessment will improve the ground management (park/gate management, handling resources and staff management ...) and will reduce the impact on departures. It will improve the airport capacity management process and thus improve the overall network performance by improving traffic evolution monitoring.

On the Network side, the Network Manager would have more accurate airport capacity and demand data and new DCB measures could be triggered.

In its validation activities, P13.02.03 validated that the dissemination of TTA from AOP to NOP was feasible and suitable.

In a first V3 exercise, P13.02.03 addressed an early integration of AOP and NOP by sharing TTA information from NOP to AOP at planning stage. This process will feed back the impact of the TTA assignments to the NOP. The NOP will try to accommodate and minimise the airport impact by adapting the TTAs whilst not degrading the overall network performance.

In a latter V3 exercise, P13.02.03 concentrated on local arrival DCB where the decision making is supported by consolidated trajectory planning integrating airport planning data from several AOPs with the NOP data related to the traffic demand forecast. The AOP/NOP Integration aspect of the exercise added the following validation objectives:

- Validate that a full integration NOP/AOP can improve the network predictability and forecast accuracy;
- Validate that the integration of the airports in the arrivals management process can improve airports arrival predictability and punctuality;
- Validate that the airport arrival management can reduce reactionary delays.

Collaborative 4D Constraints Management

Enhanced DCB in Trajectory Based Operations context is focused on safety, optimal capacity, flight efficiency, predictability and collaboration between actors. DCB Constraints to Airspace Users are minimised by introducing cooperation between En-Route Air Traffic Control centres, Airport operations and Airspace Users operations. This cooperation process should improve efficiently the use of ATC and flight resources.

The main proposed improvements are the definition of:

- A new mechanism to manage multiple constraints;
- A new mechanism to collaboratively accommodate individual needs (UDPP);
- A new mechanism to manage the adherence to constraints;
- A Network Working Position (NWP);
- A cooperative process between local DCB actors, Airports and Airspace Users.

The validation activities were centred around two validation exercises with a V2 maturity level, addressing respectively:

- the reconciliation of both multiple DCB constraints and multiple DCB and ATC constraints (i.e. Airport arrivals) processes and investigates the network impact of broader local DCB measures usage;
- the assessment of the operational feasibility of Local DCB actors (Airport & En-Route) interactions with network operations to reconcile DCB and ATC constraints and its impact on performance as well as the DCB constraints adherence monitoring and adherence plan recovery.

The work in the project revolved around validating these concepts and for that, produced the operational requirements (OSED, INTEROP & SPR) and technical specifications (TS), as well as the prototypes needed to achieve the validation objectives.

Operational Improvements and Enablers

The following table lists the Operational Improvement steps and the Enablers that the project P13.02.03 has worked on. Maturity level for Operational Improvements is provided through E-OCVM phase while for technical Enablers it corresponds to NASA Technology Readiness Levels (TRLs).

The Operational Improvement steps and the Enablers used in this document are with reference to the Integrated Roadmap DS-15.

Code	Name	Project contribution	Maturity at project start	Maturity at project end
DCB-0308	Advanced Short Term ATFCM	P13.02.03 developed, validated (through exercises VP-314, VP-522, VP-700 and VP-632) and provided recommendations on the following concept features of this OI Step: • Hotspot detection, • Analysis and preparation of STAM,	V2	V3 completed with "Acceptable issues"

