SESAR Technological Solution 18.02c: Technical Validation Report (TVALR)

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PJ18 4DTM

PJ18-02C TRL6

This Technical Validation Report is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 734161 under European Union's Horizon 2020 research and innovation programme.

Abstract

The present document constitutes the TRL6 validation report of solution PJ.18-02c technological solution aiming to contribute to the validation of the requirements for SBT transition to RBT operational. This document describes the results of the validation conducted under SESAR Solution 18-02c to assess the improvement in the accuracy of the predicted trajectories by:

- Using 4D trajectory and the flight specific performance profile information for ATC purposes
- Aligning the Airspace User, Network Manager, and Airport's view of the flight trajectory with the most up-to-date information related to:
  - Runway configuration
  - Departure and arrival procedures, planned runway and taxi time
  - ATC LoAs
- Enhancing Airspace User trajectory planning considering Target Times of Arrival.

The validation exercises including shadow-mode simulations of real and simulated flight plans conveyed by FOC (LSY) have been successfully conducted in validation platforms from Skyguide and EUROCONTROL to assess the Validation Objectives. Three iterations corresponding to three exercises have been executed to validate the different topics:

- The first iteration (validation of the Distribution and Use of eFPL Data by ATC) was conducted by EUROCONTROL and Skyguide from April 9th until April 13th 2018.
- The second iteration (validation of the use and the improvements between the 4D trajectory from the FOC being shared with the Network Manager by considering Profile Tuning Restrictions (PTR)) was conducted by EUROCONTROL and Lufthansa System in the two periods 15 – 25 October 2018 and 20-29 March 2019.
- The third iteration (validation of the use and the improvements between the 4D trajectory from the FOC being shared with the Network Manager by considering runway configuration, departure and arrival procedures and ATC TTA requirements) was conducted by EUROCONTROL and Lufthansa System between 18-19 June 2019.

This report summarizes the results of these exercises identifying key improvement achievements, gaps, potential benefits, and presents the overall conclusions and recommendations.

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1 Executive summary

The document constitutes the TRL6 technical validation report of technological solution PJ.18-02c aiming to validate of the requirements for SBT transition to RBT operational. The solution is addressing the enablers expected to achieve TRL6 maturity supporting the following operational topics:

- **Harmonised and improved integration of airspace and ATC constraints / procedures in trajectories calculated by FOCs and NM (OI AUO-0223)** - contributes to the alignment of the AU/NM 4D trajectories in planning phase with integration of PTRs.
- **Enhanced Target time management in planning phase by the use of eFPL (OI AUO-0225) –** contributes to improve accuracy of prediction of flight elapsed times shared between NMF and the AU though a better planning of the departure time to meet the Target time.
- **SBT/RBT Exchange of eFPL with ATC (OI AUO-0226) –** contributes to improve the trajectory prediction for all ATC/INAP functions and to get more precise view of AU trajectory preference.
- **Harmonised and improved integration of AOP/NOP information in trajectories calculated by FOCs and NM (OI AUO-0229)** – contributes to improve the Alignment of the AU, NMF and airport views of 4D trajectories in planning phase and the predictability by exchanging dynamic AOP/NOP information (runway configurations in use, planned runways and SIDs/STAR, departure taxi times).

The validation activities encompass three iterations corresponding to three distinct exercises with the following conclusions:

- ***Iteration #1 "Distribution of eFPL and Use by ATC"***, led by Skyguide:
    - Technical capability has been demonstrated.
    - Regarding the ATC trajectory prediction, due to technical limitation (Trajectory Predictor tool, ATC support tools), no relevant results can be shown from this exercise.
    - ATCO consider aircraft mass, TOC, TOD as useful information to get a more reliable trajectory and to better anticipate the flight profile.

- ***Iteration #2 "Use of PTRs"***, led by Lufthansa Systems*:*
    - PTR publications formats need to follow the publication format of RAD restrictions to be processed from FOC systems.

- ***Iteration #3 "Dynamic SID/STAR information in eFPL" and "Target Time Use in eFPL",*** led by EUROCONTROL. Conjointly PJ18.02c (for objectives/processes/enablers) and PJ09.03 (for DCB aspects) developed the following conclusions:
    - Updates of FPL should occur only at specific milestones rather than event based. The final milestone should be somewhere close to 1H before off-block;
    - AUs should plan a SID/STAR consistent with the departure/arrival runway in AOP/NOP when time permitting;
    - On FOC systems, FPL updates could be either fully automated in case of runway/SID/STAR changes, either partially automated with only a dispatch monitoring activity of changes;
    - The taxi time info will not trigger an update of the flight plan. However, it shall remain available in the AU system in case of FPL update for other purposes;

- The flexibility given to AU to re-optimise the trajectory considering the TTA will not be used since the current flight plan represents already the optimal trajectory in most of the cases;
- The decision related to the management of the TTA delay (e.g. shift the EOBT/low speed/route stretching) could be partially automated with human supervision.

In terms of maturity assessment,

- eFPL information use in ATC: **achieved TRL6 maturity** for enablers NIMS-21b, SWIM-APS-18; did not achieve TRL6 maturity for enablers ER APP ATC 82.
- Integration of PTRs in AUO flight planning – **did not achieve TRL6 maturity** for enablers AOC-ATM-11, ER APP ATC 170, NIMS-55, SVC-001, SVC-002, SWIM-APS-14, SWIM-APS-15, SWIM-APS-16. The corresponding OI and aforementioned enablers are proposed for removal from the scope of the solution
- Enhanced Target time management - – **did not achieve TRL6 maturity** for enablers AOC-ATM-22, SVC-003. The corresponding OI and aforementioned enablers are proposed for removal from the scope of the solution.
- Harmonised and improved integration of AOP/NOP information in trajectories calculated by FOCs and NM – **achieved TRL6 maturity** for enablers AOC-ATM-23, NIMS-54, SVC-003, SWIM-APS-17, provided that their scope is limited to departure information from CDM airports.

  The corresponding OI (AUO-0229) should be modified to focus on SID/Runway information from CDM airports, Taxi time.

Main recommendations concern the following points:

From the Distribution and Use of eFPL Data by ATC (Iteration #1)

- To further study the impact of some eFPL data (aircraft mass on each point, speed profile, vertical profile, TOC, TOD) in the processing of Trajectory computation by ground system and then study the impact on subsequent ATC support tools such as Conflict detection tools and Monitoring aids considering this improved data.

- To perform further study on ATCO situation awareness improvement about the AU expectation thanks to some eFPL new data (e.g. Top of Climb, Top of Descent, speed profile…) to measure the benefit of such information available on display.

For the Dynamic SID/STAR information in eFPL / Target Time Use in eFPL (Iteration #3):

- Adapt the NM system (ETFMS) to treat the case when AU choice of SID does not corresponds to the SID provided by the DPI by an A-CDMI, although the runway is respected. In current operation version, the ETFMS system discards an AU SID update that does not align with the received SID in DPI. For the future, should ETFMS consider a different rule of priority in the ranking of SID/STAR updates?

- The provision of AOP/A-CDM SID and runway information to AU and its use to update the AU trajectories is potentially ready for next phase industrialisation, although the positive alignment and predictability results should be confirmed first. Taxi time may require a filter to only allow changes bigger than an agreed threshold.

- The provision of AOP/ STAR and runway information to AU is not conclusive and needs further validation to better understand some negative results in alignment.

2 Introduction

2.1 Purpose of the document

This document provides the Technical Validation Report for SESAR Solution PJ.18-02c for the validation exercises defined in PJ.18-02c Technical Validation Plan [22].

This report summarizes the results of these exercises identifying key improvement achievements, gaps, potential benefits, and presents overall conclusions and recommendations.

The EXE-18-02c-TRL6-001_ECTRL exercise consists of three iterations. This Technical Validation Report describes the results from:

- Iteration #1: Distribution and Use of eFPL Data by ATC
- Iteration #2: use of PTRs
- Iteration #3: Dynamic SID/STAR information in eFPL & Target Time Use in eFPL

The parts 3 and 4 of the TVALR report separately for each of these iterations.

Appendices A, B, C include the Technical Validation Exercise Report for each iteration #1, #2 and #3.

2.2 Intended readership

This document is intended for the following readership, members of:

- PJ.18 02a solution;
- PJ18 PCIL;
- PJ09.03 with whom Joint Validation exercises are planned
- PJ07.01 solution which is also addressing evolutions related to the trajectory management in planning phase and FF-ICE services
- SESAR Programme Management;

2.3 Background

This validation activity builds upon:

- Several SESAR 1 projects have conducted validation activities in relation to the OIs/enablers addressed in the OSED/INTEROP document
    - SESAR project P7.6.2 (Validation exercises VP311, VP616 and VP713), achieving V3 maturity status regarding the use of EFPL information in NM processes and systems (solution #37), TRL-6 maturity for EFPL submission SWIM services and initial V2 results related to the contribution of PTRs to improve traffic predictability. This project did not address the distribution and use of EFPL information by ATC [16].

  - SESAR project P5.5.2 (Validation exercises VP69 and VP300), achieving V2 maturity status on the use of FOC data to improve ATC predictions and processes (solution #67). The exercises focused on the use of Take-off Mass and speed information as can be provided by the FOC in the EFPL/eFPL. The project did not address the use other information of the EFPL like the 4D trajectory, flight specific performance data and mass information at each point of the trajectory. Moreover as V2 maturity exercise, it did not address the validation of SWIM distribution services for EFPL/eFPL data.
  - SESAR project P4.5/5.5 (Validation exercise VP832), achieving V2 maturity status on the use of EFPL data to improve ATC predictions in the Maastricht ACC. The exercise showed in particular the benefit of using flight performance data from EFPL/eFPL to improve ATC traffic predictions in particular in the climbing phase. The project did not address other information of the EFPL like the 4D trajectory and mass information at each point of the trajectory. As V2 maturity exercise, it also did not address the validation of SWIM distribution services for EFPL/eFPL data. [17]
- FF-ICE planning (FF-ICE increment 1) consists in the first step of implementation focusing on flight plans/trajectory information exchanges in the planning phase, defining different “trajectory groups” (e.g. filed trajectory, agreed trajectory). [18]

PJ18.02 builds this validation plan in collaboration with PJ09.03:

- The PJ.18-02c technical architecture follows the same principle of collaboration with PJ.09-03 as described in the PJ.18-02c OSED ([20]). The architecture elements are shared between the two solutions.

The PJ.18-02c solution reuses the architecture of the Regional ATFCM and Airports as defined in SESAR 1 (AOP/NOP integration).

2.4 Structure of the document

The document is composed of the following main sections:

- Section 3 describes the technical validation context for each iteration (Distribution and Use of eFPL Data by ATC, use of PTRs, Dynamic SID/STAR information in eFPL & Target Time Use in eFPL).
- Section 4 describes the technical validation results for each iteration (Distribution and Use of eFPL Data by ATC, use of PTRs, Dynamic SID/STAR information in eFPL & Target Time Use in eFPL).
- Section 5 contains conclusions and recommendations.
- Section 6 provides references to main documentation.
- Appendices

- ○ Appendix A contains the report of the validation exercise for iteration #1 Distribution and Use of eFPL Data by ATC.
- ○ Appendix B contains the report of the validation exercise for iteration #2 use of PT
- ○ Appendix C contains the report of the validation exercise for iteration #3 Dynamic SID/STAR information in eFPL & Target Time Use in eFPL
- ○ Next applicable Appendices are relative to "Safety Assessment Report", "Technological Solution Maturity Assessment" and the "High Level Economical Appraisal".

2.5 Glossary of terms

Term	Definition	Source of the definition
Agreed Trajectory	The current 4D trajectory that is agreed between the airspace user and the ASP after collaboration, or imposition of pre-collaborated rules.	Draft FF-ICE Manual ref. [26]
AIRAC	Aeronautical Information Regulation and Control	EUROCONTROL ATM Lexicon
API	Arrival Planning Information APOC will collaborate with the Regional and the Local ATFCM actors to provide optimised pre-sequences for the arrival flows by proposing TTAs through the API service.	PJ04.01
CTOT	Calculated Take Off Time, calculated and published by the Network Manager.	Current Operations
Dynamic PTR	Dynamic management of the activation/deactivation of a PTR depending on planned sectors configurations or traffic loads – involving NM and ANSPs	SESAR 1 P07.06.02 OSED
eFPL	Filed Flight Plan	Draft FF-ICE Manual ref. [26]

EFPL	Extended Flight Plan as defined in SESAR 1. The EFPL concept is superseded by eFPL which is defined at the global level. Gradually the eFPL concept shall replace the EFPL. See section 3.1.1 of the PJ18.02c INTEROP document for more details [20].	SESAR 1 P07.06.02 OSED
FF-ICE Planning	The Planning Service facilitates ATM and operator planning for flights in airspaces where significant constraints exist, and/or where air traffic demand at times exceeds, or is expected to exceed, the declared capacity of the air traffic control services concerned.	Draft FF-ICE Manual ref. [26]
FF-ICE Filing	The filing is for the Airspace User to submit a request for Air Traffic Services.	Draft FF-ICE Manual ref. [26]
Filed Trajectory	The 4D trajectory present in the filed flight plan data provided by an AU	Draft FF-ICE Manual ref. [26]
IFPUV	Non-operational FPL validation tool used to test flight plans prior to their submission to the operational IFPS.	EUROCONTROL web site
LOA	Letters Of Agreement set out the high-level policy for cooperation between states under contingency conditions and can cover operational as well as technical support.	Skybrary web site
OFP	Operational flight plan which the AU operations provide to the pilot.	Current Operations
Reference Business Trajectory	It is the trajectory that the Airspace User agrees to fly and that the ANSP and Airport agree to facilitate. It is associated to the filed flight plan and includes both air and ground segments. It consists of 2D routes (based on published way points and/or pseudo waypoints computed by air or ground tools to build the lateral transitions and vertical profiles); altitude and time constraints where and when required; altitude, time and speed estimates at waypoints, etc.	Transition CONOPS
Shared Business Trajectory	The Shared Business (SBT) is the trajectory published by the Airspace User that is available for collaborative ATM planning purposes. The refinement of the SBT is an iterative process. The final form of the SBT becomes the Reference Business (RBT) and is part of the filed flight plan.	Transition CONOPS

Soft constraint	ATM published constraint that is not mandatory for the AU to consider when submitting the flight plan (for example some LoAs published as Profile Tuned Restrictions) but can contribute to improve predictability.	SESAR 1 P07.06.02 OSED
Static PTR	ANSPs define and provide the PTRs to NM. PTRs are activated statically - following the AIRAC cycle publication - in current operations and are declared active in most the cases H24 independently from planned sectors configuration or traffic load.	Current Operations
Target Time of Arrival (TTA)	An ATM computed arrival time. It is not a constraint but a progressively refined planning time that is used to coordinate between arrival and departure management applications. A TTA consists of a nominal value and tolerance limits around the nominal value.	Transition CONOPS SESAR 1 P07.06.02 OSED

Table 1: Glossary of terms

2.6 Acronyms and Terminology

Term	Definition
ADD	Architecture Definition Document
A-DPI	ATC DPI (CDM DPI process)
ANSP	ATC National Service Provider
API	Arrival Planning Information
ATM	Air Traffic Management
ATM	Air Traffic Management
ATMRPP	ICAO ATM Requirements and Performance Panel
AU	Airspace User
BADA	Base of Aircraft DAta
CFSP	Company Flight System Provider
CHMI	CFMU Human Machine Interface

CTFM	Current Tactical Flight Model
CTOT	Calculated Take Off Time
DOF	Date Of Flight
E-ATMS	European Air Traffic Management System
E-DPI	Early DPI (CDM DPI process)
EET	Estimated Elapsed Time
eFPL	No acronym definition provided from ICAO yet – refer to 2.5
EFPL	Extended Flight Plan – refer to 2.5
E-OCVM	European Operational Concept Validation Methodology
ETFMS	Enhanced Traffic Flow Management System
FF-ICE	Flight and Flow Information for a Collaborative Environment
FIXM	Flight Information Exchange Model
FIXM CCB	FIXM Change Control Board
FL	Flight Level
FOC	Flight Operation Centre
FTFM	Filed Tactical Flight Model (NM)
INTEROP	Interoperability Requirements
KPA	Key Performance Area
KPI	Key Performance Indicator
LOA	Letters Of Agreement
NM	Network Manager
OFP	Operational Flight Plan
OI	Operational Improvement
OPLOG	EFTMS Operation Log
OSED	Operational Service and Environment Definition
PCIT	Project Content Integration Team
PTR	Profile Tuning Restriction (i.e. soft constraint)

ROC	Rate of Climb
SESAR	Single European Sky ATM Research Programme
SID	Standard Instrument Departure procedure
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
STAR	Standard Arrival Procedure
SUT	System Under Test
SWIM	System Wide Information Model
TBO	Trajectory Based Operations
T-DPI-s	Target DPI – Sequenced (CDM DPI process)
T-DPI-t	Target DPI – Target (CDM DPI process)
TMA	Terminal Manoeuvring Area
TOC	Top-of-Descent
TOD	Top of Descent
TP	Trajectory Predictor
TRL	Technical Readiness Level
TS	Technical Specification
TT	Target Time
TTA	Target Time of Arrival
TVALP	Technical Validation Plan
TVALR	Technical Validation Report
VALP	Validation Plan
VALR	Validation Report
VALS	Validation Strategy
VP	Validation Plan
VR	Validation Report
VS	Validation Strategy

Table 2: Acronyms and terminology

3 Context of the Technical Validation

3.1 SESAR Technological Solution 18.02c: a summary

Solution 18.02c is a technological solution tackling enablers associated to OIs not addressed in wave 1 by any ATM solution. The Solution considers the following enablers shown in Table 3.

SESAR Technological Solution ID	SESAR Technological Solution Description	Master or Contributing (M or C)	Contribution to the SESAR Technological Solution short description	Enablers ref. (from EATMA)
18.02c 4D Trajectory management	eFPL supporting SBT transition to RBT	M	Validation of the better alignment of trajectories between NM, FOC and ATC.	**SWIM-APS-14** AOC Airspace Structure service PTR Status and Runway Configuration data interface consumption by the FOC
				SWIM-APS-15 Tactical Updates service PTR status update provision by the Regional ATFC
				SWIM-APS-16 ATC LOA Status publication via Tactical Updates service by EN APP ACC
				SWIM-APS-17 AOC Consume NM Flight Data service Flight List By AO interface via P/S
				SWIM-APS-18 eFPL service consumption in ATC

SESAR Technological Solution ID	SESAR Technological Solution Description	Master or Contributing (M or C)	Contribution to the SESAR Technological Solution short description	Enablers ref. (from EATMA)
				NIMS-21b Flight Planning management enhanced to support 4D
				NIMS-54 SID, STAR, TT, and Runway Configuration data applied in Initial Flight Plan Processing
				AOC-ATM-11 Integration of constraints and answers
				AOC-ATM-20 Sharing of trajectory data between FOC/WOC and the ATM world using B2B web services
				AOC-ATM-22 TT data integration in the FOC trajectory Modification of the FOC functions in order to use Target Time (TT) data for the trajectory calculation.
				AOC-ATM-23 SID/STAR and Runway Configuration Plan information integration in the FOC trajectory

SESAR Technological Solution ID	SESAR Technological Solution Description	Master or Contributing (M or C)	Contribution to the SESAR Technological Solution short description	Enablers ref. (from EATMA)
				ER APP ATC 82 Enhance EN/APP ACC to use eFPL data Modification of the EN APP ATC functions in order to use eFPL data for the trajectory prediction.
				ER APP ATC-170 ATC LOA Status U
				SVC-001 Update Tactical Update service to provide and consume PTR status update operation
				SVC-002 Update Airspace Structure service to provide and consume tactically updated PTR status via publish/subscribe
				SVC-003 Enhance the existing NM Flight Data service to publish and subscribe SID/STAR data

Table 3: SESAR Technological Solution PJ18-02c enablers

The solution addresses also OIs in a limited way and they are not aimed at achieving full V3 maturity status while associated enablers are expected to achieve TRL6 maturity.

The SESAR Solution 18-02c Scope and related OI steps is described in the following table:

OI Steps	OI Steps Title	OI Step Coverage
AUO-0223	Harmonised and improved integration of airspace and ATC constraints/procedures in trajectories calculated by FOCs and NM	Partially The solution is mainly technological so it will address mainly enablers. Operational feasibility and performance (from AU perspective) will be also partially addressed.
AUO-0225	Enhanced Target time management by the use of eFPL	Partially The solution is mainly technological so it will address mainly enablers. Operational feasibility and performance (from AU perspective) will be also partially addressed.
AUO-0226	SBT/RBT: Exchange of eFPL with ATC	Partially The solution is mainly technological so it will address mainly enablers. Operational feasibility will be also partially addressed.
AUO-0229	Harmonised and improved integration of AOP/NOP information in trajectories calculated by FOCs and NM	Partially The solution is mainly technological so it will address mainly enablers. Operational feasibility will be also partially addressed.

Table 4 : Relevant OIs for PJ 18-02c Solution

3.2 Summary of the Technical Validation Plan

3.2.1 Validation Plan Purpose

PJ18 enables other SESAR 2020 projects (mainly Solution Projects) to take advantage of this consolidated view of the trajectory (and overall flight information), which is built from individual views of the different ATM stakeholders and covers the planning and execution phase of the flight. The trajectories computed by the ground stakeholders (Air Navigation Service Providers – ANSPs—, Network manager (NM), Airport Operators, etc.) will also be improved thanks to the incorporation of additional information coming from the Airspace Users, such as Flight Operation Centre (FOC).

S2020 PJ18 4DTM project consolidates and contributes to the validation of the Trajectory Based Operations (TBO, which is used on flight efficiency, predictability, environment and capacity) concept, developing and verifying the supporting system enablers.

In the meantime, ICAO ATMRPP is defining the eFPL with its data elements in the FF-ICE context (refer to [18]). The FIXM CCB (FIXM Change Control Board) and the working groups are adapting FIXM with the mandate of implementing the FF-ICE requirements. Within the FIXM tasks, there is the development of the FIXM Implementation Guidelines task which includes the definition of FF-ICE services.

From the PJ.18-02c solution perspective, the successor of EFPL is the eFPL, containing almost all elements of EFPL. The eFPL data definition and the related services are out of the scope of PJ.18-02c solution.

The operational and technical environment for the solution PJ.18-02c consists of Network Manager, Airspace User Operations, and ATS Operations**.**

Technological solution PJ.18-02c looks at the distribution of eFPL information to ATC systems, and at the possible improvements of the alignment of AUs' and NM's trajectories especially concerning use of PTRs, Standard Instrument Departure (SID)/Standard Arrival Route (STAR) allocation and TTA management.

This TVALR covers the results of the TRL 6 validation activities undertaken in the frame of solution PJ.18-02c. These validation activities encompass one exercise shared into three iterations:

- Iteration #1 "Distribution of eFPL and Use by ATC" led by Skyguide to validate improvements to the ATC Ground "trajectory prediction" closer to the preferred trajectory from FOC, taking into account eFPL trajectory related information.
- Iteration #2 "Use of PTRs" led by Lufthansa Systems to validate how using PTR data elements in the AU filed trajectory can improve the trajectory prediction computed EUROCONTROL NM by during the planning phase.
- Iteration #3 "Dynamic SID/STAR information in eFPL" and "Target Time Use in eFPL" led by EUROCONTROL, to validate a better alignment of NM and FOC trajectories.

3.2.1.1 Distribution and Use of eFPL Data by ATC (Iteration #1)

This evolution addresses the use of eFPL information by ATC in execution mainly but based on information provided by the FOC in eFPL in pre-flight phase (FF-ICE filing).

SESAR 1 exercises have demonstrated the benefits of using some eFPL data elements like the Take-Off weight, speed information in the trajectory and Flight Specific performance data to improve ATC trajectory prediction in support to conflict detection and resolution in particular in the climbing phase. These conclusions need to be confirmed yet at TRL 6 maturity level for the system enablers.

Moreover, a number of points require further studies and V3 partial validation:

- Current means/format used for the distribution of ICAO 2012 flight plans (e.g. AFTN, ADEXP) cannot be reused as such for the eFPL. Therefore, existing services must be adapted or new services must be defined; and validated for eFPL distribution to ATC actors.
- Some elements of the 4D trajectory like the Top Of Climb (TOC) or Top Of Descent (TOD) may be useful to display to ATC actors to ease coordination processes with the flight crew and improve ATC quality of service
- Some information in the 4D trajectory like levels, times at each point may be useful in some cases to improve ATC traffic prediction. Moreover, even though the eFPL content is already defined at ICAO level; there is still the possibility to identify additional elements that could be of particular interest for ATC. They could be included as part of FIXM 5.0 or in the context of

a European extension. For example, the estimated aircraft weight at each point of the trajectory is not included in the eFPL and FIXM4.0 - and some ANSPs consider this information as potentially useful

- The management by ATC of mixed traffic - some with ICAO 012 FPLs and some with eFPL - needs to be studied

This iteration is decomposed into two phases:

- One technical phase, aiming at validating the transfer of the eFPL data from NM to ATC via the B2B services and the use of the Agreed Trajectory

Phase done in Shadow mode between the NMVP Platform and the Skyguide platform
The airspace for Flight Plans distribution will be the Swiss airspace covering Geneva and Zurich ACCs

- One operational phase, aiming at assessing the improvements of the Ground Trajectory Prediction by the ATC Ground Flight Data Processing with specific eFPL data by:
    - Quantifying the performance of Ground Trajectory Prediction with the flown trajectory (seen as Validation Baseline)
    - Quantifying the improvements of the Ground Trajectory Prediction based on specific eFPL data with the flown trajectory when compared to the baseline.

  Phase done in done in Replay mode on the Skyguide platform.

  The airspace for Flight Plans distribution will be the Swiss airspace covering the Geneva and Zurich ACCs.

3.2.1.2 Use of PTRs (Iteration #2)

The part of the validation exercise is designed to consider the LoAs (published as PTRs) by the FOC when planning 4D trajectory as included in eFPL. Main objective was to analyse improvements for the alignment between the FOC 4D trajectory and the NM trajectory by taking PTR’s already for the FOC trajectory into account. These LOA’s are shared in today’s operation to airlines, however they are not used for the profile calculation, as they are not mandatory.

SESAR 1 studies (refer to section 2.3) have shown that the use of PTRs – without dynamic activation/deactivation feature - have a very significant and positive impact on NM traffic predictions accuracy and reduce the misalignment of AU and NM trajectories.

Those conclusions need to be confirmed yet at **TRL 6 maturity** level for the system enablers.

Airlines consider their main operational impact by the use of contingency fuel, where the uncertainty of several unplanned flight execution changes vs. flight plan is accordingly embedded. The alignment of the FOC trajectory with the NM trajectory is in the interest of all ATM stakeholders, especially AU’s, ATC & NM to coordinate as best as possible the correct information share among the participants, which allows especially NM & ATC to increase the predictability. To reduce the misalignment of the planned FOC 4D trajectory and the NM trajectory calculations can help to improve the efficiency of impacted stakeholders and operators. The validation exercise especially analysed the impact of PTR’s at FOC in reference to :

- Quantifying the operational impact of PTR’s on the flight efficiency;
- Quantifying the degree of trajectory alignment between FOC and NM 4D trajectory;
- Quantifying the impact on the NM/ANSPs Trajectory prediction.

These points require further studies and **V2** validation.

This iteration is decomposed into two phases:

- One technical phase, aiming at validating the feasibility at technical levels for the FOC to integrate PTRs and aiming at quantifying the degree of trajectory alignment between FOC and NM 4D trajectory:

Phase done in Simulation mode between the NMVP Platform and the Skyguide platform

- One operational phase, aiming at assessing the improvements of NM/ANSPs Trajectory on the NM/ANSPs Trajectory prediction:
    - Phase done in Shadow mode between the NMVP Platform and the Skyguide platform

3.2.1.3 Dynamic SID/STAR information in eFPL (Iteration #3)

NM receives dynamically from main major airports planned runway configurations in use allowing adapting accordingly SID’s and STAR’s (in particular depending on runway direction) allocated to a flight and its trajectory.

The harmonisation of SID’s & STAR’s planned respectively by NM and the FOC in trajectories needs to be confirmed yet at **TRL 6 maturity** level for the system enablers.

The usage of SID and STAR by AUs in FF-ICE planning and FF-ICE filing is expected to be beneficial for the alignment of AU and NM planned trajectories (NM traffic prediction), for the AU trajectory optimisation.

These points require further studies and **V3 partial** validation:

- The impact on the AU Trajectory optimisation.
- The impact of safety and fuel: the AU is responsible to create a safe flight plan and to calculate the correct amount of fuel to carry. Each change of SID or STAR must result in activities that maintain the safety and that deal with the required amount of fuel during the FF-ICE planning and FF-ICE filing.
- The impact on the NM/ANSPs Trajectory prediction and DCB Traffic prediction: this topic is strongly linked to DCB operations and procedures, therefore the validation activities are developed in close cooperation with solution PJ09.03.

Two activities compose this iteration:

- One technical phase, addressing the SID/STAR updates published via B2B by NM: Lufthansa Systems as involved CFSP can perform the computation of a new flight plan via the eFPL update procedure.

  Phase to run in Shadow mode between the NMVP Platform and LSY FOC system.
- One operational phase, aiming at validating the real-time provision of SID/STAR updates to CFSP:
  - To validate the alignment and prediction impact to NM/ANSP's trajectories, when airlines consider the latest available information.
  - To assess the impact for the Safety and Fuel Efficiency.

  Phase to run in Shadow mode between the NMVP Platform and LSY FOC system.

3.2.1.4 Target Time Use in eFPL (Iteration #3)

The Target Time management concept as developed in SESAR 1 includes the following features:

- DCB time-based measures (TT) applied at the point of congestion (and no more at departure runway like in current operations with the CTOT).
- The FOC has the possibility to update the SBT to express his preference on how to meet the TTA and NM should adapt the CTOT in accordance.
- As the CTOT is issued to ensure the coordination with departure operations, the CTOT takes into account the estimated flight elapsed time from take-off to the point of congestion.

In that context, the eFPL

- Includes flight elapsed times as calculated by the FOC;
- Is an important enabler to align FOC and NM estimated elapsed times;
- Improves accuracy of the common prediction.

The harmonisation of the estimated elapsed time (from take-off to the point of congestion) planned respectively by NM and the FOC in trajectories needs to be confirmed yet at **TRL 6 maturity** level for the system enablers.

An AU can use the eFPL update service in reaction to the publication of a Target Time to express his trajectory preference to meet the target time. This procedure in FF-ICE planning is expected to be beneficial for the alignment of AU and NM planned trajectories (NM traffic prediction), for the AU trajectory optimisation.

These points require further studies and **V3 partial** validation:

- The impact on the AU Trajectory optimisation and AU Cost efficiency

- The impact on the NM/ANSPs Trajectory prediction and DCB Traffic prediction: this topic is strongly linked to DCB operations and procedures, therefore the validation activities are developed in close cooperation with solution PJ09.03.

Two activities compose this iteration:

- One technical phase, aiming at validating the TTA update published by NM: Lufthansa Systems as involved CFSP can perform the computation of a new flight plan via the eFPL update procedure.

  Phase to run in Shadow mode between the NMVP Platform and LSY FOC system.
- One operational phase, aiming at validating the real-time provision of SID/STAR updates from ANSP's to CFSP:
  - To validate the alignment and prediction impact to NM/ANSP's trajectories, when airlines consider the latest available information.
  - To assess the impact AU Trajectory optimisation and AU Cost efficiency.

  Phase to run in Shadow mode between the NMVP Platform and LSY FOC system.

3.2.2 Summary of Technical Validation Objectives and success criteria

3.2.2.1 Distribution and Use of eFPL Data by ATC (Iteration #1)

Three Technical Validation objectives were assigned to Iteration #1 (one Technical Feasibility objective and two Operational Feasibility objectives):

- OBJ-18.02c-TRL6-TVALP-TF1: eFPL Distribution to ATC.

  This objective aims at assessing if the distribution of eFPLs to the involved ATC (Skyguide for this iteration) works technically in a successful way. In order to do so, it should be checked that the eFPLs are duly distributed, extracted and processed by the ATC ground Flight Data Processing system at Skyguide. Rejected or corrupted eFPLs were identified and recorded in particular flights that were not crossing Swiss airspace.
- OBJ-18.02c-TRL6-TVALP-OF1: Use of eFPL data in ATC system for Trajectory Prediction

  This second objective aims at assessing the actual benefits of the distribution of eFPLs to ATM regarding trajectory prediction. When using eFPL additional information or data, ATC Ground Trajectory Predictor should be more precise than when using legacy ICAO FPL compared to the actual flown trajectory. This analysis has been performed to assess such improved prediction.
- OBJ-18.02c-TRL6-TVALP-OF2: Exhaustiveness of eFPL data in ATC system for Trajectory Prediction

> This third objective is focused on assessing that all the information from the eFPL distributed is exhaustive and fulfil ATC needs bringing benefits to the ATC in terms of trajectory prediction. It should be checked that all useful information is included in the distributed eFPLs.

