Final Project Report

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Abstract

Project 07.06.02 addressed the topics related to Business and Mission Trajectories management and the Airspace Users Driven Prioritization Process (UDPP). Within Time-Based Operations context, two distinct evolutions addressing Business Trajectories have been developed: the definition of an extended flight plan (SESAR solution #37 contributing to ATM Functionality AF#4 of the Pilot Common Projects) used to enhance the quality of the planned trajectory information and the collection of user preferred route information in the medium-term planning phase. Those evolutions provided the basis to develop an initial implementation of the Shared Business Trajectory (SBT) and Reference Business Trajectory (RBT), supported by ICAO (FF-ICE increment 1, FIXM) and Flight Object developments (including the development of NM/ATC interoperability using the Flight Object Server). In the same context, the Mission Trajectory concept has been addressed by the development of the improved Operational Air Traffic flight plan (iOAT FPL) (SESAR Solution #38) including their harmonization and centralized verification and management at European level. On the other hand, the UDPP concept has been developed by providing Airspace Users the

opportunity to prioritize their flights to minimize the effects of delay, and validated with two SESAR Solutions: Enhanced ATFM Slot Swapping (SESAR Solution #56), and UDPP Departure (SESAR Solution #57). In the Trajectory-Based Operations context, P07.06.02 addressed the Business Trajectory life cycle, covering aspects of the creation of the SBT and the process for transition from the Shared Business Trajectory to the RBT, focused on the Medium and Short Term ATM planning phase and on Network Management in the ATM Execution phase from a network perspective only. P07.06.02 addressed as well processes and interactions between Actors and Systems required to manage the 4D trajectory. P07.06.02 developed the first steps on concept elaboration and validation of UDPP in the DCB context by allowing Airspace Users to collaboratively request in planning the reprioritisation of their important flights and/or delay apportionment on their set of flights based on fleet-relative priority information during a Hotspot at an Airport or/and Network Capacity Constrained Situation.

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Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
4D	4-dimensional
A-CDM	Airport-Collaborative Decision Making
ACC	Area Control Center
AF	ATM Functionality
AIRM	ATM Information Reference Model
ANSP	Air Navigation Service Provider
AOG	Aircrafts Operator Group
AOLO	Aircraft Operators Liaison Officer
AOP	Airport Operations Plan
AOWIR	Aircraft Operator What-If Reroute
ASM	Airspace Management
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATMRPP	Air Traffic Management Requirements and Performance Panel
AU	Airspace Users
B2B	Business to Business
CCS	Capacity Constrained Situation
CDM	Collaborative Decision Making
CFSP	Computerized Flight Plan Service Provider
CPS	City Pair Stats
CTOT	Calculated Take-Off Time
DCB	Demand Capacity Balancing

dDCB	Dynamic DCB (Demand Capacity Balancing)
DFLEX	Departure FLEXibility
DS	Data Set
EAD	European Aeronautical Information Service Database
EFPL	Extended Flight Plan
E-OCVM	European Operational Concept Validation Methodology
ETFMS	Enhanced Tactical Flow Management System
FDA	Fleet Delay Apportionment
FDP	Flight Data Processing
FF-ICE	Flight & Flow Information for a Collaborative Environment
FIXM	Flight Information Exchange Model
FMP	Flow Management Position
FO	Flight Object
FOC	Flight Operation Center
FOS	Flight Object Server
FPL	Flight Plan
GAT	General Air Traffic
HMI	Human Machine Interface
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFPS	Initial Flight Plan Processing System
iOAT	Improved Operational Air Traffic
IP	Internet Protocol
iRBT	initial Reference Business Trajectory
iSBT	initial Shared Business Trajectory
iSMT	initial Shared Mission Trajectory
ISRM	Information Services Reference Model
KPA	Key Performance Area

LOA	Letter Of Agreement
M-T	Medium Term
NM	Network Manager
NMC	Network Management Cell
NOP	Network Operation Plan
NPR	Nominal Preferred Route
OAT	Operational Air Traffic
OI	Operational Improvement
OSED	Operational Service and Environment
PCP	Pilot Common Projects
PTR	Profile Tuning Restriction
RAD	Route Availability Document
RBT	Reference Business Trajectory
RFL	Requested Flight Level
SBT	Shared Business Trajectory
SESAR	Single European Sky ATM Research
SFP	Selective Flight Protection
SID	Standard Instrument Departure Route
SME	Subject Matter Experts
SPR	Safety and Performance Requirements
S-T	Short-Term
STAM	Short Term ATFCM Measures
STAR	Standard Instrument Terminal Arrival Route
SWIM	System Wide Information Management
TI	Technical Infrastructure
TRL	Technology Readiness Levels
TS	Technical Specification
TTA	Target Time of Arrival

TTO	Target Time of Overflight
UDPP	User Driven Prioritisation Process
VALP	Validation Plan
VALR	Validation Report
VPA	Variable Profile Area
WOC	Wing Operation Centre
WP	Work Package

1 Project Overview

The main goal of this project was to develop and validate the management of user trajectories, preferences and priorities from a Network Management point of view. It includes the topics related to Business and Mission Trajectories management and the Airspace Users Driven Prioritization Process (UDPP):

- An initial implementation of the SBT (iSBT) and the RBT (iRBT) through two quick wins (extended flight plan and Nominal Preferred routes) and the implementation of the Flight Object concept,
- The Business Trajectory life cycle, covering aspects of the creation of the SBT and the process for transition from the Shared Business Trajectory to the Reference Business Trajectory,
- The development of NM/ATC interoperability using the Flight Object Server,
- An improvement of OAT ICAO 2012 Flight Plans (FPL) creating a view on the planned Mission Trajectory,
- The development of the UDPP concept to provide Airspace Users the possibility to play a role and keep their business priorities on track when operations are disrupted.
- The integration of UDPP in the Demand and Capacity Balancing (DCB) process

The following organisations contributed to the project: ENAIRE, ENAV, EUROCONTROL, INDRA, NATS, THALES.

1.1 Project progress and contribution to the Master Plan

SESAR Project P07.06.02 "Optimised Airspace User Operations" focused mainly on nine 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:

- EFPL (Extended Flight PLan) in NM processes: OI AUO-0203-A / SESAR Solution #37
- Harmonised and improved integration of airspace and ATC constraints/procedures in trajectories calculated by FOCs and NM: AUO-0223
- Nominal Preferred Routes within iSBT: AUO-0224
- Agreed iRBT to provide target time to ATM systems: AUO-0225
- Agreed iRBT: Exchange of EFPL with ATC: AUO-0226
- Agreed iRBT: Exchange of ATFCM measures with ATC: AUO-0227
- Sharing iSMT through improved OAT flight plan: AUO-0215
- Mission Trajectories: AOM-0304-A
- Enhanced ATFM Slot Swapping: AUO-0101-A / SESAR Solution #56
- UDPP Departure: AUO-0103 / SESAR Solution #57

Within the Trajectory Based Operations context, P07.06.02 focused on the following Operational Improvements:

- SBT including user preferences and trajectory information for DCB processes: AUO-0208
- SBT including User preferences associated to meteo scenario and DCB scenario: AUO-0218
- Use of all NOP information (DCB, ASM, weather), to compute optimal trajectory: AUO-0219
- Selective Flight Protection: AUO-0104

- Fleet Delay Apportionment: AUO-0105
- Re-prioritising flights during Execution: AUO-0106
- Flexible Credits: AUO-0107

In support to Project P07.06.01, P07.06.02 also contributed to validate the following Operational Improvement:

- Collaborative NOP: OI DCB-0103-A / SESAR Solution #20 (P07.06.01)

Extended Flight Plan (EFPL)

Most Airspace Users are currently using sophisticated flight planning tools in order to calculate as accurately as possible an operational flight plan for their flight. Flight planning tools then derive from the operational flight plan a flight plan in ICAO format. In this process, valuable information regarding the flight, including its calculated 4D trajectory, are lost because the ICAO flight plan format neither allows nor requires such information to be included. The resultant flight plan in ICAO format is used by ATC for the provision of air traffic services to the flight as well as the Network Manager and FMPs for air traffic flow and capacity management. Tools that are used by ATC, the Network Manager and FMPs are based on the calculation of a flight profile that is extracted from the flight plan in ICAO format. A number of assumptions are made and generic aircraft performance information is used in this process that make the locally calculated flight profile different from to the one originally calculated by the flight planning tools.