		• STAM coordination, • STAM implementation, • NMOC supervision.		
DCB-0208	DCB in a Trajectory Management Context	P13.02.03 developed, validated (through exercises VP-632, VP-634, VP-723 and VP-749) and provided recommendations on the following concept features of this OI Step: • TTA dissemination • TTA Adherence • Local TTA assignments • Roles & Responsibilities (NM, local DCB actor & Airport side)	V2	V3 completed with "Acceptable issues"
DCB-0310 AO-0801-A	Improved Efficiency in the management of Airport and ATFCM Planning Collaborative Airport Planning Interface	P13.02.03 through its validation activities, including VP-632, VP-634 and VP-749 contributed to the V3 maturity level. The last exercise VP-749 covers the Target Time Management and AOP-NOP Integration in a collaborative effort with P07.06.01 covering AOP/NOP Integration, and P06.03.01 (covering the AOP and airport DCB related aspects) of the following aspects: • AOP-NOP harmonized interface and data synchronisation • Airport / AU / NM Interface for Airport Impact Assessment and TTA window improvement into ATFCM	V2	V3 (TBC). Refer to P06.03.01 Final Project Report for more information
DCB-0103-A	Collaborative NOP for Step 1	P13.02.03 contributed to this validation through a set of exercises: VP-522, VP-632, VP-700, VP-749 and VP-772. MassDiv: The level of maturity reached in the definition of the concept, the roles and responsibilities and the operational requirements allowed to start the preparation of the operational deployment and to perform the next validation via a Pilot Phase.	V2	V3 (TBC). Refer to P07.06.01 Final Project Report for more information V4
DCB-0209	Collaborative 4D Constraints	P13.02.03 brought this OI to an initial V2 maturity level through validation activities (exercises VP-	V1	V2

	Management	315 & VP-746).		
METEO-06b	Generate and provide MET information relevant for Network related operations, Step 1		TRL2	TRL6
NIMS-13b	Enhanced short term ATFM measures (STAM)		TRL2	TRL6
NIMS-27	Network DCB sub-system enhanced with improved accuracy of processing real-time data		TRL2	TRL6
NIMS-43	Enhanced NM systems to process the Flight Object (FO) data related to the NM cluster including STAM, TTA and EFPL information		TRL2	TRL4
PRO-022	FCM procedures for collaborating on SBT changes with Airspace Users		TRL2	TRL6
PRO-247	FCM Procedures for hotspots information sharing and for CDM process to support STAM coordination and implementation		TRL2	TRL6
ER APP ATC 162	ATC Flight Data Exchange with NM Using the Flight Object		TRL2	TRL4
ER APP ATC 17	Enhance Traffic and Flow Management sub-systems to support dynamic flow management in co-ordination with local, regional, and European levels		TRL2	TRL4
NIMS-21a	Initial Flight Planning management enhanced to support 4D for Step 1		TRL2	TRL6
NIMS-38	Calculation and dissemination of the		TRL2	TRL6

	TTO & TTA			
SWIM-APS-03a	Provision of ATFCM Information Services for Step 1		TRL2	TRL6
SWIM-APS-04a	Consumption of ATFCM Information Services for Step 1		TRL2	TRL6
SWIM-INFR-05a	General SWIM Services Infrastructure Support and Connectivity		TRL2	TRL6
SWIM-NET-01a	SWIM Network Point of Presence		TRL2	TRL6
SWIM-SUPT-01a	SWIM Supporting Registry Provisions		TRL2	TRL6
SWIM-SUPT-03a	SWIM Supporting Security Provisions		TRL2	TRL6
SWIM-SUPT-05a	SWIM Supporting IP Network Bridging Provisions		TRL2	TRL6

1.2 Project achievements

Advanced Short-Term ATFCM Measures (STAM)

The validation activities demonstrated a clear and positive evolution in the development and validation of the Hotspot detection concept feature.

There was a positive evolution in the analysis and STAM preparation tasks. It has been demonstrated that flight and STAM selection can be significantly automated based on the pre-agreed scenarios. NM data provided by SWIM / B2B services can be enriched by locally available data (complexity, weather, ASM) to prepare a more efficient STAM measure.

STAM concept did show that less flights are impacted overall by STAM measures than the current DCB resolution techniques, although a minor fuel increase was recorded (in the case of flight level cap measures). This minor fuel increase was partially compensated tactically by ATC actions and in general must be seen as a trade-off to large amount of delay saved (cost of extra fuel vs cost of delay).