The following tables summarise the Technical Validation Objectives details, including their associated Success Criteria and Traceability tables.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-TF1
Objective	To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service
Title	eFPL Distribution to ATC
Category	<Technical feasibility>
Key environment conditions	ACCs, Nominal conditions
TRL Phase	TRL6

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS >	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0002
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-TDM1.0003
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0001
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0004
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0005

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-TVALP-TF1-001	Solution 18.02c provides evidence that a set of eFPL has been distributed to ATC using B2B service (yellow SWIM).

Identifier	Success Criterion
CRT-18.02c-TRL6-TVALP-TF1-002	Solution 18.02c provides evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF1
Objective	To Assess the benefits of the eFPL Distribution to ATC on the Trajectory Prediction.
Title	Use of eFPL data in ATC system for Trajectory Prediction
Category	<Performance>, <Safety>
Key environment conditions	ACCs, Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS >	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0002
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0002
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0006
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0007
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0008
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0009

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF1-001	Solution 18.02c provides evidence that the ATC Ground Trajectory Predictor using specific eFPL data (Aircraft Mass, speed profile, ...) is more accurate than legacy ATC Ground Trajectory Predictor using legacy ICAO FPL, when both are compared to the flown trajectory.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF2
Objective	To assess that all the information from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC.
Title	Exhaustiveness of eFPL data in ATC system for Trajectory Prediction
Category	<Operational Feasibility>
Key environment conditions	ACCs, Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS >	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0002
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0002
<COVERS>	<ATMS Requirement>	REQ-18.02c-ANS1.0003

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF2-001	Solution 18.02c provides evidence that all the information from the eFPL distributed by NM through the B2B service fulfil ATC needs for better Trajectory Prediction and no useful information for ATC needs are missing (exhaustiveness of the information for ToC, ToD, Flight Specific performance data, weight...).

3.2.2.2 Use of PTRs (Iteration #2)

Four Technical Validation objectives were assigned to Iteration #2 (one Technical Feasibility objective and three Operational Feasibility objectives):

- OBJ-18.02c-TRL6-TVALP-TF2

  This objective aims at assessing if the PTRs integration in the FOC system works technically in a successful way. In order to do so, it should be checked that the PTR's are duly inserted into the FOC database at Lufthansa Systems. PTR's which could not mapped into today's FOC systems architecture are not considered for the exercise execution.

- OBJ-18.02c-TRL6-TVALP-OF19

  This objective aims at evaluating the AU 4D trajectory alignment between the FOC considering PTR's and the NM trajectory. The assessment is done through the analysis of the FOC profile and the NM profile provided from the CHMI application from the Network Manager.

- OBJ-18.02c-TRL6-TVALP-OF20

  This objective aims at assessing the improvement of the NM / ATC DCB Traffic Predictability.

- OBJ-18.02c-TRL6-TVALP-OF21

  This objective aims at assessing the impact of integrating PTRs (LOA) in the eFPL 4D Trajectory on the total planned fuel is done through the fuel calculations of Lido/Flight from Lufthansa Systems by comparing the trip fuel difference without PTR's and with PTR's inside the 4D trajectory.

The following tables summarise the Technical Validation Objectives details, including their associated Success Criteria and Traceability tables.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-TF2
Objective	To Assess Technical Feasibility of the PTRs integration in the FOC system.
Title	Integration of the PTRs in FOC System

Category	<Technical feasibility>
Key environment conditions	Nominal conditions
TRL Phase	TRL6

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS >	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0005
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<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-NOP1.0002
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0004

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-TVALP-TF2-001	Solution 18.02c provides evidence of the integration of PTRs (LOA) by FOC System in the eFPL.
CRT-18.02c-TRL6-TVALP-TF2-002	Solution 18.02c provides analysis about the complexity to implement PTRs (LOA) by FOC System in the eFPL.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF19
Objective	To validate that the integration of PTRs (LOA) in the eFPL 4D trajectory improves AU Trajectory Alignment with NM systems trajectory.
Title	Impact of the PTRs (LOA) on the AU Trajectory Alignment
Category	<Performance>, <Safety>

Key environment conditions	Nominal conditions
TRL Phase	V2

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
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<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.005
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<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-NOP1.0001
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0004
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-TVALP-OF19-001	Solution 18.02c provides evidence that the eFPL 4D Trajectory with PTRs implemented (LOA) is closer to the NM computed trajectory than the eFPL 4D Trajectory without PTRs implemented (LOA). The difference is reduced in vertical dimension mainly, and in time dimension.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF20
Objective	To validate that the integration of PTRs (LOA) in the eFPL 4D Trajectory improves NM / ATC DCB Traffic Predictability.
Title	Impact of the PTRs (LOA) on the NM/ATC Traffic Predictability

Category	<Performance>, <Safety>
Key environment conditions	Nominal conditions
TRL Phase	V2

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
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<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.005
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<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-NOP1.0001
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0004
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF20-001	Solution 18.02c provides evidence that the integration of the PTRs (LOA) in the eFPL 4D Trajectory reduces the difference in vertical dimension : the NM / ATC planned trajectory computed with PTRs is closer to the flown trajectory than the NM / ATC planned trajectory computed without PTRs.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF21

Objective	To assess the impact of integrating PTRs (LOA) in the eFPL 4D Trajectory on the total planned fuel
Title	Impact of the PTRs (LOA) on the Fuel
Category	<Performance>
Key environment conditions	Nominal conditions
TRL Phase	V2

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS >	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0004
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<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0008

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF21-001	Solution 18.02c performs a qualitative assessment on the fuel (planned and extra fuel) for a flight with and without including PTRs (LOA) in the eFPL 4D Trajectory.

3.2.2.3 Dynamic SID/STAR information in eFPL (Iteration #3)

Nine Technical Validation objectives were assigned to Iteration #3 for SID/STAR (three Technical Feasibility objectives and six Operational Feasibility objectives):

- OBJ-18.02c-TRL6-TVALP-TF3

This objective aims at assessing the Technical Feasibility of the Runway Configuration integration in the FOC system.

- OBJ-18.02c-TRL6-TVALP-TF4

This objective aims at assessing the Technical Feasibility of the SID integration in the FOC system.

- OBJ-18.02c-TRL6-TVALP-TF5

This objective aims at assessing the Technical Feasibility of the STAR integration in the FOC system.

- OBJ-18.02c-TRL6-TVALP-OF11

This objective aims at assessing the improvement of AU Trajectory Alignment with NM Systems with the integration of dynamic SID/STAR updates.

- OBJ-18.02c-TRL6-TVALP-OF10

This objective aims at assessing the improvement of NM DCB Traffic Predictability the integration of dynamic SID updates.

- OBJ-18.02c-TRL6-TVALP-OF22

This objective aims at assessing the improvement of NM DCB Traffic Predictability the integration of dynamic STAR updates.

- OBJ-18.02c-TRL6-TVALP-OF12

This objective aims at assessing the impact of integrating SID / STAR in the eFPL on the fuel efficiency.

- OBJ-18.02c-TRL6-TVALP-OF13

This objective aims at assessing the impact of dynamic SID/STAR updates in the eFPL on the FOC workload.

- OBJ-18.02c-TRL6-TVALP-OF14

This objective aims at assessing that the increase of FOC workload due to FOC action is acceptable.

The following tables summarise the Technical Validation Objectives details, including their associated Success Criteria and Traceability tables.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-TF3

Objective	To Assess Technical Feasibility of the Runway Configuration integration in the FOC system
Title	Integration of the Runway Configuration in FOC System
Category	<Technical feasibility>
Key environment conditions	Nominal conditions
TRL Phase	TRL6

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
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<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
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<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0003
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-TVALP-TF3-001	Solution 18.02c provides evidence of the integration of Runway Configuration by FOC System in the eFPL.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-TF4

Objective	To Assess Technical Feasibility of the SID integration in the FOC system
Title	Integration of the SID in FOC System
Category	<Technical feasibility>
Key environment conditions	Nominal conditions
TRL Phase	TRL6

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS >	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
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<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-TVALP-TF4-001	Solution 18.02c provides evidence of the integration of SID by FOC System in the eFPL.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-TF5

Objective	To Assess Technical Feasibility of the STAR integration in the FOC system
Title	Integration of the STAR in FOC System
Category	<Technical feasibility>
Key environment conditions	Nominal conditions
TRL Phase	TRL6

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS >	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
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<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0003
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-TVALP-TF5-001	Solution 18.02c provides evidence of the integration of STAR by FOC System in the eFPL.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF10

Objective	To validate that the integration of dynamic SID updates in the eFPL improves NM DCB Traffic Predictability
Title	Impact of the SID/STAR on the NM Traffic Predictability
Category	<Performance>, <Safety>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0012
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-TDM1.0002

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF10-001	Solution 18.02c provides evidence that the integration of the dynamic SID on the eFPL reduces the difference in 4 dimensions: the NM / ATC trajectory planned with dynamic SID included in eFPL trajectory is closer to the flown trajectory than the NM / ATC trajectory planned without dynamic SID.
CRT-18.02c-TRL6-VALP-OF10-002	Solution 18.02c provides evidence that the Integration of the updated SID within the operational flight plan improves the predictability of the estimated landing time ELDT hence the airport planning is improved.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF22

Objective	To validate that the integration of dynamic STAR updates in the eFPL improves NM DCB Traffic Predictability.
Title	Impact of the SID/STAR on the NM Traffic Predictability
Category	<Performance>, <Safety>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0012
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-TDM1.0002

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF22-001	Solution 18.02c provides evidence that the integration of the dynamic STAR on the eFPL reduces the difference in 4 dimensions: the NM / ATC trajectory planned with dynamic STAR included in eFPL trajectory is closer to the flown trajectory than the NM / ATC trajectory planned without dynamic STAR.
CRT-18.02c-TRL6-VALP-OF22-002	Solution 18.02c provides evidence that the Integration of the updated STAR within the operational flight plan improves the predictability of the estimated landing time ELDT hence the airport planning is improved.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF11
Objective	To validate that the integration of dynamic SID/STAR updates in the eFPL improves AU Trajectory Alignment with NM Systems
Title	Impact of the SID/STAR on the AU Trajectory Alignment
Category	<Performance>, <Safety>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0012
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0001
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0003
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF11-001	Solution 18.02c provides evidence that the integration of the dynamic SID/STAR on the eFPL reduces the difference in 4 dimensions: the AU EFPL 4D planned trajectory computed with dynamic SID/STAR is closer to the NM planned trajectory (ETFMS) than the AU EFPL 4D planned trajectory computed without dynamic SID/STAR.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF12
Objective	To assess the impact of integrating SID / STAR in the eFPL on the fuel efficiency
Title	Impact of the SID/STAR on the Fuel efficiency
Category	<Performance>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0012

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF12-001	Solution 18.02c performs a qualitative assessment on the fuel decision making (planned and extra fuel) related to the real time SID/STAR planning confidence.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF13
Objective	To assess the impact of dynamic SID/STAR updates in the eFPL on the FOC workload
Title	Impact of the SID/STAR on FOC workload

Category	<Performance>, <Safety>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0012
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF13-001	Solution 18.02c provides evidence that the increase of FOC workload due to FOC action is acceptable.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF14
Objective	To validate that the integration of dynamic SID/STAR updates in eFPL improves the safety
Title	Impact of the SID/STAR on the Safety
Category	<Safety>
Key environment conditions	Nominal conditions

TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0010
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0012

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF14-001	Solution 18.02c provides evidence that the integration of real time SID/STAR updates in the eFPL reduces or at least does not increase the pilot workload.

3.2.2.4 Target Time Use in eFPL (Iteration #3)

Five Technical Validation objectives were assigned to Iteration #3 for Target Time (one Technical Feasibility objective and four Operational Feasibility objectives):

- OBJ-18.02c-TRL6-TVALP-TF6

  This objective aims at assessing the Technical Feasibility of the TTA integration in the FOC system.

- OBJ-18.02c-TRL6-TVALP-OF16

  This objective aims at assessing that the TTA/TTO integration in the AU trajectory eFPL improves the AU cost efficiency.

- OBJ-18.02c-TRL6-TVALP-OF17

  This objective aims at assessing the impact of TTA integration into the eFPL on the FOC workload

- OBJ-18.02c-TRL6-TVALP-OF18

This objective aims at assessing that the TTA/TTO integration in the AU trajectory eFPL improves the flexibility on departure time.

- OBJ-18.02c-TRL6-TVALP-CO1

This objective aims at assessing Operational acceptability of the eFPL use in TTA management from DCB perspective.

The following tables summarise the Technical Validation Objectives details, including their associated Success Criteria and Traceability tables.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-TF6
Objective	To Assess Technical Feasibility of the TTA integration in the FOC system
Title	Integration of the TTA in FOC System
Category	<Technical feasibility>
Key environment conditions	Nominal conditions
TRL Phase	TRL6

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS >	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0015
<COVERS >	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0016
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-TVALP-TF6-001	Solution 18.02c provides evidence of the integration of TTAs by FOC System in the eFPL.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF16
Objective	To validate that the TTA/TTO integration in the AU trajectory eFPL improves the AU cost efficiency.
Title	Impact of the TTA/TTO on the AU cost efficiency
Category	<Performance>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0015
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0016
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF16-001	Solution 18.02c provides evidence that the CTOT slot influenced by the FOC reduces the extra operating costs (flight cost delay related) compared to the initial CTOT provided by the NM

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF16-002	Solution 18.02c provides evidence that the difference of total planned fuel is reduced between the trajectory taking the NM given CTOT and the trajectory taking the influenced CTOT (trajectory before and after TTA)

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF17
Objective	To assess the impact of TTA integration into the eFPL on the FOC workload
Title	Impact of the TTA/TTO on FOC workload
Category	<Performance>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0015
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0016
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0005
<COVERS>	<ATMS Requirement>	REQ-18.02c-TS-FM01.0006

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF17-001	Solution 18.02c provides evidence that the number of manual FOC updates does not increase.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-OF18
Objective	To validate that the TTA/TTO integration in the AU trajectory eFPL improves the flexibility on departure time.
Title	Impact of the TTA/TTO on the Departure time
Category	<Performance>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c
<COVERS>	<ATMS Requirement>	REQ-18.02.c.01-SPRINTEROP-UU01.02
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0015
<COVERS>	<ATMS Requirement>	IER-18-02c-OSED-eFPL.0016

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-OF18-001	Solution 18.02c provides evidence that TTA integration in the AU trajectory improves the flexibility on Departure Time by at least 10% of the cases.

[OBJ]

Identifier	OBJ-18.02c-TRL6-TVALP-CO1
Objective	To Assess Operational acceptability of the eFPL use in TTA management from DCB perspective.
Title	Compatibility
Category	<Compatibility>
Key environment conditions	Nominal conditions
TRL Phase	V3 partial

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	SESAR Solution 18.02c

[OBJ Suc]

Identifier	Success Criterion
CRT-18.02c-TRL6-VALP-CO1-001	Solution 18.02c assesses the operational acceptability – from a DCB perspective - of the management of Target times in conjunction with eFPLs integrating AOP/NOP information and provides evidence that the NMF actors/experts do not identify any side effect – e.g instability of the demand or Target Time – impacting negatively network or local DCB performances.

3.2.3 Technical Validation Assumptions

The next parts , these Technical Validation assumptions are applicable are required to interpret the Technical Validation results and are applicable to *all the Technical Validation exercises* that are contained in this TVALR. Additional Technical Validation assumptions at *exercise level* have been captured for each iteration (Refer to A.1.4, B.1.4, C.1.4).

To keep a trace of the iteration owner of the assumption, this chapter has been sub-divided for each iteration.

3.2.3.1 Distribution and Use of eFPL Data by ATC (Iteration #1)

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
ASM-PJ.18-02c-TRL6-TVALP-EX1.001	eFPL data consistency	Data consistency	Within an eFPL, the whole data set is supposed to be consistent.	Inconsistencies would mean that the AU system producing the eFPL is faulty, and would introduce biases in exercises' results (e.g. by generating artificially high rejection rates in the validation process).	ALL	Operational & Technical feasibility		N/A	18-02c	High
ASM-PJ.18-02c-TRL6-TVALP-EX1.002	Airspace structure	Airspace layout	The airspace used to generate the eFPL is current airspace structure with fixed route configuration.	In order to compare with legacy Flight Data Processing, it is necessary to keep current airspace and route structure.	ER TMA	All	Expert opinion	N/A	18-02c	High
ASM-PJ.18-02c-TRL6-TVALP-EX1.003	Traffic sample		The traffic sample selected to produce eFPL contains a limited number of flights in order to have minimised changes of trajectories.	For comparison purpose with flown trajectories, it is necessary to have a limited number of trajectories that have been tactically change by the ATCOs in the airspace selected for the exercises.	All	Operational & Technical feasibility	Expert opinion		18.02c	High

Table 5: Technical Validation Assumptions overview – iteration #01

3.2.3.2 Use of PTRs (Iteration #2)

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
ASM-18-02c-TRL6-TVALP-EX002.001	Traffic sample	Traffic characteristics	EFPL format correctness – not rejected by IFPS for any other reasons than PTRs implementation in the 4D trajectory	To get a sufficient traffic sample for the analysis	Not airborne	Alignment Predictability	Operational & Technical feasibility		EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX002.002	Use of B2B Service	Technical characteristics	Right B2B service used to validate EFPL flight plans on IFPUV (EFPL flight plan validation), providing the PTR list in return. Right B2B services used to create, update or cancel EFPL flight plans on NMVP	To get a sufficient traffic sample for the analysis	Not airborne	Alignment Predictability	Operational & Technical feasibility		EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX002.003	Traffic sample crossing PTR contraints	Traffic characteristics	FOC to identify and send to IFPUV EFPL AO4D trajectories crossing PTR constraints	To avoid a dataset of flights not crossing at all any PTRs and having by the way no PTR to	Not airborne	Alignment Predictability	Operational & Technical feasibility		EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	High

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
				be implemented in the trajectory						
ASM-18-02c-TRL6-TVALP-EX002.004	Traffic sample with PTR contraints	Traffic characteristics	FOC to implement missing PTRs in the EFPL AO4D trajectories identified as trajectories with missing PTRs	To get a representative population of EFPL trajectories including the PTRs for the metrics computation	Not airborne	Alignment Predictability	Operational & Technical feasibility		EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX002.005	PTR definition		Lufthansa Systems data experts can understand the content of the PTRs based on definition and NM OPS experts explanation	Core of the EFPL trajectory computation with PTR included	Not airborne	Alignment Predictability	Operational & Technical feasibility		EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX002.006	PTR implementation in FOC system		Lufthansa System is capable to translate the identified PTRs in their today's available architecture for	Core of the EFPL trajectory computation with PTR included	Not airborne	Alignment Predictability	Operational & Technical feasibility		EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	High

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
			maintaining RAD regulations							
ASM-18-02c-TRL6-TVALP-EX002.007	PTR management in FOC system		The amount of identified PTRs is manageable and it is feasible to maintain those PTRs right in time before the envisaged validation exercise	To get a representative population of EFPL trajectories including the PTRs for the metrics computation	Not airborne	Alignment Predictability	Operational & Technical feasibility		EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX002.008	PTR data data consistency	Data consistency	The PTR data are supposed to be consistent with actual AIRAC structure	PTR data could be connected to in the Lido database available aviation elements	Not Airborne	Alignment Predictability	Technical feasibility	N/A	EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	Medium

Table 6: Technical Validation Assumptions overview – iteration #02

3.2.3.3 Dynamic SID/STAR information in eFPL / Target Time Use in eFPL (Iteration #3)

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
ASM-18-02c-TRL6-TVALP-EX003.001	Traffic sample	Traffic characteristics	EFPL format correctness – not rejected by IFPS for any other reasons than PTRs implementation in the 4D trajectory	To get a sufficient traffic sample for the analysis	Not airborne	Alignment Predictability	Operational & Technical feasibility	N/A	EXE-18.02c-TRL6-TVALP-001/3_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX003.002	Use of B2B Service	Technical characteristics	Right B2B service used to create / update / cancel EFPL flight plans, retrieve the flight list from a specific departure or arrival airport, retrieve the runway configuration from a specific departure / arrival airport.	To get a sufficient traffic sample for the analysis	Not airborne	Alignment Predictability	Operational & Technical feasibility	N/A	EXE-18.02c-TRL6-TVALP-001/3_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX003.003	Traffic sample from specific airlines and city pairs	Traffic characteristics	FOC to identify and send to NMVP EFPL AO4D trajectories for specific airlines and for specific city pairs, based on Operational flight plans published on OPS FOC.	To reduce the size for the dataset of flights to the airlines participating in the exercise and having a flown trajectory.	Not airborne	Alignment Predictability	Operational & Technical feasibility	N/A	EXE-18.02c-TRL6-TVALP-001/3_ECTRL Phase 1 & 2	High

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
ASM-18-02c-TRL6-TVALP-EX003.004	Traffic sample with SID / STAR / Runway configuration updates	Traffic characteristics	FOC to detect updates for SID / STAR / Runway configuration at departure / arrival airports and to inform the flight dispatchers to update the EFPL AO4D trajectories.	To get a representative population of EFPL trajectories including updates for SID / STAR for the metrics computation	Not airborne	Alignment Predictability	Operational & Technical feasibility	N/A	EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX003.005	Traffic sample with TTA constraint		FOC to detect TTA constraint on a flight and to inform the flight dispatchers to update the EFPL AO4D trajectories with the TTA constraint	To get a representative population of EFPL trajectories including TTA constraint for the metrics computation	Not airborne	Alignment Predictability	Operational & Technical feasibility	N/A	EXE-18.02c-TRL6-TVALP-001/3_ECTRL Phase 1 & 2	High
ASM-18-02c-TRL6-TVALP-EX003.006	Traffic sample with OPS messages	Technical characteristics	FOC receives from OPS FOC the flight messages like creation, updates, cancel. Even if the Flight Dispatcher does an update during the exercise, the modification could be discarded by an OPS message. The analysis must be done at the	To identify correctly the updates done by the Flight Dispatcher on with FOC tool, to distinguish them from OPS updates, and to focus the data analysis at the	Not airborne	Alignment Predictability	Operational & Technical feasibility	N/A	EXE-18.02c-TRL6-TVALP-001/3_ECTRL Phase 1 & 2	High

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
			moment of the Flight dispatcher Update. The type of updates done by the Flight Dispatcher must be identifiable in the Update message: the flight dispatcher fills correctly all RMK fields (see C.1.3.1.a), stipulating any actions done.	moment of the updates						

Table 7: Technical Validation Assumptions overview – iteration #03

3.2.4 Technical Validation Exercises List

3.2.4.1 Distribution and Use of eFPL Data by ATC (Iteration #1)

As stated below, Iteration #1 has been conducted into two different phases. Specific details on both Iteration #1 phases are provided in the tables below.

[EXE] – Phase 1

Identifier	EXE-18.02c-TRL6-TVALP-001/1_ECTRL Phase1
Title	Distribution of eFPL Data to ATC via B2B services
Description	To validate the reception of eFPL by ATC from NM B2B service and the data extraction.
Expected achievements	Technical improvement
TRL	<TRL6>
T. Validation Technique	<Platform Test – shadow mode for NMVP / SKYGUIDE platforms>
Start Date	09/04/2018
End Date	30/05/2018
T. Validation Coordinator	Exercise Coordinator EUROCONTROL Iteration Leader SKYGUIDE
T. Validation Platform	SKYGUIDE/SKYSOFT-ATM skysim platform EUROCONTROL NMVP Platform
T. Validation Location	SKYGUIDE (GENEVA), EUROCONTROL BRUSSELS
Status	<executed>
Dependencies	EXE-18.02c-TRL6-TVALP-001/1_ECTRL Phase2

[EXE Trace]

Linked Element Type	Identifier
<SESAR Solution>	PJ18-02c
<V&V Objective>	OBJ-18.02c-TRL6-TVALP-TF1

Table 8: Technical validation exercise layout – iteration #01 Phase 1

[EXE] – Phase 2

Identifier	EXE-18.02c-TRL6-TVALP-001/1_ECTRL Phase2
Title	eFPL Use by ATC
Description	To validate that the SESAR Technological Solution 18.02c improves the accuracy of ATC ground Trajectory Prediction tool (compared to trajectories computed with legacy FPL and compared to flown trajectories) and therefore the ATC support tools.
Expected achievements	Safety improvements. Accurate flight predictability may at least maintain or impact positively safety Cost efficiency / flight efficiency. Improving flight predictability will have positive impact of cost and flight efficiency Capacity improvement. As flight predictability may be increase, therefore it is expected to improve capacity
TRL	<TRL6>
T. Validation Technique	<Platform Test – replay mode for SKYGUIDE / SKYSOFT ATM skysim platform>
Start Date	09/04/2018
End Date	30/05/2018
T. Validation Coordinator	Exercise Coordinator EUROCONTROL Iteration Leader SKYGUIDE
T. Validation Platform	SKYGUIDE / SKYSOFT ATM skysim platform
T. Validation Location	SKYGUIDE (GENEVA)
Status	<executed>
Dependencies	EXE-18.02c-TRL6-TVALP-001/1_ECTRL Phase1

[EXE Trace]

Linked Element Type	Identifier
<SESAR Solution>	PJ18-02c
<V&V Objective>	OBJ-18.02c-TRL6-TVALP-OF1 OBJ-18.02c-TRL6-TVALP-OF2

Table 9: Technical validation exercise layout – iteration #01 Phase 2

3.2.4.2 Use of PTRs (Iteration #2)

As stated below, Iteration #2 has been conducted into two different phases. Specific details on both Iteration #2 phases are provided in the tables below.

[EXE] – Phase 1

Identifier	EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1
Title	Use of PTRs
Description	To validate that the SESAR Technological Solution 18.02c improves the trajectory alignment between NM and AUs
Expected achievements	Technical Feasibility of the PTRs integration in the FOC system.
TRL	<TRL6>
T. Validation Technique	<Platform Test >
Start Date	Session 1: 15/10/2018 – Session 2: 18.05.2019
End Date	Session 1: 19/10/2019 - Session 2: 29/03/2019
T. Validation Coordinator	Exercise Coordinator EUROCONTROL Iteration Leader Lufthansa Systems LSY
T. Validation Platform	EUROCONTROL NMVP Platform / EUROCONTROL IFPUV Lufthansa Systems SESAR research platform
T. Validation Location	EUROCONTROL BRUSSELS, Lufthansa Systems (Raunheim)
Status	<executed>
Dependencies	None

[EXE Trace] – Phase 1

Linked Element Type	Identifier
<SESAR Solution>	PJ18-02c
<V&V Objective>	OBJ-18.02c-TRL6-TVALP-TF2 OBJ-18.02c-TRL6-TVALP-OF19

Table 10: Technical validation exercise layout – iteration #02 Phase 1

[EXE] – Phase 2

Identifier	EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 2
Title	Use of PTRs
Description	To validate that the SESAR Technological Solution 18.02c improves the NM DCB Traffic predictability, allows AUs to optimise the trajectory according to their needs as well as to plan more accurately the fuel consumption.
Expected achievements	Safety improvements. Accurate Network Traffic Predictability may at least maintain or impact positively safety Cost efficiency / flight efficiency. Improving Network Traffic Predictability will have positive impact of cost and flight efficiency Capacity improvement. As Network Traffic Predictability may be increase, therefore it is expected to improve capacity
TRL	<TRL6>
T. Validation Technique	<Platform Test – shadow mode>
Start Date	01/02/2019
End Date	29/03/2019
T. Validation Coordinator	Exercise Coordinator EUROCONTROL Iteration Leader Lufthansa Systems LSY
T. Validation Platform	EUROCONTROL NMVP Platform / EUROCONTROL IFPUV Lufthansa Systems SESAR research platform
T. Validation Location	EUROCONTROL BRUSSELS, Lufthansa Systems (Raunheim)
Status	<executed>
Dependencies	EXE-18.02c-TRL6-TVALP-001/2_ECTRL Phase 1

[EXE Trace] – Phase 2

Linked Element Type	Identifier
<SESAR Solution>	PJ18-02c
<V&V Objective>	OBJ-18.02c-TRL6-TVALP-OF20

	OBJ-18.02c-TRL6-TVALP-OF21

Table 11: Technical validation exercise layout – iteration #02 Phase 2

3.2.4.3 Dynamic SID/STAR information in eFPL / Target Time Use in eFPL (Iteration #3)

As stated below, Iteration #3 has been conducted into two different phases. Specific details on both Iteration #3 phases are provided in the tables below.

[EXE] – Phase 1

Identifier	EXE-18.02c-TRL6-TVALP-001/3_ECTRL Phase 1
Title	Dynamic SID/STAR information in eFPL / Target Time Use in eFPL (planning phase)
Description	To validate that the SESAR Technological Solution 18.02c improves the trajectory alignment between NM and AUs
Expected achievements	Technical Feasibility of the Dynamic SID/STAR information and Target Time Use integration in the FOC system.
TRL	<TRL6>
T. Validation Technique	<Platform Test – shadow mode>
Start Date	18/06/2019
End Date	19/06/2019
T. Validation Coordinator	Exercise Coordinator EUROCONTROL Iteration Leader EUROCONTROL
T. Validation Platform	EUROCONTROL NMVP Platform Lufthansa Systems SESAR research platform
T. Validation Location	EUROCONTROL BRUSSELS, Lufthansa Systems (Raunheim)
Status	<executed>
Dependencies	None

[EXE Trace] – Phase 1

Linked Element Type	Identifier

<SESAR Solution>	PJ18-02c
<V&V Objective>	OBJ-18.02c-TRL6-TVALP-TF3 OBJ-18.02c-TRL6-TVALP-TF4 OBJ-18.02c-TRL6-TVALP-TF5 OBJ-18.02c-TRL6-TVALP-TF6 OBJ-18.02c-TRL6-TVALP-OF11

Table 12: Technical validation exercise layout – iteration #03 Phase 1

[EXE] – Phase 2

Identifier	EXE-18.02c-TRL6-TVALP-001/3_ECTRL Phase 2
Title	Dynamic SID/STAR information in eFPL / Target Time Use in eFPL (planning phase)
Description	To validate that the SESAR Technological Solution 18.02c improves the NM DCB Traffic predictability, allows AUs to optimise the trajectory according to their needs as well as to plan more accurately the fuel consumption.
Expected achievements	Safety improvements. Accurate Network Traffic Predictability may at least maintain or impact positively safety Cost efficiency / flight efficiency. Improving Network Traffic Predictability will have positive impact of cost and flight efficiency Capacity improvement. As Network Traffic Predictability may be increase, therefore it is expected to improve capacity
TRL	<TRL6>
T. Validation Technique	<Platform Test – shadow mode>
Start Date	18/06/2019
End Date	19/06/2019
T. Validation Coordinator	Exercise Coordinator EUROCONTROL Iteration Leader EUROCONTROL
T. Validation Platform	EUROCONTROL NMVP Platform Lufthansa Systems SESAR research platform
T. Validation Location	EUROCONTROL BRUSSELS, Lufthansa Systems (Raunheim)

Status	<executed>
Dependencies	EXE-18.02c-TRL6-TVALP-001/3_ECTRL Phase 1

[EXE Trace] – Phase 2

Linked Element Type	Identifier
<SESAR Solution>	PJ18-02c
<V&V Objective>	OBJ-18.02c-TRL6-TVALP-OF10 OBJ-18.02c-TRL6-TVALP-OF22 OBJ-18.02c-TRL6-TVALP-OF12 OBJ-18.02c-TRL6-TVALP-OF13 OBJ-18.02c-TRL6-TVALP-OF14 OBJ-18.02c-TRL6-TVALP-OF16 OBJ-18.02c-TRL6-TVALP-OF17 OBJ-18.02c-TRL6-TVALP-OF18 OBJ-18.02c-TRL6-TVALP-CO1

Table 13: Technical validation exercise layout– iteration #03 Phase 2

3.3 Deviations

3.3.1 Deviations with respect to the SJU Project Handbook

The solution 18.02c is presented in the PJ18 as a technological solution so its scope should be limited in theory to enablers.

However, since the enablers tackled by the solution are associated to OIs not addressed in Wave 1 by any ATM solution, the solution addresses also OIs to avoid system driven operational evolutions (this is reflected in the PMP). Due to its technological nature, the solution addresses operational aspects only in a limited way: very limited safety assessment, no human performance assessment, operational performances only partially addressed (i.e. no quantitative assessment of benefits for operational KPAs like capacity, safety, and flight efficiency).

That is why the four OIs addressed by the solution are not aimed at achieving full V3 maturity status while associated enablers are expected to achieve TRL6 maturity.

The management by ATC of mixed traffic - some with ICAO 012 FPLs and some with eFPL – has not been addressed by the solution.

3.3.2 Deviations with respect to the Technical Validation Plan

PJ18.02c planned to use the eFPL services: due to the unavailability of the eFPL services for the exercises, the EFPL services have been used. The EFPL services are very closed to the eFPL services, as well as the data content. This deviation has no impact on the exercise sessions neither on the exercise results.