The Extended Flight Plan (EFPL) allows the exchange of trajectory information - in addition to ICAO 2012 flight plan information - between Aircraft Operators' Flight Operations Centre (FOC) and ATM in the short-term planning phase through SWIM-based B2B services. As an extension to ICAO 2012 FPL, it adds the 4D trajectory (filed trajectory) as calculated by the FOC flight planning system in support of the generation of the operational flight plan and flight specific performance data on climbing and descending capabilities of the aircraft.

Within Time based operations context, "softs" ATM constraints (constraints used for trajectory calculation but not for FPL validation) are integrated in the trajectory, either by Airspace Users themselves (after retrieval from a global database where they are published) or by NM in its EFPL reply message after its trajectory management process is completed upon reception of a EFPL by the Airspace User. It increases the accuracy and consistency of the planned 4D trajectory of a flight and therefore increases predictability both for AUs and NM.

In order to address regulatory and worldwide applicability aspects, the Extended FPL solution (SESAR Solution #37) is refined in close relation with the latest ICAO flight data exchange concept and standard developments (FF-ICE, FIXM).

A set of SWIM compliant EFPL services have been defined allowing the sharing of Business trajectories – Shared and agreed reference business trajectories - between all ground actors (including FOCs) through the NOP.

A set of validation exercises (from V2 to V3 maturity levels) have been performed to explore the feasibility of the EFPL data exchange between Airspace Users and the Network Manager, looking in particular onto flight plan validation process, DCB traffic prediction and human performance aspects. These exercises were performed in close cooperation with Airspace users and computerised flight plan service providers (CFSPs) from WP11.

After the validation activities, open points have been raised but they are not considered as showstoppers and do not need to be addressed in the first step of implementation of the solution #37. Involved stakeholders (including NM, the CFSPs and AUs) agreed that the SESAR Solution #37 achieved the E-OCVM V3 maturity level. This solution contributes to PCP ATM Sub-functionality AF#4-4 "Automated support for Traffic Complexity Assessment".

Nominal Preferred Route (NPR)

The Medium Term (M-T) planning carried out at present is based on historical data. This historical data is the result of the balance between the initial intention of the users and all the environmental factors and constraints (weather, ATFCM measures, special events, strikes …).

In order to improve the M-T planning, it is proposed to share commercial flight plans, allocated airport slot and Airlines preferred routing information with ATM actors, to support a better informed collaborative planning, as early as possible. The goal is to derive more reliable traffic forecasts that are needed to support operational use cases participating to the elaboration of the network operation plan. It is required for producing more accurate M-T capacity forecasts (seasonal capacity plans, monthly rostering and pre-tactical sector opening configurations better fitting the planned traffic) and for developing less impacting DCB measures with better informed decisions taken in collaboration with airspace users.

The Nominal Preferred Route concept consists of the collection of user-preferred routing information corresponding to the routing planned in nominal situations. This allows maintaining a more accurate view on the planned utilization of airspaces and sectors composing each airspace and better accommodating airspace users' preferences.

Functions dealing with the use of early flight intents are developed primary by DCB projects. P07.06.02 mainly focused on the concept of Nominal Preferred Routing to improve traffic demand prediction and the possible options for capturing and consolidating it with schedules and allocated airport slot data.

A V2 maturity level exercise has been performed as the first step in the concept validation to evaluate the use of NPR to support improved route predictions. Following this exercise and the limited outcome in terms of benefits for end users, the NPR concept is considered to be in maturity level V1.

NM/ATC trajectory alignment and TTA distribution through FO network

Conceptually the Flight Object (FO) is intended to hold all flight data that needs to be shared between any interested stakeholders: Civil ATC, Military ATC, Flow Management Systems, Airport Operators, Airspace Users and Aircraft Systems.

The Flight Object Server concept, and associated standard (ED-133), is a key enabler to improve interoperability between ground actors and move towards trajectory based operations. Initially focused on ATC/ATC interoperability, all stakeholders expressed the need for integrating NM in the future FOS network for different purposes:

- Ease the dissemination of flow management information to tactical ATC actors,
- Improve the accuracy of NM traffic predictions with ASNPs' information about local ATC constraints and tactical interventions,
- Better link trajectory management processes in planning and execution phases.

Initial FO developments and validation of ATC FOS and the NM FOS prototypes addressed these three areas of improvement:

- Communication of flight planning constraints (target times like TTO) and derived measures (e.g. CTOT) to relevant actors;
- Distribution of Flight Plan information;
- Network planning trajectory enriched with local ANSPs information on constraints and procedures affecting the trajectory. This allows reducing the gap between the different trajectories in the ATM system and improving efficiency of network monitoring and DCB/dDCB processes.

Through a validation exercise, P07.06.02 demonstrated the technical feasibility of sharing FPL information via the Flight Object server, and the improved interoperability thanks to 4D trajectories enriched with ANSPs and NM information.

The validation activities, at an early V2 maturity level (TRL 3), allowed identifying topics that should be addressed by the next version of the EUROCAE ED-133 "Flight Object Interoperability Specification" document.

Initially a V3 validation, addressing NM/ATC interoperability through the Flight Object (FO), was planned in 2016, but it was cancelled due to the overlap with other FO exercises dealing with ATC/ATC interoperability and the lack of resources from ANSPs to perform several FO exercises in parallel.

iOAT Flight plans

The Single European Sky, aiming at maximising the usage of the airspace by coordinating the requirements of all airspace users, requires full transparency on all flights planned for both civil and military airspace managers, Network Manager and ATS units.

A single flight plan repository for Europe, containing both civil and military flight plans, is a logical evolution together with adopting a common format for all military flights i.e. GAT, mixed OAT/GAT and all OAT flights for which a filed flight plan is required. The goal is that improved OAT ICAO Flight Plans (FPL), creating a view on the planned Mission Trajectory, are delivered at the day of operations through Base/Wing Operations into the respective civil and military channels taking advantage of system facilities and communication means available at regional network level for the management and dissemination of GAT flight plans.

P07.06.02 defined and validated operating methods, operational scenarios, use-cases and detailed requirements related to improving OAT Flight Plans in close cooperation with WP11. The objective was to define a common format for OAT flight plans with the integration of military aeronautical data in the EAD database to have a better consistency with civil data and avoid/reduce errors in the flight plan definition. It should facilitate the definition of a cross-border OAT flights by having a single definition of the flight plan.