The capacity improvement benefit has not been demonstrated although subjective assessments did confirm a notion of higher exploitation of the sector capacity in the case of increased predictability.

However, a dedicated delay impact analysis with large scale STAM deployment was done and showed large benefits for top 20 delay producing ACCs.

The ATFCM delay per flight (both average delay per delayed flight and average delay per flight) have been reduced in the STAM scenarios compared to scenarios with CASA regulations. A clear potential has also been shown to reduce the number of required CASA regulations. As a consequence the departure punctuality was shown to be improved.

The analysis of ATFCM delay and avoided regulations also confirmed the reduction in number of regulated flights. The flights regulated through STAM measures see predictability improved especially in the upstream sectors.

The outcome of the qualitative safety assessment (questionnaires) clearly confirms positive safety impact through resolution of the traffic imbalance and reduced load.

The tool support evolved in the right direction and showed a good progress in automating (defaulting) some key parameters regarding the hotspot creation but still has not reached the "deployment ready" status. The tool's ergonomics and integration with existing tools has to be improved for operational feasibility, as the workload reported was still too high during specific STAM tasks and traffic situations.

The project clearly demonstrated the operational benefits of STAM to the Airspace Users. With the introduction of STAM at the 20 most delay producing ACCs, the operational benefit to cost ratio (delay reduction vs extra fuel costs) would be anticipated at the order of 15:1 !

These validation exercises clearly demonstrated the feasibility of the proposed tools and methods. With the last exercise VP-700 in Release 5, the solution #17 "Advanced STAM" reached for most of the concept features an end of V3 maturity level.

Recommendations have been formulated for the V4 phase of STAM concept/enabler maturity.

A mapping of the AF#4-1 & AF#4-4 PCP requirements coverage by Solution #17 has been performed. All requirements have been covered.

DCB in a Trajectory Management Context (CTOT and TTA/TTO)

P13.02.03 validated positively that assignment of target times by a local actor, based on local business intelligence is feasible.

The HMI prototype used by the FMPs during validation was simple in terms of HMI features, but highly effective in accomplishing the FMP tasks and in supporting the workflow of the concept. Feed-back from FMPs and visitors during the validation activities was highly positive.

It has been demonstrated that all human tasks related to the concept can be performed without significant problems and that the skills related to the activities/tasks are compatible with the skills associated to the actors' roles of today. Although FMP workload is increased by the monitoring and revision task, it is believed that if the proposed AIMA solution solves the hotspot, there is not much more workload for an FMP as in today's operations.

The system to system data exchanges between AOP, local FMP Tool and NM System, using SWIM B2B services have been demonstrated as fit for purpose.

Validation activities showed that the overall concept continues to work, even with extremely low capacity values compared to the demand values, but cumulative delay, number of impacted flights and delay per delayed flight significantly grow as from a capacity/demand ratio of 60%.

Target Time adherence increases predictability and contributes to the resolution of a hotspot. However, the assignment of target times to a limited number of flights in a hotspot would not be sufficient to ensure a reasonable improvement in the predictability of the hotspot.

Further improvements in the predictability of traffic loads can only be achieved in combination with other complementing time and trajectory based operations including improved departure time management.

Fast Time simulations revealed that Target Time Management supported by minor speed adjustments has the potential to increase the predictability of sector loads and hotspots. A potential capacity increase due to this increased predictability was validated positively, but no link to safety was made. An average capacity gain per sector estimated to be between 2.7% and 5.3% has been demonstrated. A marginal fuel increase was measured.

The assignment of Target Times by the arrival airport under consideration of Airport & AU priorities and constraints (i.e. turn around constraints) showed significant benefits. The project demonstrated that TTA dissemination (supported by the AOP/NOP integration) can improve punctuality at the TT fix (especially under degraded airport conditions) and potentially minimize reactionary delays. However it has been highlighted as well that the in-block punctuality is dependent on the integration of TT management with the arrival management process. Clear benefits of TTA consolidation in the planning phase has also been demonstrated.