3.3.2.1 Distribution and Use of eFPL Data by ATC (Iteration #1)

In the frame of the Iteration 1 exercise, the following Airspace Users were planned to participate:

- Air France,
- El Al,
- Transavia,
- Lufthansa

They were asked to provide their eFPL through the Lufthansa Systems FOC system.

However due to some technical constraints and compatibility between the airspace user's FOC tool and the Lufthansa Systems FOC tool system used for the exercise, it was not possible to receive the eFPL from Air France and Transavia.

Also during the trial period, some technical issues did not permit to receive eFPL by the ATC ground system during the first days of the trial. This analysis has been based mainly on the last day of trial eFPLs received.

The data collection has been essentially performed on eFPL provided by Lufthansa airline.

Also some technical issues have been encountered with the provision of the eFPLs and therefore the sample to be used for trajectory data computation has been limited.

The number of valuable eFPL data in the sample is therefore limited to provide sufficient relevant data for exhaustive conclusion.

3.3.2.2 Use of PTRs (Iteration #2)

For the Phase 1 (refer to 3.2.4.2 Trajectory alignment),

> Originally, it was planned to run flight plans on the Lido/Flight SESAR environment for several major hubs within Europe and to produce approximately 100 flight plans. Due to the enormous manual workload for the PTR data maintenance in the FOC database, the numbers of flight plans have to be reduced to a number of 40 flight plans. The routings have been also limited to Lufthansa flights, as for the calculations a simplification to available company routings from Lufthansa was performed. The re-calculations from company routings ensured a re-calculation on several days, as the routings are fixed. This enabled the process to detect routings, which

are affected by PTR's, where afterward the implementation of the corresponding PTR's into the Lido/Flight Database was guaranteed.

For the Phase 2 (refer to 3.2.4.2 NM DCB Traffic predictability),

A Shadow mode session was planned, aiming at validating the impact on NM / ATC DCB Traffic Predictability, when AUs consider the latest available information in reference to the PTRs (activated or deactivated by ANSP's and provided to AUs through NM) and at seeking the conditions under which airlines can cope with dynamic PTRs. Due to the enormous manual workload to complete the PTR FOC database for the full AIRAC cycle, and due to specialist resource not available, this phase of the exercise with operational flight plans has not been performed.

The deviation for the exercise data analysis with the impact on the exercise results are listed in "Appendix B.2 Deviation from the planned activities".

3.3.2.3 Dynamic SID/STAR information in eFPL / Target Time Use in eFPL (Iteration #3)

The Technical Validation Plan ([22]) delivered in due time does not include the part 5 ("Technical Validation Exercises") for this exercise #3 as we didn't know if the iteration #03 could be technically validated due to delays in development and testing of the FOC prototype. As soon as the level of confidence with the tool has been reached, an Exercise Plan has been developed internally. The deviations below are based on it.

Below are listed the deviations with the justification for the preparation and execution of the exercise. The deviation for the exercise data analysis with the impact on the exercise results are listed in "Appendix C.2 Deviation from the planned activities" (it concerns the use of the flown trajectory, the impact of OPS messages on the exercise, the pilot availability).

No.	Deviation	Justification
1	Exercise #03 has been postponed from February 2019 to June 2019.	The FOC prototype has experienced delay in doing the planned developments and testing.
2	The level of automation for the AU FOC prototype has been limited.	Due to timely constraints during the development phase.
3	In addition to the SID/Departure Runway updates available for the Fight Dispatcher, the *departure taxi time* updates from DPI messages have been made available to update the AU trajectory.	New criteria to assess strongly link with the SID updates.

No.	Deviation	Justification
	Deviations for the exercise data analysis with the impact on the exercise results are listed in "Appendix C.2 Deviation from the planned activities"	

4 SESAR Technological Solution 18.02c Validation Results

4.1 Summary of Validation Results

As described in the Technical Validation Plan ([22]). The Solution Validation Objectives have been shared into three iterations, each iteration associated to an Exercise. Each Solution Validation Objective is validated by one iteration. We present below the result per iterations.

4.1.1 Distribution and Use of eFPL Data by ATC (Iteration #1)

In the following table is presented the summary of the results per validation objective and associated success criteria, obtained through the Iteration #1 "Distribution and Use of eFPL Data by ATC".

SESAR Technological Solution 18-02c – Iteration #1

SESAR Technological Solution Technical Validation Objective ID	SESAR Technological Solution Technical Validation Objective Title	SESAR Technological Solution Success Criterion ID	SESAR Technological Solution Success Criterion	SESAR Technological Solution Validation Results	SESAR Technological Solution Technical Validation Objective Status
OBJ-18.02c-TRL6-TVALP-TF1	eFPL Distribution to ATC To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	CRT-18.02c-TRL6-TVALP-TF1-001	Solution 18.02c provides evidence that a set of eFPL has been distributed to ATC using B2B service (yellow SWIM).	EX1-CRT-18.02c-TRL6-TVALP-TF1-001: The distribution of eFPL to ATC via the B2B service has worked properly. No technical issues have been noticed during the validation period	OK
OBJ-18.02c-TRL6-TVALP-TF1	eFPL Distribution to ATC To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	CRT-18.02c-TRL6-TVALP-TF1-002	Solution 18.02c provides evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing.	EX1-CRT-18.02c-TRL6-TVALP-TF1-002: The eFPL flight Plan data distributed to ATC via the B2B service have been extracted and injected in the ATC ground Flight Data	OK

SESAR Technological Solution 18-02c – Iteration #1					
SESAR Technological Solution Technical Validation Objective ID	**SESAR Technological Solution Technical Validation Objective Title**	**SESAR Technological Solution Success Criterion ID**	**SESAR Technological Solution Success Criterion**	**SESAR Technological Solution Validation Results**	**SESAR Technological Solution Technical Validation Objective Status**
				Processing system from the validation platform. All eFPLs have been treated in the FDP system	
OBJ-18.02c-TRL6-TVALP-OF1	Use of eFPL data in ATC system for Trajectory Prediction To Assess the benefits of the eFPL Distribution to ATC on the Trajectory Prediction.	CRT-18.02c-TRL6-VALP-OF1-001	Solution 18.02c provides evidence that the ATC Ground Trajectory Predictor using specific eFPL data (Aircraft Mass, speed profile ...) is more precise than legacy ATC Ground Trajectory Predictor using legacy ICAO FPL, when both are compared to the flown trajectory.	EX1-CRT-18.02c-TRL6-VALP-OF1-001: Due to technical limitation on the Trajectory Predictor tool from the platform, the assessment of the increased precision of the trajectory computation could be only verified on the introduction of the aircraft Mass in the trajectory computation process. Other elements such as speed profiles could not be tested.	NOK
OBJ-18.02c-TRL6-TVALP-OF2	Exhaustiveness of eFPL data in ATC system for Trajectory Prediction To assess that all the information from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs	CRT-18.02c-TRL6-VALP-OF2-001	Solution 18.02c provides evidence that all the information from the eFPL distributed by NM through the B2B service fulfil ATC needs for better Trajectory Prediction and no useful information for ATC needs are missing (exhaustiveness of	EX1-CRT-18.02c-TRL6-VALP-OF2-001: Due to technical limitation on the Trajectory Predictor tool from the platform, the assessment of the increased precision of the trajectory computation could be only verified on the introduction of the aircraft Mass in the trajectory computation process. Other elements	PARTIALLY OK

SESAR Technological Solution 18-02c – Iteration #1					
SESAR Technological Solution Technical Validation Objective ID	SESAR Technological Solution Technical Validation Objective Title	SESAR Technological Solution Success Criterion ID	SESAR Technological Solution Success Criterion	SESAR Technological Solution Validation Results	SESAR Technological Solution Technical Validation Objective Status
	bringing benefits to the ATC.		the information for ToC, ToD, Flight Specific performance data, weight...).	such as speed profiles could not be tested.	

4.1.2 Use of PTRs (Iteration #2)

The following table is presented the summary of the results per validation objective and associated success criteria, obtained through the Iteration #2 “Use of PTRs”.

SESAR Technological Solution 18-02c – Iteration #2					
Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #1 Validation Results	Technical Validation Objective Status
OBJ-18.02c-TRL6-TVALP-TF2	To Assess Technical Feasibility of the PTRs integration in the FOC system.	CRT-18.02c-TRL6-TVALP-TF2-001	Solution 18.02c provides evidence of the integration of PTRs (LOA) by FOC System in the eFPL.	EX2-CRT-18.02c-TRL6-TVALP-TF2-001 The embedding of PTR’s into the FOC system has worked properly for those restrictions, which are published similar to RAD restrictions. This limitation was noticed, as the available DB structure in the FOC systems was not extended for this exercise. Due to the geographic limitation of the city pairs used for the validation	PARTIALLY OK (Low representativeness)

SESAR Technological Solution 18-02c – Iteration #2					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
				exercise and Dynamic PTR's not been considered at all, the technical validation status could also only be rated as partially ok.	
OBJ-18.02c-TRL6-TVALP-TF2	To Assess Technical Feasibility of the PTRs integration in the FOC system.	CRT-18.02c-TRL6-TVALP-TF2-002	Solution 18.02c provides analysis about the complexity to implement PTRs (LOA) by FOC System in the eFPL.	EX2-CRT-18.02c-TRL6-TVALP-TF2-002 For all flight plans considered within this exercise, an expert assessment for the feasibility study to transfer the PTR into the FOC systems was executed. Results delivered the strong need to make PTR publications similar to RAD publications. Otherwise extensive database architecture & software changes are required to make use of the PTR'S. The limitation of the selected city pairs and the consideration of static PTR's lead to a partially achieved objective status.	PARTIALLY OK (Low representativeness)
OBJ-18.02c-TRL6-TVALP-OF19	To validate that the integration of PTRs (LOA) in the eFPL 4D trajectory improves AU Trajectory Alignment with NM systems trajectory.	CRT-18.02c-TRL6-TVALP-OF19-001	Solution 18.02c provides evidence that the eFPL 4D Trajectory with PTRs implemented (LOA) is closer to the NM computed	EX2- CRT-18.02c-TRL6-TVALP-OF19-001 The embedding of PTR's into the 4D trajectory demonstrated a significant alignment improvement in the	PARTIALLY OK

SESAR Technological Solution 18-02c – Iteration #2					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
			trajectory than the eFPL 4D Trajectory without PTRs implemented (LOA). The difference is reduced in vertical dimension mainly, and in time dimension.	vertical dimension of the profile. It was not possible to identify a clear improvement in the alignment of the time dimension. A more detailed analysis of the trajectories would be required to find the reason for it.	
OBJ-18.02c-TRL6-TVALP-OF20	To validate that the integration of PTRs (LOA) in the eFPL 4D Trajectory improves NM / ATC DCB Traffic Predictability.	CRT-18.02c-TRL6-VALP-OF20-001	Solution 18.02c provides evidence that the integration of the PTRs (LOA) in the eFPL 4D Trajectory reduces the difference in vertical dimension : the NM / ATC planned trajectory computed with PTRs is closer to the flown trajectory than the NM / ATC planned trajectory computed without PTRs.	EX2- CRT-18.02c-TRL6-VALP-OF20-001 See Deviation 3.3.2.2 for phase 2. Due to the requirement of an high number of flight plans to be used for traffic predictions, this part of the exercise has not been analysed.	NOK
OBJ-18.02c-TRL6-	To assess the impact of integrating PTRs (LOA) in the eFPL 4D Trajectory on	CRT-18.02c-TRL6-VALP-	Solution 18.02c performs a qualitative assessment on the fuel (planned	EX2- CRT-18.02c-TRL6-VALP-OF21-001 The embedding of PTR's into the 4D trajectory	PARTIALLY OK

SESAR Technological Solution 18-02c – Iteration #2					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
TVALP-OF21	the total planned fuel	OF21-001	and extra fuel) for a flight with and without including PTRs (LOA) in the eFPL 4D Trajectory.	demonstrated a small increase of the planned trip fuel ~~(about 1 %).~~ The increase was expected; the exercise provided an evidence about the amount. To be confirmed by AUs that the small increase in operations is acceptable.	

4.1.3 Dynamic SID/STAR information in eFPL (Iteration #3)

In the following table is presented the summary of the results per validation objective and associated success criteria, obtained through the Iteration #3 “Dynamic SID/STAR information in eFPL”.

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #3 Validation Results**	**Technical Validation Objective Status**
OBJ-18.02c-TRL6-TVALP-TF3	To Assess Technical Feasibility of the Runway Configuration integration in the FOC system	CRT-18.02c-TRL6-TVALP-TF3-001	Solution 18.02c provides evidence of the integration of Runway Configuration by FOC System in the eFPL.	EX3-CRT-18.02c-TRL6-TVALP-TF3-001 The integration of the available B2B services for the Runway Configuration into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019	OK
EX3-OBJ-18.02c-	To Assess Technical Feasibility of the	CRT-18.02c-TRL6-	Solution 18.02c provides evidence of the integration	EX3-CRT-18.02c-TRL6-TVALP-TF4-001	OK

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #3 Validation Results**	**Technical Validation Objective Status**
TRL6-TVALP-TF4	SID integration in the FOC system	TVALP-TF4-001	of SID by FOC System in the eFPL.	The integration of the available B2B services for assigned SID information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.	
EX3-OBJ-18.02c-TRL6-TVALP-TF5	To Assess Technical Feasibility of the STAR integration in the FOC system	CRT-18.02c-TRL6-TVALP-TF5-001	Solution 18.02c provides evidence of the integration of STAR by FOC System in the eFPL.	EX3-CRT-18.02c-TRL6-TVALP-TF5-001 The integration of the available B2B services for assigned STAR information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.	OK
OBJ-18.02c-TRL6-TVALP-OF11	Impact of the SID/STAR on the AU Trajectory Alignment	CRT-18.02c-TRL6-VALP-OF11-001	Solution 18.02c provides evidence that the integration of the dynamic SID/STAR on the eFPL reduces the difference in 4 dimensions: the AU EFPL 4D planned trajectory computed with dynamic SID/STAR is closer to the NM planned trajectory	EX3-CRT-18.02c-TRL6-VALP-OF11-001 The integration of the dynamic SID/STAR on the eFPL demonstrated a significant improvement on the AU Trajectory Alignment with NM systems in three dimensions as well as the time dimension.	PARTIALLY OK (Low representativeness)

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #3 Validation Results**	**Technical Validation Objective Status**
			(ETFMS) than the AU EFPL 4D planned trajectory computed without dynamic SID/STAR.		
OBJ-18.02c-TRL6-TVALP-OF10	To validate that the integration of dynamic SID updates in the eFPL improves NM DCB Traffic Predictability	CRT-18.02c-TRL6-VALP-OF10-001	Solution 18.02c provides evidence that the integration of the dynamic SID on the eFPL reduces the difference in 4 dimensions: the NM / ATC trajectory planned with dynamic SID included in eFPL trajectory is closer to the flown trajectory than the NM / ATC trajectory planned without dynamic SID.	EX3-CRT-18.02c-TRL6-VALP-OF10-001 The integration of the dynamic SID on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension. Due to the low number of flight dispatcher updates, the results are not representative.	PARTIALLY OK (Low representativeness)
OBJ-18.02c-TRL6-TVALP-OF10	To validate that the integration of dynamic SID updates in the eFPL improves NM DCB Traffic Predictability	CRT-18.02c-TRL6-VALP-OF10-002	Solution 18.02c provides evidence that the Integration of the updated SID within the operational flight plan improves the predictability of the estimated landing time ELDT hence the airport	EX3-CRT-18.02c-TRL6-VALP-OF10-002 The integration of the dynamic SID on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability of the estimated landing time ELDT.	PARTIALLY OK (Low representativeness)

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #3 Validation Results**	**Technical Validation Objective Status**
			planning is improved	Due to the low number of flight dispatcher updates, the results are not representative.	
OBJ-18.02c-TRL6-TVALP-OF22	Impact of the STAR on the NM Traffic Predictability	EX3-CRT-18.02c-TRL6-VALP-OF22-001	Solution 18.02c provides evidence that the integration of the dynamic STAR on the eFPL reduces the difference in 4 dimensions: the NM / ATC trajectory planned with dynamic STAR included in eFPL trajectory is closer to the flown trajectory than the NM / ATC trajectory planned without dynamic STAR.	EX3-CRT-18.02c-TRL6-VALP-OF22-001 The integration of the dynamic STAR on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension. Due to the low number of flight dispatcher updates, the results are not representative.	PARTIALLY OK (Low representativeness)
OBJ-18.02c-TRL6-TVALP-OF22	Impact of the STAR on the NM Traffic Predictability	EX3-CRT-18.02c-TRL6-VALP-OF22-002	Solution 18.02c provides evidence that the Integration of the updated STAR within the operational flight plan improves the predictability of the estimated landing time ELDT hence the airport planning is improved.	EX3-CRT-18.02c-TRL6-VALP-OF22-002 The integration of the dynamic STAR on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability of the estimated landing time ELDT. Due to the low number of flight dispatcher updates, the results are not representative.	PARTIALLY OK (Low representativeness)

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #3 Validation Results**	**Technical Validation Objective Status**
OBJ-18.02c-TRL6-TVALP-OF12	Impact of the SID/STAR on the Fuel efficiency	CRT-18.02c-TRL6-VALP-OF12-001	Solution 18.02c performs a qualitative assessment on the fuel decision making (planned and extra fuel) related to the real time SID/STAR planning confidence.	EX3-CRT-18.02c-TRL6-VALP-OF12-001 The fuel assessment with the decision process for updating SID/STAR was done by the flight dispatchers during the exercise. They did not show us explicitly a scenario, where the flight dispatcher declined to use another STAR due to fuel reason. In general, the more precise SID/STAR information however leads to an overall more precise fuel calculation. Nevertheless, the questionnaire highlighted a good level of confidence for the fuel decision making (planned and extra fuel) related to the SID planning, but a low level of confidence for the STAR planning.	OK for SID PARTIALLY OK for STAR
OBJ-18.02c-TRL6-TVALP-OF13	To assess the impact of dynamic SID/STAR updates in the eFPL on the FOC workload	CRT-18.02c-TRL6-VALP-OF13-001	Solution 18.02c provides evidence that the increase of FOC workload due to FOC action is acceptable.	EX3-CRT-18.02c-TRL6-VALP-OF13-001 Details listed in the survey report. Automation for future dispatch use is required. Such an automation functionality was not foreseen for the validation exercise.	PARTIALLY OK
OBJ-18.02c-	To validate that the integration of	EX3-CRT-	Solution 18.02c provides evidence	As no pilots have attended the validation	NOK

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #3 Validation Results**	**Technical Validation Objective Status**
TRL6-TVALP-OF14	dynamic SID/STAR updates in eFPL improves the safety	18.02c-TRL6-VALP-OF14-001	that the integration of real time SID/STAR updates in the eFPL reduces or at least does not increase the pilot workload.	exercise, this objective has not been assessed during the exercise.	🟥

4.1.4 Target Time Use in eFPL (Iteration #3)

In the following table is presented the summary of the results per validation objective and associated success criteria, obtained through the Iteration #3 “Target Time Use in eFPL”.

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
OBJ-18.02c-TRL6-TVALP-TF6	To Assess Technical Feasibility of the TTA integration in the FOC system	CRT-18.02c-TRL6-TVALP-TF6-001	Solution 18.02c provides evidence of the integration of TTAs by FOC System in the eFPL.	EX3- CRT-18.02c-TRL6-TVALP-TF6-001 The dispatcher changed according to the TTA information the original operational flight plan, modifying the Estimated Off-block time or the Cost Index. Nevertheless, the integration of the available B2B services for TTA from LEBL airport into Lido/Flight from Lufthansa Systems was not fully demonstrated: the Validation Objective	NOK

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
				has not been demonstrated at TRL6 level (No proper technical requirements to propose).	
OBJ-18.02c-TRL6-TVALP-OF16	To validate that the TTA/TTO integration in the AU trajectory eFPL improves the AU cost efficiency.	CRT-18.02c-TRL6-VALP-OF16-001	Solution 18.02c provides evidence that the CTOT slot influenced by the FOC reduces the extra operating costs (flight cost delay related) compared to the initial CTOT provided by the NM	EX3-CRT-18.02c-TRL6-VALP-OF16-001 The costs trajectory oriented always increased due to the additional TTA requirement. A delay impact assessment in reference to costs have not been performed by the flight dispatchers.	NOK
EX3-OBJ-18.02c-TRL6-TVALP-OF16	To validate that the TTA/TTO integration in the AU trajectory eFPL improves the AU cost efficiency.	CRT-18.02c-TRL6-VALP-OF16-002	Solution 18.02c provides evidence that the difference of total planned fuel is reduced between the trajectory taking the NM given CTOT and the trajectory taking the influenced CTOT (trajectory before and after TTA)	EX3-CRT-18.02c-TRL6-VALP-OF16-002 Not assessable due to lack of data.	NOK
OBJ-18.02c-TRL6-TVALP-OF17	To assess the impact of TTA integration into the eFPL on the FOC workload	CRT-18.02c-TRL6-VALP-OF17-001	Solution 18.02c provides evidence that the number of manual FOC updates does not increase.	EX3-CRT-18.02c-TRL6-VALP-OF17-001 Due to missing any automation in the FOC prototype for TTA management, the dispatchers rate the	NOK

SESAR Technological Solution 18-02c – Iteration #3					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
				workload as not acceptable to manage their tasks.	
OBJ-18.02c-TRL6-TVALP-OF18	Impact of the TTA/TTO on the Departure time	CRT-18.02c-TRL6-VALP-OF18-001	Solution 18.02c provides evidence that TTA integration in the AU trajectory improves the flexibility on Departure Time by at least 10% of the cases.	EX3-CRT-18.02c-TRL6-VALP-OF18-001 Not assessable due to very limited data and due to prototype limitations.	NOK
OBJ-18.02c-TRL6-TVALP-CO1	To Assess Operational acceptability of the eFPL use in TTA management from DCB perspective.	CRT-18.02c-TRL6-VALP-CO1-001	Solution 18.02c assesses the operational acceptability – from a DCB perspective - of the management of Target times in conjunction with eFPLs integrating AOP/NOP information and provides evidence that the NMF actors/experts do not identify any side effect – e.g instability of the demand or Target Time – impacting negatively network or local DCB performances.	EX3-CRT-18.02c-TRL6-VALP-CO1-001 Not enough data to draw conclusions but no negative effects were observed in the AOP/NOP and DCB with the TTA updated flights.	PARTIALLY OK

4.2 Detailed analysis of SESAR Technological Solution Validation Results per Validation objective

4.2.1 Distribution and Use of eFPL Data by ATC (Iteration #1)

4.2.1.1 OBJ-18.02c-TRL6-TVALP-TF1 Results

SESAR Technological Solution 18-02c – Iteration #1					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
OBJ-18.02c-TRL6-TVALP-TF1	eFPL Distribution to ATC To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	CRT-18.02c-TRL6-TVALP-TF1-001	Solution 18.02c provides evidence that a set of eFPL has been distributed to ATC using B2B service (yellow SWIM).	The distribution of eFPL to ATC via the B2B service has worked properly. No technical issues have been noticed during the validation period	OK
OBJ-18.02c-TRL6-TVALP-TF1	eFPL Distribution to ATC To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	CRT-18.02c-TRL6-TVALP-TF1-002	Solution 18.02c provides evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing.	The eFPL flight Plan data distributed to ATC via the B2B service have been extracted and injected in the ATC ground Flight Data Processing system from the validation platform. All eFPLs have been treated	OK

SESAR Technological Solution 18-02c – Iteration #1					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
				in the FDP system	

The objective was to assess the technical feasibility of the eFPL distribution from NM to ATC via B2B service.

There were two success criteria in order to validate the abovementioned objective, therefore:

- **CRT-18.02c-TRL6-TVALP-TF1-001** - To provide evidence that a set of eFPL has been distributed to ATC using B2B service (yellow SWIM)
- **CRT-18.02c-TRL6-TVALP-TF1-002** - To provide evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing

CRT-18.02c-TRL6-TVALP-TF1-001 :

The reception of eFPL via the B2B service of NMVP has been performed without any technical issues or problems. The connection was established during the exercise validation period and eFPLs were received in skyguide premises as expected.

The following results and conclusions have been gathered from the Iteration #1 exercise:

- 1.703 flights have been considered throughout the days of operations (tracks and flight plans recorded) as they were controlled by Geneva ACC, in the operational systems.
- 1.043 extended Flight Plans (eFPLs) have been received from EUROCONTROL using the NMVP B2B system. In order to ensure completeness of received data, the eFPLs have also been distributed by email. Therefore, it has been possible to check the completeness of data. No discrepancy has been noticed.
- 84 of these eFPLs flew over Geneva FIR and therefore were controlled by Geneva ACC.
- None of the flights controlled by Geneva ACC were rejected. Hence, the rejected flight plans did not cross the Geneva FIR.

CRT-18.02c-TRL6-TVALP-TF1-002

The sample of eFPL Flight Plan data (Lufthansa) has been analysed and extracted. Internal Trajectory Prediction tool has been adapted to take into account data coming from eFPL. Mainly the evolving Mass of the aircraft has been considered as the main input in the Trajectory Prediction tool.

The OSYRIS O4D Trajectory Prediction tool algorithm is using BADA aircraft parameters. The aircraft Mass linked to each navigation point in the eFPL have been extracted and taken into account in the internal computation of the Mass Factor, which is the parameter used by the Trajectory Prediction tool to compute the trajectory taking into account the aircraft performance linked with the Mass Factor.

This Mass Factor computed from the eFPL Mass data has been used to compute the Trajectories of the sample all along their flight through the Swiss airspace.

The following results and conclusions have been gathered from the conducted exercise:

- 1.703 flights have been considered throughout the day of operations (tracks and flight plans recorded) as they were controlled by Geneva ACC.
- 1.043 extended Flight Plans (eFPLs) have been received from EUROCONTROL using the NMVP B2B system. In order to ensure completeness of received data, the eFPLs have also been distributed by email. Therefore it has been possible to check the completeness of data. No discrepancy has been noticed.
- 84 of these eFPLs flew over Geneva FIR and therefore were controlled by Geneva ACC..
- None of the flights controlled by Geneva ACC were rejected. Hence, the rejected flight plans did not cross the Geneva FIR.

4.2.1.2 OBJ-18.02c-TRL6-TVALP-OF1 Results

SESAR Technological Solution 18-02c – Iteration #1					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
OBJ-18.02c-TRL6-TVALP-OF1	Use of eFPL data in ATC system for Trajectory Prediction To Assess the benefits of the eFPL Distribution to ATC on the	CRT-18.02c-TRL6-VALP-OF1-001	Solution 18.02c provides evidence that the ATC Ground Trajectory Predictor using specific eFPL data (Aircraft Mass, speed profile ...)	Due to technical limitation on the Trajectory Predictor tool from the platform, the assessment of the increased	NOK

SESAR Technological Solution 18-02c – Iteration #1

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #1 Validation Results	Technical Validation Objective Status
	Trajectory Prediction.		is more precise than legacy ATC Ground Trajectory Predictor using legacy ICAO FPL, when both are compared to the flown trajectory.	precision of the trajectory computation could be only verified on the introduction of the aircraft Mass in the trajectory computation process. Other elements such as speed profiles could not be tested.	🟥

The objective was to assess the benefits of the eFPL Distribution to ATC on the Trajectory Prediction.

There was one success criteria in order to validate the abovementioned objective, therefore:

- To provide evidence that the ATC Ground Trajectory Predictor using specific eFPL data (aircraft Mass, speed profile ...) is more precise than legacy ATC Ground Trajectory Predictor using legacy ICAO FPL, when both are compared to the flown trajectory.

In most of the Trajectory Predictor used in the operational systems, the computation of the trajectory is based on generic data and aircraft model. The algorithm is often based on a Total Energy Model using data from a database (e.g. BADA). As it is mainly generic, the real performance of the aircraft is not taken into account in the computation. Several factors (parameters) have a significant importance on the calculation of the trajectory and in particular at planning level.

In this iteration, the objective was to take into account some more accurate parameters that are included in the eFPL standard format. Mainly the weight if the aircraft on each navigation point has been taken into account in the trajectory computation therefore including some more accurate data in that process.

Refer to A.1.1.1 Platform description and B2B connection.

The computation of the trajectory prediction considers a mass factor, that is set to its maximum value in the baseline system, i.e. a pessimistic approach is chosen for the estimation of the trajectories. This mass factor has been recalculated considering the weight obtained for each route point in the eFPL and the maximum weight of the aircraft.

There are 72 ETOs differing significantly between their baseline recorded trajectory (without eFPL) and the recorded trajectory with aircraft weight (with eFPL). These differences are uniquely associated to configuration differences/mismatches between the two machines (runway).

Some ETOs show a slight difference (one or two seconds for the whole trajectory – multiple minutes of flights). Therefore, it is not meaningful to develop or to show statistics on the impact of the aircraft mass on the 4D trajectory predictions, given the limited sample of flights impacted.

4.2.1.3 OBJ-18.02c-TRL6-TVALP-OF2 Results

SESAR Technological Solution 18-02c – Iteration #1					
Technical Validation Objective ID	**Technical Validation Objective Title**	**Success Criterion ID**	**Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
OBJ-18.02c-TRL6-TVALP-OF2	Exhaustiveness of eFPL data in ATC system for Trajectory Prediction To assess that all the information from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC.	CRT-18.02c-TRL6-VALP-OF2-001	Solution 18.02c provides evidence that all the information from the eFPL distributed by NM through the B2B service fulfil ATC needs for better Trajectory Prediction and no useful information for ATC needs are missing (exhaustiveness of the information for ToC, ToD, Flight Specific performance data, weight...).	Due to technical limitation on the Trajectory Predictor tool from the platform, the assessment of the increased precision of the trajectory computation could be only verified on the introduction of the aircraft Mass in the trajectory computation process. Other elements such as speed profiles could not be tested.	Partially OK

The objective was to assess that all the information from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC.

There was one success criteria in order to validate the abovementioned objective, therefore:

- To provide evidence that all the information from the eFPL distributed by NM through the B2B service fulfil ATC needs for better Trajectory Prediction and no useful information for ATC needs are missing (exhaustiveness of the information for ToC, ToD, Flight Specific performance data, weight...)

For TP improvement, mainly the aircraft mass has been considered in trajectory prediction computation.

Considering one of the only two flights departing from Geneva Airport (LSGG) and having an eFPL with aircraft weight, some differences can be identified between the flight climbing envelopes (steepest/lowest) for the two recorded scenarios. For the baseline scenario, green lines in the figure below, the steepest and the lowest profiles are significantly different (wider envelope). Whereas for the scenario considering aircraft weights, red/rose lines in the figure below, the envelope is narrower (steepest and lowest profiles are closer to each other).

In terms of climbing profiles, they have been found to be identical for both recording scenarios (with and without eFPL) throughout the duration of the exercise (full day).

Due to the limited number of samples, no firm conclusion can be drawn.

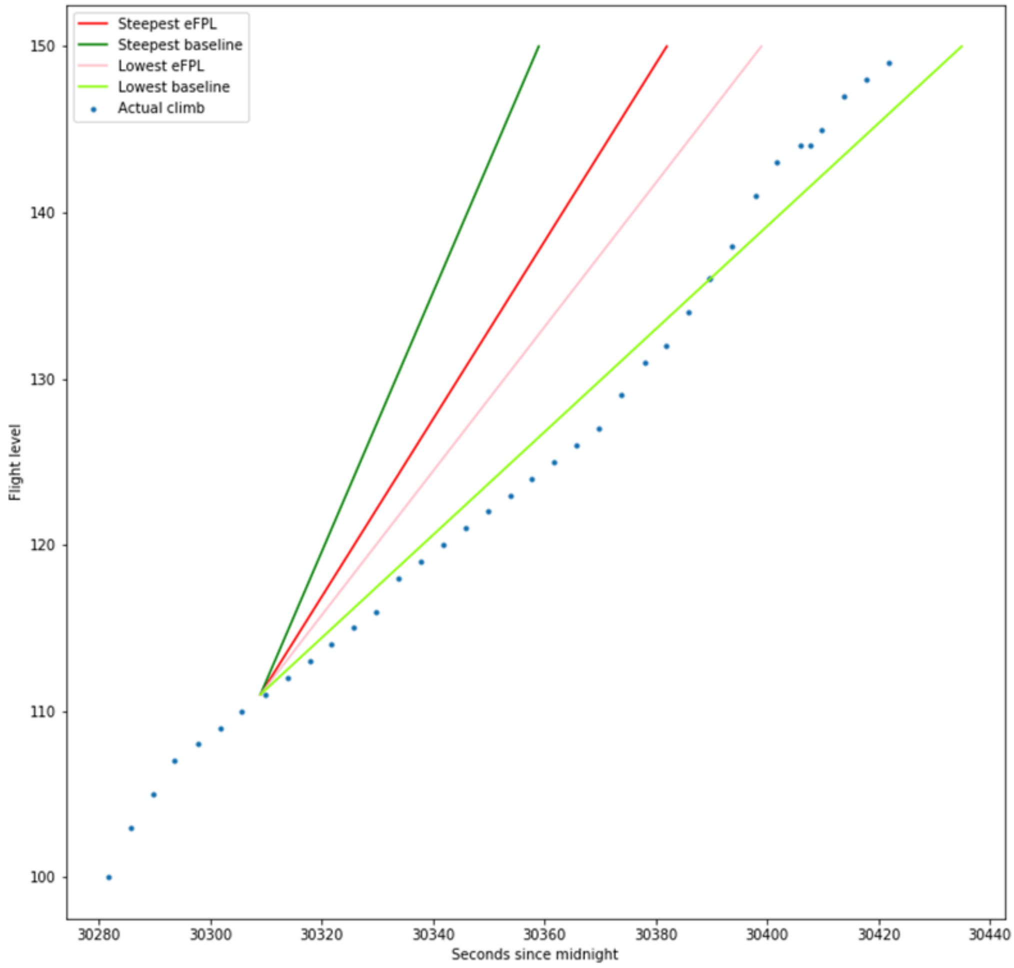

Figure 1: flight climbing envelopes (steepest/lowest) for the two recorded scenarios

4.2.2 Use of PTRs (Iteration #2)

4.2.2.1 OBJ-18.02c-TRL6-TVALP-TF2 Results

The exercise phase covering this objective is described in full details in B.3.2.1.