The distribution by military AUs of the flight plan is done by sending a single copy to the central flight plan validation and management service provided by the Network Manager. The Network Manager would be in charge of the further distribution to all concerned military and civil ACCs as already in place for civil FPLs.

Validations activities brought the associated OI AOM-0304-A to E-OCVM V2 maturity level / TRL 3.

Business Trajectory within Trajectory Based Operations

Within Trajectory Based Operations context, P07.06.02 addressed at concept level the Business Trajectory life cycle, focusing on the Medium and Short Term ATM planning phase and on Network Management in the ATM Execution phase from a network perspective only. It covered aspects of the creation of the Shared Business Trajectory (SBT) and the process for transition from the Shared Business Trajectory to the Reference Business Trajectory (RBT). It also addressed the processes and interactions between Actors (human and organisation) and Systems required to manage the 4D trajectory. Initially, it addressed the more general Operational Improvements AUO-0203-B “Shared Business/Mission Trajectory (SB/MT)” and AUO-0204-B “Agreed Reference Business / Mission Trajectory (RBT/ RMT)” which were too wide, and thus, split in different OIs with a more defined scope: AUO-0218 "SBT including User preferences associated to meteo scenario and DCB scenario", AUO-02019 "Use of all NOP information (DCB, ASM, weather), to compute optimal trajectory" and AUO-0208 "SBT including user preferences and trajectory information for DCB processes".

The validation activities addressed, from a Network Manager perspective, the aspects related to the Planning phase of the Business Trajectory, from Medium-Term to Execution, focusing on the interactions between stakeholders, evaluation of key data, impact assessment of trends on different KPAs, evaluation of limiting factors and roles & responsibilities.

The validation exercises embraced all the planning phase of the Business Trajectory, from the first SBT submission until the transition SBT→RBT, focusing mainly on the activities related to the short-term planning. The results of this activity are qualitative in content due to the nature of the gaming exercises undertaken and the method of feedback obtained from Subject Matter Experts (SMEs) during the exercises.

The overall definition of the SBT management process in Trajectory Based Operations has not fully achieved E-OCVM V1 Maturity level.

User Driven Prioritisation Process (UDPP)

Long in advance, Airspace Users (AUs) schedule their flights to match their commercial strategy. However, on Medium/Short-Term Planning or Execution phases, high Demand Capacity Imbalance situations generate delays that affect Airspace Users operations. Sometimes delay is such that AUs have to cancel some of their flights.

However, from an AU point of view, all flights are not equal: some are fully booked whereas others aren't; some transport connecting passengers, some are important to get on time to respect IATA airport slot punctuality, etc. The AUs have few means to react on disrupted situations delays and "choose" which flight they would like to get least/most impacted.

The UDPP aims to provide AUs the possibility to play a role and keep their business priorities on track when operations are disrupted. UDPP ensures that within the capacity limitations given, the maximum usage of the available capacity is being used, while taking Airspace User priorities into account.

By giving the Airspace Users the opportunity to prioritize their flights, the benefit obtained with UDPP can be summarized as:

- Reducing the inefficiency caused by primary delay and reactionary delay of Airspace User operations, and
- Reducing the cancellation-induced cost for passenger compensation, both direct (paying the passenger) as well as indirect (rerouting, lodging, etc.).

Within Time based operations context, UDPP provides AUs more opportunities and flexibility to rearrange their flight sequences by prioritising, swapping, or reordering. Two SESAR solutions have been put through validation: Enhanced ATFM Slot Swapping (OI AUO-0101-A / SESAR Solution #56), and UDPP Departure (OI AUO-0103 / SESAR Solution #57):

- On en-route congestion, the existing air traffic flow management (ATFM) slot-swap is extended to allow an enhanced service, providing a wider range of possibilities and increased flexibility.
- On departure, the AUs priority demands is taken into account and processed into the pre-departure sequence. UDPP is in essence a collaborative decision making (CDM)-based process, all stakeholders contribute to the decision making process that ultimately produces a pre-departure sequence, respecting the Business Interest of the Airspace User. Departure swapping is not just available during times of capacity constraint at the departure airport, but is also available for flights that have accumulated their own delays in the absence of any network or airport delay.

These solutions have been brought to V3 maturity level

Within Trajectory based operations context, P07.06.02 addressed specifically Airport Departure and Arrival Constrained Situations at planning phase. Two different concept components, Fleet Delay Apportionment (FDA), and Selective Flight Protection (SFP), can be employed to facilitate the anticipative management of flight schedules.

- Fleet Delay Assignment (FDA) lets AUs decide how the delay they must absorb in a Hotspot should be distributed among their flights;
- Selective Flight Protection (SFP) lets AUs put important flights onto their scheduled times by suspending other less important flights, i.e. push them at the end of the hotspot.

AUs individually provide fleet-relative priority information on their set of flights and collaboratively request reprioritisation of their flights. Prioritisation information helps DCB (and airport) identifying relative priorities among flights of one AU as an input to the Airport and Network Sequencing processes.

Through a set of validation exercises, the validation activity has been concluded with an E-OCVM mid-V2 human in the loop validation exercise involving AUs acting for fleet prioritisation using EUROCONTROL Airport APOC platform extended with UDPP as a new FOC functionality and connected to a SABRE prototype dealing with cost of delay for each flight.

Operational Improvements and Enablers

The following lists the Operational Improvement steps and the Enablers linked to topics and Solutions presented previously. 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	Maturity at

			project start	project end
AUO-0203-A	EFPL in NM processes	The Solution #37 "Extended Flight Plan" has been validated by P07.06.02 through a set of exercises (VP-311, VP-616 and VP-713) and achieved V3 maturity level at the end of VP-713.	V2	V3
AUO-0223	Harmonised and improved integration of airspace and ATC constraints/procedures in trajectories calculated by FOCs and NM.	This OI should have been validated within VP-713 but prototypes were not ready. It has been partially addressed in VP-311. Its maturity level is considered V1.	V2	V1
AUO-0224	Nominal Preferred Routes within iSBT	A V2 maturity level exercise (VP-715) has been performed. Following this exercise and the limited outcome in terms of benefits for end users, the NPR concept is considered to be in maturity level V1.	V1	V1
AUO-0225 AUO-0227	Agreed iRBT to provide target time to ATM systems Agreed iRBT: Exchange of ATFCM measures with ATC	The validation of these OIs has been partially addressed with exercise VP-714. Due to technical limitations and low maturity of some of the concept elements considered at that time (e.g. Target times) the exercise cannot be considered as a pure operational validation. It must be rather viewed as “system validation” encompassing verification of technical feasibility, validation of interoperability improvements and assessment of benefits for enabling processes (e.g. traffic prediction). Their maturity level is V2/TRL3.	V1	V2
AUO-0101-A	Enhanced ATFM Slot Swapping	The project 07.06.02 developed the SESAR Solution #56 "Enhanced ATFM Slot Swapping" defined by the OI AUO-0101-A through a set of validation exercises (VP-726, VP-727 & VP-712). The Solution #56 defines new features aiming to provide more flexibility and re-prioritising opportunities for AUs to reduce their cost of delay: these features defined in the concept reached different maturity levels. Two of these features are now at the V3 maturity level i.e. the "Multi-swap (up to 3 times per flight) and the "Substitution	V1	V3