A mapping of the AF#4-2 & AF#4-3 PCP requirements coverage by Solution #18 has been performed. In particular it is highlighted that the integration of TTA within the AMAN needs to be continued in SESAR 2020.

Collaborative NOP / MassDiv

The concept of operations for MassDiv has been elaborated and validated during 2014, in the framework of SESAR, with the support of more than 40 experts, including ANSPs, Aerodromes, Airspace Users and the Network Manager. At the end of the validation a general consensus was agreed among the participants that the level of maturity reached in the definition of the concept, the roles and responsibilities and the operational requirements allowed to start the preparation of the operational deployment and to perform the next validation via a Pilot Phase (i.e. operational procedures relying on operational systems). In May 2015, the MassDiv concept has been presented to the AOT (Airport Operations Team) which provided its formal support for the inclusion of the MassDiv tool in the NM NOP development plan. An additional support has been received from the ODSG (ATFCM Operations & Development Sub-Group) in June 2015.

Collaborative 4D Constraints Management

It has been demonstrated the ability for the Local DCB to manage DCB solutions with massive Target Time measures. The Multiple Constraint Manager tool is providing relevant information to local DCB to manage the most penalizing constraint issue.

It has been demonstrated that the Local DCB can accommodate Airport and Airspace Users' individual needs (reactionary delay) and for that, 3 different options have been validated:

- Local DCB actor is responsible for proposing a solution ensuring the relevant smoothing to resolve the hotspot.
- The local DCB actor delegates to the Airport actor the elaboration of the DCB solution on their side.
- The local DCB and APOC actors delegate to the Airspace Users the elaboration of the DCB solution according to the priorities of their business needs.

The monitoring of the constraint adherence (Target-Time measures) and the monitoring of the hotspot resolution progress has been demonstrated and approved.

It has been demonstrated that the collaborative decision-making process in the planning and execution phase between Local DCB, Airport and Airspace Users to manage DCB solutions is clear and effective. It allows a drastic improvement of cooperation between DCB and Airport to accommodate individual needs and optimisation criteria.

It has also been demonstrated how the Cooperative process can be guided by basic performance indicators (ATFCM, APT, AU) and basic what-if capabilities.

On the Roles & Responsibilities side, the subsidiary principle has been validated confirming that the local DCB (Airport and En-Route) will have significant increase in role and responsibilities in the management of a collaborative framework with other actors (adjacent local DCB, Airport, AU) to accommodate individual needs and determining coordinated and agreed DCB solutions.

The process and procedure have been validated and confirmed to be clear and effective. It is based on a unified and standardised modus operandi. The EATMA model defined in the OSED document is validated.

It has been demonstrated that the different functionalities given by the Network Working Position have positive impacts to manage efficiently the user's tasks.

In order to resolve an En-route hotspot, the STAM flight level capping measure, imposes the flight to fly a non-optimal flight level (in terms of vertical profile) until the constrained airspace is avoided. A negative impact on fuel burnt has been observed. While being negative, the severity in the increase in fuel burnt per flight is relatively small, ranging from 1.2% up to 1.7% in the worst case.

Fuel and delays are primary components of airline costs and hence typically fuel and delay efficiency improvements translate into cost savings. Average delay reduction per flight and extra fuel consumption metrics have been measured; as a result of the comparison, and in regards to the small increase in fuel consumptions, the costs induced by flight level capping measures (i.e. extra fuel burnt) are marginal in regards to the cost savings obtained thanks to reactionary and ATFCM delay reduction. There representing between 6% and 9% of the total savings.

Capacity was not directly assessed as such; however the capability to better use the airspace and to avoid resorting to NM CASA regulation mechanism has been proven to be effective. It has been observed that in average 40% of the identified residual hotspots can be managed by using only STAM mechanisms. This will lead to improvements in network capacity and we can conclude that the STAM concept may potentially increase airspace capacity, by using the airspace more efficiently.