4.2.2.2 OBJ-18.02c-TRL6-TVALP-OF19 Results

The exercise phase covering this objective is described in full details in B.3.2.2.

4.2.2.3 OBJ-18.02c-TRL6-TVALP-OF20 Results

The exercise phase covering this objective is described in full details in B.3.2.3.

4.2.2.4 OBJ-18.02c-TRL6-TVALP-OF21 Results

The exercise phase covering this objective is described in full details in B.3.2.4.

4.2.3 Dynamic SID/STAR information in eFPL (Iteration #3)

4.2.3.1 OBJ-18.02c-TRL6-TVALP-TF3 Results

The exercise phase covering this objective is described in full details in C.3.2.1.

The dispatcher changed according to the Departure/Arrival Runway information the original operational flight plan based on new runway configuration information. As displayed in the remark field of the FOC prototype, which was the trigger to change the flight plan: for many of the flights the flight dispatcher has adapted additional information like SID, STAR and taxi time .

The adaptation of the Runway information has been performed for the SID/STAR scenario as well as the TTA scenarios.

4.2.3.2 OBJ-18.02c-TRL6-TVALP-TF4 Results

The exercise phase covering this objective is described in full details C.3.2.2.

The technical integration of the available B2B services for assigned SID information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.

4.2.3.3 OBJ-18.02c-TRL6-TVALP-TF5 Results

The exercise phase covering this objective is described in full details C.3.2.3.

The technical integration of the available B2B services for assigned STAR information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.

4.2.3.4 OBJ-18.02c-TRL6-TVALP-OF11 Results

The exercise phase covering this objective is described in full details C.3.2.4.

Due to the low number of flight dispatcher updates, the results are not representative. Below are expressed first the results in average for the full dataset (low significance) and then the results for individual cases with positive impact for the success criteria.

With metrics computed in average,

> The integration of the dynamic SID / Runway updates on the eFPL demonstrated the following trend in the improvement of the AU Trajectory Alignment with NM systems:

For the situations with SID/Departure Runway updates,

- The average results are not significant for the alignment of the EET / FL in the SID & STAR procedures neither for the points in common on the trajectory:
- The trend is a significant improvement for the alignment of the Arrival Time, especially when the SID procedure before the CHG update was not aligned (Up to 24% of reduction of the Arrival Time difference at ADES – 61s in average).

For the situations with STAR / Arrival Runway updates,

- The average results are not significant for the alignment of the EET / FL in the SID & STAR procedures neither for the points in common on the trajectory.
- The average results are not significant for the alignment of the Arrival Time.

With the study of individual cases (those with positive impact with improvement above 10 FL / 60 seconds),

The integration of the dynamic SID/STAR on the eFPL demonstrated a significant trend in the improvement of the AU Trajectory Alignment with NM systems. The AU EFPL 4D planned trajectory computed with dynamic SID/STAR is closer to the NM planned trajectory (ETFMS) than the AU EFPL 4D planned trajectory computed without dynamic SID/STAR - It reduces the difference in four dimensions for multiple individual cases:

For the situations with SID/Departure Runway updates:

- Up to 70% of reduction of the difference of Flight Levels at last SID point (16% of the cases)
- Up to 75% of reduction of EET difference at last SID point (22% of the cases)
- Up to 76% of reduction of EET difference at last STAR point (33% of the cases)
- Up to 64% of reduction of EET difference for the trajectory point in common (27% of the cases).
- Up to 70% of reduction of Arrival Time difference at ADES (39% of the cases).

For the situations with STAR / Arrival Runway updates (especially when AU and NM trajectories are not aligned before the flight dispatcher update):

- Up to 61% of reduction of the difference of Flight Levels at first STAR point (22% of the cases).

- Up to 87% of reduction of the of EET difference on the first STAR point (33% of the cases).
- Up to 54% of reduction of Arrival Time difference at ADES (78% of the cases).

For the other individual cases,

Some degradation of the Alignment have been explained by the lack of implementation for the Vertical Limits in the SID/STAR definition or the non-correctness of the AU 4D trajectory or the mis-alignment of the “other” procedure (SID misaligned when STAR is updated, STAR misaligned when the SID is updated).

For the remaining cases, the results of the metrics, analysed in average, does not demonstrate neither an improvement nor a degradation of the AU Trajectory alignment with NM systems.

4.2.3.5 OBJ-18.02c-TRL6-TVALP-OF10 Results

Due to the low number of updates, the results are not representative.

The integration of the dynamic SID on the eFPL demonstrated a significant trend for improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension:

For the time dimension,

- Up to 100% of EET improvement on the last SID point;
- Up to 90% of EET improvement on the first STAR point;
- Up to 91% of EET improvement for the points in common on the trajectory;
- Up to 95% of improvement for the Arrival Time.

For the altitude dimension,

- Full predictability (0 FL difference) in the SID & STAR procedures either for the points in common on the trajectory;

Nevertheless,

Due to the low number of updates, the results are not representative.

The Predictability is not based on the last real flown trajectory.

Because all the necessary updates have not been done by the flight dispatcher, for example when the FOC prototype receives an OPS update following an update done by the AU Flight Dispatcher, some AU trajectories have been discarded from the analysis. We could assume that other AU Trajectory updates (including the SID update) could be missing (not done neither by the Flight dispatcher, neither automatically by the FOC prototype) and that could continuously improve the trend for improvement of the predictability.

4.2.3.6 OBJ-18.02c-TRL6-TVALP-OF22 Results

The exercise phase covering this objective is described in full details C.3.2.6.

Due to the low number of updates, the results are not representative.

The integration of the dynamic STAR on the eFPL demonstrated a significant trend for improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension:

For the time dimension,

- Up to 84% of EET improvement on the first STAR point;
- Up to 75% of improvement for the Arrival Time.

For the altitude dimension,

- Full predictability (0 FL difference) in the SID & STAR procedures either for the points in common on the trajectory;

Nevertheless,

Due to the low number of updates, the results are not representative.

The Predictability is not based on the last real flown trajectory.

Because all the necessary updates have not been done by the flight dispatcher, for example when the FOC prototype receives an OPS update following an update done by the AU Flight Dispatcher, some AU trajectories have been discarded from the analysis. We could assume that other AU Trajectory updates (including the SID update) could be missing (not done neither by the Flight dispatcher, neither automatically by the FOC prototype) and that could continuously improve the trend for improvement of the NM Traffic predictability.

4.2.3.7 OBJ-18.02c-TRL6-TVALP-OF12 Results

The exercise phase covering this objective is described in full details C.3.2.1.

The fuel assessment with the decision process for updating SID/STAR was done by the flight dispatchers during the exercise. There did not show us explicitly a scenario, where the flight dispatcher declined to use another STAR due to fuel reason. In general, the more precise SID/STAR information however leads to an overall more precise fuel calculation.

Nevertheless, the questionnaire highlighted a good level of confidence for the fuel decision making (planned and extra fuel) related to the SID planning, but a low level of confidence for the STAR planning.

4.2.3.8 OBJ-18.02c-TRL6-TVALP-OF13 Results

The exercise phase covering this objective is described in full details C.3.2.2.

The integration of the dynamic SID/STAR on the eFPL demonstrated partially that the increase of FOC workload due to FOC action is acceptable.

Automation for future dispatch use in the FOC prototype is required. Such an automation functionality was not foreseen for the validation exercise.

4.2.3.9 OBJ-18.02c-TRL6-TVALP-OF14 Results

The exercise phase covering this objective has not been able to assess the objective (refer to C.3.2.3).

4.2.4 Target Time Use in eFPL (Iteration #3)

4.2.4.1 OBJ-18.02c-TRL6-TVALP-TF6 Results

The exercise phase covering this objective is described in full details C.3.2.4.

The dispatcher changed according to the TTA information the original operational flight plan, modifying the Estimated Off-block time or the Cost Index.

The integration of the available B2B services for TTA from LEBL airport into FOC Systems was not used satisfactorily by the Flight Dispatchers and was not fully demonstrated. The Validation Objective has not been demonstrated at TRL6 level (No proper technical requirements to propose).

4.2.4.2 OBJ-18.02c-TRL6-TVALP-OF16 Results

The exercise phase covering this objective is described in full details C.3.2.5.

This AU cost efficiency with the TTA/TTO integration in the AU trajectory has not been assessed due to lack of data.

4.2.4.3 OBJ-18.02c-TRL6-TVALP-OF17 Results

The exercise phase covering this objective is described in full details C.3.2.6.

The impact of TTA integration into the eFPL on the FOC workload has been assessed with a survey: Due to missing any automation in the FOC prototype for TTA management, the flight dispatchers rate the workload as not acceptable to manage their tasks.

4.2.4.4 OBJ-18.02c-TRL6-TVALP-OF18 Results

The exercise phase covering this objective is described in full details C.3.2.7.

The impact of the TTA/TTO on the Departure time has not been assessed.

4.2.4.5 OBJ-18.02c-TRL6-TVALP-CO1 Results

The exercise phase covering this objective is described in full details C.3.2.8.

Before and after the TTA publication and flight plans updates, no specific variation of the traffic loads, traffic counts have been observed.

4.3 Confidence in the Validation Results

4.3.1 Limitations of Technical Validation Results

4.3.1.1 Distribution and Use of eFPL Data by ATC (Iteration #1)

Regarding Iteration #1, four main limitations that have been identified, considering the used data, tools and the scope of the analysis. These limitations are the following:

- ***Limited number of eFPL flights:***

  within the sample of flights considered for the analysis, the number of eFPL flights has been scarce, leading to limited results and conclusions in particular for measuring Trajectory Predictor improvement.

- ***Within the sample of eFPL, there was a limited number of vertical evolving eFPL flights:***

  the analysis conducted for vertical evolving flights also leads to very limited conclusions due to the fact that only few eFPL flights had a vertical evolving profile within the geographical scope of the analysis

- ***Limited trajectory prediction tool modification possibilities (software):***

  The Trajectory Predictor available on the validation platform for this exercise is a COTS and some modifications envisaged initially could not be implemented as access to some functions was limited. Therefore only the aircraft Mass extracted from the eFPL could be used in the Mass Factor computation of the Trajectory Predictor tool.

- ***Limitations about replay:***

  Due to some issues of data recording and storage, it could not be possible to perform the replay session as expected. However, the initial analysis of trajectories with the limited Trajectory Predictor improvement showed only minor improvement compared to trajectories computed without Trajectory Predictor improvement.

4.3.1.1.1 Quality of Technical Validation Exercises Results

Upon the execution of the technical validation exercises, it can be concluded that the results of these exercises are of good quality in terms of accuracy and confidence for the technical part limited to ability to receive eFPL data and inject these data in the Flight Data Processing system.

However, concerning the use of eFPL data in the Trajectory Predictor to get better accuracy on trajectories used by the ATM system, limitations have been encountered on the Trajectory Predictor module used in the platform dedicated to PJ.18-02c. Therefore the Trajectory Predictor algorithm could not be modified as expected and only limited eFPL data could be used in the algorithm.

4.3.1.1.2 Significance of Technical Validation Exercises Results

Regarding the technical validation of the B2B connection and the distribution of eFPL though this B2B connection, no issue have been noticed during the validation exercise and therefore the significance of the technical validation results is considered high for this part.

Regarding the results of Iteration #1 Technical Validation Exercises, limited significance has been identified due to limited number of data (number of eFPL) used for the exercises.

The Trajectory Predictor improvement could not be assessed as expected due to the fact that the Trajectory Predictor was not accessible as initially envisaged, therefore, only limited modification using the Mass extracted from the eFPL and injected in the Trajectory Predictor were performed, limiting the potential benefit analysis.

However, the use of some additional data (TOC, TOD) provided in the eFPL certainly bring benefit to the ATC support tools and situation awareness of the ATCO. The use of these data in the Trajectory Predictor computation could be envisaged if the trajectory coming from eFPL could include some ATC constraints that have impact on the TOC and TOD. The Rate of Climb (ROC) and speed schedule can also be foreseen as useful information as it takes into account the aircraft information (mass, cost index etc…).

4.3.1.2 Use of PTRs (Iteration #2)

For the limitations influencing the quality and the significance of this Technical Validation Exercise Results #2, refer to B.3.4.1.

4.3.1.2.1 Quality of Technical Validation Exercises Results

The core limitation of the exercise execution base on the limited flights (~26) used for the exercise. So the statistical results for the alignment analysis shows primary trends, as the sample of considered flights is too low. However, it can be concluded that the results of these exercises are of good quality in terms of accuracy and confidence for considered flight plans.

In overall it is guaranteed, that it will be a significant improvement for the 4D Trajectory alignment between FOC systems and NM, if the PTR's are already considered within the flight planning process.

4.3.1.2.2 Significance of Technical Validation Exercises Results

Regarding the technical validation of the B2B connection and the validation of flight plans either through NMVP or IFPUV, no issue have been noticed during the validation exercise and therefore the significance of the technical validation results is considered high for this part.

For the PTR implementation into the FOC system, however no B2B services were used, all translations of the publication was done an manual level. This could somehow influence the right implementation, as always interpretation for the PTR regulations was possible. This was best limited through expert discussions of EUROCONTROL and Lufthansa Systems.

4.3.1.3 Dynamic SID/STAR information in eFPL & Target Time Use in eFPL (Iteration #3)

For the limitations influencing the quality and the significance of this Technical Validation Exercise Results #3, refer to C.3.4.1.

4.3.1.3.1 Quality of Technical Validation Exercises Results

For the SID/STAR updates,

The Phase 1 (Technical feasibility) of the exercise analysed the content of the flight messages exchanged between the FOC prototype and NM Systems. It proved the feasibility of using SID/STAR/Runway updates in the AU trajectory as an additional means to update the ETFMS profile. . The ***quality*** of these values is considered as ***good***.

In the Phase 2 for Alignment and NM Traffic Predictability, these updates resulted in improved ETFMS profiles with extraction of the point profiles, identification of the SID/STAR procedures flown by the flight, extraction of the EET/FL at some points of the trajectory. The ***quality*** of these values is considered as ***good***.

However, the scope of the study was limited due to external circumstances. This scope reduction only allowed producing general indicators of improvement or degradation: With the limited sample size, ***the metrics do not have statistical significance***.

Due to limitations listed in part C3.4.1, the quality of the results leaves room from improvement with:

- The adaptation of the CDM process;
- AU 4D trajectory with implementation of the Vertical Limits in the SID/STAR definition.

For the TTA updates,

The ***quality*** of these results is considered as ***low***. The questionnaire (Refer to F.1.3 TTA) highlights a low level of confidence from the Flight Dispatchers.

4.3.1.3.2 Significance of Technical Validation Exercises Results

Due to the low number of updates, the ***results are not representative***. The quantitative results should be taken very cautiously and hence be confirmed with a further runs.

For the SID/STAR updates,

Regarding the results of Iteration #3 Technical Validation Exercises, ***limited significance*** of the results has been identified due to low number of Flight Dispatcher updates used for the exercises. The data processed was rather limited due to prototype constraints that forced to more manual actions by dispatchers than expected, reducing the amount of processed data.

The results leaves room for improvement due to the following limiting factors

- Traffic sample Size limited to a small list of city pairs
- Only 68 updates (SID/STAR/TTA))

Nevertheless, the results can be seen as an important milestone on towards the full validation of the SID/STAR concept; operational experts gathered with questionnaires first impressions (Refer to F.1).

For the TTA updates,

These results are considered ***as non-significant***.

5 Conclusions and recommendations

5.1 Conclusions

This section gives a summary of the conclusions raised by the synthesis of the different Technical Validation exercises analysis.

5.1.1 Conclusions on SESAR Technological Solution maturity

The following table provides an overview of the technical maturity achieved for the three OIs and associated enablers addressed by the solution.

OI /Topic	TRL 6 maturity status	Justification
0I AUO -0226 eFPL information use in ATC	**TRL 6 achieved for the following enablers:** - **NIMS-21b** - **SWIM-APS-18** **TRL 6 not achieved for the enabler ER APP ATC 82**	The technical objectives related to eFPL data distribution by NM and the integration of the information in ATC system have been achieved. The benefit of using some eFPL data in ATC trajectory prediction has been demonstrated in SESAR 1 projects (projects PJ.5.5.2 and PJ.4.5/5.5.). The enabler ER APP ATC 82 cannot be considered as having achieved TRL 6 since this enabler was only very partially addressed during the iteration 1 exercise.
0I AUO-0223 Integration of PTRs in AUO flight planning	**TRL 6 not achieved for the following enablers:** - **AOC-ATM-11** - **ER APP ATC 170** - NIMS-55 - SVC-001 - SVC-002 - SWIM-APS-14 - SWIM-APS-15 - SWIM-APS-16	Technical feasibility of integrating all PTRs in AU systems has only been partially achieved. Objectives related to dynamic PTRs have not been addressed. Objectives related to predictability improvement have not been addressed.
OI AU0-0225 Enhanced Target time management by the use of eFPL	**TRL 6 not achieved** for the following enablers:. - AOC-ATM-22 - SVC-003	TTA Benefit mechanisms related to eFPL updates considering TTA information not agreed in general by end users TTA Use-case not fully clarified.
OI AUO-0229	**TRL 6 achieved** for the following enablers	Technical feasibility to integrate dynamic SID/runway information in AU flight planning demonstrated.

Harmonised and improved integration of AOP/NOP information in trajectories calculated by FOCs and NM	provided that their scope is limited to departure information from CDM airports: - AOC-ATM-23 - NIMS-54 - SVC-003 - SWIM-APS-17.	Use cases and information flows related to the use of departure SID and Taxitime for CDM airports clarified (Including timeliness of information). Benefit mechanisms related to SID/ Runway / Taxitime info use in FPL agreed by end users (dispatchers).
		Technical feasibility to integrate dynamic STAR/runway information in AU flight planning demonstrated. Planned STAR information reliability and positive contribution to predictability not demonstrated. Runway configuration in use information, which is available in NOP, is not reliable enough to allow predictability improvement at AU flight planning side.

5.1.2 Conclusions on technical feasibility

For the Distribution and Use of eFPL Data by ATC (Iteration #1)

The technical validation has demonstrated the technical capability of the distribution of eFPLs from NM to ATC using the B2B services and the ability of ATC Flight Data Processing systems to treat Flight Plan data from the eFPL format.

Regarding the use of eFPL to improve ATC trajectory prediction and ATC support tools (conflict detection tools, monitoring aids…)**,** due to technical limitation for the modification of the Trajectory Predictor tool and subsequently the ATC support tools, no relevant results can be shown from this exercise.

However, from brainstorming sessions with end-users, TOC, TOD can be considered useful as information for the ATCO and the use of these data in the TP computation could be envisaged if trajectory coming from eFPL could include some ATC constraints that have impact on TOC and TOD. ROC and speed schedule can also be foreseen as useful information as it takes into account the aircraft information (mass, cost index etc…).

Moreover, in the past two SESAR 1 projects have demonstrated the benefits to use some eFPL data to improve ATC trajectory prediction:

- Project 5.5.2 ([24], [25]) has showed the benefits of using the Take-off mass and the speed profile of the 4D trajectory to improve traffic prediction as well as conflict detection and resolution in the climbing phase.
- Project 4.5/5.5 ([17]) has showed the benefit to use flight specific performance data in the eFPL to improve ATC trajectory prediction in climbing and descending phases.

Therefore the **TRL6** maturity level can be considered as achieved.

Flight Data Processing systems are able to treat Flight Plan data from the eFPL format, therefore the use of additional data coming from the eFPL in the overall Trajectory Prediction process is possible and depends on Trajectory Prediction tool flexibility in development phase.

For the Dynamic SID/STAR information in eFPL & Target Time Use in eFPL (Iteration #3)

The qualitative results recorded from questionnaires and extensive feedback are positive or very positive regarding the use of departure as well as arrival information as provided by AOP/NOP to elaborate the final flight plan easier and more accurately than in current operations and to increase awareness.

The following elements were clarified during human-in-loop exercise:

- Updates of FPL should occur only at specific milestones rather than event based when receiving AOP/NOP information. The final milestone should be somewhere close to 1H before off-block defined by each AU based on their characteristics of their operations;
- AUs should not necessary plan in the FPL the same SID/STAR as the planned SID or STAR information received from airports but they should at least plan a SID/STAR consistent with the planned departure/arrival runway or the runway configuration in use in AOP/NOP;
- Depending on AU and the FOC organisation and system, FPL updates could be either fully automated in case of runway/SID/STAR changes, either partially automated with only a dispatch monitoring activity of changes;
- In most of the cases, the taxi time info will not trigger an update of the flight plan. However, it would be useful to have it available in the AU system in case of FPL update for other purpose.

The integration of the dynamic SID/STAR/runway information on the eFPL with their consequent updates to NM demonstrated an improvement of the NM predictability from predicted to the last planned/before airborne (updated by an A-CDM or AOP message), reducing in particular the difference in overall profile EET calculated respectively by the AU and NM.

Regarding TTA, in general the feeling is that TTA would be useful to increase awareness and be informed about the main constraint at the arrival but not to update the flight plan. However the opposite opinion was also clearly stated but in minority.

More precisely the following conclusions were derived from human-in the-loop sessions:

- In general, the flexibility given to AU to re-optimise the trajectory considering the TTA will not be used since the current flight plan represents already the optimal trajectory in most of the cases. There may be some cases when it will be useful but it will be the exception;
- The decision related to the management of the TTA delay (e.g. shift the EOBT/low speed/route stretching) could be partially automated but will require human supervision;
- It may be useful to generate a new eFPL with shift of Departure Time to cope with TTA for high delay to check that the flight plan is still flyable and optimised.

For the Use of PTRs (Iteration #2)

PTR publications formats need to exactly follow the publication format of RAD restrictions to be processed from FOC systems.

E.g. publications like following are not easy to automatize through an FOC system.

LFRR1041A Y DEST LFRB LFRJ LFRU LFRQ LFRO VIA TERPO UM616 KORER AVOID LFRRNS. PROFILE DOES NI-NS-IN-ID PHONE CALL FROM FMP MANAGER; DMR 099718 AVOID LFRRNS$28/05/2015 11/12/2036 Y 0000 0000 ---- 1234567

From airline perspective, only the flight specific and relevant PTR's must be considered.

ATC authorities have to publish and transform valid PTR's.

5.1.3 Conclusions on performance assessments

N/A.

5.2 Recommendations

5.2.1 Recommendations for next phase

This section provides general recommendations to address the concepts under validation in the next phase for each iteration.

For the Distribution and Use of eFPL Data by ATC (Iteration #1):

- To further study the impact of some eFPL data in the processing of Trajectory computation by ground system and then study the impact on subsequent ATC support tools such as Conflict detection tools, monitoring aids with this improved data.
- To perform a study on ATCO situation awareness improvement about the AU expectation thanks to some eFPL new data (e.g. Top of Climb, Top of Descent, speed profile…) to measure the benefit of such information available on display.

For the Dynamic SID/STAR information in eFPL / Target Time Use in eFPL (Iteration #3):

- Adapt the NM system (ETFMS) to treat the case when AU choice of SID does not corresponds to the SID provided by the DPI by an A-CDMI, although the runway is respected. In current operation version, the ETFMS system discards an AU SID update that does not align with the received SID in DPI. For the future, should ETFMS consider a different rule of priority in the ranking of SID/STAR updates?

- The provision of AOP/A-CDM SID and runway information to AU and its use to update the AU trajectories is potentially ready for next phase industrialisation, although the positive alignment and predictability results should be confirmed first. Taxi time may require a filter to only allow changes bigger than an agreed threshold.
- The provision of AOP/ STAR and runway information to AU is not conclusive and needs further validation to better understand some negative results in alignment.

For the Use of PTRs (Iteration #2)

Airlines should investigate in the context of operations if PTR information should be included into the briefing documentation.

Airlines & NM can think on long term, if the provision of a trajectory in the eFPL considering PTR's will help them to increase the predictability.

Airlines and NM have to assess further in implementation (i.e. not in SESAR) the aspect of the predictability improvements, as this has not been done in this validation exercise.

Airlines should in future analyze the NM calculated trajectories and brief internal all relevant stakeholders about the trajectory provided from the NM.

5.2.2 Recommendations for updating ATM Master Plan Level 2

The following changes are proposed with the aim to focus the solution on elements having achieved TRL6 maturity level:

- The OI AUO-0229 related AOP/NOP information in AU flight planning and associated enablers should be modified to focus on SID/Runway information from CDM airports. Taxi time information should also be included.
- The OIs AUO-0225 related to TTA and AUO-0223 related to PTR use in AU flight planning could be proposed for removal from the scope of the solution. Associated enablers should also be removed from the scope of the solution.

5.2.3 Recommendations on regulation and standardisation initiatives

The iteration 1 exercise has shown the feasibility and the interest for ATC – in particular for traffic departing outside ECAC - to use the information of aircraft mass at each point of the trajectory Ideally this information should be included in the eFPL – as optional information – defined by ICAO in the context of FF-ICE increment 1 and part of core FIXM data in the next release (FIXM V5.0) . Alternatively, this information should be defined in FIXM as part of a European extension.

6 References

6.1 Applicable Documents

Content Integration

[1] B.04.01 D138 EATMA Guidance Material

[2] EATMA Community pages https://ost.eurocontrol.int/sites/eatmac/default.aspx

[3] SESAR ATM Lexicon https://ext.eurocontrol.int/lexicon/index.php/SESAR

Validation

[4] SESAR 2020 Requirements and Validation Guidelines (1.1), Decembre 2017

[5] System Engineering - Methodology for the V&VP, V&VI and Demonstration Platform development, 02.00.00, February 2019

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

System Engineering

[7] SESAR 2020 Requirements and Validation Guidelines, Edition 00.01.01

Safety

[8] SESAR, Safety Reference Material, Edition 4.01, December 2018

[9] SESAR, Guidance to Apply the Safety Reference Material, Edition 3.01, December 2018

[10] WP16.06.01b D04 SESAR, Resilience Engineering Guidance, April 2017

Solution Validation

[11] SESAR 2020 Requirements and Validation Guidelines (1.1), December 2017

[12] System Engineering - Methodology for the V&VP, V&VI and Demonstration Platform development, Edition 02.00.00

6.2 Reference Documents

[13] ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.[1]

[14] Common assumptions for CBAs as maintained by Pj19 (provisionally the ones included in the 16.06.06- D68_Part 1, New CBA Model and Methods 2015, Edition 00.01.01 can be used)

[15] SESAR P07.06.02 D55 Step 1 EFPL Validation Report, October 2016

[16] SESAR P07.06.02 D05 Step 1 Business Trajectory Validation Report for 2013-2014 exercises

[17] SESAR P05.05.01 D843 Internal Validation Exercise Reports VP832 (5.5.1 Deliverable – 4.5 Contribution), Edition 01.00.00, 02/09/2016

[18] Manual on Flight and Flow — Information for a Collaborative Environment (FF-ICE), Doc 9965, https://www.icao.int/airnavigation/IMP/Documents/Doc%209965%20-%20Manual%20on%20FF-ICE.pdf

[19] D3.4.080 SESAR 2020 TS IRS - 18-02c, Edition 00.01.00, 08 Oct 2019

[20] D3.4.070 SESAR Solution 18-02c SPR-INTEROP/OSED Part I, Edition 00.01.00 - Final, 13 September 2019

[21] SESAR Solution 18-02c: Validation Plan (VALP) for V3 - Part II - Safety Assessment Plan, January 2018

[22] D.3.4.035 - SESAR 2020 TVALP Solution 18.02c v1_06

[23] SESAR Solution 18-02c SPR-INTEROP/OSED - Part II - Safety Assessment Report, 13th of August 2019

[24] SESAR P05.05.02 D03 Validation Results for Enhanced TP using AOC data, December 2011

[25] SESAR P05.05.02 D04 Final Project Report on the concept and benefits for improving TP using AOC data, August 2012

[26] FF-ICE Manual ***Draft*** Version 0.8 for ATMRPP Review, 2017-12-22, draft edition on STELLAR

[27] D3.4.070 SESAR Solution 18-02c SPR-INTEROP/OSED Part II, Edition 00.01.00 - Final, 13 September 2019

Appendix A Technical Validation Exercise #01 Report

A.1 Summary of the Technical Validation Exercise #01 Plan

The Technical Validation Exercise #1 is related to the first iteration of the PJ18.02c exercise “Iteration #1: Distribution and Use of eFPL Data by ATC” and is managed into two phases as described in PJ18.02c TVALP (Refer to [21]):

- Phase 1: Technical feasibility for the ATC Trajectory predictors
- Phase 2: The performance measurement of trajectory predictors (TPs) for the use of specific eFPL in the ATC Trajectory predictors.

A.1.1 Technical Validation Exercise #01 description and scope

This evolution addresses the use of eFPL information by ATC (OI AU0-0223) in execution mainly but based on information provided by the FOC in eFPL in pre-flight phase (FF-ICE filing).

Following previous validations results, a number of points required further studies and validation:

- Current means/format used for the distribution of ICAO 2012 flight plans (e.g. AFTN, ADEXP) cannot be reused as such for the eFPL. Therefore, existing services must be adapted or new services must be defined; and validated for eFPL distribution to ATC actors.
- Some elements of the 4D trajectory like the Top Of Climb (TOC) or Top Of Descent (TOD) may be useful to display to ATC actors to ease coordination processes with the flight crew and improve ATC quality of service.
- Some information in the 4D trajectory like levels, times at each point may be useful in some cases to improve ATC traffic prediction. Moreover, even though the eFPL content is already defined at ICAO level; there is still the possibility to identify additional elements that could be of particular interest for ATC. They could be included as part of FIXM 5.0 or in the context of a European extension. For example, the estimated aircraft weight at each point of the trajectory is not included in the eFPL and FIXM4.0 - and some ANSPs consider this information as potentially useful.
- The management by ATC of mixed traffic - some with ICAO 012 FPLs and some with eFPL - needs to be studied.

Therefore the Iteration #1 has been composed of two phases:

One technical phase, aiming at validating the transfer of the eFPL data from NM to ATC via the B2B services and the use of the Agreed Trajectory. The airspace for Flight Plans distribution will be the Swiss airspace covering Geneva and Zurich ACCs.

- Phase to be run in Shadow mode between the NMVP Platform and the Skyguide platform.

One operational phase, aiming at assessing the improvements of the Ground Trajectory Prediction by the ATC Ground Flight Data Processing with specific eFPL data by:

  - Quantifying the performance of Ground Trajectory Prediction with the flown trajectory (seen as Validation Baseline)
  - Quantifying the improvements of the Ground Trajectory Prediction based on specific eFPL data with the flown trajectory when compared to the baseline.
- To be run in Replay mode on the Skyguide platform
- The airspace for Flight Plans distribution will be the Swiss airspace covering the Geneva and Zurich ACCs.

This iteration #1 is detailed in the following paragraphs.

A.1.1.1. Platform description and B2B connection

For iteration 1, the platform used is based on the Skyguide operational system and enhanced with additional functions needed for Verification & Validation (V&V) purpose.

In particular B2B features have been implemented in order to receive the eFPLs from the NM.

The eFPLs have been retrieved from the NM eFPL distribution Publish/Subscribe service prototype in FIXM 4.0 format with the following procedure:

- Connection to NM B2B broker over AMQP 1.0..
- Creation of a subscription via the Subscription Management API.
- Recording of the messages received from the broker via a specific queue allocated for the subscription.

The data provided to the Trajectory Predictor have been upgraded with more accurate data (e.g. mass) in order to take into account in the Trajectory computation process some relevant data extracted from the eFPLs. In the Trajectory Predictor used for the iteration 1, the Trajectory computation is using the mass from the aircraft by calculating a mass index that is used in the Trajectory Predictor algorithm.