		on cancellation". It has to be noted that for this solution a "swap identification tool" has been developed and is still being used with live traffic by an increasing number of airlines since the trial under the supervision of the NM AOG, until deployment by NM in 2017. The functionality should be deployed by the NM in 2017.		
AUO-0103	UDPP Departure	Regarding Airport CDM, the Solution #57 based on the OI AUO-0103 allows the Airspace Users to change (via the pre-departure management process) the priority order of flights in the pre-departure sequence. This solution has proven through 07.06.02 validation activities (VP-726, VP-727 and DFLEX SESAR demonstration project) to be at least at V3 maturity level (already deployed at CDG airport).	V1	V3
AOM-0304-A	Mission Trajectories	With the exercise VP-716, the project 07.06.02, validated, in cooperation with P11.01.05, the feasibility of a central verification and management of the improved OAT Flight Plans (iOAT FPL) by NM - OI AOM-0304-A. PRO-014 enabler has been brought to TRL4 with this exercise. V2 maturity/TRL3 has been achieved.	V1	V2
AUO-0218 AUO-0219 AUO-0208	SBT including User preferences associated to meteo scenario and DCB scenario Use of all NOP information (DCB, ASM, weather), to compute optimal trajectory SBT including user preferences and trajectory information for DCB processes	The VP-744 exercise addressed, from a Network Manager perspective, the aspects related to the planning phase of the Business Trajectory, from medium term to execution, focusing on the interactions between stakeholders, evaluation of key data, impact assessment of trends on different KPAs, evaluation of limiting factors and roles & responsibilities. As OIs AUO-0203-B and AUO-0204-B had a wide operational scope, they were split in DS14 in several OIs focusing on defined operational scope: AUO-0218, AUO-0219 and AUO-0208. The overall definition of the SBT management process in step 2 has	V1	V1

		not fully achieved V1. Some items assessed during the exercise (i.e. 4D What-if tool, Congestion Level Indicator) are mature enough to be moved to V2 phase, some others (Desired Trajectory, Alternative Trajectory, Negotiating Trajectory, Agreed Trajectory, Confidence Level, Preferences, Fully CDM AU and Partially CDM AU) require further refinement and agreement from all stakeholders involved.		
AUO-0104 AUO-0105 AUO-0107	Selective Flight Protection Fleet Delay Apportionment Flexible Credits	P07.06.02 extended the UDPP concept with a collaborative prioritisation process. In capacity-constrained situations, airspace users can provide flight priorities (Selected Flight Protection AUO-0104 and Flight Delay Apportionment AUO-0105) based on their business needs. The OIs are progressing in V2 maturity (exercises VP-728, VP-729 and VP-730). P07.06.02 extended the UDPP concept for a potential use by “low volume” AUs (typically BA/GA, ore scheduled AU with few flights in a hotspot) (AUO-0107). This extension is in a V1 maturity level. The associated enabler AIRPORT-48 is as the same maturity level.	V0	Mid-V2 (V2 maturity not reached)
AUO-0106	Re-prioritising flights during Execution	Although a request from the AUs, no progress have been made in the possibility to re-prioritise flights in planning even during their execution (typically for arrivals).	V0	V0
AIMS-06	Ground-Ground AIS provision to ASM	Developments undertaken validation activities of OI AOM-0304-A allowed to contribute to validate this technical enabler to TRL6: exercise VP-716	TRL3	TRL6
AIMS-19b	Aeronautical Information system is interfaced to receive and distribute aeronautical information electronically to military systems.	Developments undertaken validation activities of OI AOM-0304-A allowed to contribute to validate this technical enabler to TRL4: exercise VP-716.	TRL2	TRL4
AIRPORT-06	UDPP Departure on A-	Developments undertaken validation activities of OI AUO-0103 allowed to	TRL1	TRL6

	CDM Airport system	contribute to validate this technical enabler to TRL6: DFLEX. This enabler has only been covered within DLEX demonstration project not under P7.6.2 responsibility.		
AOC-ATM-17	UDPP Departure system for FOC	Developments undertaken validation activities of OI AUO-0103 allowed to contribute to validate this technical enabler to TRL6: DFLEX. This enabler has only been covered within DLEX demonstration project not under P7.6.2 responsibility.	TRL1	TRL6
AOC-ATM-18	FOC adaptation to support UDPP	Developments undertaken validation activities of OIs AUO-0104, AUO-0105 allowed to contribute to validate this technical enabler to TRL4: exercise VP-728, VP-729, VP-730. Sabre prototype for SESAR 1 possibly not available in SESAR 2020.	TRL1	TRL3
AOC-ATM-20	Sharing of trajectory data between AOC/WOC and the ATM world using B2B web services	Developments undertaken validation activities of OI AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713, VP-616.	TRL2	TRL6
ER APP ATC 82	Enhance FDP to use SBT/SMT, RBT/RMT	Developments undertaken validation activities of OIs AUO-0225 & AUO-0227 allowed to contribute to validate this technical enabler to TRL3: VP-714	TRL1	TRL3
MIL-0502	Upgrade of military ground systems to allow bi-directional exchanges with non-military IP networks	Developments undertaken validation activities of OI AOM-0304-A allowed to contribute to validate this technical enabler to TRL6: exercise VP-716.	TRL2	TRL6
MIL-STD-03	Update of IFPS User Manual to include OAT Specificities in the Flight Plan (Improved OAT flight plan)	Developments undertaken validation activities of OI AOM-0304-A allowed to contribute to validate this technical enabler to TRL4: exercise VP-716.	TRL1	TRL4
NIMS-21a	Initial Flight Planning management enhanced to support 4D for Step 1	Developments undertaken validation activities of OI AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713, VP-616, VP-311.	TRL2	TRL6
NIMS-21b	Flight Planning management enhanced to support 4D	Developments undertaken validation activities of OI AUO-0227 allowed to contribute to validate this technical enabler to TRL3: exercise VP-744.	TRL1	TRL3

NIMS-35	Flight Planning management sub-system enhanced to process improved OAT flight plans	Developments undertaken validation activities of OI AOM-0304-A allowed to contribute to validate this technical enabler to TRL4: exercise VP-716.	TRL1	TRL4
NIMS-39a	Enhancement of ETFMS	Developments undertaken validation activities of OI AUO-0101-A allowed to contribute to validate this technical enabler to TRL6: VP-726, VP-727 & VP-712	TRL1	TRL6
NIMS-39b	Enhancement of FOC HMI	Developments undertaken validation activities of OI AUO-0101-A allowed to contribute to validate this technical enabler to TRL6: VP-726, VP-727 & VP-712	TRL1	TRL6
NIMS-40	Use of FO trajectory and constraints in NM systems	Developments undertaken validation activities of OI AUO-0227 allowed to contribute to validate this technical enabler to TRL3: VP-714.	TRL1	TRL3
NIMS-43	Enhanced NM systems to process the Flight Object (FO) data related to the NM cluster including STAM, TTA and EFPL information	Developments undertaken validation activities of Ois AUO-0225 & AUO-0227 allowed to contribute to validate this technical enabler to TRL2: VP-714	TRL1	TRL2
NIMS-44	Evolution of NIMS to support management of UDPP	Has not been validated so far in P7.6.2 but integration of UDPP in DCB is partially covered in the OSED. Shall be further refined in SESAR2020.	TRL1	TRL1
NIMS-51	NM systems adaption to support the NPR concept	Developments undertaken validation activities of OI AUO-0224 allowed to contribute to validate this technical enabler to TRL2: VP-715.	TRL1	TRL2
SWIM-APS-01a	Provision of Aeronautical Information services for Step 1	Developments undertaken validation activities of OIs AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713	TRL3	TRL6
SWIM-APS-02a	Consumption of Aeronautical Information services for Step 1	Developments undertaken validation activities of OIs AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713	TRL3	TRL6
SWIM-APS-03a	Provision of ATFCM Information Services for Step 1	Developments undertaken validation activities of OIs AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713	TRL3	TRL6