Efficiency is a primary driver for Network operations. The ATFCM and reactionary delays impact due to the implementation of the STAM concept over the ECAC area has been fully studied and measured. The results showed a total delay reduction, combination of reactionary and ATFCM delays that ranged from 9% up to around 14%. This represents a significant improvement in network operations.

1.3 Project Deliverables

The following table presents the relevant deliverables that have been produced by the project.

Reference	Title	Description
D383	VALR S1 R5 - Vol.1 STAM	Volume 1 of the P13.02.03 D383 Step1 Validation Report, and is dedicated to report on the P13.02.03 validation regarding SESAR Solution # 17 Advanced STAM.
D383	VALR S1 R5 - Vol.2 Target Time Management	Volume 2 of the P13.02.03 D383 Step1 Validation Report, and is dedicated to report on the P13.02.03 validation regarding SESAR Solution # 18 CTOT and TTA
D303	OSED Step1 V3 Final	Final Operational Service and Environment Description for P13.02.03, for Dynamic DCB operational concept defined as Solution#17 Advanced Short ATFCM Measures (STAM) and Solution#18 – CTOT and TTA for Step 1 of SESAR in the “time based operations” context
D403	OSED Step2 Final Update for SESAR 1	Final Operational Service and Environment Description for 13.02.03, for Dynamic DCB operational concept to prepare Air Traffic Flow and Capacity Management in “trajectory based operations” context: two main concept elements are proposed: Collaborative 4D Constraints Management and Full integration of Dynamic Airspace Configurations into DCB.
D323	SPR S1 Final	Final Safety and Performance Requirements for SESAR Enhanced DCB Step1 concept in the “time based operations” context
D353	Technical Specification S1 R5 (Final): Fed DCB and TT Manager	Final Technical Specification for systems required to ensure the support for Demand and Capacity Balancing in short-term planning phases. It provides complete coverage of all related SESAR Step1 requirements. This version includes consolidated requirements produced for EXE 13.02.03-VP-314,

		EXE 13.02.03-VP-522 and EXE 13.02.03-VP-632, EXE 13.02.03-VP-700, EXE 13.02.03-VP-749
D342	VALP S1 R4	Validation plan for Release 3 and Release 4. It covers exercises EXE 13.02.03-VP-632, EXE 13.02.03-VP-723 and EXE 13.02.03-VP-522, as well as the EXE 13.02.03-VP-634 exercise, performed in collaboration with FairStream
D342	VALP S1 R5	Validation plan for Release 5. It covers exercises EXE-13.02.03-VP-700 and EXE-13.02.03-VP-749
D02	DCB-ASM Scenario step1 System Definition final	Technical Specification for and Final System Definition, describing the requirements pertinent to the implementation of “DCB/ASM Scenario management” system in step1 associated to “Cooperative Scenario Planning” Functional Block. The requirements are derived from the P04.07.07 Final Operational Service and Environment Definition (D25 OSED).
D482	VALR S2 R5 (covering VP746 results)	Step2 V2 Validation Report (final) addresses validation of the Collaborative 4D constraints management concept in a SESAR Step 2 DCB & Dynamic DCB environment. It covers exercises EXE 13.02.03-VP-746 and EXE 13.02.03-VP-315.
D422	SPR S2 V2 R6	Final Safety and Performance Requirements for SESAR Enhanced DCB Step2 concept in the “trajectory based operations” context
D453	Technical Specification S2 V2 (final): VP-746 Collaborative Constraint Management	Technical Specification for Release 5 exercise EXE 13.02.03-VP-746 on Collaborative Constraint Management. It covers the technical requirements for a new mechanism to manage the reconciliation of multiple constraints, the Constraint Reconciliation Manager, the introduction of a new mechanism to help in pro-actively managing the DCB Target-Time measures, the Constraint Adherence Manager and the consideration of Airspace User business constraints (their preferences and priorities).
D443	VALP S2 R6	Validation plan for Step 2 V1 and V2 exercises EXE-13.02.03-VP-315 and EXE-13.02.03-VP-746

1.4 Contribution to Standardisation

The project has not contributed to any standardisation activities.