This mass index is calculated from the data in eFPL. It takes into account the aircraft weight at each trajectory point, instead of using a fixed value for the overall trajectory, as it is implemented now in Operational system. Therefore by using more realistic data, it is expected to improve the trajectory computation and therefore the accuracy of the Controller Support tools using this trajectory prediction may improve.

The V&V platform has been adapted in order to test the proposed concept and new technical means through a live environment recording, shadow mode interaction and replay session.

The validation technique is based on record and replay. Data has been recorded for analysis. Traffic is displayed on dedicated Controller Working Positions allowing monitoring and potential controller inputs.

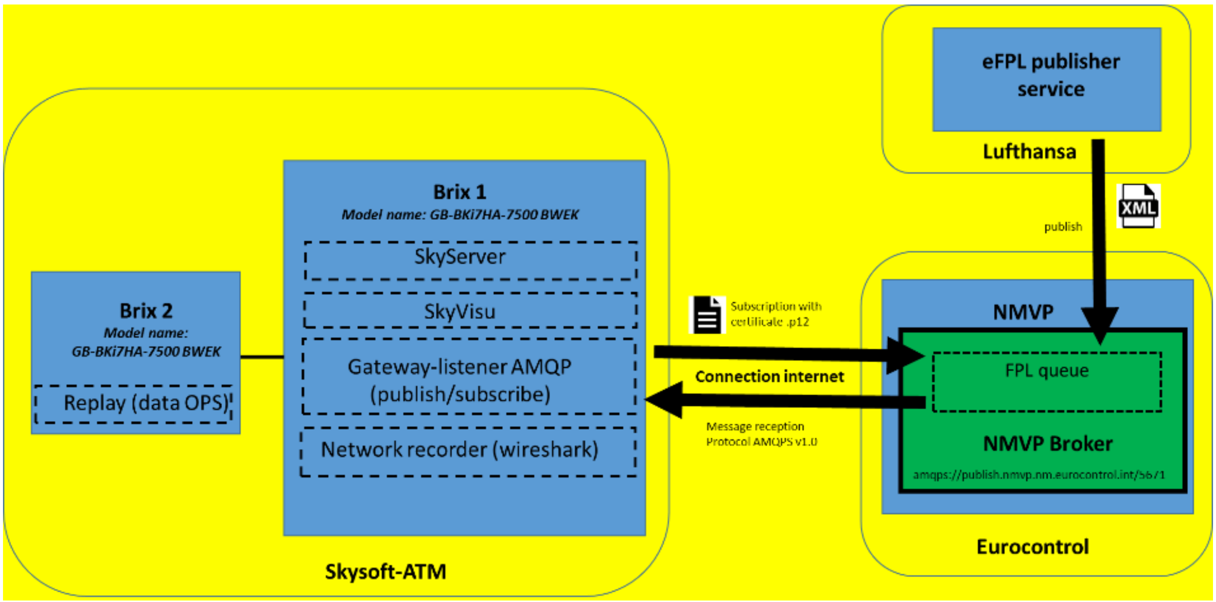

Figure 2: EXE-18.02c-TRL6-TVALP-001 – overall architecture

The 4 Dimensional Trajectory Prediction :

The skyguide platform encompasses a advanced 4D trajectory Prediction tool.

The Osyris O4D Trajectory Predictor Provides a reliable 4-dimensional (space and time) predicted trajectory. This is a pre-requisite for the computation algorithms of the advanced ATC tools that are implemented in the skyguide ATC system. Therefore the Controller support tools such as Flight Path Monitoring, Medium Term Conflict Detection and resolution, the Arrival Manager take benefit of data computed by the Trajectory Predictor and accuracy can then be improved.

The Trajectory Predictor is part of the Flight Data Processing system (FDP).

Trajectory is the core data used by all support tools and is an essential item for the Air Traffic Controller. Several trajectories are computed depending on the position and the status of a flight. These system trajectories provide a consistent representation of current and future traffic situation ; representation that is used by all the controller support tools.

Osyris O4D Trajectory Predictor provides accurate predicted trajectories based on flight plan information, meteorological data, and a detailed aircraft performance model taking into account mass, speed and flight level constraints. Therefore the additional data provided by the eFPL is aimed at improving the computation accuracy of the Trajectory itself and can have a positive impact on different support tools calculation (Conflict detection and resolution, monitoring…)
Trajectory calculation :

It is based on the following input data:

- Flight plan data for the individual flights, containing route information as a list of waypoints and A/C type.
- Track data (if available) for each individual flight, at least current position and altitude. Speed, heading, and rate of climb/descent might be calculated internally if not available.
- Meteorological data, wind fields
- Configuration including airspace data,

- Constraints e.g. standard handover conditions at the initial approach fixes, a speed constraint for intermediate waypoints or altitude restrictions

The output of Trajectory Predictor can be summarized in following groups:

- Trajectories including a list of points that are passed, either waypoints, geographical points, or specific calculation points like Top Of Climb (TOC), Top of Descent (TOD). For each trajectory point the whole flight state (altitude, speed, heading, time) is defined.
- Notifications if the passage of specific waypoints is to be detected for a given flight. This passage is detected by evaluating the track data, comparing it to the planned route, and using configurable geometric detection criteria.

Therefore the Trajectory Predictor provides in particular Flight profile calculation based on flight plan data.

Process by steps:

Step 1 : processing of Input Data

The current track position (if available) and the route information from the flight plan are used to predict the route of the flight which is described as a sequence of points to be followed.

The track and flight plan data are used to determine boundary conditions (altitude, speed) at the first and the last point and other points of the trajectory being calculated.

Step 2 : Construction of Flight Profiles

The altitude and speed profiles used for the trajectory prediction are constructed based on "standard parameters". Some of these data can be extracted from the eFPL. and enriched with track information.

The horizontal profile contains the 2D route information

Step 3 : Trajectory Calculation

Based on the horizontal and vertical profiles issued from step 2, flight manoeuvres are modelled using the equations of motion given by the physical aircraft model and its performance parameters.

In the operational system, the mass factor for this trajectory predictions is considered as the maximum for the type of aircraft. For the exercise, it has been calculated considering the weight received in the eFPL and in particular the weight on each trajectory point.

A.1.1.2. Exercise planning

The planning of the exercises of Iteration #1 englobed multiple tasks, starting by ensuring the participation of all the relevant stakeholders, as well as by organising the exercise logistics (schedule sessions, define technical staff involvement, prepare briefing and debriefing materiel, prepare simulation room, …).

Once ready, the following tasks have been performed to run the Shadow mode exercise and to save and consolidate all the exercise outputs needed for Replay Simulation and result analysis:

- Ensure reception of ICAO OPS traffic data by ATC
- Select via Flight Data Processing system flown Trajectories in skyguide Controlled Airspace
- Transmit filed eFPL from FOC via B2B services, containing the filed Trajectory and associated extended Flight Plan data

Distributed eFPL to skyguide prototype from NMVP via B2B services (Publish/Subscribe) containing the Agreed Trajectory.

Afterwards, the tools for post data analysis for Shadow mode execution have been prepared in order to analyse the exercise results performed in Shadow mode.

The following activities have been performed according to the following planning:

Activity	**Months**														
	Dec 17	**Jan 18**	**Feb 18**	**Mar 18**	**Apr 18**	**May 18**	**Jun 18**	**Jul 18**	**Aug 18**	**Sept 18**	**Oct 18**	**Nov 18**	**Dec 18**	**Jan 19**	**Feb 19**
Definition of the validation platform software and configuration	🟩														
Writing the validation plan			🟩	🟩											
Preparation of exercise platform		🟩	🟩	🟩											
Data testing – traffic data (eFPLs) configurations, data logging			🟩	🟩											
Validation execution					🟩	🟩	🟩	🟩	🟩	🟩					
Analysis and reporting										🟩	🟩				
Writing the Validation Report											🟩	🟩	🟩	🟩	🟩

A.1.1.3. Description of exercise execution

The validation technique is based on record and replay. Data have been recorded for analysis. Traffic could be displayed on dedicated Controller Working Positions allowing monitoring and potential controller inputs in order to assess the operational benefit from Trajectory Prediction using eFPL data input.

The conduction of the exercise implied a set of sub-activities:

- **Preparing the platform**: software engineers prepared all platform components and verify that correct data was exchanged between them.
- **Performing the exercises**:

Getting data from NMVP platform via B2B service
Transfer of data in the Flight Data Processing system including Trajectory Prediction tool.
Transfer of data recordings corresponding to the flights associated to eFPL received data to validation team after each run

- **Setting up the analysis framework**: software engineers prepared analysis capabilities for the comparison of trajectories coming from eFPL with recorded trajectories

The iteration #1 has been decomposed into two phases:

- **One technical phase**,

  aiming at validating the transfer of the eFPL data from NM to ATC via the B2B services and the use of the Agreed Trajectory.

  This phase has been performed in Shadow mode between the NMVP Platform and the Skyguide platform.

- **One operational phase**,

  aiming at assessing the improvements of the Ground Trajectory Prediction by the ATC Ground Flight Data Processing with specific eFPL data by:

Quantifying the performance of Ground Trajectory Prediction with the flown trajectory (seen as Validation Baseline)
Quantifying the improvements of the Ground Trajectory Prediction based on specific eFPL data with the flown trajectory when compared to the baseline.

The airspaces for Flight Plans distribution will be the Swiss airspace covering the Geneva and Zurich ACCs.

A.1.1.4. Metrics used

The **technical phase** has focused on validating the transfer of eFPL data from NM to ATC via the B2B services.

Metrics	Qualitative / Quantitative	Success Criteria reference	Collection Method
Number of rejected eFPLs	Quantitative	Limited number of eFPLs rejected	Counts from logs

The **operational phase** has been geared towards assessing the improvements of the Ground Trajectory Prediction by the ATC round Flight Data Processing with specific eFPL.

Metrics	Qualitative / Quantitative	Success Criteria reference	Collection Method
Mean difference between Time over a Navpoint between flown trajectory and calculated Flight Plan (Legacy FPL, eFPL (NM), eFPL (FOC))	Quantitative	Mean time difference between time computed with eFPL and flown trajectory is less than Mean time difference between time computed with FPL and flown trajectory	Counts from logs
Accuracy of eFPL data display	Operational accuracy of data display trajectory computed with eFPL	Trajectory information displayed is operationally acceptable	Expert Judgments

Qualitative results have been combined with results from quantitative sources from the data logs. The subjective results have been used, where appropriate, to provide evidence supporting, or contradicting, the statistical conclusions.

The following stepwise method of analysis has been followed as described below:

- **Level 1:** raw data is collected (objective and subjective);
- **Level 2**: raw data synopsis in order to underline the significant aspects concerning both objective and subjective collected data;
- **Level 3:** Information integration (integration of descriptive statistical analysis with the qualitative one) with comments provided by operative experts and exercise experts;
- **Level 4:** Final conclusion in relation to specific exercise objectives.

A.1.2 Summary of Exercise 1 Technical Validation Objectives and success criteria

SESAR Solution Validation Objective	SESAR Solution Success criteria	Coverage and comments on the coverage of SESAR Solution Validation Objective in Exercise 001	Exercise Validation Objective	Exercise Success criteria
OBJ-18.02c-TRL6-TVALP-TF1 eFPL Distribution to ATC To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	CRT-18.02c-TRL6-TVALP-TF1-001 Solution 18.02c provides evidence that a set of eFPL has been distributed to ATC using B2B service (yellow SWIM).	FULLY COVERED	EX1-OBJ-18.02c-TRL6-TVALP-TF1 To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	EX1-CRT-18.02c-TRL6-TVALP-TF1-001 Solution 18.02c provides evidence that a set of eFPL has been distributed to ATC using B2B service (yellow SWIM).
OBJ-18.02c-TRL6-TVALP-TF1 eFPL Distribution to ATC To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	CRT-18.02c-TRL6-TVALP-TF1-002 Solution 18.02c provides evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing. Solution 18.02c provides evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing.	FULLY COVERED	EX1-OBJ-18.02c-TRL6-TVALP-TF1 To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	EX1-CRT-18.02c-TRL6-TVALP-TF1-002 Solution 18.02c provides evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing.
OBJ-18.02c-TRL6-TVALP-OF1 Use of eFPL data in ATC system for Trajectory Prediction	CRT-18.02c-TRL6-VALP-OF1-001 Solution 18.02c provides evidence that the ATC Ground Trajectory Predictor using	FULLY COVERED	EX1-OBJ-18.02c-TRL6-TVALP-OF1 To Assess the benefits of the eFPL Distribution to ATC on the	EX1-CRT-18.02c-TRL6-VALP-OF1-001 Solution 18.02c provides evidence that the ATC Ground

To Assess the benefits of the eFPL Distribution to ATC on the Trajectory Prediction.	specific eFPL data (Aircraft Mass, speed profile, ...) is more precise than legacy ATC Ground Trajectory Predictor using legacy ICAO FPL, when both are compared to the flown trajectory.		Trajectory Prediction.	Trajectory Predictor using specific eFPL data (Aircraft Mass, speed profile, ...) is more precise than legacy ATC Ground Trajectory Predictor using legacy ICAO FPL, when both are compared to the flown trajectory.
OBJ-18.02c-TRL6-TVALP-OF2 Exhaustiveness of eFPL data in ATC system for Trajectory Prediction To assess that all the information from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC.	CRT-18.02c-TRL6-VALP-OF2-001 Solution 18.02c provides evidence that all the information from the eFPL distributed by NM through the B2B service fulfil ATC needs for better Trajectory Prediction and no useful information for ATC needs are missing (exhaustiveness of the information for ToC, ToD, Flight Specific performance data, weight...).	FULLY COVERED	EX1-OBJ-18.02c-TRL6-TVALP-OF2 To assess that all the information from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC.	EX1-CRT-18.02c-TRL6-VALP-OF2-001 Solution 18.02c provides evidence that all the information from the eFPL distributed by NM through the B2B service fulfil ATC needs for better Trajectory Prediction and no useful information for ATC needs are missing (exhaustiveness of the information for ToC, ToD, Flight Specific performance data, weight...).

A.1.3 Summary of Technical Validation Exercise #01 Validation scenarios

Reference Scenario

The Reference Scenario is used for the two phases.

The reference scenario is the Baseline traffic sample with current ICAO Flight Plan format. Flight Plans have been received by ATC ground system from the NM. All trajectories have been computed with the legacy Trajectory Predictor and have served as baseline for trajectories comparison.

The reference scenario was extracted from a recording of traffic during the week 15 2018.

Data corresponding to the reference scenario traffic sample have been recorded from the Skyguide operational system for replay and comparison purpose.

Solution Scenario

The solution scenario content the same traffic sample as the Baseline scenario; however, flight plans have been computed by the FOC system (LSY LIDO) using the eFPL format.

The eFPLs computed by the FOC took into account the initial real data of the flight (e.g. aircraft mass, speed schedule linked to Cost Index, vertical profile, predicted wind data…).

eFPLs have been distributed by FOC to NM for capacity assessment and then provided to ATC ground system using B2B after NM treatment.

eFPLs have also been directly distributed by FOC to ATC without potential NM changes.

eFPLs data have been used to compute ground Trajectories (from the Ground System Trajectory Prediction tool) in both cases:

- eFPLs received from NM
- eFPLs received from FOC

Trajectories have been compared to support quality and performance improvement assessment:

1. Trajectories computed by ground TP using data from eFPLs received from NM will be compared to trajectories computed by ground TP with legacy FPLs
2. Trajectories computed by ground TP using data from eFPLs received from FOC system will be compared to trajectories computed by ground TP with legacy FPLs
3. Trajectories computed by ground TP using data from eFPLs received from NM will be compared to trajectories computed by ground TP with eFPLs received from FOC system
4. Trajectories computed by ground TP using data from legacy FPL and eFPLs received from NM and FOC will compared to flown trajectories (whenever possible)

The Ground System Trajectory Prediction tool has been upgraded to take into account some elements from the eFPL such as Aircraft Mass on Navpoints, TOC, TOD.

In addition, the technical B2B connection has been used to download eFPLs from NM repository.

As the initial Flight Plans including accurate data (aircraft mass, speed schedule linked to Cost Index, vertical profile, predicted wind data..) have been provided by Lufthansa, Air France, Transavia and El Al, only these Flight Plans have been considered in the iteration #1.

Here after is the list of Flight Plans in eFPL format that were finally included in the Trajectory Prediction process.

Note that the list includes only Lufthansa Flights as other companies eFPLs could not be delivered by the other participating airlines. (see Deviation from the planned activities A.2).

List of eFPL used for Trajectory Prediction analysis:

TRK_TIME	TRK_NUM	TRK_ALT	TRK_CLS	TRK_SEC	TRK_TYP	TRK_WTC	TRK_MAG	TRK_GSP	TRK_IAS	TRK_MAC	TRK_WIN	TRK_WIN	ADEP	ADES
00:18.0	1201	370	DLH09Y	8	A320	M	212.3438	437.915	255.9814	0.792	27.24609	179.7583	EDDM	LEBL
01:57.6	1228	32	DLH3RM	130	CRJ9	S	223.5938	161.9385	170.0684	0.272	16.04004	222.2095	EDDF	LSGG
21:21.6	1743	20	DLH5K	129	A319	M	224.6484	154.0283	161.9385	0.256	12.30469	239.7821	LSGG	EDDF
23:04.6	4022	340	DLH23C	7	A321	M	60.29297	482.0801	268.9453	0.776	36.03516	238.1506	LPPT	EDDF
27:31.4	1008	285	DLH54C	6	A321	M	204.082	475.9277	295.0928	0.76	43.72559	70.83984	EDDF	LEBL
28:51.0	301	298	DLH1822	7	A321	M	241.5234	471.9727	295.0928	0.776	18.01758	61.89148	EDDM	LEZL
42:23.6	3444	269	DLH28Y	8	A321	M	190.8984	473.9502	310.0342	0.768	43.94531	75.63538	EDDF	LEVC
45:32.6	1997	340	DLH72T	7	A320	M	53.78906	477.9053	268.9453	0.776	32.08008	239.1174	LFBO	EDDF
48:36.6	2608	320	DLH35E	6	A320	M	60.99609	511.9629	288.9404	0.8	54.49219	233.2452	LEMD	EDDF
11:23.6	2843	273	DLH1152	7	A321	M	191.6016	435.9375	279.9316	0.704	40.42969	73.37219	EDDF	LEPA
28:44.2	600	214	DLH17N	5	A319	M	339.4336	446.0449	330.9082	0.736	35.15625	253.6029	LFMN	EDDF
39:11.0	2430	350	DLH55J	5	A319	M	246.2695	442.0898	259.0576	0.768	10.54688	193.8922	EDDM	LFLL
46:40.4	971	380	DLH91H	9	A321	M	11.42578	475.9277	248.0713	0.784	23.73047	216.7987	LEBL	EDDF
47:23.2	3993	286	DLH09W	7	E195	M	244.1602	448.0225	288.0615	0.744	16.91895	32.57996	EDDM	LEBL
47:41.0	1488	51	DLH25M	1	A320	M	73.65234	214.0137	188.9648	0.312	16.25977	299.2511	LFLL	EDDF
51:23.0	2839	300	DLH8CJ	3	E195	M	249.4336	455.9326	290.918	0.768	5.932617	73.81165	EDDM	LSGG
52:23.4	2504	262	DLH568	7	A333	H	189.668	455.9326	299.9268	0.736	32.73926	66.22009	EDDF	DNMM
53:11.2	3317	292	DLH38E	5	A320	M	244.1602	480.1025	304.1016	0.792	23.73047	33.52478	EDDM	LFBO
53:51.2	147	278	DLH44W	7	A321	M	257.6953	455.9326	299.0479	0.76	14.0625	86.6217	EDDM	LPPT
01:13.6	853	21	DLH2K	129	CRJ9	S	221.4844	159.9609	166.9922	0.264	12.74414	205.329	LSGG	EDDF
05:31.0	2805	289	DLH1834	7	A321	M	248.2031	475.9277	304.1016	0.784	22.63184	32.28882	EDDM	LEMG
06:31.6	1857	323	DLH08X	7	A20N	M	188.4375	437.915	270.0439	0.752	35.15625	93.15857	EDDF	LEBL
14:32.6	2563	242	DLH47E	9	A320	M	359.6484	477.9053	324.9756	0.76	24.38965	207.7679	LFML	EDDF
16:10.8	2453	331	DLH35X	9	A319	M	256.9922	448.0225	272.0215	0.768	1.977539	67.96143	EDDM	LEBB
20:31.2	2968	258	DLH06Y	5	A321	M	264.9023	464.0625	317.9443	0.768	12.52441	74.43787	EDDM	LEMD
37:31.2	779	292	DLH12J	5	E195	M	263.8477	453.9551	286.9629	0.752	28.34473	29.37195	EDDM	LFML
43:08.4	338	340	DLH13C	5	A320	M	61.875	486.0352	266.0889	0.768	43.72559	226.3953	LEBB	EDDM
53:07.4	545	290	DLH8NH	3	A319	M	190.5469	488.0127	308.0566	0.792	33.17871	52.26746	EDDF	LSGG
24:57.2	1305	51	DLH08F	3	A319	M	170.5078	176.001	192.041	0.32	32.51953	193.3649	LFLL	EDDM
25:40.6	3881	357	DLH75E	8	A321	M	61.17188	484.0576	263.0127	0.792	32.95898	217.3206	LEMD	EDDM
29:36.6	636	380	DLH62K	8	A320	M	61.875	480.1025	254.0039	0.8	0	0	LPPR	EDDM
31:23.2	1001	290	DLH04C	7	A320	M	245.2148	464.0625	299.0479	0.776	22.19238	23.17017	EDDM	LEBL
41:40.4	458	380	DLH85N	8	A321	M	23.90625	480.1025	252.0264	0.8	22.41211	196.3257	LEBL	EDDF
46:31.6	1641	277	DLH1158	7	A320	M	197.4023	462.085	299.0479	0.752	22.41211	29.4104	EDDF	LEPA

TRK_TIME	TRK_NUM	TRK_ALT	TRK_CLS	TRK_SEC	TRK_TYPI	TRK_WTC	TRK_MAG	TRK_GSP	TRK_IAS	TRK_MAC	TRK_WINI	TRK_WINI	ADEP	ADES
50:23.4	2712	275	DLH61U	8	A320	M	194.2383	462.085	299.0479	0.752	25.48828	35.68359	EDDF	LFBO
59:31.4	3808	310	DLH4RT	1	E190	M	190.5469	457.9102	286.084	0.776	20.43457	68.40088	EDDF	LSGG
15:31.6	3215	261	DLH55A	7	A321	M	192.4805	453.9551	304.1016	0.744	16.47949	0.549316	EDDF	LEBL
22:48.6	685	340	DLH38P	7	A321	M	63.80859	495.9229	272.9004	0.792	57.12891	210.2509	LEMD	EDDF
27:52.6	2647	333	DLH97F	7	A320	M	53.96484	502.0752	279.9316	0.792	53.39355	214.151	LFBO	EDDM
39:44.4	1607	283	DLH65U	5	E195	M	352.0898	451.9775	288.9404	0.744	45.92285	243.3966	LFML	EDDM
45:40.4	279	340	DLH1153	5	A321	M	7.207031	486.0352	273.999	0.792	47.90039	228.4827	LEPA	EDDF
08:14.8	2848	310	DLH77W	5	CRJ9	S	242.4023	437.915	286.9629	0.776	14.0625	241.7377	EDDM	LFLL
08:31.2	2091	317	DLH1830	5	A320	M	242.9297	437.915	283.0078	0.776	14.0625	244.8303	EDDM	LEVC
26:00.8	2692	340	DLH1823	5	A321	M	63.10547	484.0576	268.0664	0.776	52.0752	210.6299	LEZL	EDDM
27:25.6	2032	18	DLH8K	129	E190	M	226.9336	137.9883	152.0508	0.24	19.55566	250.3784	LSGG	EDDF
32:08.6	3222	300	DLH58H	5	A321	M	61.52344	502.0752	293.9941	0.776	0	0	LPPT	EDDF
51:15.0	534	292	DLH1VY	3	CRJ9	S	244.1602	430.0049	286.084	0.744	3.955078	254.4818	EDDM	LSGG
57:32.2	3596	186	DLH54N	5	A321	M	331.6992	442.0898	330.9082	0.696	35.15625	225.791	LFMN	EDDF
57:36.6	2882	320	DLH62T	7	A319	M	61.875	480.1025	273.999	0.76	47.90039	226.2799	LEBB	EDDM
06:11.2	2379	329	DLH88W	8	CRJ9	S	249.082	430.0049	275.0977	0.776	20.87402	268.028	EDDM	LFML
16:15.0	1074	331	DLH01X	8	E195	M	243.2813	422.0947	268.0664	0.76	20.21484	255.6024	EDDM	LFBO
19:00.4	1756	320	DLH68W	7	A20N	M	20.21484	502.0752	290.918	0.8	52.51465	236.8103	LEBL	EDDF
26:23.0	365	350	DLH69V	8	CRJ9	S	257.6953	402.0996	237.085	0.712	11.20605	288.3087	EDDM	LEBB
33:31.4	1431	276	DLH6HU	3	A319	M	195.8203	439.8926	286.084	0.72	14.94141	40.02319	EDDF	LSGG
36:12.4	3491	320	DLH97E	7	A320	M	61.52344	508.0078	288.9404	0.8	53.39355	228.5431	LFBO	EDDF
43:25.2	3446	53	DLH57F	3	CRJ9	S	161.0156	234.0088	235.9863	0.392	23.73047	208.7622	LFLL	EDDM
45:24.6	997	360	DLH38H	8	A321	M	56.95313	480.1025	259.0576	0.784	31.4209	220.5011	LEMD	EDDM
51:23.2	2210	272	DLH04J	7	A321	M	247.1484	460.1074	301.9043	0.752	18.01758	42.21497	EDDM	LEMD
12:23.6	3591	265	DLH98F	5	A321	M	189.8438	455.9326	306.0791	0.752	12.52441	29.8114	EDDF	LFML
27:49.4	271	20	DLH2NF	129	CRJ9	S	223.5938	156.0059	170.0684	0.264	19.99512	230.8722	LSGG	EDDM
41:08.6	857	360	DLH55E	8	A321	M	61.69922	480.1025	259.0576	0.784	30.32227	218.7158	LPPT	EDDM
59:36.4	2858	376	DLH12T	8	A320	M	21.97266	480.1025	244.9951	0.768	26.36719	211.3055	LEBL	EDDF
07:11.4	1577	290	DLH74U	5	A320	M	192.1289	446.0449	301.9043	0.784	10.32715	178.6871	EDDF	LFLL
23:15.0	686	337	DLH06C	5	A319	M	257.3438	417.9199	273.999	0.784	38.23242	262.4854	EDDM	LFLL
49:23.4	198	250	DLH6UX	3	CRJ9	S	191.4258	404.0771	279.0527	0.672	7.910156	54.17358	EDDF	LSGG
59:00.8	449	354	DLH94C	8	E195	M	62.05078	484.0576	261.9141	0.784	50.31738	196.9958	LFBO	EDDM
30:34.8	1646	310	DLH1VC	3	CRJ9	S	246.2695	393.9697	281.9092	0.768	50.97656	266.9183	EDDM	LSGG
44:40.8	614	360	DLH92K	8	CRJ9	S	62.92969	495.9229	268.0664	0.808	38.45215	203.703	LEBB	EDDM
57:37.0	3446	53	DLH07K	3	A319	M	170.1563	201.9287	212.0361	0.352	0	0	LFLL	EDDM

TRK_TIME	TRK_NUM	TRK_ALT	TRK_CLS	TRK_SEC	TRK_TYP	TRK_WTC	TRK_MAG	TRK_GSP	TRK_IAS	TRK_MAC	TRK_WIN	TRK_WIN	ADEP	ADES	XPT
12:29.4	3355	20	DLH1K	129	CRJ9	S	225.5273	170.0684	170.0684	0.272	5.932617	232.4872	LSGG	EDDF	KORED
16:22.8	3364	355	DLH08Y	8	A320	M	248.5547	399.9023	246.9727	0.744	30.76172	240.238	EDDM	LEBB	NINTU
31:52.2	1964	361	DLH42K	8	A321	M	26.71875	500.0977	259.9365	0.784	52.51465	201.1102	LEMG	EDDF	GODRA
35:34.8	632	330	DLH05A	5	A321	M	245.0391	406.0547	272.0215	0.768	40.64941	267.8851	EDDM	LPPT	NINTU
38:02.8	2047	333	DLH88V	5	A321	M	245.3906	410.0098	275.0977	0.784	42.40723	265.9955	EDDM	LEBL	BALSI
52:25.6	1846	26	DLH6MH	129	CRJ9	S	225.8789	170.0684	170.9473	0.272	8.569336	249.2194	LSGG	EDDM	KORED
02:22.8	1179	340	DLH37N	8	A320	M	244.8633	413.9648	270.9229	0.784	38.23242	265.7153	EDDM	LFBO	NINTU
13:15.4	490	307	DLH03Y	5	A320	M	194.9414	450	284.1064	0.768	23.07129	306.0022	EDDF	LFML	BALSI
36:28.6	2617	320	DLH11J	5	A321	M	64.6875	473.9502	275.0977	0.76	52.9541	199.4238	LEMD	EDDM	DITON
38:35.4	3870	288	DLH06J	5	A321	M	195.293	457.9102	306.958	0.792	26.58691	281.3928	EDDF	LFLL	AMKEN
49:35.4	2017	336	DLH27J	5	A320	M	202.3242	410.0098	259.9365	0.744	36.69434	255.8826	EDDF	LFBO	NINTU
24:15.4	762	276	DLH31U	8	A321	M	196.875	435.9375	304.1016	0.768	34.7168	266.6766	EDDF	LEVC	BALSI
30:22.8	999	300	DLH4XU	3	E195	M	248.5547	364.0869	279.9316	0.744	74.04785	272.5983	EDDM	LSGG	ETA
31:15.4	1172	279	DLH75U	3	A321	M	198.2813	435.9375	301.9043	0.768	42.40723	271.3953	EDDF	LEBL	BALSI
36:15.6	3498	285	DLH1330	8	A320	M	196.5234	435.9375	297.0703	0.76	33.39844	272.6971	EDDF	GMMN	NINTU

Table 14: List of eFPL used for Trajectory Prediction analysis

A.1.4 Summary Technical Validation Exercise #01 Assumptions

Refer to 3.2.3.1.

A.2 Deviation from the planned activities

EXE-18.02c-TRL6-TVALP-001/1_ECTRL Phase1 :

No specific deviation has occurred during the phase 1 of the EXE-18.02c-TRL6-TVALP-001/1_ECTRL.

EXE-18.02c-TRL6-TVALP-001/1_ECTRL Phase2 :

During the execution of the Phase 2, several technical issues have been encountered which altered the expected results of this phase.

eFPLs:

It was anticipated to receive eFPLs from several airlines (Air France, El Al, Transavia, Lufthansa), however due to limitations of the CFSP tools used by these airlines, it was not possible to get Flight Plan in eFPL format for Air France, El Al and Transavia. Only eFPLs including Lufthansa parameters could be used for analysis.

Trajectory Predictor tool:

The technical platform used for the exercise is set-up with a COTS Trajectory Predictor engine. It was not anticipated that the introduction of new parameters such as mass would led to so many difficulties and software developers could not find alternatives to include new parameters in the computation process.

In particular, the algorithm of the Trajectory Predictor used in this exercise did not permit to introduce directly the mass of the aircraft on each navigation point in the processing, therefore the eFPL mass could be only used to compute a "Mass factor" as input in the Bada model table. This Mass factor permit to extract more accurate data from the Bada model table, data that are then used in the Trajectory Prediction algorithm.

Data replay on the Skyguide platform:

Due to unforeseen event, some data were altered or lost after the validation exercise and could not be retrieved. This limited the analysis of trajectories and therefore impact the overall outcomes from the exercise.