SWIM-APS-04a	Consumption of ATFCM Information Services for Step 1	Developments undertaken validation activities of OIs AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713	TRL3	TRL6
SWIM-APS-05a	Provision and Consumption of Flight Object Sharing services for Step 1	Developments undertaken validation activities of OIs AUO-0225 & AUO-0227 allowed to contribute to validate this technical enabler to TRL3: VP-714	TRL3	TRL3
SWIM-GOV-05a	Regulatory Provisions for SWIM roles and responsibilities (organisational requirements)	Developments undertaken validation activities of OIs AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713	TRL3	TRL6
SWIM-INFR-05a	General SWIM Services infrastructure Support and Connectivity.	Developments undertaken validation activities of OIs AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713	TRL3	TRL6
SWIM-NET-01a	SWIM Network Point of Presence	Developments undertaken validation activities of OIs AUO-0203-A allowed to contribute to validate this technical enabler to TRL6: VP-713	TRL3	TRL6

1.2 Project achievements

Extended Flight Plan (EFPL)

Most of operational requirements related to information to include in the Extended flight plan, to the use of the information in NM operations and systems and to the required B2B services in support to implementing the solution have been validated.

Validation activities clarified the need to include both the 4D trajectory and flight performance data in the EFPL to achieve improvements on the following aspects:

- Flight plan acceptance process by reducing both the rates of wrongly accepted and wrongly rejected flight plans;
- Reduction of trajectory misalignment between the AU and NM actors;
- Traffic predictability (mainly on prediction of sector crossed in climbing phase and occupancy times).

It showed that in the first implementation step, full alignment cannot be achieved without a risk of reducing predictability. In particular, NM needs to adapt the AU trajectory received in the EFPL to better reflect ATC procedures (e.g. Letter Of Agreements that will impact the trajectory in execution).

It clarified the impact of the EFPL on operators:

- At AU side, the EFPL will provide much more situation awareness to operators of NM operations impacting the flight due to increased alignment of trajectory views at both sides. This will provide AU operators with much more fine-tune means to minimise the impact of network constraints (flight restrictions, ATFCM regulations) on the trajectory.

- AT NM side, the role of IFPS operators will progressively evolve from the current role of manually correcting flight plans towards a role of advising AU operators on how to change themselves the trajectory when a flight plan is rejected.

The SWIM compliance assessment team concluded that the EFPL SWIM services ExtendedFlightPlanSubmission and FlightPlanDataDistribution are: Information Service Compliant (ISRM), Information Ready (AIRM) and TI Binding Yellow Profile Compliant (TI Level).

Validation activities contributed to identify significant HMI improvements both at NM and AU sides to better integrate the new information exchanged.

One major unclarified point is related to flight information returned back by NM to the AU in case of flight plan acceptance and how this information could be used by AU to improve trajectory alignment and predictability (while not increasing operator workload).

The KPA capacity was not directly measured but was addressed through the metrics related to traffic predictability. The following results have been obtained related to the impact of the EFPL on sectors traffic predictions:

- No clear trend regarding the impact of EFPLs on entry times prediction accuracy;
- A more significant improvement of the predictions of the sector occupancy times mainly in climbing phase.

Regarding cost- efficiency related to NM operator workload, two factors were considered:

- The impact of EFPL on the rate of FPL rejection (shadow mode sessions)
- The time consumed by NM operators per rejection.

For the first factor, quantitative measures were performed showing that, under certain conditions, the EFPL pass rate could become very close to 98% and the number of rejections could decrease significantly (between 30% and 50%).

For the second factor, gaming exercise highlighted that in the future the role of NM operators will evolve. Most of the rejections will be probably treated in automatic rejection mode and in that case the NM operator will be involved only if the AU dispatcher contacts him to request for support.

For Airspace Users' Cost-Efficiency, the predominant conclusion of the participating AUs was that use of the EFPL would decrease the workload of the flight dispatchers as the number of wrongly rejected ICAO flight plans can be reduced to a minimum. Apart from that, AU cost efficiency could also be related to the ability to file the most optimum trajectory for a flight.

Main critical safety requirements have been validated. In particular, it has demonstrated that the EFPL does not create risks in some safety critical processes like flight plan distribution to ANSPs and identification of potential overloads in DCB.

Nominal Preferred Route (NPR)

The analysis of the impact of NPR on predictability in Medium-Term planning phase is showing potential benefits in particular in terms of prediction of traffic counts in airspaces. Better predictions can positively impact the KPAs Capacity, Efficiency and cost-efficiency

However, validation exercise did not provide quantitative assessment since the impact is indirect and needs to be addressed by relevant projects (P13.02.03 regarding benefits at DCB level, P07.05.04 regarding planning of ATM resources).

NM/ATC trajectory alignment and TTA distribution through FO network

The validation activities demonstrated:

- The technical feasibility of NM integration in ATSUs FOS-enabled network
- This integration could allow ATCOs to visualize valuable TTO/TTA information.
- Exchanging information between NM and MUAC through FO mechanism improves NM traffic prediction.
- NM-ATC interoperability is perceived as improved by all participants

iOAT Flight plans

The validation activities demonstrated the feasibility to implement the improved OAT flight plan and the corresponding military aeronautical environmental data in the central flight plan management and validation process of the Network Manager.

The implementation of the iOAT FPL and related military environment data alone, as expected, does not trigger immediate performance benefits on its own, but their availability has to be considered as the required foundation stones to build on.

Benefits are expected to become visible with the use of the additional information contained in the iOAT FPLs by the DCB and ATC processes (in particular due to a better knowledge of military flight intentions and aircraft performances).

Business Trajectory within Trajectory Based Operations

Validation activities provided useful input for the further refinement of Business Trajectory planning process, supplying qualitative feedback on the different components identified in the planning phase of BT:

- The "What-if 4D" tool was the best-valued concept as an enhancement of a similar tool already extensively used today (AOWIR).
- Agreed Trajectories, Desired Trajectories, Preferences, Confidence Level, Alternative Trajectories in short term and the provision of DCB information to the AU were quite well evaluated.
- On the other hand, the use of Alternative Trajectories in Medium term obtained the lowest evaluation.

The validation activities allowed to clarify the maturity level of all concept features presented above. It also allowed to identify the convergence and differences with ICAO FF-ICE concept.

User Driven Prioritisation Process (UDPP)

The validations allowed the development of the "ATFM slot swapping" prototype. This prototype continues to be used operationally by a small group of pioneer airlines, since the end of the validations in March 2015. The NM is giving access to the prototype to an increasing number of airlines since the trial until deployment (foreseen in 2017).

The ATFM slot-swapping prototype was also observed to increase significantly the acceptance rate of swap requests by preventing requests that broke one of the many swapping rules or constraints. This may also reduce the workload of both airspace user and the NM operator (because fewer revised requests are needed).