P13.02.03 participated in the identification of relevant SWIM services for DCB Federation Service and SWIM services relevant to NOP services. The Service Design has been performed in the context of Service Activity SVA009 (entailing Federated Demand and Capacity Balancing) and SVA001 (entailing AOP-NOP Integration). In particular, it developed and assessed the following SWIM services:

- HotspotManagement: supports the Short-Term ATFCM Measures (STAM) concept by providing the concerned stakeholders with capabilities for managing Hotspot in support of network demand and capacity balancing.
- MCDM (Measure Collaborative Decision Making): manages and promotes the collaboration and coordination on the measures and messages exchanged.
- METHazardEnrouteForecast: defines an information service for exchanging Forecasts and Nowcasts of significant weather phenomena.
- METHazardEnrouteObservation: addresses the delivery of information on observed significant weather phenomena for air traffic.
- NMCapacityData: provides data and enable the update of capacity data (entry and occupancy) on traffic volumes
- NMFlightData: provides the list of flights per traffic volume, and detailed information about single flights.
- STAMMeasures: provides ways to manage Regulations, Reroutings, MCDMOnly measures and assess the impact of these measures by querying the ETFMS OpLog.
- TrafficVolumeInformation: provides detailed information on Traffic Volumes in AIXM format.
- AirportFlightPlanningInformation: supports the AOP-NOP integration concept by providing the concerned stakeholders with capabilities for exchanging extended departure and arrival planning information in support of network operations planning and airport operations to enhance predictability.

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1.5 Project Conclusion and Recommendations

Advanced Short-Term ATFCM Measures (STAM)

Conclusions

The validation activities encompassed the full scale of the STAM concept and its supporting enablers, covering the hotspot detection, STAM analysis and preparation, STAM coordination, STAM implementation and the STAM tool support.

The operational concept of Advanced Short term ATFCM Measures has been widely accepted and proven to work. All concept features are considered to have reached the following E-OCVM maturity level: V3 completed with acceptable issues.

Validation activities demonstrated that the STAM coordination task and information sharing is a crucial component of the STAM concept as it ensures the consistency between local and regional planning throughout the entire ATFCM process. During the validation it became apparent that the STAM coordination process and the relevant HMI was a source of a number of workload related issues and that, if moving away from phone coordination to more collaborative decision making with network information sharing is essential for the future wide-scale deployment of STAM, it requires an evolution in the support tool to allow a smoother coordination, less time and action demanding

Supporting enablers are considered at V3 maturity level (TRL6) with acceptable issues.

The STAM support tool evolution showed a good progress during the three validation exercises, but it still have outstanding issues to be resolved during V4.

The intense use of B2B services allowed to identify some caveats and to provide some recommendations.

Airspace Users are positive about their participation in the DCB coordination process but some simplification still need to be made to limit their coordination task to the minimum necessary.

The PCP requirements coverage is considered as complete.

Recommendations

Based on the conclusions described above, the following recommendations are formulated for the V4 phase of STAM concept/enabler maturity. These recommendations shall be reviewed and actioned if considered appropriate in the context of the forthcoming SESAR2020, as well as eventual PCP activities related to implementation of the Solution:

- Automation of the hotspot detection and assistance in the hotspot resolution monitoring shall be further elaborated.
- Improve the assistance in flight selection and STAM measure selection by development and usage of predefined STAM scenarios.
- Develop What If capabilities to facilitate assessment and sharing of STAM impact (for both ground and airborne measures).
- Simplify the overall STAM coordination process by for example:
    - Development of the procedures for the very short term STAM (V-STAM) with simplified coordination workflow.
    - Simplify STAM coordination procedures possibly by pre-approving certain STAM measures via STAM scenario management.
- The concept needs to provide means to coordinate flow oriented measures (MDI/MIT), which have not been sufficiently validated in SESAR 1.
- Limit the involvement of Airspace users to coordination of ground measures only (unless some AUs require being involved for airborne measures too) and further simplify the AU STAM tool support.
- AU consultation shall be made to discuss the trade-off between the costs of extra fuel burnt vs cost of delay saved (validated to be in the ratio of 1:10).
- Clarify with wider group of AUs (representing different business models) their interest in STAM process involvement (coordination of airborne/ground measures).
- Refine and test the role and responsibility of NMOC in the STAM process – e.g. Network performance monitoring role.
- Depending on the outcome of the NMOC actor role and responsibility refinement action, a Network Performance Monitoring support tool shall be developed to support the wide spread use of STAM (also useful for the Network Manager Function at the regional, sub-regional and local level).
- Further improve the local FMP tools to address the usability and integration issues.
- Prepare appropriate training in the industrialisation and implementation phase to help to reduce the workload impact by familiarisation with the concept and the tool support
- ANSPs and local tool industry suppliers need to better understand the NM business rules when connecting to existing B2B services, but also collaborate closely with NM on development of the new B2B services.
- Define a SLA with each B2B user in order to find an agreement on the service level, including frequency or requests, response time and the exchanged volume of data.
- Common and consistent definition of each B2B service shall be shared and agreed by all the actors involved in the use and implementation of B2B services (e.g. operational definition shall be in line with technical specification).
- Provide B2B users support to handle ad manage the transition between NMVP, NM PreOps and NM Ops for both testing and implementation.
- Discrepancy between data owned by the local systems and NM systems raised some problems during the STAM process: it needs to be investigated, together with the accuracy, predictability and synchronisation needs. According to the time horizon, different options

could be evaluated. Whilst it is clear that concepts such as the Flight Object Interoperability (FO & IOP) will address this issue in the long-term, a solution acceptable to all parties needs to be found that will mitigate these concerns in the short and medium terms.

DCB in a Trajectory Management Context (CTOT and TTA/TTO)

Conclusions

This Solution is strongly linked with the Collaborative NOP Solution, and especially with its aspects of Airport Operations Plan (AOP) integration. A huge leap was made from the initial Airport Impact Assessment and AOP/NOP Integration available in 2013 and the AOP/NOP Integration with embedded AIMA through full B2B service connections available in 2016. From the NM operations and systems side, all enablers are ready to accept and integrate Target Time DCB solutions proposed by a local tool.

With regard to the Airport and Airspace Users role in TTA allocation, the question whether Airspace Users always need to be actively involved or if Airports can act in some cases on behalf of Airspace Users could not be finally answered. Airspace Users consider a strong involvement in the Target Time Management process mandatory. Whilst the Airport Operators involved in the validation activities are convinced that the TTA allocation process as for the A-CDM process can only work with a reasonable degree of automation.

As from April 2016, the TTA dissemination is now part of the Flight List information provided by B2B Services and this data has been added to the Slot Allocation Message (SAM) and Slot Revision Message (SRM) within NM Release 20; the essential requirement of this concept is mature and already operationally available.

The shift of focus from departure to arrival for ATFCM constraints opens the potential to regulate long-haul flights. The distribution mechanisms for airborne flights need a different implementation which may need different communication technology and should be subject to a cost/benefit analysis.

Within Time Based Operations context, there is no active role of ATC in the target time adherence; however, the further evolution of the role of ATC in the context of trajectory based operations including TT adherence is not yet fully defined. The question is really to what extent ATCOs shall take assigned TTAs into consideration in their tasks of expediting traffic and traffic separation. Revising TTAs of flights already airborne has not been validated, and the real need may not be there in the future.

FMPs will not monitor individual flight's TTA adherence, but will rather monitor the evolution of hotspots. The TTA monitoring and revision process for airport hotspots needs to be revisited. Triggers for hotspot evolution and appropriate tools need to be developed.