A.3 Technical Validation Exercise #01 Validation Results

A.3.1 Summary of Technical Validation Exercise #01 Results

SESAR Technological Solution Iteration #1					
Technical Validation Exercise #01 Validation Objective ID	**Technical Validation Exercise #01 Validation Objective Title**	**Technical Validation Exercise #01 Success Criterion ID**	**Technical Validation Exercise #01 Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
OBJ-18.02c-TRL6-TVALP-TF1	eFPL Distribution to ATC To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	CRT-18.02c-TRL6-TVALP-TF1-001	Solution 18.02c provides evidence that a set of eFPL has been distributed to ATC using B2B service (yellow SWIM).	The distribution of eFPL to ATC via the B2B service has worked properly. Not technical issues have been noticed during the validation period	OK
OBJ-18.02c-TRL6-TVALP-TF1	eFPL Distribution to ATC To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service	CRT-18.02c-TRL6-TVALP-TF1-002	Solution 18.02c provides evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing.	The eFPL flight Plan data distributed to ATC via the B2B service have been extracted and injected in the ATC ground Flight Data Processing system from the validation platform. All eFPLs have been treated in the FDP system	OK

SESAR Technological Solution Iteration #1					
Technical Validation Exercise #01 Validation Objective ID	**Technical Validation Exercise #01 Validation Objective Title**	**Technical Validation Exercise #01 Success Criterion ID**	**Technical Validation Exercise #01 Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
OBJ-18.02c-TRL6-TVALP-OF1	Use of eFPL data in ATC system for Trajectory Prediction To Assess the benefits of the eFPL Distribution to ATC on the Trajectory Prediction.	CRT-18.02c-TRL6-VALP-OF1-001	Solution 18.02c provides evidence that the ATC Ground Trajectory Predictor using specific eFPL data (Aircraft Mass, speed profile ...) is more precise than legacy ATC Ground Trajectory Predictor using legacy ICAO FPL, when both are compared to the flown trajectory.	EX1-CRT-18.02c-TRL6-VALP-OF1-001: Due to technical limitation on the Trajectory Predictor tool from the platform, the assessment of the increased precision of the trajectory computation could be only verified on the introduction of the aircraft Mass in the trajectory computation process. Other elements such as speed profiles could not be tested.	NOK
OBJ-18.02c-TRL6-TVALP-OF2	Exhaustiveness of eFPL data in ATC system for Trajectory Prediction To assess that all the information from the eFPL distributed by NM	CRT-18.02c-TRL6-VALP-OF2-001	Solution 18.02c provides evidence that all the information from the eFPL distributed by NM through the B2B service fulfil ATC needs for better Trajectory	EX1-CRT-18.02c-TRL6-VALP-OF2-001: Due to technical limitation on the Trajectory Predictor tool	PARTIALLY OK

SESAR Technological Solution Iteration #1					
Technical Validation Exercise #01 Validation Objective ID	**Technical Validation Exercise #01 Validation Objective Title**	**Technical Validation Exercise #01 Success Criterion ID**	**Technical Validation Exercise #01 Success Criterion**	**Iteration #1 Validation Results**	**Technical Validation Objective Status**
	through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC.		Prediction and no useful information for ATC needs are missing (exhaustiveness of the information for ToC, ToD, Flight Specific performance data, weight...).	from the platform, the assessment of the increased precision of the trajectory computation could be only verified on the introduction of the aircraft Mass in the trajectory computation process. Other elements such as speed profiles could not be tested.	

Table 15: Technical Validation Results Exercise #01

A.3.1.1. Results on technical feasibility

The distribution of eFPL to ATC via the B2B service has worked properly. Not technical issues have been noticed during the validation period.

The eFPL flight Plan data distributed to ATC via the B2B service have been extracted and injected in the ATC ground Flight Data Processing system from the validation platform.

All eFPLs have been treated in the FDP system without rejection.

A.3.1.2. Results per KPA

N/A

A.3.2 Analysis of Exercise 1 Results per Technical Validation objective

A.3.2.1. EX1-OBJ-18.02c-TRL6-TVALP-TF1 Results

"eFPL Distribution to ATC - To Assess Technical Feasibility of the eFPL Distribution from NM to ATC via B2B service"

The objective was to assess the technical feasibility of the eFPL distribution from the NM to the ATC using B2B service.The technical platform has been adapted to be connected to the NM B2B platform. During the days of validation, the connection between NM and ATC has been used and the eFPLs were distributed to the ATC using this channel.

No technical issues have been encountered.

Two validation criteria have been assigned to validate this objective.

EX1-CRT-18.02c-TRL6-TVALP-TF1-001 Solution 18.02c provides evidence that a set of eFPL has been distributed to ATC using B2B service (yellow SWIM)	1084 eFPLs have been distributed to ATC using B2B service (yellow SWIM).	**OK**

EX1-CRT-18.02c-TRL6-TVALP-TF1-002 Solution 18.02c provides evidence that eFPL Flight Plan data have been extracted and treated by the ATC ground Flight Data Processing	The received eFPLs have been extracted and transferred to the Flight Data Processing system. They have been treated by the Ground Flight Data Processing. No eFPLs have been rejected by the system.	**OK**

This objective was successfully validated.

A.3.2.2. EX1-OBJ-18.02c-TRL6-TVALP-OF1 Results

"To assess that all the information from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC."

The objective was to assess the benefits of the eFPL Distribution to ATC on the Trajectory Prediction by using new data available in the eFPL into the Trajectory Prediction tool.

One validation criteria has been assigned to validate this objective.

EX1-CRT-18.02c-TRL6-VALP-OF1-001 Solution 18.02c provides evidence that the ATC Ground Trajectory Predictor using specific eFPL data (Aircraft Mass, speed profile, ...) is more accurate than legacy ATC Ground Trajectory Predictor using legacy ICAO FPL, when both are compared to the flown trajectory.	Due to technical limitation, only the aircraft mass has been used in the computation of trajectories and limited comparison have been made possible. Due to unforeseen event, some data were altered or lost after the validation exercise and could not be retrieved. This limited the analysis of trajectories and the comparison with flown trajectories. Therefore the validation criteria cannot be fully assessed and it cannot be considered as fully or partially be only considered as Partially achieved.	NOK

Due to technical limitation on the Trajectory Predictor tool from the platform, the assessment of the increased precision of the trajectory computation could be only verified on the introduction of the aircraft Mass in the trajectory computation process. Other elements such as speed profiles could not be tested.

The validation platform was equipped with a COTS Trajectory Predictor module and introduction of new data extracted from the eFPL into the Trajectory Predictor engine was not possible and therefore reduced the initial objective.

Only the Mass of the aircraft could be used in the process through the computation of a "Mass Factor" using the aircraft Mass and injection of the "Mass Factor" into the Trajectory Predictor engine that use a BADA model. Therefore the BADA model was enriched with the aircraft Mass know on each point of the route described in the Flight Plan.

A.3.2.3. EX1-OBJ-18.02c-TRL6-TVALP-OF2 Results

"To assess that all the information from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC."

The objective was to assess that all the information that can be extracted from the eFPL distributed by NM through the B2B service is exhaustive and fulfil ATC needs bringing benefits to the ATC.

One validation criteria has been assigned to validate this objective.

EX1-CRT-18.02c-TRL6-VALP-OF2-001 Solution 18.02c provides evidence that all the information from the eFPL distributed by NM through the B2B service fulfil ATC needs for better Trajectory Prediction and no useful information for ATC needs are missing (exhaustiveness of the information for ToC, ToD, Flight Specific performance data, weight...).	The use of information from the eFPL has been limited to the mass, other extracted information have not been used by the ground Trajectory Predictor. However, operational experts and ATCOs confirmed that information extracted from the eFPL (information that is not available in current FPL format) could be used in the operational system either as displayed information either in Trajectory Prediction tools and controller support tools such as Conflict Detection Tools, Monitoring Aids... and therefore improve	**PARTIALLY OK**

	situation awareness and accuracy of controller support tools outputs.	

Despite it was possible to extract all relevant information from the eFPL for a given flight, the use of this information in the Trajectory Predictor tool was limited to the use of the Mass. Other extracted information could not be used in the technical system.

However it has been pointed out by operational experts and ATCOs that some information extracted from the eFPL (information that is not available in current FPL format) could be used in the operational system either as displayed information either in Trajectory Prediction tools and controller support tools such as Conflict Detection Tools, Monitoring Aids…

Information such as Top of Climb, Top of Descent, vertical profiles, speed profiles can bring benefit in more precise computation or to improve ATCO situation awareness.

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A.3.3 Unexpected Behaviours/Results

As already mentioned, there were no unexpected behaviours concerning the Technical validation especially all the process of eFPL distribution from NM via B2B to ATC.

Thanks to the limitations already described, the operational benefits could not be validated as initially foreseen. (A.3.2.2, A.3.2.3)

A.3.4 Confidence in Results of Validation Exercise 1

A.3.4.1. Level of significance/limitations of Technical Validation Exercise Results

The confidence in results for the technical objective OBJ-18.02c-TRL6-TVALP-OF1 can be considered "high". The technical infrastructure and B2B service were working as expected and no particular problem was encountered during the validation exercise period.

Due to the limitations as listed in 4.3.1, the operational objective could not be demonstrated and could not provide sufficient confidence in results to draw useful conclusions.

A.3.4.2. Quality of Technical Validation Exercises Results

The quality of the Technical Validation Exercises Results concerning the distribution of eFPL from NM to TAC via B2B service can be considered "high" as no technical problems in the reception of eFPLs were encountered.

Concerning the operational use of eFPL data, despite the quality of the information provided in the eFPLs could be considered "good", the quality of the results from the trajectory comparison cannot be considered as "high" enough to provide concrete outcomes to the improvement of the overall ATC support tools using these data.

A.3.4.3. Significance of Technical Validation Exercises Results

Regarding the results of Iteration #1 Technical Validation Exercises, limited significance of the results has been identified due to limited number of data (number of eFPL) used for the exercises. This is particularly true for the operational thread.

A.3.5 Conclusions

This exercise #1 has been split in **two threads**,

> **One technical thread**, validating the process of data distribution from NM to ATC using the B2B services and the ability to get additional data using the eFPL format.
>
> **One technical and operational thread**, validating the improvement of Trajectory Predictor tool and therefore ATC support tools (conflict detection tools, monitoring aids…) by the use of additional data in the processing

On the first thread, the technical validation has demonstrated the technical capability of the distribution of eFPLs from NM to ATC using the B2B services.

Therefore for this first thread, next step in the validation process can be envisaged without any restriction.

On the second thread, due to technical limitation for the modification of the Trajectory Predictor tool and subsequently the ATC support tools, no relevant results can be shown.

Therefore for this second thread, next step in the validation process cannot be envisaged as such. Despite some positive perception in the use of the eFPL data in Trajectory Predictor module and ATC support tools, new validations will need to be performed to reach operational maturity level.

However, TOC, TOD can be considered useful as information for the ATCO, the use of these data in the TP computation could be envisaged if trajectory coming from eFPL could include some ATC constraints that have impact on TOC and TOD.

ROC and speed schedule can also be foreseen as useful information as it takes into account the aircraft information (mass, cost index etc…).

A.3.5.1. Conclusions on technical feasibility

Refer to 5.1.2

A.3.5.2. Conclusions on performance assessments

N/A

A.3.6 Recommendations

Refer to 5.2.1

- Concerning the iteration #1, the technical feasibility of the process of data distribution from NM to ATC using the B2B services and the ability to get additional data using the eFPL format is achieved.
- The benefit of the use of eFPL data in the Trajectory Predictor and the ATC support tools has not been demonstrated in this iteration due to the technical limitations as explained previously. Therefore it is recommended to further study the impact of some eFPL data in the processing of Trajectory computation by ground system and then study the impact on subsequent ATC support tools such as Conflict detection tools (with eFPL Vertical profile), monitoring aids with this improved data (With eFPL Aircraft mass on waypoints, TOC, TOD, Vertical Profile, speed schedule).
- A study on ATCO situation awareness improvement about the AU expectation thanks to some eFPL new data (e.g. Aircraft mass on waypoints, Top of Climb, Top of Descent, speed profile…) should be envisaged to measure the benefit of such information available on display.

Appendix B Technical Validation Exercise #02 Report

B.1 Summary of the Technical Validation Exercise #02 Plan

The validation exercise has proven the overall exercise objective of further alignment from the FOC system generated flight plans and the recalculated NM 4D trajectories. This was achieved by embedding PTR's into an FOC system and consider them during the 4D trajectory calculation for the airlines, which are send via B2B service to the EUROCONTROL NVMP platform. The fuel impact is very small, however it must noted that today's airline procedures by considering the uncertainty of flight executions with respective contingency fuel is appropriate to manage the PTR impact.

B.1.1 Technical Validation Exercise #02 description and scope

The core activities & developments at the FOC system side during this validation exercise part covered the technical implementation of PTR's into the FOC system. The processing and consideration of these PTR during the flight plan generation based on the capabilities of the extended flight plan (EFPL) was successfully demonstrated.

As described in 3.2.4.2, the exercise includes two phases:

- One technical phase, aiming at validating the PTR implementation in the FOC prototype and aiming at assessing the impact on trajectory Alignment between NM and AUs.
- One operational phase, aiming at assessing the prediction impact to NM/ANSP's trajectories and the Fuel Efficiency, when airlines consider the latest available information.

  Phases to run in Shadow mode between the NMVP Platform and LSY FOC system.

B.1.1.1. Phase 1: Trajectory Alignment

Within phase 1 it is envisaged to generate at FOC approx. 50 flight plans for different city pairs EFPL's including profile tuning restrictions. The PTRs to be considered are based on corresponding published B2B SWIM services from EUROCONTROL. For the validation exercise execution and the upfront necessary data preparation, information from https://www.nm.eurocontrol.int/RAD/common/PTR.html were taken into account, as well detailed information from CFMU Human Machine Interface (CHMI). These PTRs are today not yet considered from airlines flight operation centres within the flight plan: today PTRs are operationally managed by the pilots and controllers on tactical level, but they are not part of the operational flight plan. Their unknown fuel impact is incorporated in the contingency fuel. As PTR data are even not maintained in airlines FOC today and to facilitate however the execution of the validation exercise, OPS experts from NM offered to identify upfront the most likely PTRs occurring for the envisaged fixed flight list. These profile tuning restrictions are planned to be maintained by data specialists from the FOC, including consultation of the NM OPS experts and support of the CHMI tool. This procedure should help to limit huge data maintenance effort at FOC for the unique usage of PTRs required for the validation exercise. Unfortunately B2B services offered from NM for PTRs are not used by FOC today.

The PTR implementation into the Lido database will be executed by RAD data maintenance experts from Lido, who are responsible for daily operation of traffic flow restrictions. It is assumed, that PTR publications are comparable to RAD restrictions and could be therefore transferred in similar way to the Lido database. However, the experts have to analyse upfront each single PTR publication used for this exercise, if the translation to available database elements is feasible. In case of a PTR publication could not be mapped into the existing Lido architectures, this PTR could not be considered for the validation exercise. For those PTRs where the publication creates understanding difficulties, the Lido experts discuss with the NM operators to clarify the general meaning. In a second step, the feasibility check for implementation is executed. In general for the validation exercise execution those PTRs are preferably implemented into Lido Database which are comparable to RAD restrictions.

The validation exercise aims to analyse the expected profile alignment between the 4D trajectory produced from the FOC and the calculated profile from the NM system. The flight plans analysed will cover city pairs at random within Europe.

The validation exercise scenario is displayed in the figure below. The FOC is calculating the 4D trajectory without considering PTRs at the beginning. The respective flight plan in EFPL format is sent via B2B service to the IFPUV system. The feedback from to the IFPUV is the recalculated 4D trajectory from the NM and listing the applied PTRs within IFPUV. Especially this procedure is required for the upfront running PTR data preparation phase, where it is not known at airlines 4D trajectory calculation, which PTRs might impact which routing.

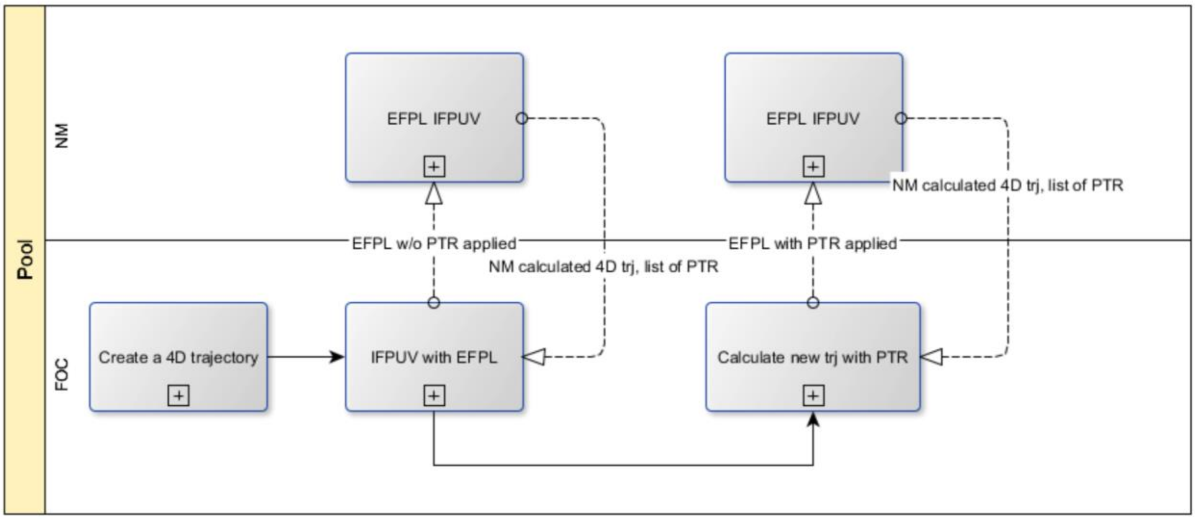


Figure 3:4D trajectory with PTRs for Trajectory Alignment with NM

The IFPUV is a non-operational FPL validation tool used to test flight plans prior to their submission to the operational IFPS. IFPUV is available on NM OPS Systems and NMVP. For the needs of the Phase 1 Trajectory Alignment, IFPUV available on NM OPS is used.

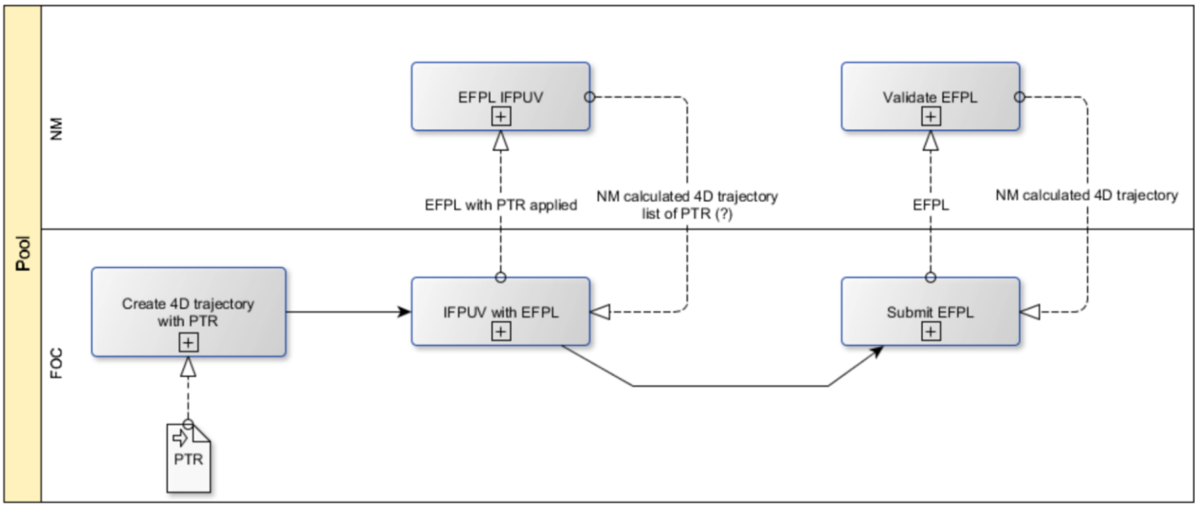
IFPUV is an automated system which is not manned by IFPS Operators. Test flight plans may be submitted with a Date of Flight (DOF) up to 120 hours (5 days) in advance by means of DOF. The DOF may be used to validate route data that becomes applicable after an AIRAC date. The airspace data for the next AIRAC cycle will normally be loaded five days in advance of the AIRAC change. Although the

IFPUV is a copy of the IFPS, it is not connected to the operational IFPS and test messages are neither distributed nor stored in the system.

In a second step, FOC will calculate a 4D trajectory including PTRs. The initial IFPUV feedback with indicating the application of PTRs primary in the climb, descent or en-route phases was the input for the FOC data maintenance to implement those PTRs in their database. After the PTRs have been maintained within the FOC system, the flight plan was calculated again considering the PTRs within their database. This procedure will enable NM to assess the profile alignment between the 4D trajectory from FOC and the recalculated profile from the NM systems (IFPUV). In addition the airline is able to evaluate the operational impact in reference to the fuel aspects, as the comparison from the flight plan without PTR and a flight plan considering PTRs is possible.

B.1.1.2. Phase 2: DCB Traffic Predictability

The second phase of the validation exercise will focus on use of EFPL's including PTRs in reference to traffic & demand prediction at NM systems. The main objective is to validate improvement in trajectory calculation through enriched input of the 4D trajectory provided from the FOC. The envisaged scenario is displayed in below figure:



The additional part within this scenario is visible in the submission of the EFPL from the FOC to NMVP after the IFPUV check has been performed. Based on these EFPL's including PTRs, NM will perform the traffic predictability assessments.

The validation exercise is intending to use operational flight plans, where airlines and FOC systems are participating to the validation exercise. The advantage of embedding operational flight plans might offer the possibility to compare the planned flight plan including PTRs with the actual flown flight. The evidence for the occurrence for PTRs primarily based on LOA's and its statistical frequency might be of interest for participating airlines.

The process to validate is close to the Alignment process for the flight plans produced by the FOC systems: NMVP systems receives EFPL flight plans with a fix of the PTRs (if needed) in the 4D trajectory during the planning phase. For each flight, the NMVP planned trajectory is compared to the actual flown flight plan.

B.1.2 Summary of Exercise #02 Technical Validation Objectives and success criteria

The Technical Validation Objectives of the Solution have been shared into three iterations and validated only by one iteration. The table below gives the list of the Exercise Validation Objective validated by the Exercise #2, each Exercise Validation Objective having the same description than the Solution Validation Objective (refer to 3.2.2.2). The Exercise Success criteria have in the same way the same description of the Solution Success criteria (refer to 3.2.2.2).

SESAR Solution Validation Objective	SESAR Solution Success criteria	Coverage and comments on the coverage of SESAR Solution Validation Objective in Exercise #02	Exercise Validation Objective	Exercise Success criteria
OBJ-18.02c-TRL6-TVALP-TF2	CRT-18.02c-TRL6-TVALP-TF2-001	Fully covered	EX2-OBJ-18.02c-TRL6-TVALP-TF2 Same description as OBJ-18.02c-TRL6-TVALP-TF2	EX2-CRT-18.02c-TRL6-TVALP-TF2-001 Same description as CRT-18.02c-TRL6-TVALP-TF2-001
OBJ-18.02c-TRL6-TVALP-TF2	CRT-18.02c-TRL6-TVALP-TF2-002	Fully covered	EX2-OBJ-18.02c-TRL6-TVALP-TF2 Same description as OBJ-18.02c-TRL6-TVALP-TF2	EX2-CRT-18.02c-TRL6-TVALP-TF2-002 Same description as CRT-18.02c-TRL6-TVALP-TF2-001
OBJ-18.02c-TRL6-TVALP-OF19	CRT-18.02c-TRL6-TVALP-OF19-001	Fully covered	EX2-OBJ-18.02c-TRL6-TVALP-OF19 Same description as OBJ-18.02c-TRL6-TVALP-OF19	EX2-CRT-18.02c-TRL6-TVALP-OF19-001 Same description as CRT-18.02c-TRL6-TVALP-OF19-001
OBJ-18.02c-TRL6-TVALP-OF20	CRT-18.02c-TRL6-TVALP-OF20-001	Fully covered	EX2-OBJ-18.02c-TRL6-TVALP-OF20 Same description as OBJ-18.02c-TRL6-TVALP-OF20	EX2-CRT-18.02c-TRL6-TVALP-OF20-001 Same description as CRT-18.02c-TRL6-TVALP-OF20-001

OBJ-18.02c-TRL6-TVALP-OF21	CRT-18.02c-TRL6-TVALP-OF21-001	Fully covered	EX2-OBJ-18.02c-TRL6-TVALP-OF21 Same description as OBJ-18.02c-TRL6-TVALP-OF21	EX2-CRT-18.02c-TRL6-TVALP-OF21-001 Same description as CRT-18.02c-TRL6-TVALP-OF21-001

Table 16: Validation Objectives addressed in Technical Validation Exercise 2 – Phase 1 Alignment / Phase 2 Predictability

The contents of the exercise success criteria are identical to the equally numbered SESAR solution success criteria.

B.1.3 Summary of Technical Validation Exercise #02 Validation scenarios

As described in 3.2.4.2, the exercise includes two phases.

B.1.3.1. Reference Scenario(s)

B.1.3.1.a. Phase 1: Trajectory Alignment

The Reference scenario corresponds to current operations when the flight plans are submitted to NM systems without any consideration of the PTR information:

- IFPUV system receives via B2B services from the FOC system of Lufthansa System EFPL flight plans not considering any PTR information.
- IFPUV system validates the EFPL flight plan, recomputes the 4D trajectory (sector and point profiles) including PTRs and forwards the 4D trajectory using PTRs back via B2B services to the FOC system with the list of PTRs.

The baseline traffic sample is based on a flight list example arriving and departing from several major hubs in Europe. The use of operational flights is not compulsory for this Alignment phase; past recorded flight plans match the needs. The routings itself are based on classical LH standard routes, which are updated from AIRAC to AIRAC. To minimize the impact of the ECAC Environment updates, the choice of the flight plans shall be those published during the same AIRAC cycle than the days of the exercise.

An IFPS operator provides support to interpret the PTR definitions, via the CHMI tool.

The baseline metrics for Trajectory Alignment will be developed from the list of PTRs computed by IFPUV and deviations of Estimated Elapsed Time (EET), Flight levels (FL), Sector Entry Times and Fuel between the EFPL 4D trajectory *not using* PTRs from the FOC system injected in the IFPUV system and the 4D trajectory computed by IFPUV using PTRs.

B.1.3.1.b. Phase 2: DCB Traffic Predictability

The Reference scenario for the Predictability phase does not correspond to the current operations: usually the Predictability studies are based on the operational flight data (actual flown trajectories versus planned trajectories), but those flight data are currently received in ICAO format on NM OPS system. If we would have considered the NM OPS data as the Reference dataset, and if, on NMVP running in shadow mode, we run the Exercise Scenario with trajectories computed with PTRs in EFPL format, we would have measured the improvements not only due to the PTRs integrated in the FOC trajectories, but the improvements due to the EFPL format as well. This is not the validation objective.

Thereby the Reference dataset has to be created for the needs of the Validation Objectives. Even though for the Phase 1 Alignment the Reference dataset provides the traffic sample used for the Exercise dataset, here the Exercise Dataset for the Predictability is the source to define the Reference traffic sample:

- Because we need to inject FOC EFPL messages in NMVP without the PTRs, the EFPL messages (creation, updates, delays, cancellation) injected during the Exercise Scenario Phase 2 without PTRs (Initial round with IFPUV) are the messages to be injected in NMVP.
- Because the Predictability metrics need a comparison with the last planned trajectories (based on EFPL) and actual flown trajectories (based on Radar tracks and computed on the basis of the last planned EFPL trajectory), a Replay of the Reference Dataset is foreseen.

Thus EFPL messages without PTRs are injected on NMVP in Replay mode, any B2B NMVP messages from the Exercise scenario are recorded and filtered for the data preparation to inject only the EFPL messages without the PTRs. About the actual events like Radar tracks and ATC events, these events are recorded from OPS NM Systems and injected on NMVP in Replay mode.

The Reference metrics for Predictability will be developed from the list of PTRs computed by IFPUV and deviations of Estimated Elapsed Time (EET), Flight levels (FL), Sector Entry Times and Fuel between the actual flown trajectory and the ETFMS planned profiles (sectors and points profiles) based on FOC EFPL 4D trajectory *not using* PTRs injected in the NMVP IFPS system.

B.1.3.2. Solution Scenario(s)

B.1.3.2.a. Phase 1: Trajectory Alignment

The Solution Scenario extends the Reference Scenario with a capability to compute AU EFPL 4D trajectories using the PTRs list provided the IFPUV. To perform the technical validation of this Solution Scenario, the Reference Scenario is completed in the following way:

- The Solution dataset is made of the traffic sample as the Reference scenario;
- At the end of the Reference scenario, for each flight a list of PTRs implemented by the IFPUV is provided to the FOC system;
- FOC system computes EFPL flight plans considering an upfront listed and maintained PTRs and sends the flight plans to IFPUV via B2B services;
- IFPUV system validates the EFPL flight plan using PTRs, recomputes if needed the 4D trajectory (sector and point profiles) including potentially missing PTRs and forwards it back via B2B services to the FOC system with the list of PTRs.

The EFPLs computed by the FOC are not connected to real flight information of an airline (aircraft mass, departure time, load …) sourcing from an operational system. Only data exchanged with IFPUV are part of the dataset.

The Scenario metrics for Trajectory Alignment will be developed from the list of PTRs computed by IFPUV and deviations of Estimated Elapsed Time (EET), Flight levels (FL), Sector Entry Times and Fuel between the EFPL 4D trajectory *using* PTRs from the FOC system injected in the IFPUV system and the 4D trajectory computed by IFPUV.

From the Scenario metrics, it is intended that an EFPL 4D Trajectory using PTRs from FOC system is closer to the IFPUV trajectory, than the Reference metrics.

B.1.3.2.b. Phase 2: DCB Traffic Predictability

To quantify the impact on the DCB Traffic predictability,

- The Solution dataset is made of a sample of operational flight plans for the airlines participating in the exercise.
- NMVP platform is running in shadow mode:

For the airlines **not** participating in the exercise, NMVP receives the flight plans in ICAO format.
For the participating airlines, the FOC system is connected to the real flight information (aircraft mass, departure time, load, …) sourcing from an operational system. The FOC system creates EFPL 4D trajectories including PTRs with the same procedure defined in the Solution Scenario for Alignment. Flight creation as well as flight updates are sent to NMVP in EFPL format.

The FOC submits the EFPL flights plan via the NMVP B2B services (flight plan creation, updates, cancellation …). The participating airlines send EFPL messages with a specific comment added in the field "remark" of the B2B services (Flight plan creation, flight plan updates). The comment is related to the Exercise scenarios and eases the identification of these flights.

The Scenario metrics for Predictability will be developed from the list of PTRs computed by IFPUV and deviations of Estimated Elapsed Time (EET), Flight levels (FL), Sector Entry Times and Fuel between the actual flown trajectory and the ETFMS planned profiles (sectors and points profiles) based on FOC EFPL 4D trajectory *using* PTRs injected in the NMVP IFPS system.

From the Scenario metrics, it is intended that an ETFMS flight profiles based on EFPL 4D Trajectory using PTRs is closer to the actual flown trajectory, than the Reference metrics.

B.1.4 Summary Technical Validation Exercise #02 Assumptions

Refer to 3.2.3.2.

B.2 Deviation from the planned activities

No.	Deviation	Mitigating actions	Expected consequences for Exercise Results
1	Phase 1 Technical feasibility & Alignment Originally, it was planned to run flight plans on the Lido/Flight SESAR environment for several major hubs within Europe and to produce approximately 100 flight plans. Due to the enormous manual workload for the workload on the PTR data maintenance in the FOC database, this dataset could not be maintained.	To reduce the workload on the PTR data maintenance in the FOC database, the numbers of flight plans have to be reduced to a number of 40 flight plans. The routings have been also limited to Lufthansa flights, as for the calculations a simplification to available company routings from Lufthansa was performed. The re-calculations from company routings ensured a re-calculation on several days, as the routings are fixed. This enabled the process to detect routings, which are affected by PTR's, where afterward the implementation of the corresponding PTR's into the Lido/Flight Database was guaranteed	Reduced Exercise dataset for the Validation objectives relative to alignment, predictability and fuel assessment (B.3.2.2, B.3.2.3, B.3.2.4).
2	Phase 2 Shadow mode session for Predictability This phase of the exercise plans to use operational flight plans. Due to the enormous manual workload to complete the PTR FOC database for the full AIRAC cycle, and due to specialist resource not available, this phase cannot be performed.	N/A	The validation objective EX2- OBJ-18.02c-TRL6-TVALP-OF20 is not assessable.