The validations demonstrated that the Solution #56 could save an estimated 4900 euros for airspace users, on average, per swap. Scaled up to a year, the savings would be 7.6M€ (based on 1500 swaps observed in 2013). Enhanced slot swapping will also provide Airspace Users with more swap opportunities, which will improve the flexibility for mitigating capacity constrained situations and reducing their cost of delays.

The Solution #57 (UDPP Departure) demonstrated that it can provide flexibility to Airspace Users to better cope with delay and to minimize the impact on priority flights, most especially to those that have a significant presence at the airport. On the equity aspect, “Flexibility can be given to airlines without impacting operations and capacity and with respecting equity among airlines”. However, there appears to be an impact on some flights that are not involved in the actions, but that happen to be temporally in proximity. The impact is an increase in average delay. On the other hand, flights that are subject to users actions (i.e. flights that are improved and deteriorated) experience on average a reduced delay. It will be up to decision makers and stakeholders at each airport to decide prior to operational implementation if the benefits and possible disadvantage are sufficiently appealing.

The Solution features have been implemented operationally at Paris CDG, and are now therefore available to all airspace users.

Within Trajectory Based Operations context, the validation activities centred on two new UDPP concept features useful for departure and arrival capacity constraints (fleet delay apportionment (FDA) and selective flight protection (SFP)) allowed demonstrating that:

- The FDA and SFP are in early to mid V2 maturity according to the E-OCVM
- FDA and SFP concepts are both needed (rather than just one or the other). FDA provides most to achieve the goal of the airspace user.
- The 'what-if' capability to play test the prioritization of the fleet is appreciated by airspace users and should be kept in the concept.
- UDPP appears useful for both departure and arrival capacity constraints.
- FDA and SFP do not increase the total delay in the hotspot.
- Both FDA & SFP algorithms behave as designed
- SFP will be used if there is a net cost saving for an airspace user, meaning an increase in total delay would be a price worth paying.
- FDA does not improve markedly an airspace user's punctuality in a hotspot. However, SFP could provide a significant improvement in punctuality for an airspace user (but at the expense of accepting significant extra delay for some of his flights).
- The validation activities cannot provide an exhaustive analysis of the merits of FDA and SFP in terms of equity because too few validation scenarios and runs were carried out. But it appeared that:
    - Airspace users that don't participate in UDPP are affected by the prioritization decisions of others. This happens whether FDA is used or SFP, or both.
    - The total delay for non-participant airspace users decreases if other airspace users use only SFP. If only FDA is used to prioritize, the total delay for non-participants may increase or decrease (a couple of percent was observed).
    - The flights of non-participants are not affected equally. Some flights experience increased delay and some reduced delay, which is true whether FDA or SFP are used for prioritization. In either case, most flights belonging to non-participants have a delay very similar to their baseline delay (within a few minutes), and a few have slightly larger gains or losses.

1.3 Project Deliverables

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

Reference	Title	Description
D69	Step 2 V1 Business trajectory Updated OSED	This Operational Service and Environment Description document for Business Trajectory concept in "Trajectory based operations" context at V1 maturity level describes the proposed approach to develop a solution for the trajectory management in short-term planning phase from a network operational perspective, meeting the Stakeholders expectations. The document also addresses the processes and interactions between Actors (human and organisation) and Systems required to iteratively refine SBT in short term planning phase.
D57	Step 1 Business trajectory final	This Safety and Performance Requirements (SPR)

	SPR	document provides the safety and performance requirements for Services related to the operational Processes defined in Step1 Business Trajectory concept OSED in the “time based operations” context and more specifically to the Extended Flight Plan concept.
D92	Step 1 EFPL Technical Specification	This Technical Specifications document specifies requirements for SESAR Solution #37 that will affect the NM B2B web services and NM systems and the way that the different systems of the Airspace Users verify and communicate the Extended Flight Plans with NM through B2B services.
D56	Step 1 Business trajectory OSED final update	This Operational Service and Environment Description document for Business Trajectory concept within "Time based operations" context describes two distinct evolutions including the definition of an extended flight plan (which corresponds to the SESAR solution #37) allowing the exchange of trajectory information between Airspace Users and ATM and the collection of user preferred route information in the medium term planning phase.
D51	Step 1 Mission trajectory OSED final update	This Operational Service and Environment Description document for Mission Trajectory concept in "Time based operations" context develops improvements for Operational Air Traffic (OAT) flight plans including their harmonization and centralized management at European level and the provision and management of early intentions for military activities.
D55	Step 1 Business trajectory validation report for VP713	This Final Validation Report presents the results of the validation activities for Exercise VP-713 validating Solution #37 in "Time based operations" context
D93	07 06 02 delivery of contribution to updated 4D Trajectory Architecture Study	Document describing a possible architecture for the exchange of trajectory data between all ATM actors having in mind the "Time based operations" scope.
D53	Step 1 final Technical Specs for FOS	Technical Specifications providing in "Time based operations" context a solution for integrating the Eurocontrol Network Manager Systems into the world of Air Traffic Control Centres Interoperability which is based on the Flight Object concept.
D17	Step 2 V1 Business trajectory VALR for VP-744	This Final Validation Report presents the results of the validation activities for Exercise VP-744 validating Business trajectory concept in "Trajectory based operations" context.
D46	Step 1 Business Trajectory validation report for VP714	This Final Validation Report presents the results of the validation activities for Exercise VP-714 validating Business trajectory concept in "Time

		based operations" context.
D50	Step 1 Mission trajectory VALR update for OAT	This Final Validation Report presents the results of the validation activities for Exercise VP-716 validating Mission trajectory concept in "Time based operations" context.
D48	Step 1 Technical Specs for OAT prototype	Technical Specifications for prototype supporting the validation of the Improved OAT Flight Plan concept as part of VP-716 validation exercise in "Time based operations" context
D90	Step 2 V2 UDPP VALR - final	This Final Validation Report presents the results of the validation activities (VP-728, VP-729, VP-730 and human impact assessment) for UDPP validation activities in "Trajectory Based Operations" context at mid V2 maturity level (at the end of the project).
D79	Step 2 V2 UDPP FINAL OSED	Final Operational Service and Environment Description for UDPP concept in "Trajectory Based Operations" context at V2 maturity level. It addresses specifically Airport Departure and Arrival Constrained Situations. It also includes provision for Low Volume Users like business aviation and general aviation.
D66	Step 1 V3 UDPP final OSED	This Operational Service and Environment Description document for UDPP concept in "Time Based Operations" context at V3 maturity level describes operational requirements for SESAR Solutions #56 & #57.
D68	Step 1 V3 UDPP SPR	This Safety and Performance Requirements (SPR) document provides the safety and performance requirements for Services related to the operational Processes defined in " Time Based Operations" UDPP concept OSED in the “time based operations” context and more specifically to SESAR Solutions #56 & #57.
D67	Step 1 V3 UDPP Validation Report	Final Validation Report for UDPP validation activities (VP-725, VP-726, VP-712) in "Time Based Operations" context at V3 maturity level, including SESAR Solutions #56 & #57.
D63	Step 1 UDPP technical specs for ESS prototype	Technical Specifications for prototype allowing to evaluate possible benefits of UDPP Extended Slot Swapping process in "Time Based Operations" context. In support to exercise VP-712.

1.4 Contribution to Standardisation

The development of the Extended Flight Plan in Europe has been conducted in close coordination with the definition of ICAO FF-ICE increment 1 provision and FIXM V4.0 standards. Therefore, any validation on EFPL impacts potentially these regulation and standardisation initiatives.