Recommendations

Based on the conclusions described above, the following recommendations are formulated:

- A CBA for TTA dissemination to long haul flights needs to be done.
- ATC involvement, including integration of TT in ATC support tools (i.e. MTCD) should be consolidated at conceptual level before further validation involving ATC can be done.
- In connection with ATC involvement, integration with Arrival Management systems and procedures needs to be consolidated at conceptual level before any further validation involving ATC can be done. Still under consideration is enabling the Extended AMAN to propose actions on flights subject to DCB TTO and that are crossing a declared hotspot within the limits of the DCB static Target Window declared by DCB. This work will be continued in SESAR 2020 through the OI step DCB-0213 "Consolidation and facilitation of Target Times between local DCB, Airport CDM and Extended Arrival Management".
- The TTA Monitoring and Revision process for FMPs in case of airport hotspots has to be revisited at conceptual level, and new tools have to be defined.
- Airspace User preferences and other airspace user interaction should be integrated in the AIMA workflow process.

- Benefits of TTA adherence for all stakeholders have to be proven / demonstrated in large scale demonstrations before deployment.
- A joint consolidation workshop with the iStream Project shall be organised when the iStream Demonstration Report is available.

Collaborative NOP

The validation of OI DCB-0103-A / Solution #20 is under the responsibility of P07.06.01: conclusions are recommendations are part of the corresponding Final Project Report.

However, on the MassDiv concept, part of Collaborative NOP, it has agreed among the participants that the level of maturity reached in the definition of the concept, the roles and responsibilities and the operational requirements allowed to start the industrialization phase.

Collaborative 4D Constraints Management

Conclusions

Enhanced DCB in Trajectory Based Operations is focused on safety, optimal capacity, flight efficiency, predictability and collaboration between actors. DCB Constraints to Airspace Users will be minimised by introducing cooperation between En-Route Air Traffic Control centres, Airport operations and Airspace Users operations. This cooperation process should improve efficiently the use of ATC and flight resources.

The demonstration of the effectiveness, consistency and complementarity of solutions based on a mix of centralised CASA time-based constraints and use of boarder local time-based constraints are a first step in this direction. It paves the way to a new paradigm allowing the management of the Network with time-based solutions defined locally and with the centralised CASA mechanism.

The gap between the planning and the execution phase is filled with the introduction of the DCB plan monitoring in the execution phase allowing the local DCB in a continuous process to revise and adjust the DCB plan and to update/cancel the DCB constraints both for ground flight and airborne.

The delegation of responsibility has been demonstrated. A framework for Airspace Users to intervene with UDPP and for Airport to intervene with their own criteria (e.g. reactionary delay, Gate management) has been defined.

The prototype Network Working Position proposes an advanced DCB Toolkit which receives a positive feedback. It clearly lays the foundation for the NWP to fill its role:

- Support the management of many local DCB solutions,
- Support a what-if and the Network Performance assessment,
- Support the Dynamic Airspace Configuration and military interface,
- Support the accommodation of AU preferences and priorities (UDPP),
- Support the DCB plan monitoring and revision.

The process and procedures were successfully demonstrated through several collaborative decision-making scenarios.

It was demonstrated the feasibility to resolve a DCB hotspot while accommodating different optimisation criteria. A new paradigm based on a holistic approach in which, instead leaving DCB working in isolation, the ATM actors can collaboratively determine agreed solutions satisfying the individual needs, has been validated.

The concept is clear and effective and allows actors to manage efficiently and timely the coordination of DCB Measures.

Recommendations

Nevertheless, some conceptual elements of the concept have not been addressed; this paves the way for key recommendations that will have to be taken on board by the SESAR 2020:

- Integration of Dynamic Airspace Configuration (incl. military negotiation),

- Consideration of Airspace Users' preferences,
- Integration and support functions for UDPP,
- Improved Predicted Workload with complexity criteria and confidence index,
- Aid tool to provide automatic intelligent solutions (hotspot resolution) mixing types of measures (LevelCap, rerouting, target-Time), KPI, AU preference/priority.

2 References

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