B.3 Technical Validation Exercise #02 Validation Results

B.3.1 Summary of Technical Validation Exercise #02 Results

Technical Validation Exercise #02 Validation Objective ID	Technical Validation Exercise #02 Validation Objective Title	Technical Validation Exercise #02 Success Criterion ID	Technical Validation Exercise #02 Success Criterion	Technical Validation Exercise #02 Technical Results	Technical Validation Exercise #02 Validation Objective Status
EX2-OBJ-18.02c-TRL6-TVALP-TF2	To Assess Technical Feasibility of the PTRs integration in the FOC system.	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	Solution 18.02c provides evidence of the integration of PTRs (LOA) by FOC System in the eFPL.	The embedding of PTR's into the FOC system has worked properly for those restrictions, which are published similar to RAD restrictions. This limitation was noticed, as the available DB structure in the FOC systems was not extended for this exercise. Due to the geographic limitation of the city pairs used for the validation exercise and Dynamic PTR's not been considered at all, the technical validation status could also only be rated as partially ok.	PARTIALLY OK (Low representativeness)
EX2-OBJ-18.02c-TRL6-TVALP-TF2	To Assess Technical Feasibility of the PTRs integration in the FOC system.	EX2-CRT-18.02c-TRL6-TVALP-TF2-002	Solution 18.02c provides analysis about the complexity to implement PTRs (LOA) by FOC System in the eFPL.	For all flight plans considered within this exercise, an expert assessment for the feasibility study to transfer the PTR into the FOC systems was executed. Results delivered the strong need to make PTR publications similar to RAD publications. Otherwise extensive database architecture &	PARTIALLY OK (Low representativeness)

Technical Validation Exercise #02 Validation Objective ID	Technical Validation Exercise #02 Validation Objective Title	Technical Validation Exercise #02 Success Criterion ID	Technical Validation Exercise #02 Success Criterion	Technical Validation Exercise #02 Results	Technical Validation Exercise #02 Validation Objective Status
				software changes are required to make use of the PTR'S. The limitation of the selected citypairs and the consideration of static PTR's lead to a partially achieved objective status.	
EX2-OBJ-18.02c-TRL6-TVALP-OF19	To validate that the integration of PTRs (LOA) in the eFPL 4D trajectory improves AU Trajectory Alignment with NM systems trajectory.	EX2-CRT-18.02c-TRL6-TVALP-OF19-001	Solution 18.02c provides evidence that the eFPL 4D Trajectory with PTRs implemented (LOA) is closer to the NM computed trajectory than the eFPL 4D Trajectory without PTRs implemented (LOA). The difference is reduced in vertical dimension mainly, and in time dimension.	The embedding of PTR's into the 4D trajectory demonstrated a significant alignment improvement in the vertical dimension of the profile. It was not possible to identify a clear improvement in the alignment of the time dimension. A more detailed analysis of the trajectories would be required to find the reason for it.	PARTIALLY OK
EX2-OBJ-18.02c-TRL6-TVALP-OF20	To validate that the integration of PTRs (LOA) in the eFPL 4D Trajectory improves	EX2-CRT-18.02c-TRL6-VALP-OF20-001	Solution 18.02c provides evidence that the integration of the PTRs (LOA) in the eFPL 4D Trajectory reduces the difference in vertical dimension :	Due to the requirement of an high number of flight plans to be used for traffic predictions, this part of the exercise could have not been analysed	NOK

Technical Validation Exercise #02 Validation Objective ID	Technical Validation Exercise #02 Validation Objective Title	Technical Validation Exercise #02 Success Criterion ID	Technical Validation Exercise #02 Success Criterion	Technical Validation Exercise #02 Technical Results	Technical Validation Exercise #02 Validation Objective Status
	NM / ATC DCB Traffic Predictability.		the NM / ATC planned trajectory computed with PTRs is closer to the flown trajectory than the NM / ATC planned trajectory computed without PTRs.		🟥
EX2-OBJ-18.02c-TRL6-TVALP-OF21	To assess the impact of integrating PTRs (LOA) in the eFPL 4D Trajectory on the total planned fuel	EX2-CRT-18.02c-TRL6-VALP-OF21-001	Solution 18.02c performs a qualitative assessment on the fuel (planned and extra fuel) for a flight with and without including PTRs (LOA) in the eFPL 4D Trajectory.	The embedding of PTR's into the 4D trajectory demonstrated a small increase of the planned trip fuel (about 1 %). The increase was expected; the exercise provided an evidence about the amount. To be confirmed by AUs that the small increase in operations is acceptable.	PARTIALLY OK

Table 17: Technical Validation Results Exercise 2

B.3.1.1. Results on technical feasibility

The exercise proved that it is technically feasible to implement the PTR and to include the Profile Restriction into the AU 4D trajectory.

The results of Technical Validation Objectives demonstrated the technical feasibility – refer to B.3.2.1.

B.3.1.2. Results per KPA

Not applicable – KPAs have not been defined for solution PJ.18-02c.

B.3.2 Analysis of Exercise 1 Results per Technical Validation objective

B.3.2.1. EX2-OBJ-18.02c-TRL6-TVALP-TF2 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #02 Validation Results	Technical Validation Objective Status
EX2-OBJ-18.02c-TRL6-TVALP-TF2	To Assess Technical Feasibility of the PTRs integration in the FOC system.	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	Solution 18.02c provides evidence of the integration of PTRs (LOA) by FOC System in the eFPL.	The embedding of PTR's into the FOC system has worked properly for those restrictions, which are published similar to RAD restrictions. This limitation was noticed, as the available DB structure in the FOC systems was not extended for this exercise. Due to the geographic limitation of the city pairs used for the validation exercise and Dynamic PTR's not been considered at all, the technical validation status could also only be rated as partially ok.	PARTIALLY OK (Low representativeness)

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #02 Validation Results	Technical Validation Objective Status
EX2-OBJ-18.02c-TRL6-TVALP-TF2	To Assess Technical Feasibility of the PTRs integration in the FOC system.	EX2-CRT-18.02c-TRL6-TVALP-TF2-002	Solution 18.02c provides analysis about the complexity to implement PTRs (LOA) by FOC System in the eFPL.	For all flight plans considered within this exercise, an expert assessment for the feasibility study to transfer the PTR into the FOC systems was executed. Results delivered the strong need to make PTR publications similar to RAD publications. Otherwise extensive database architecture & software changes are required to make use of the PTR'S. The limitation of the selected citypairs and the consideration of static PTR's lead to a partially achieved objective status.	PARTIALLY OK (Low representativeness)

DATA COLLECTION

The AU 4D trajectories without PTR implementation (Flight plan Creation FPL without Profile Restriction) sent via the B2B services have been collected, called *AU B2B requests without PTR*.

In reply to *AU B2B requests without PTR*, NM flight plans computed on the basis of the AU 4D trajectories have been collected via the B2B Service, called *NM B2B reply*: these logs include the trajectory computed by NM IFPUV as well as the list of PTRs constraints to be avoided by the AU 4D trajectory. *NM B2B reply* includes the NM IFPUV 4D trajectory implementing the PTR constraints in the profile.

The AU 4D trajectories with PTR implementation (Flight plan Update CHG with Profile Restriction) sent via the B2B services have been collected, called *AU B2B requests with PTR*.

In reply to *AU B2B requests with PTR*, NM flight plans computed on the basis of the AU 4D trajectories have been collected via the B2B Service.

The PTR validation exercise was performed in two sessions, one in October 2018 and one session in May 2019.

DATA LOGGING EXTRACTION

We identified the Reference and Scenario dataset for each flight:

- Reference dataset: from the records of the *AU B2B requests without PTR* and *NM B2B replies* (based AO EFPL 4D trajectory without PTRs implemented) from the IFPUV Validation Service, we extracted the AU 4D trajectory without PTR implementation and the IFPUV computed trajectory. Refer to B.1.3.1
- Scenario dataset: from the records of the *AU B2B requests with PTR* and *NM B2B replies* (AO EFPL 4D trajectory with PTRs) from the IFPUV Validation Service, we extracted the AU 4D trajectory with PTR implementation and the IFPUV computed trajectory. Refer to B.1.3.2.

From the CHMI, we extracted the vertical profiles for each flights in both datasets.

METRICS FOR EX2-CRT-18.02C-TRL6-TVALP-TF2-001

Phase	Metrics	Gaming	Quantitative / Qualitative	Success criteria	Analysis method
P1	"#eFPL without PTR included by FOC", already compliant with RAD & PTR constraints	Ref. scenario eFPL wo PTR	Quantitative	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	B2B logs extraction
P2	"#eFPL without PTR included by FOC ", not compliant with PTR constraints (compliant with RAD only)	Ref. scenario eFPL wo PTR	Quantitative	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	B2B logs extraction
P3	"#eFPL with PTR included by FOC " compliant with PTR constraints after recomputation (only those from phase P2)	Exercise scenario eFPL w PTR	Quantitative	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	B2B logs extraction
P4	"#eFPL trajectory with PTR included by FOC" not compliant with PTR constraints after recomputation (only those from phase P2)	Exercise scenario eFPL w PTR	Quantitative	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	B2B logs extraction

RESULTS EX2-CRT-18.02C-TRL6-TVALP-TF2-001

The first step of the technical activity is the validation of an AU 4D trajectory without any consideration of the PTR on the route (EFPL on the Lido/Flight FOC where no PTR's are considered at all), via the B2B Service and the use of IFPUV (NM 22.5 `ExtendedFlightPlanValidationRequest / ExtendedFlightPlanValidationReply`). IFPUV returns the list of Profile Tuning Restrictions (PTR) included in the NM 4D trajectory in reply to the AU 4D trajectory validation request.

Example 1: extraction of the XML trajectory for a flight plan from LSGG – EDDM on the 17 of October 2018 (session 1) – and the PTR list replied by IFPUV:

ExtendedFlightPlanValidationRequest

```
<soapenv:Envelope />
   <soapenv:Header/>
   <soapenv:Body>
      <flig:ExtendedFlightPlanValidationRequest>
         <endUserId>EH001463</endUserId>
         <sendTime>2018-10-17 08:00:00</sendTime>
         <flightPlan>
            <structuralEFPL>
       <fourDimensionalTrajectory>
          <fourDTrajectoryPoints>
            <fourDPoint>
               …
              <altitude>
                <unit>M</unit>
                <level>42</level>
              </altitude>
              <elapsedTime>0</elapsedTime>

<distanceFromTakeOff>0</distanceFromTakeOff>
            </fourDPoint>

<trajectoryPointType>adep</trajectoryPointType>
            <trajectoryPointRole>
              <bottomOfClimb>true</bottomOfClimb>
            </trajectoryPointRole>

<aerodromeIdentifier>LSGG</aerodromeIdentifier>
            <windInformation>
              <windDirection>24</windDirection>
              <windSpeed>
                <speed>9</speed>
                <unit>KNOTS</unit>
              </windSpeed>
            </windInformation>
            <grossWeight>66964</grossWeight>
          </fourDTrajectoryPoints>
          <fourDTrajectoryPoints>
….
```

ExtendedFlightPlanValidationReply

```
<S:Envelope />
   <S:Body>
      <fl:ExtendedFlightPlanValidationReply …>
         <requestReceptionTime>2018-10-17
07:34:39</requestReceptionTime>
         <requestId>B2B_CUR:60226</requestId>
         <sendTime>2018-10-17 08:00:02</sendTime>
         <status>OK</status>
         <data>
            <fourDimensionalTrajectory>
               <fourDTrajectoryPoints>
                  <fourDPoint>
                     …
                     <altitude>
                        <unit>SM</unit>
                        <level>426</level>
                     </altitude>
                     <elapsedTime>0</elapsedTime>

<distanceFromTakeOff>0</distanceFromTakeOff>
                  </fourDPoint>

<trajectoryPointType>adep</trajectoryPointType>

<aerodromeIdentifier>LSGG</aerodromeIdentifier>
               </fourDTrajectoryPoints>
               <fourDTrajectoryPoints>
                  <fourDPoint>
                     <position>
                  </fourDPoint>
…

<profileTuningRestrictions>
               <identifier>FR_LSAG40A</identifier>
               <entryTime>2018-10-17
15:10:00</entryTime>
               <exitTime>2018-10-17
15:24:25</exitTime>
            </profileTuningRestrictions>
            <profileTuningRestrictions>
               <identifier>FR_LSAG40P</identifier>
               <entryTime>2018-10-17
15:10:00</entryTime>
               <exitTime>2018-10-17
15:24:25</exitTime>
            </profileTuningRestrictions>
            <profileTuningRestrictions>
               <identifier>FR_LSAG57A</identifier>
               <entryTime>2018-10-17
15:12:26</entryTime>
               <exitTime>2018-10-17
15:12:26</exitTime>
            </profileTuningRestrictions>
            <profileTuningRestrictions>
               <identifier>FR_LSAG55A</identifier>
               <entryTime>2018-10-17
15:19:00</entryTime>
```

	`<exitTime>2018-10-17 15:19:00</exitTime>` `</profileTuningRestrictions>`

As displayed in the above response, the flight is affected by 4 PTR’s (id LSAG40A, LSAG40P, LSAG57A, LSAG55A).

From the CHMI, the graphical vertical view for this flights is displayed in below picture:

Figure 4: Example 1 - Vertical profile for AU Trajectory without PTR implementation and IFPUV trajectory

The blue line is the profile ofAU 4D trajectory without PTR; the black line is the profile of the computed IFPUV trajectory based on AU 4D trajectory and implementing PTR’s (and flight restrictions).

In this example the PTR’s LSAG55A, LSAG40A & LSAG40P are not taken into account from the original Lido/Flight plan during the ascent phase. After analysis from Lido/Flight data specialist, these PTR’s were coded into the Lido database according to their feasibility.

As mentioned above this process was done manually, it was quite time consuming leading to the fact, that the intended flight sample has to been reduced from 100 flights to approx. 40 flights taken into account during the validation exercise.

The new calculated flight plan from Lido/Flight FOC (with PTR’s) shows the adapted 4D profile in below picture.

Figure 5: Example 1 - Vertical profile for AU Trajectory with PTR implementation and IFPUV trajectory

In the ascent phase, we demonstrate an almost 1-1 alignment between the 4D trajectory from the Network Manager (black line) and the FOC trajectory (blue line).

Some further examples are shown below.

Example 2: Flight from EETN – EDDF, initial FOC trajectory without PTR consideration – done during session 1 October 2018.

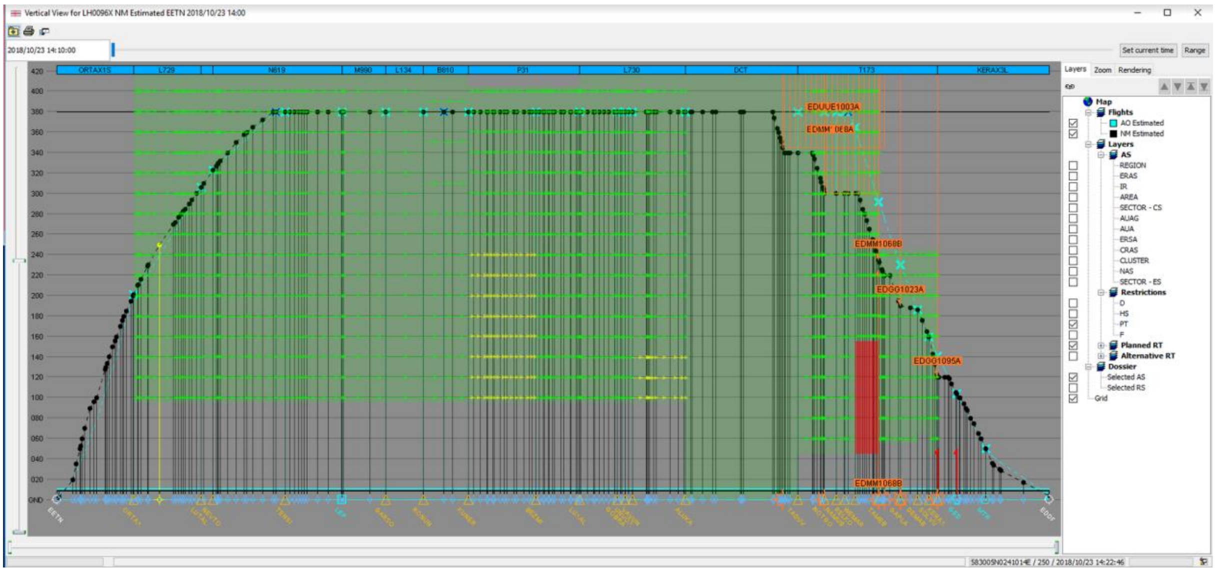


Figure 6: Example 2 - Vertical profile for AU Trajectory without PTR implementation and IFPUV trajectory

PTR's are affecting in this case the descent profile of the AU trajectory (blue line) : EDUUE1003A, EDMMDE8A, EDMM1068B, EDGG1023A, EDGG1095A

After the maintenance of the corresponding PTR's in the Lido database, the recalculated 4D trajectory considering these PTR's is displayed below. Again the FOC trajectory is almost perfectly aligned with the NM trajectory.

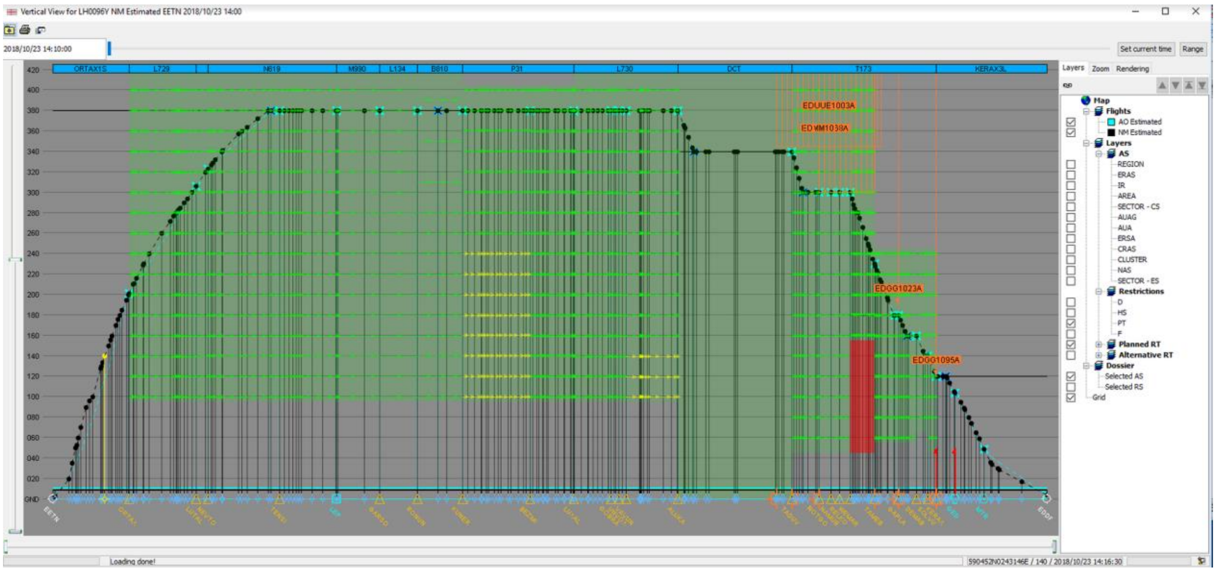


Figure 7: Example 2 - Vertical profile for AU Trajectory with PTR implementation and IFPUV trajectory

Example 3: flight from EIDW to EDDM. First the 4D trajectory without PTR consideration (blue line) - done during session 1 october 2018:

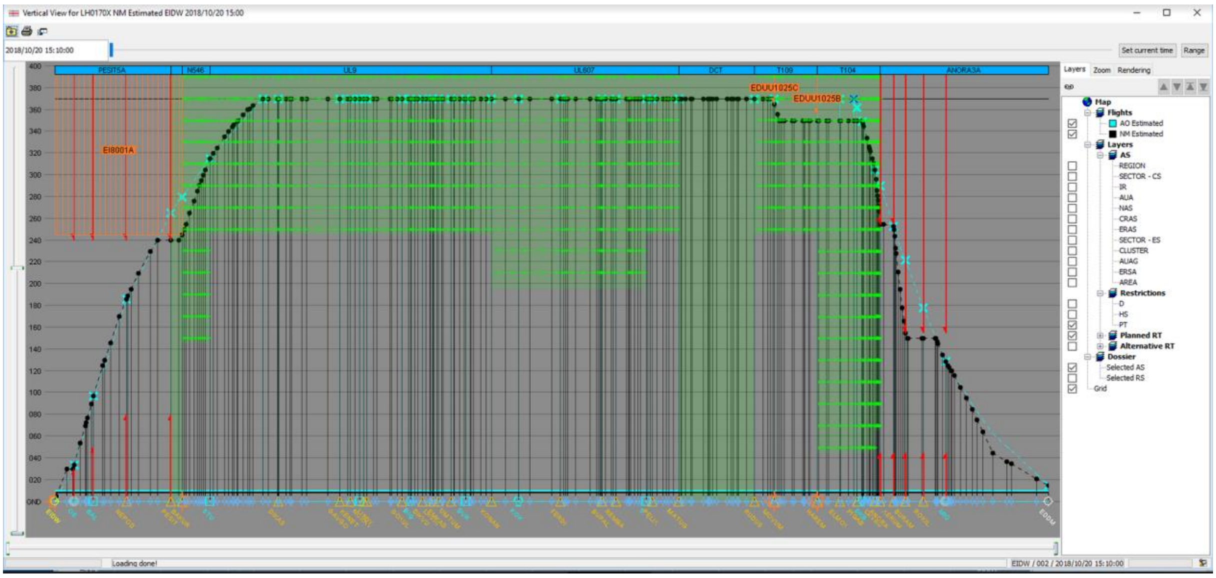


Figure 8: Example 3 - Vertical profile for AU Trajectory without PTR implementation and IFPUV trajectory

After considering the PTR's EI8001A in the ascent phase and EDUU1025C, EDUU1025B in the descent phase, the new AU trajectory profile is:

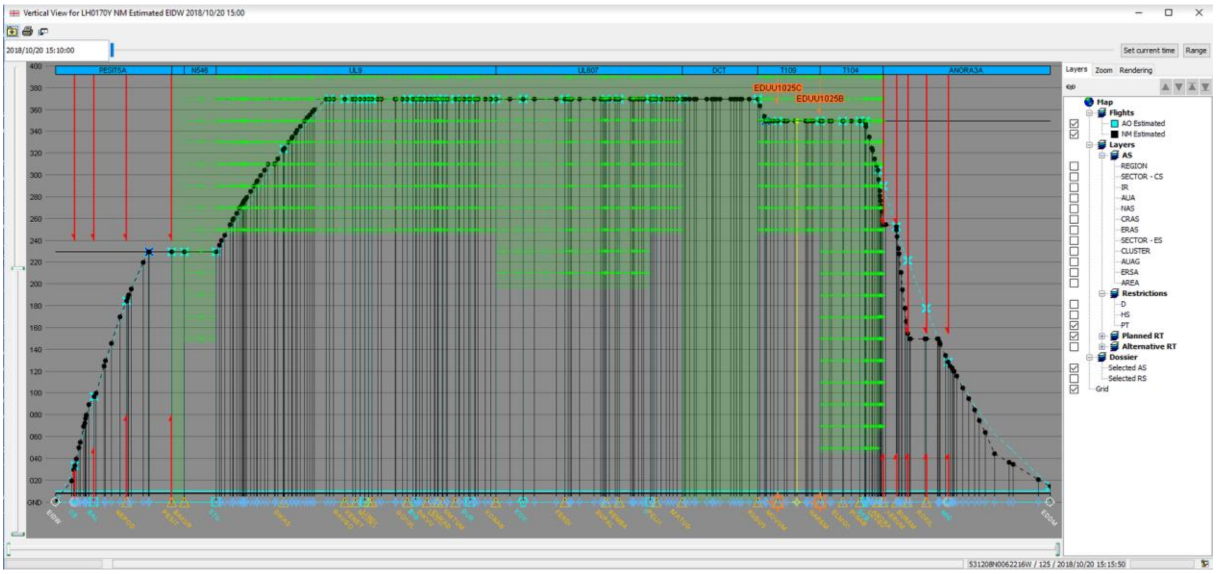


Figure 9: Example 3 - Vertical profile for AU Trajectory with PTR implementation and IFPUV trajectory

The profile is almost aligned between the NM profile and the FOC trajectory, however there are still some differences due to Flight restriction in the STAR procedure (descent phase).

Attached two further example from the profile alignment of the second session May 2019. The blue profile is from the FOC trajectory, the black line is the computed IFPUV profile based on FOC trajectory and implementing PTR's (and flight restrictions):

Example 4: flight from EDDK-EDDM – session 2 May 2019

The PTR EDGG1100A was not considered in the initial flight plan from the FOC:

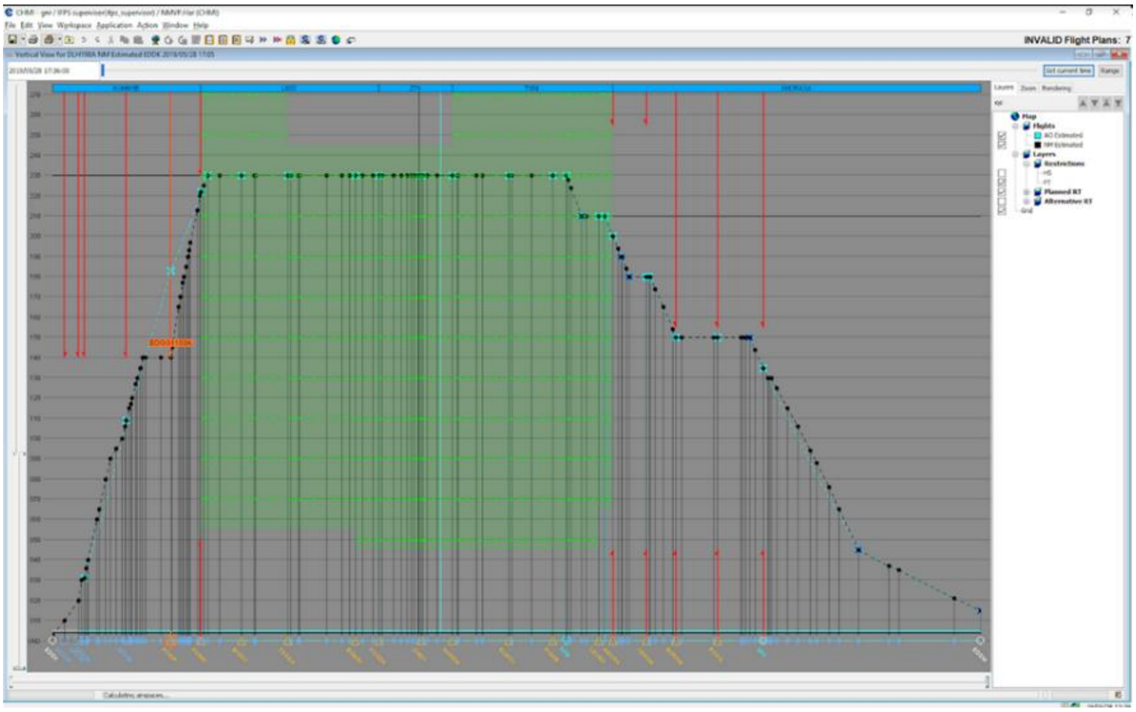


Figure 10: Example 4 - Vertical profile for AU Trajectory without PTR implementation and IFPUV trajectory

After embedding the corresponding PTR into the Lido/Flight FOC systems:

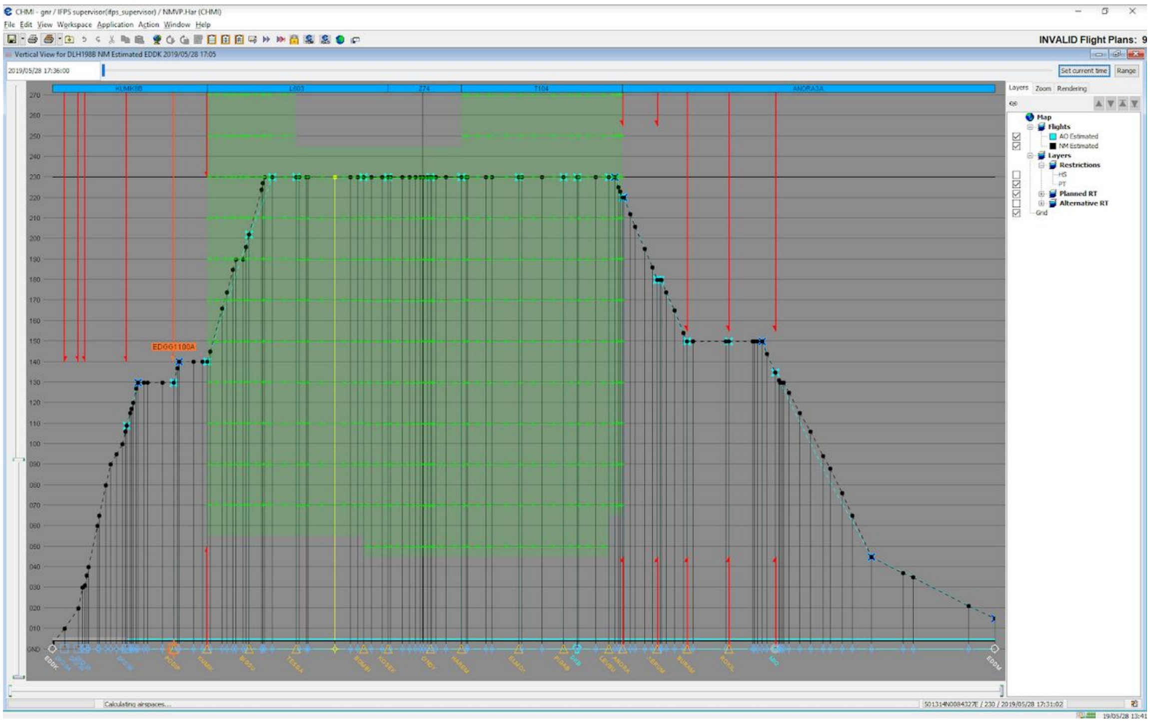


Figure 11: Example 4 - Vertical profile for AU Trajectory with PTR implementation and IFPUV trajectory

The FOC includes a step climb to consider the needs of the PTR.

<u>Final example</u>: flight from LIPE to EDDF- – session 2 May 2019.

After sending the initial FOC flight plan to IFPUV, the feedback for PTR's impacting the flight plan are listed: EDUUS14000A, EDUUS1105A, EDMM1041A, EDGG1117A and EDGG1110A. After analysing the NM profile, the FOC profile is only violating against EDUUS1105A which was afterward inserted into the Lido/Flight FOC database. The FOC profile considering the PTR is displayed in the following picture, demonstrating the step decent to consider the corresponding PTR.

Figure 12: Example 5 - Vertical profile for AU Trajectory with PTR implementation and IFPUV trajectory

For the both session in October 2018 and May 2019, we count below from the B2B service requests that have been accepted and validated by the IFPUV. The count is used in the next validation objectives for the representativeness of the results.

Phase	Metrics	Gaming	Quantitative / Qualitative	Success criteria	Results
P1	"#eFPL without PTR included by FOC", already compliant with RAD & PTR constraints	Ref. scenario eFPL wo PTR	Quantitative	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	0

Phase	Metrics	Gaming	Quantitative / Qualitative	Success criteria	Results
P2	"#eFPL without PTR included by FOC ", not compliant with PTR constraints (compliant with RAD only)	Ref. scenario eFPL wo PTR	Quantitative	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	26
P3	"#eFPL with PTR included by FOC " compliant with PTR constraints after recomputation (only those from phase P2)	Exercise scenario eFPL w PTR	Quantitative	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	26
P4	"#eFPL trajectory with PTR included by FOC" not compliant with PTR constraints after recomputation (only those from phase P2)	Exercise scenario eFPL w PTR	Quantitative	EX2-CRT-18.02c-TRL6-TVALP-TF2-001	0 (Only remaining the Vertical Limits in the SID/STAR definition not implemented)

CONCLUSION

Success criteria EX2-CRT-18.02c-TRL6-TVALP-TF2-001:

The embedding of PTR's into the FOC system has worked properly for those restrictions, which are published similar to RAD restrictions. This limitation was noticed, as the available DB structure in the FOC systems was not extended for this exercise.

Nevertheless, due to limited geographical scope, and the limited number of flight plans published with PTR's, the results are not representative and the success criteria is considered as partially OK.

Success criteria EX2-CRT-18.02c-TRL6-TVALP-TF2-002:

For all flight plans considered within this exercise, an expert assessment for the feasibility study to transfer the PTR into the FOC systems was executed. Results delivered the strong need to make PTR publications similar to RAD publications. Otherwise extensive database architecture & software changes are required to make use of the PTR'S.

Nevertheless, due to limited geographical scope, and the limited number of flight plans published with PTR's, the results are not representative and the success criteria is considered as partially OK.

B.3.2.2. EX2-OBJ-18.02c-TRL6-TVALP-OF19 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #02 Validation Results	Technical Validation Objective Status
EX2-OBJ-18.02c-TRL6-TVALP-OF19	To validate that the integration of PTRs (LOA) in the eFPL 4D trajectory improves AU Trajectory Alignment with NM systems trajectory.	EX2-CRT-18.02c-TRL6-TVALP-OF19-001	Solution 18.02c provides evidence that the eFPL 4D Trajectory with PTRs implemented (LOA) is closer to the NM computed trajectory than the eFPL 4D Trajectory without PTRs implemented (LOA). The difference is reduced in vertical dimension mainly, and in time dimension.	The embedding of PTR's into the 4D trajectory demonstrated a significant alignment improvement in the vertical dimension of the profile. It was not possible to identify a clear improvement in the alignment of the time dimension. A more detailed analysis of the trajectories would be required to find the reason for it.	PARTIALLY OK

DATA COLLECTION

The AU 4D trajectories (Flight plan Creation FPL, Flight plan Update CHG) sent via the B2B services have been collected, called *AU B2B requests*.

In reply to *AU B2B requests*, NM flight plans computed on the basis of the AU 4D trajectories have been collected via the B2B Service, called *NM B2B reply*: these logs include the trajectory computed by NM IFPUV.

From *NM B2B reply,* the list of PTRs constraints to be avoided by the 4D trajectory is available and extracted.