The results of validation activities, in particular the technical exercise addressing the validation of the FIXM based B2B services in support to Extended FPL submission, provide a solid material for promoting the Extended Flight plan in ICAO groups (ATMRPP) and FIXM community. All the new information elements of the Extended Flight Plan addressed in the different SESAR exercises (e.g. 4D trajectory, flight performance data, Take-off mass) have already included in FIXM 4.0 and are part of FF-ICE provisions.

Moreover, the developed FIXM extension is providing strong input to the FIXM community not only in terms of data elements but also in terms of service and message definition.

iOAT Flight plan

The experience gained by the exercise VP-716 provides valuable inputs to the work on regulation and standardisation at the ICAO FF-ICE level towards a unique future FPL format for both GAT and OAT. In addition, further work is required to develop the future standards for aeronautical data, to allow the integration of military and civil environment data in one database.

The B2B SWIM service for iOAT submission developed and validated by P07.06.02 will be an input to FIXM 4.0 developments.

Flight Objects and TTA/TTO information

Prototypes developed during validation of "NM/ATC trajectory alignment and TTA distribution through FO network" define new information exchange specification between ATC and NM Flight Object Servers. These technical specifications cover an extension from ED 133 standards and results of validation activities provided recommendations for future version of ED-133 Flight Object Interoperability Specification.

1.5 Project Conclusion and Recommendations

Extended Flight Plan (EFPL)

Conclusions

Operational feasibility of the use of the extended flight plan has been proven both at the level of flight planning and flow management.

- Main critical safety requirements have been validated. In particular, it has demonstrated that the EFPL does not create risks in some safety critical processes like flight plan distribution to ANSPs and identification of potential overloads in DCB. Some specific issues in some geographical areas need further analysis and resolution but these can be addressed during implementation on a case by case basis.
- Some immediate benefits have been demonstrated both at the level of flight planning and flow management in terms of increased transparency and trajectory alignment, less FPL rejections or increased traffic predictability in some specific areas.
- The EFPL provides to Airspace users with fine-tuned means to plan trajectories avoiding flight planning constraints or ATFCM regulations leading to more optimised filed 2D routes and/or vertical profiles.
- The technical feasibility of EFPL dedicated services has been proven. Dedicated services using the current NM B2B interface were prototyped and successfully used in the context of shadow mode sessions by on AUs on-site legacy flight planning systems.
- Standardisation needs have been covered and the migration to FIXM - the format for the future ICAO FPL - has been tested successfully.

A number of points have remained open:

- Validation activities shown that in a first implementation step, a full alignment of AU and NM trajectories is not possible. In order, to avoid the risk to decrease traffic predictability, NM needs to adapt the AU trajectory in particular to better integrate ATC procedures like LOAs.
- Related to the previous point, in the context of the EFPL information exchanges, NM is providing back to the AU more information about the PTRs (LOAs) impacting the flight and the resulting trajectory calculated by NM. How this information could be used by the AU, as well as the associated benefits have not been clarified yet.

The open points are not showstoppers and do not need to be addressed in the first step of implementation of the solution #37. All stakeholders involved in validation activities (including NM, the CFSPs and AUs) agreed that solution #37 can be considered as having achieved the E-OCVM V3 maturity level.

Recommendations

Even if the concept is already highly mature, a number of items are recommended to be further addressed in future activities. Two types of recommendation can be derived from the outcomes of the exercises.

Regarding the short-term implementation, the following recommendations are:

- To perform pre- operational live trials (V4) with candidate airlines in order to:
  - Minimise the risk of new flight plan rejections during the initial learning phase;
  - Further validate some aspects of the EFPL benefit mechanisms, and in particular the possibility for AUs to optimise todays filed 2D routes and 3D profiles and improve flight efficiency;
  - Identify the best options in terms of EFPL data to be used by the NM systems in order to optimise traffic predictability improvements and in particular study the non-mandatory provision of the performance data and their influence to the predictability in climb and descent phases;
  - Assess in coordination with concerned ASNPs the impact of EFPLs on flight plan distribution and traffic predictability in some specific areas.
- To implement NM HMI improvements in order to support IFPS operators in the management of Extended Flight Plans;

Regarding further steps of the EFPL implementation (but out of the scope of Solution #37), the recommendation is to plan additional SESAR validations in SESAR 2020 in order to:

- Assess the feasibility and benefits for AUs to better integrate ATC constraints in the AU planned trajectory included in the EFPL;
- Clarify the requirements in terms of more detailed error messages provided by NM to the AUs in the reply for an invalid EFPL;
- Validate EFPL distribution services and the use of EFPL data in ATC systems and processes;
- Investigate the use of the Extended Flight Plan for the management of ATFCM regulations and the determination of TTOs/TTAs.

Nominal Preferred Route (NPR)

Conclusions

Despite the limitations, the study has found that the Nominal Preferred Route information provided by Airspace users is of added value in medium term planning phase while in ATFCM pre-tactical phase – from D-6 to D-1, current method based on the use of historical data remains more efficient.

Validation activities have proven that a proper impact assessment of the rerouting with respect to the preferences of the AU's could be done in post-ops using the NPR information. In addition, if the NPR information would be integrated in the NM systems, the NM operators (e.g. AOLO, NMC) could use that reference to calculate compliant rerouting closer to the user preference.

The Nominal Preferred Route information seems to allow a better forecast regarding route assignment in Medium Term Planning compared to the current available information of City Pair Stats (CPS) and Pathfinder. Nevertheless, it would be necessary to evaluate also the effect of a potential improvement in the technique used in CPS, like considering several possible RFLs, or a categorization of the statistical routes according to airlines or aircraft types, days of the week, etc.

However, considering the limitations of the study and the limited outcome in terms of benefits for end users, the maturity level of the concept is still V1.

Recommendations

Future validation activities should address the following aspects:

- Increase of the significance of results by involving a wider range of data providers, including AUs, that can produce the NPRs required for the different use cases. This would include more city pairs, aircraft types as well as different types of AU's policies/strategies for producing the NPR.
- Extension of the scope to address some use-cases related to the management of DCB problems (to be addressed by PJ09).
- Clarification of ATM constraints (e.g. RAD) and environment data (e.g. SID/STARs needed to be taken into account in the production of the NPR).
- Agreement on NPR format and NPR information update processes.
- The production of the NPR data requires an important investment in time and resources on the AU's side, so a benefit assessment is required in future steps of the validation.

NM/ATC trajectory alignment and TTA distribution through FO network

Conclusions

The project managed to run the exercise achieving most of the validation objectives:

- Technical feasibility has been proven
- Integrating NM in the FO-network could allow ATCOs to visualize valuable TTO/TTA information.
- Exchanging information between NM and an ANSP through FO mechanism improves NM traffic prediction
- NM-ATC interoperability is perceived as improved by all actors participating to validation activities.

However, the exercise highlighted some potential problems and weaknesses:

- Concept implementation maturity had limited the scope of the validation activities
- Roles transfer have been tested in a limited set of cases
- Although several FOs have been successfully exchanged, their effect on the legacy FDPS is not always aligned with the operational expectations.

Recommendations

Based on this consideration and on conclusions presented above, the exercise has raised the following recommendations:

- SESAR FO steering group to be set for future FO exercises. It will be in charge of concept and exercises coherency on the SESAR level
- Future validation activities shall investigate some aspects such as:
    - Running several operational traffic levels and scenarios to cover less nominal cases
    - Address the whole lifecycle of a flight (also through several interoperable ANSPs)
    - Define processes to take into account FO estimates updates (e.g. Entry Time, EOBT, TTO, ATT…) in ANSPs' FDPS.

  - CDM for FPL changes before the flight departure (i.e. re-route proposals from ANSPs to be accepted/confirmed by AU before inclusion in the FO by NM)

- The validation activities were based on EUROCAE ED-133 “Flight Object Interoperability Specification” document; during these activities some topics that should be addressed by the next version of the document have been identified, some of them being raised already to EUROCAE Working Group 59, in charge of the ED-133. Since the recommendations were issued, the FO steering has been set up together with some working groups dealing with operational and technical aspects.

iOAT Flight Plan

Conclusions

Following validation activities, the main conclusions are:

- The integration of military aeronautical environmental data is demonstrated to be feasible, though further harmonisation and standardisation efforts are required,
- The iOAT FPL format is suitable to express typical military missions.
- iOAT FPLs are processed verified and managed internally by NM as operationally required.
- The use of AFTN to connect existing military legacy system to the NM systems to support the iOAT FPL submission is technically feasible and suitable.
- The use of SWIM B2B service in support to iOAT FPL submission is technically feasible and suitable.
- The NM production of the re-distribution address list is correct and complete, subject of additional military addresses to be provided for implementation.
- The complete iOAT FPL validation process, including all actors’ contribution, processes, communication and messaging does satisfy operational expectations.
- Its introduction should be manageable by operators both at AUs and NM sides.
- Considering both Validation studies and on-going developments, the operational requirements are considered as being in V2 / TRL 3 maturity level.

Recommendations

To complete the V2 level and to achieve TRL4, further validation work should be planned in PJ07/PJ18 and include:

- iOAT processing in the ETFMS
- iOAT FPL inclusion/impact in/on ATFCM/DCB
- More complete AIP integration (i.e. SID/STAR)
- Evolution of the iOAT FPL to increase flexibility for the use of VPA modules
- More detailed analysis of IFPS profile(processed) vs. AUs profile intension (planned)
- Enlarge validation scale/scope: i.e. more Air forces, increased geographical scope and higher number of iOAT FPLs to consolidate representativity, widen validity of proposed procedures and create statistically solid base allowing
- Increased statistical solidity: i.e. higher number of iOAT FPLs allowing quantitative benefit assessment
- Further standardisation efforts shall be included in FF-ICE/ICAO efforts towards a unified GAT/OAT format.

Beside the operational and technical aspects, which most probably can be validated and implemented, the four biggest challenges for the implementation of the iOAT FPL concept are:

- On the required harmonisation and standardisation of the national military environment (AIP) data to comply with civil standards and naming conventions; pre-requisite for their integration in the EAD,
- On the harmonisation of the civil-military interface and processes, to reduce the need to implement country specific solutions,
- On the provision of military AC performance data to assure most realistic trajectory calculations by the IFPS and related systems and
- On the satisfaction of the required security and confidentiality needs.

Business Trajectory within Trajectory Based Operations

Conclusions

Validation activities provided useful input for the further refinement of BT planning process, supplying qualitative feedback on the different components identified in the planning phase of BT.

The overall definition of the SBT management process in step 2 has not fully achieved V1. Some items assessed during the exercise (i.e. 4D What-if tool, Congestion Level Indicator) are mature enough to be moved to V2 phase, some others (Desired Trajectory, Alternative Trajectory, Negotiating Trajectory, Agreed Trajectory, Confidence Level, Preferences, Fully CDM AU and Partially CDM AU) require further refinement and agreement from all stakeholders involved.

The different input will be used for the concept evolution as well as for the coming validation activities SESAR 2020.

Recommendations

The Recommendations fall into two categories: changes to the concept and alignment with FF-ICE/1.

- Further elaborate the concept features still in V1 as described previously in the context of PJ07;
- Initiate V2 validation activities on the more mature concept features in coordination with the latest FF-ICE/1 defined services (e.g. planning service).

User Driven Prioritisation Process (UDPP)

Conclusions

The Multi-Swap and Substitution on Cancellation features have reached the end of V3 validation and deployment is recommended.

The Multi-Swap and Pre-Allocated Slot Swap features need software changes to NM's systems and should be subject to a future live trial before a deployment decision can be taken.

These two concept features have been transferred to the Network Manager for potential further development, validation and deployment.

Much work is required to validate the Most Penalizing Delay feature to a V3 maturity level: the feature has been transferred to SESAR2020 and rebadged as OI step AUO-0108.

Within Trajectory Based Operations, the validation activities evaluated the Fleet Delay Apportionment (FDA) and Selective Flight Protection (SFP) concepts. The general conclusions are:

- The problem that UDPP is attempting to address must be quantified, and the benefits brought by the solutions estimated.
- It is imperative that delay-cost functions for flights in the traffic sample in a future validation exercise must be carefully constructed and rigorously checked to ensure that they accurately and realistically reflect the true cost of operational decisions to protect, suspend or reassign delay.
- For future human-in-the-loop validation exercises: testing and further development should be done with the close coordination of airspace users in particular, but more generally with all members of the UDPP project.

Recommendations

For the ATFM slot swapping:

- And deployment of Solution #56
    - The Multi-Swap feature (type 1) should be deployed operationally, with a maximum of three swaps allowed per flight. NM operators should have a swap counter in ETFMS to log the number of times a given flight has swapped;
    - The Substitution on Cancellation feature should be deployed operationally; an improved manual procedure, or even an automated approach should be conceived for deployment to reduce the workload on the NM operator and to remove the unnecessary safety check on the flight to be cancelled;
    - The Network Manager should use the slot swapping prototype to develop an operational swapping tool for all airspace users in Europe. The 'one-click swap request' functionality is an essential requirement for this tool. The ATFM live trial report presents other requirements for the tool and should be considered;
    - Once deployed, the swapping behaviour from airspace users and the performance of the slot swapping tool should be monitored to confirm that the performance impacts identified and quantified during validation are realised;
- And for future deployment out of the SESAR and Solution#56 scopes:
    - The Pre-Allocated Slot Swapping feature should be subject to a live trial to complete its journey to the end of V3 validation. This will require a modification to NM's ETFMS so that deteriorated flights in the 'allocated' status are not automatically promoted back by ETFMS;
    - The Multi-Swap feature (type 2) should be subject to a live trial, but first NM's NID tool needs modifying so that all the swaps in the single request are evaluated (and carried out) simultaneously;
- for S2020 activities (AUO-0108/PJ9):
    - CDM airports should identify and publish the delay caused by the airport itself so that the most penalizing delay (airport v arrival / en route) for flights can be calculated. (This may require a modification to the current A-CDM protocol.).

For Departure Swapping deployment (Solution #57):

- European CDM airports should consider a local deployment of DFlex;
- Paris CDG to monitor and publish the effect that DFlex actions may have on the pre-departure sequence, in a similar but more detailed fashion to that already done for the demonstration project. The monitoring should distinguish between flights involved in a DFlex action, and those impacted, and should also distinguish between different airspace users. The monitoring activity should include the distribution of change in delay for flights that are subject to a DFlex action, and, separately, for those that are in temporal proximity. The motivation should be to assure/ensure that equity is achieved for airspace users;

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