The PTR validation exercise was performed in two sessions, one in October 2018 and one session in May 2019.

DATA LOGGING EXTRACTION

We identified the Reference and Scenario dataset for each flight:

- Reference dataset: from the records of the *AU B2B requests* and *NM B2B replies* (AO EFPL 4D trajectory without PTRs) from the IFPUV Validation Service, we extracted the AU 4D trajectory and the IFPUV computed trajectory. See B.1.3.1.aB.1.3.2.a

- Scenario dataset: from the records of the *AU B2B requests* and *NM B2B replies* (AO EFPL 4D trajectory with PTRs) from the IFPUV Validation Service, we extracted the AU 4D trajectory and the IFPUV computed trajectory. See B.1.3.2C.1.3.2.b

The AU 4D trajectory from the *AU B2B requests* includes only the point profile. No sector profile is available.

From the CHMI, we extracted the vertical profiles for each flights in both datasets.

METRICS FOR ALIGNMENT EX2-CRT-18.02C-TRL6-TVALP-OF19-001

We computed the following quantitative metrics for the Reference (before SID/STAR updates) and Scenario Datasets (with SID/STAR updates): for each flight, for each SID/STAR Updates from the flight dispatcher,

Alignment in Altitude:

- M1 Considering all named trajectory points both in the AU 4D Trajectory and the IFPUV trajectory, Average of the Difference of Flight levels (Absolute values).

Alignment in Elapsed Time:

- M2 Considering all named trajectory points both in the AU 4D Trajectory and the IFPUV trajectory, Average of the Difference of Estimated Elapsed Time (EET) from take-off time (Absolute values).

RESULTS FOR ALIGNMENT EX2-CRT-18.02C-TRL6-TVALP-OF19-001

- Alignment in Altitude:

In the following table there is an analysis shown for the comparison of the flight levels on the points in common with the AU trajectory (B2B flight plan request) with the reply from IFPS (B2B reply) and computed the average of the “absolute difference of flight levels between NM and AU”. This is done for the flight plans without considering PTR’s and also for the flight plans, where PTR’s have been implemented.

<u>Session 1 – October 2018:</u>

ABSOLUTE DIFFERENCE FOR FLIGHT LEVEL (FL)					
Without PTR			With PTR		
Flight ID	**Average of ABS DIFF FL NM-AU (FL)**		**Flight ID**	**Average of ABS DIFF FL NM-AU (FL)**	Var %
LH000217OCT18LFPG171400171700EDDF	9,56		LH000217OCT18LFPG171400171700EDDF	9,56	0,00%
LH004217OCT18LFMN171400171700EDDF	28,14		LH004217OCT18LFMN171400171700EDDF	6,45	-77,08%
LH005417OCT18EPWA171400171700EDDF	11,86		LH005417OCT18EPWA171400171700EDDF	0,27	-97,70%
LH006817OCT18LFLL171400171700EDDF	18,08		LH006817OCT18LFLL171400171700EDDF	7,83	-56,68%
LH007617OCT18LKPR171400171700EDDF	12,38		LH007617OCT18LKPR171400171700EDDF	0,81	-93,43%
LH009617OCT18EETN171400171700EDDF	13,43		LH009617OCT18EETN171400171700EDDF	0,25	-98,14%
LH013017OCT18LSGG171500171800EDDM	19,05		LH013017OCT18LSGG171500171800EDDM	13,10	-31,23%
LH017017OCT18EIDW171500171800EDDM	5,93		LH017017OCT18EIDW171500171800EDDM	3,17	-46,50%

Session 2 – May 2019:

ABSOLUTE DIFFERENCE FOR FLIGHT LEVEL (FL)					
Without PTR			With PTR		
Flight ID	**Average of ABS DIFF FL NM-AU (FL)**		**Flight ID**	**Average of ABS DIFF FL NM-AU (FL)**	Var %
LH008124MAY19EDDLEDDF	8,38		LH008124MAY19EDDLEDDFwithPTREDGG1097A	1,50	-82,09%
LH011124MAY19EDDMEBBR	7,68		LH011124MAY19EDDMEBBRwithPTREDGG1093A	2,63	-65,75%
LH011527MAY19LEMGEDDF	11,43		LH011527MAY19LEMGEDDFwithPTREDGG1099A	8,26	-27,71%
LH012927MAY19LTFMEDDF	3,92		LH012927MAY19LTFMEDDFwithPTREDMM1041B	0,70	-82,05%
LH013428MAY19EDDFEPWA	8,39		LH013428MAY19EDDFEPWAwithPTREDGG1094A	1,97	-76,58%
LH013627MAY19EDDFEPKK	8,68		LH013627MAY19EDDFEPKKwithPTRLKAA9001A	1,48	-82,95%

ABSOLUTE DIFFERENCE FOR FLIGHT LEVEL (FL)					
Without PTR			With PTR		
LH014727MAY19LUKKEDDF	5,33		LH014727MAY19LUKKEDDFwithPTREDMM1041B	0,86	-83,93%
LH017128MAY19LOWWEDDH	3,70		LH017128MAY19LOWWEDDHwithPTRLKLO9006A	3,70	0,00%
LH019828MAY19EDDKEDDM	3,05		LH019828MAY19EDDKEDDMwithPTREDGG1100A	0,84	-72,41%
LH023628MAY19LOWWEDDH	4,79		LH023628MAY19EDDTLOWWwithPTRLKLO9013A	2,21	-53,85%
LH025920MAY19LIRFEDDF	8,59		LH025920MAY19LIRFEDDFwithPTREDGG1099	1,48	-82,76%
LH026021MAY19EDDFEDDT	3,53		LH026021MAY19EDDFEDDTwithPTREDGG1094A	0,80	-77,36%
LH028524MAY19LIPEEDDF	11,40		LH028524MAY19LIPEEDDFwithPTREDMM1041A	0,60	-94,74%
LH032927MAY19LIPZEDDF	3,61		LH032927MAY19LIPZEDDFwithPTREDMM1041A	0,26	-92,77%
LH124222MAY19EDDFLOWW	10,23		LH124222MAY19EDDFLOWWwithPTRLKLO9013A	7,38	-27,82%
LH168222MAY19EDDMLHBP	8,00		LH168222MAY19EDDMLHBPwithPTRLZBB9026A	3,90	-51,25%
LH209922MAY19EDDVEDDM	6,14		LH209922MAY19EDDVEDDMwithPTREDMM1085A	2,55	-58,52%

The validation exercise in overall demonstrate a significant alignment improvement between the NM profile and the FOC profile in the scenario, where the PTR's are considered within the 4D trajectory of the FOC system.

- Alignment in Elapsed Time:

A further parameter for the analysis of the profile alignment is displayed in the following table: The elapsed time difference between the profile is summarized for the points on the trajectory in common:

Session 1 – October 2018:

ABSOLUTE DIFFERENCE FOR ELAPSED TIME FROM TAKE-OFF TIME (s)					
Without PTR			With PTR		
Flight ID	**Average of ABS DIFF Elapsed Time NM-AU (s)**		**Flight ID**	**Average of ABS DIFF Elapsed Time NM-AU (s)**	Var %
LH000217OCT18LFPG171400171700EDDF	14,83		LH000217OCT18LFPG171400171700EDDF	14,61	-1,50%
LH004217OCT18LFMN171400171700EDDF	27,79		LH004217OCT18LFMN171400171700EDDF	25,66	-7,69%
LH005417OCT18EPWA171400171700EDDF	38,73		LH005417OCT18EPWA171400171700EDDF	31,91	-17,61%
LH006817OCT18LFLL171400171700EDDF	19,88		LH006817OCT18LFLL171400171700EDDF	17,58	-11,53%
LH007617OCT18LKPR171400171700EDDF	25,88		LH007617OCT18LKPR171400171700EDDF	4,69	-81,88%
LH009617OCT18EETN171400171700EDDF	71,00		LH009617OCT18EETN171400171700EDDF	73,68	3,77%
LH013017OCT18LSGG171500171800EDDM	44,85		LH013017OCT18LSGG171500171800EDDM	32,20	-28,21%
LH017017OCT18EIDW171500171800EDDM	44,12		LH017017OCT18EIDW171500171800EDDM	40,98	-7,13%

Session 2 – May 2019:

ABSOLUTE DIFFERENCE FOR ELAPSED TIME FROM TAKE-OFF TIME (s)					
Without PTR			With PTR		
Flight ID	**Average of ABS DIFF ElapsedTime NM-AU (s)**		**Flight ID**	**Average of ABS DIFF ElapsedTime NM-AU (s)**	Var %
LH008124MAY19EDDLEDDF	47,38		LH008124MAY19EDDLEDDFwithPTREDGG1097A	91,50	93,14%
LH011124MAY19EDDMEBBR	14,21		LH011124MAY19EDDMEBBRwithPTREDGG1093A	18,53	30,37%
LH011527MAY19LEMGEDDF	177,86		LH011527MAY19LEMGEDDFwithPTREDGG1099A	191,36	7,59%
LH012927MAY19LTFMEDDF	132,12		LH012927MAY19LTFMEDDFwithPTREDMM1041B	143,37	8,52%
LH013428MAY19EDDFEPWA	128,29		LH013428MAY19EDDFEPWAwithPTREDGG1094A	141,10	9,99%
LH013627MAY19EDDFEPKK	144,24		LH013627MAY19EDDFEPKKwithPTRLKAA9001A	148,76	3,13%
LH014727MAY19LUKKEDDF	191,52		LH014727MAY19LUKKEDDFwithPTREDMM1041B	135,29	-29,36%
LH017128MAY19LOWWEDDH	87,39		LH017128MAY19LOWWEDDHwithPTRLKLO9006A	109,09	24,83%

ABSOLUTE DIFFERENCE FOR ELAPSED TIME FROM TAKE-OFF TIME (s)					
Without PTR			With PTR		
Flight ID	**Average of ABS DIFF ElapsedTime NM-AU (s)**		**Flight ID**	**Average of ABS DIFF ElapsedTime NM-AU (s)**	Var %
LH019828MAY19EDDKEDDM	36,26		LH019828MAY19EDDKEDDMwithPTREDGG1100A	17,26	-52,39%
LH023628MAY19LOWWEDDH	56,89		LH023628MAY19EDDTLOWWwithPTRLKLO9013A	48,89	-14,06%
LH025920MAY19LIRFEDDF	25,78		LH025920MAY19LIRFEDDFwithPTREDGG1099	25,19	-2,30%
LH026021MAY19EDDFEDDT	19,87		LH026021MAY19EDDFEDDTwithPTREDGG1094A	22,40	12,75%
LH028524MAY19LIPEEDDF	17,20		LH028524MAY19LIPEEDDFwithPTREDMM1041A	19,08	10,93%
LH032927MAY19LIPZEDDF	76,09		LH032927MAY19LIPZEDDFwithPTREDMM1041A	78,65	3,37%
LH124222MAY19EDDFLOWW	42,12		LH124222MAY19EDDFLOWWwithPTRLKLO9013A	49,31	17,08%
LH168222MAY19EDDMLHBP	24,10		LH168222MAY19EDDMLHBPwithPTRLZBB9026A	55,70	131,12%
LH209922MAY19EDDVEDDM	49,68		LH209922MAY19EDDVEDDMwithPTREDMM1085A	57,73	16,19%

As the numbers show, there is no obvious improvement for the difference of Elapsed time to be noticed for 4D profile calculations when PTR's are considered within the FOC trajectory. An explanation could be that the elapsed time is influenced by more parameters (for instance the wind conditions) than the altitude. A more detailed analysis of the trajectories and the influencing parameters would be required to find the reason for the unclear picture.

The EET of the trajectory points can be compared for the points only that are identical in a continuous sequence from the departure airport for the AU trajectory and the related IFPUV trajectory. This means: a continuous sequence of identical points with regard to the horizontal coordinates. Starting with the first point that has a horizontal deviation, a comparison of the EET of this and all subsequent points is not possible anymore.

In addition the EET of the trajectory points can be compared only:

- In the case that the AU and the IFPUV trajectories with consideration of PTR's are completely aligned vertically in the climb phase.
- Or in the case that the AU and the IFPUV trajectories with consideration of PTR's are not completely aligned vertically in the climb phase, if the climb phases of the AU and IFPUV trajectories without consideration of the PTR's coincide with the climb phases of the AU and IFPUV trajectories with consideration of the PTR's.

Unfortunately for above listed table it was not analyzed, for which flight the above listed conditions are fulfilled, so that a real trajectory alignment in reference to the time could be displayed, where these conditions have been fulfilled. The table includes of course city pairs, where AU & NM trajectory are aligned in reference to the routing, so that the time alignment value could be listed. However it was due to time limitations not feasible to identify those flights, where horizontal deviations prevent a time alignment analysis.

CONCLUSION

Success criteria EX2-CRT-18.02c-TRL6-TVALP-OF19-001:

The embedding of PTR's into the 4D trajectory demonstrated a significant alignment improvement in the vertical dimension of the profile.

It was not possible to identify a clear improvement in the alignment of the time dimension. A more detailed analysis of the trajectories would be required to find the reason for it.

B.3.2.3. EX2-OBJ-18.02c-TRL6-TVALP-OF20 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #02 Validation Results	Technical Validation Objective Status
EX2-OBJ-18.02c-TRL6-TVALP-OF20	To validate that the integration of PTRs (LOA) in the eFPL 4D Trajectory improves NM / ATC DCB Traffic Predictability.	EX2-CRT-18.02c-TRL6-VALP-OF20-001	Solution 18.02c provides evidence that the integration of the PTRs (LOA) in the eFPL 4D Trajectory reduces the difference in vertical dimension : the NM / ATC planned trajectory computed with PTRs is closer to the flown trajectory than the NM / ATC planned trajectory computed without PTRs.	See Deviation 3.3.2.2 for phase 2. Due to the requirement of a high number of flight plans to be used for traffic predictions, this part of the exercise has not been analysed.	NOK

B.3.2.4. EX2-OBJ-18.02c-TRL6-TVALP-OF21 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #02 Validation Results	Technical Validation Objective Status
EX2-OBJ-18.02c-TRL6-TVALP-OF21	To assess the impact of integrating PTRs (LOA) in the eFPL 4D Trajectory on the total planned fuel.	EX2-CRT-18.02c-TRL6-VALP-OF21-001	Solution 18.02c performs a qualitative assessment on the fuel (planned and extra fuel) for a flight with and without including PTRs (LOA) in the eFPL 4D Trajectory.	The embedding of PTR's into the 4D trajectory demonstrated a small increase of the planned trip fuel ~~(about 1 %).~~ The increase was expected; the exercise provided an evidence about the amount. To be confirmed by AUs that the small increase in operations is acceptable.	PARTIALLY OK

DATA COLLECTION

On the Lido FOC prototype, the flight messages have been retrieved from logs.

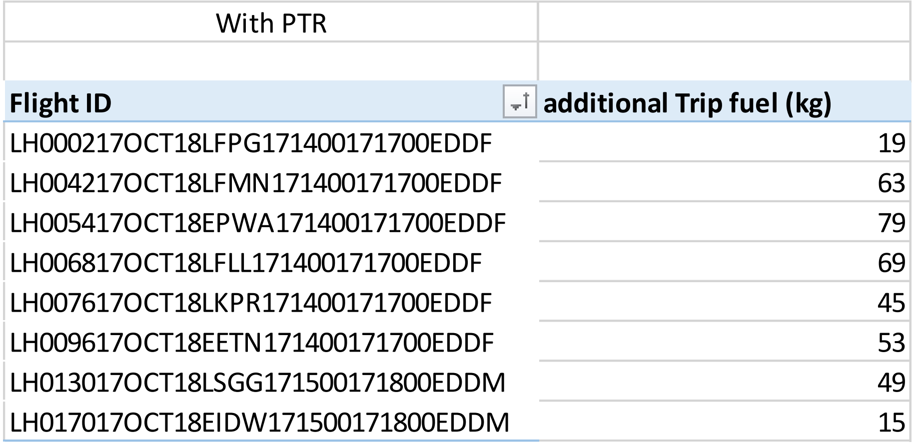
METRICS

- M1 Difference between trip fuel of FOC trajectory considering PTR's and FOC trajectory not considering PTR's

RESULTS FOR EX2-CRT-18.02C-TRL6-VALP-OF21-001

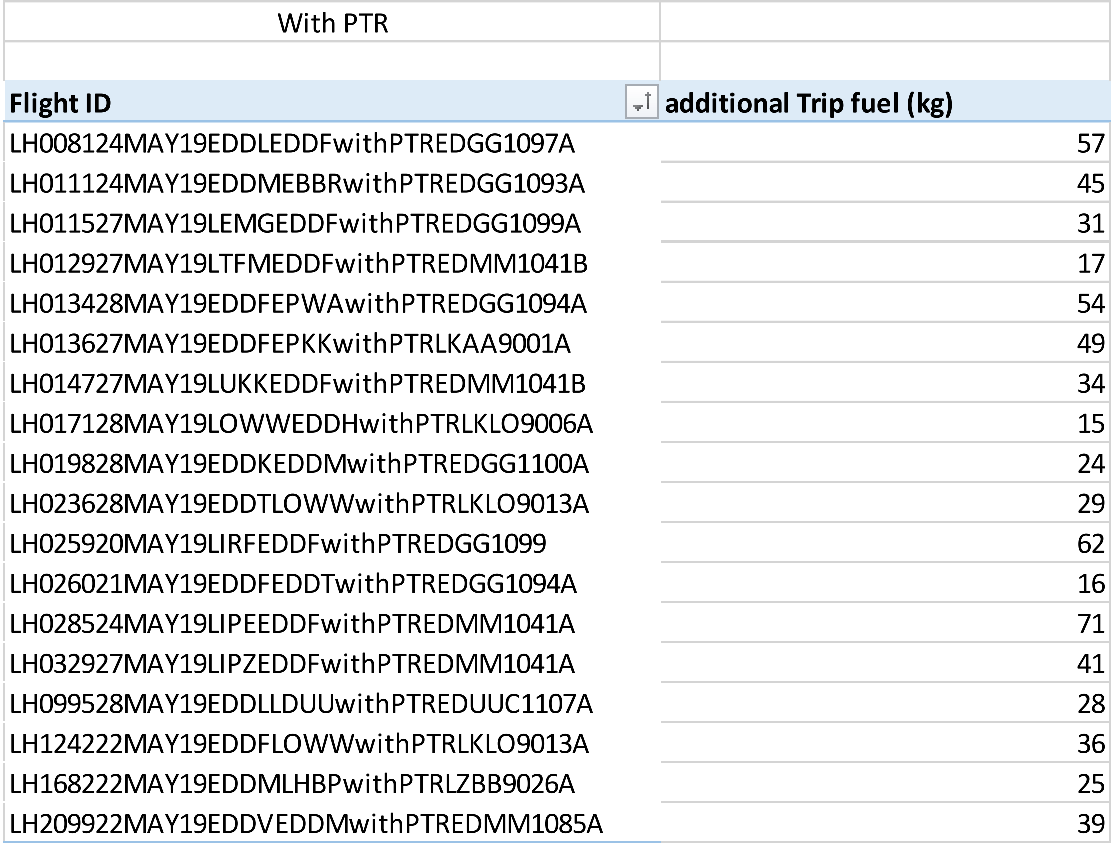
The fuel differences for the trip fuel considering the PTR's in the 4D trajectory in comparison to the 4D trajectory without taking PTR's into account is listed in below table. The Validation exercise gives indications about the additional planned trip fuel when considering PTR's in the profile calculations in comparison to today's flight planning procedure. Today flight planning use contingency fuel to be prepared for ATC inflight instructions based on PTR regulations.

Session 1 – October 2018:



With PTR	
Flight ID	**additional Trip fuel (kg)**
LH000217OCT18LFPG171400171700EDDF	19
LH004217OCT18LFMN171400171700EDDF	63
LH005417OCT18EPWA171400171700EDDF	79
LH006817OCT18LFLL171400171700EDDF	69
LH007617OCT18LKPR171400171700EDDF	45
LH009617OCT18EETN171400171700EDDF	53
LH013017OCT18LSGG171500171800EDDM	49
LH017017OCT18EIDW171500171800EDDM	15

Session 2 – May 2019:



With PTR	
Flight ID	**additional Trip fuel (kg)**
LH008124MAY19EDDLEDDFwithPTREDGG1097A	57
LH011124MAY19EDDMEBBRwithPTREDGG1093A	45
LH011527MAY19LEMGEDDFwithPTREDGG1099A	31
LH012927MAY19LTFMEDDFwithPTREDMM1041B	17
LH013428MAY19EDDFEPWAwithPTREDGG1094A	54
LH013627MAY19EDDFEPKKwithPTRLKAA9001A	49
LH014727MAY19LUKKEDDFwithPTREDMM1041B	34
LH017128MAY19LOWWEDDHwithPTRLKLO9006A	15
LH019828MAY19EDDKEDDMwithPTREDGG1100A	24
LH023628MAY19EDDTLOWWwithPTRLKLO9013A	29
LH025920MAY19LIRFEDDFwithPTREDGG1099	62
LH026021MAY19EDDFEDDTwithPTREDGG1094A	16
LH028524MAY19LIPEEDDFwithPTREDMM1041A	71
LH032927MAY19LIPZEDDFwithPTREDMM1041A	41
LH099528MAY19EDDLLDUUwithPTREDUUC1107A	28
LH124222MAY19EDDFLOWWwithPTRLKLO9013A	36
LH168222MAY19EDDMLHBPwithPTRLZBB9026A	25
LH209922MAY19EDDVEDDMwithPTREDMM1085A	39

The consideration of PTR in the trajectory results in a vertical profile with partially lower altitudes. An aircraft needs more fuel if it is flying on lower altitudes. Moreover, the resulting additional trip fuel needs fuel to carry it. The embedding of PTR's into the 4D trajectory demonstrated a small increase of the planned trip fuel.

If the planned fuel for a trajectory considering PTR's would be compared with the burned fuel for a flight that was planned without considering PTR's but where the PTR's have been applied tactically, then a difference can be identified that represents mostly the fuel to carry.

CONCLUSION

Success criteria EX2-CRT-18.02c-TRL6-VALP-OF21-001:

The embedding of PTR's into the 4D trajectory demonstrated a small increase of the planned trip fuel. The increase was expected; the exercise provided an evidence about the amount.

Unfortunately, a percentage of the additional required fuel in reference to the trip fuel or contingency fuel could not be provided, as those values have been not stored during the validation exercise.

B.3.3 Unexpected Behaviours/Results

No unexpected Behaviours / Results.

B.3.4 Confidence in Results of Validation Exercise 2

B.3.4.1. Level of significance/limitations of Technical Validation Exercise Results

Due to the limited flight plans used for this validation exercise, primary the alignment aspects between the trajectories from FOC system and NM is approved. In reference to the fuel impact there might be further analysis for long haul flights interesting.

B.3.4.2. Quality of Technical Validation Exercises Results

The overall quality results are good, which is documented in part 4.3.1.2.1.

B.3.4.3. Significance of Technical Validation Exercises Results

Refer to part 4.3.1.2.2.

B.3.5 Conclusions

B.3.5.1. Conclusions on technical feasibility

Refer to 5.1.2.

B.3.5.2. Conclusions on performance assessments

N/A

B.3.6 Recommendations

Refer to 5.2.1.

Appendix C Technical Validation Exercise #03 Report

C.1 Summary of the Technical Validation Exercise #03 Plan

The Technical Validation Exercise #03 is related to the third iteration of the PJ18.02c exercise Iteration #3 “Dynamic SID/STAR information in eFPL” and “Target Time Use in eFPL”. It is a joint exercise with PJ9.3.2.

The Technical Validation exercise includes Network Manager, Flight Dispatcher (AU), Flow Manager and Local Traffic Manager. Exercise was held on 17th, 18th and 19th June 2019, Lufthansa Systems Frankfurt.

C.1.1 Technical Validation Exercise #03 description and scope

C.1.1.1. Operational scope

The exercise 18-02c iteration #03 is managed in two phases:

- *Phase 1 “Dynamic SID/STAR information in eFPL” ([NOV-5]), validating partially the OI AUO-0229*:

  NM receives dynamically from main major airports planned runway configurations in use allowing adapting accordingly SID’s and STAR’s (in particular depending on runway direction) allocated to a flight and its trajectory.

  The harmonisation of SID’s & STAR’s planned respectively by NM and the FOC in trajectories needs to be confirmed yet at **TRL 6 maturity** level for the system enablers.

  These points require further studies and **V3 partial** validation:

The impact on the AU Trajectory optimisation.
The impact of safety and fuel: the AU is responsible to create a safe flight plan and to calculate the correct amount of fuel to carry. Each change of SID or STAR must result in activities that maintain the safety and that deal with the required amount of fuel during the FF-ICE planning and FF-ICE filing.
The impact on the NM/ANSPs Trajectory prediction and DCB Traffic prediction: this topic is strongly linked to DCB operations and procedures, therefore the validation activities are developed in close cooperation with solution PJ09.03.

Two activities compose this iteration:

  - **One technical phase**, addressing the SID/STAR updates published via B2B by NM: Lufthansa Systems as involved CFSP can perform the computation of a new flight plan via the eFPL update procedure.
  - **One operational phase**, aiming at validating the real-time provision of SID/STAR updates to CFSP:

    - To validate the alignment and prediction impact to NM/ANSP's trajectories, when airlines consider the latest available information.
    - To assess the impact for the Safety, Fuel Efficiency and the the Flight Dispatcher Workload.

- *Phase 2 "Target Time Use in eFPL (planning phase)" ([NOV-5]), validating partially the OI AUO-0225*:

  The Target Time management concept as developed in SESAR 1 includes the following features:

    - DCB time-based measures (TT) applied at the point of congestion (and no more at departure runway like in current operations with the CTOT).
    - The FOC has the possibility to update the SBT to express his preference on how to meet the TTA and NM should adapt the CTOT in accordance.
    - As the CTOT is issued to ensure the coordination with departure operations, the CTOT takes into account the estimated flight elapsed time from take-off to the point of congestion.

  In that context, the eFPL

    - Includes flight elapsed times as calculated by the FOC;
    - Is an important enabler to align FOC and NM estimated elapsed times;
    - Improves accuracy of the common prediction.

  The harmonisation of the estimated elapsed time (from take-off to the point of congestion) planned respectively by NM and the FOC in trajectories needs to be confirmed yet at **TRL 6 maturity** level for the system enablers.

  An AU can use the eFPL update service in reaction to the publication of a Target Time to express his trajectory preference to meet the target time. This procedure in FF-ICE planning is expected to be beneficial for the alignment of AU and NM planned trajectories (NM traffic prediction), for the AU trajectory optimisation.

  These points require further studies and **V3 partial** validation:

    - The impact on the AU Trajectory optimisation and AU Cost efficiency

  Two activities compose this iteration:

    - **One technical phase**, aiming at validating the TTA update published by NM: Lufthansa Systems as involved CFSP can perform the computation of a new flight plan via the eFPL update procedure.

- **One operational phase**, aiming at validating the real-time provision of TTA updates from ANSP's to AU's:
    - To assess the impact AU Trajectory optimisation, AU Cost efficiency and the Flight Dispatcher Workload.

C.1.1.2. Validation technique and platform

The two phases (refer to C.1.1.1) are run in "Shadow mode" between the NMVP Platform and LSY FOC system, with the following platform layout:

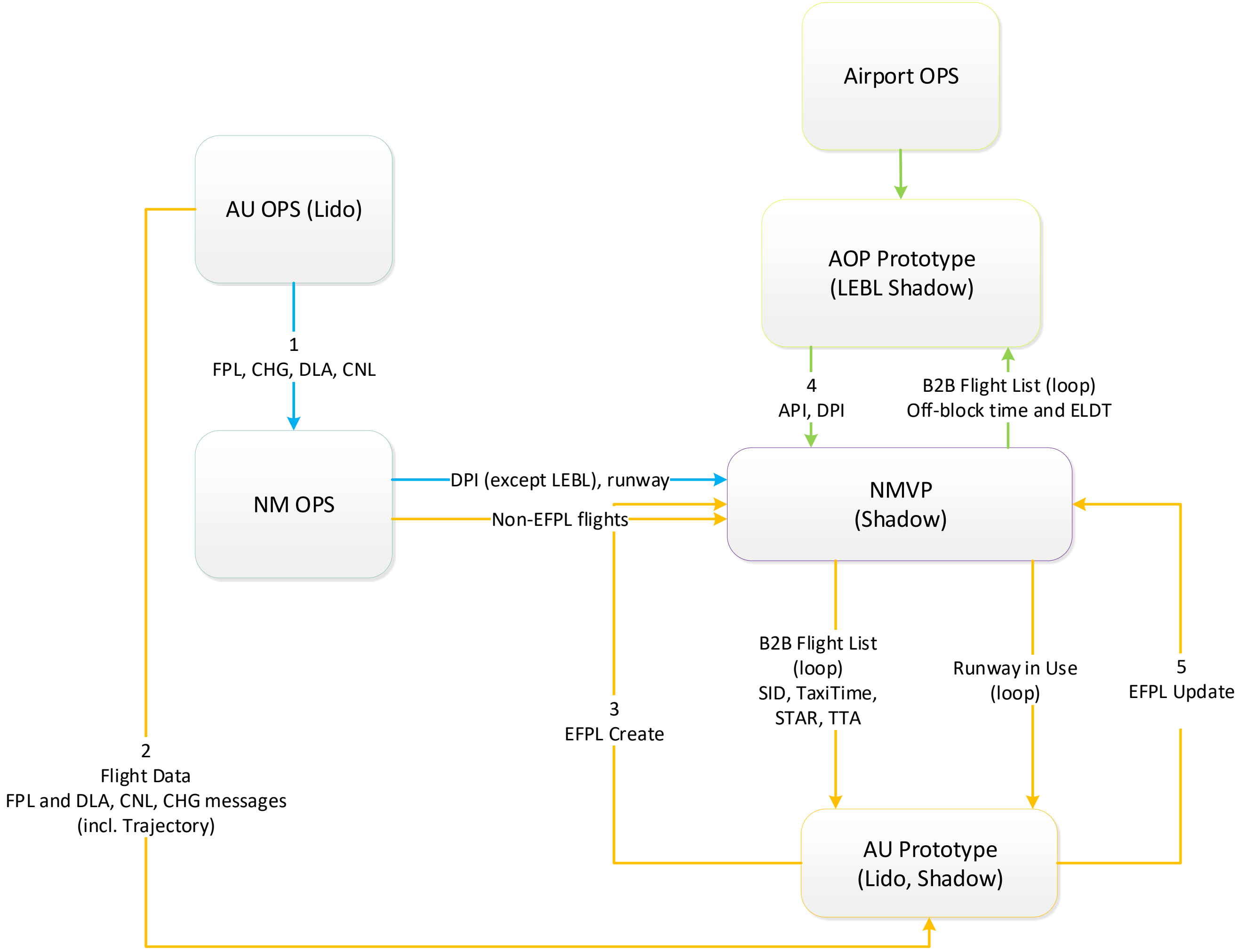


Figure 13: Exercise platform

Conditions of the shadow mode

- The NM OPS system feeds the NMVP with the flight plans of the airlines who do not participate to this exercise. The NMVP shadows the capacity situation of OPS as well.

- The Lido prototype sends the flight plans of the participating airlines as Extended Flight Plans to the NMVP by adding '**OPSLIDO**' text in their Remark field.
- Lido prototype does not send all flight plans to the NMVP. The traffic is as described further in section **C.1.3.2.d**.
- The flight plan messages without the **OPSLIDO** in the Remark field come from the NM OPS system, and they are ICAO flight plans.
- The AOP prototype monitors the flights in the NMVP and allocates SID, Taxi Time, STAR and TTA as required for LEBL.
- The airport restrictions are created on NMVP; they may not exist on OPS.
- The flight dispatchers monitor the flight plans and modify when needed, according to the SID/STAR/TTA/TaxiTime changes.

Barcelona airport (LEBL) provides the SID, TaxiTime, STAR and TTA in shadow mode.

Main actors:

Flight dispatchers for airlines:

- AIR FRANCE:
- EL AL
- TRANSAVIA
- Lufthansa
- VUELING
- AIR EUROPA

Network Manager (regulations, network impact assessment)

Departure Airports: All CDM airports for SID, TaxiTime

Arrival Airports: Barcelona Airport (LEBL) for SID, TaxiTime, STAR and TTA

Validation scenarios:

Dynamic assignment will be considered according to the situation.

Refer to C.1.3 for details on scenarios.

Three sessions have been organised for the Validation Scenarios:

- SID/TaxiTime/STAR Scenario (18/06/2019 10:00 - 12:30):

  To align the AU trajectory with the SID, Runway in Use, TaxiTime and the STAR allocated by the CDM airport.

- TTA Scenario (small delay – 18/06/2019 14:30 – 17:00) & TTA Scenario (big delay – 19/06/2019 09:30 – 12:00):

  To align the AU trajectory with the TTA constraint published by the CDM airport.

Flight Plan Update identification:

In order to facilitate the data analysis after the exercise, we need to identify the reason/purpose of an update sent by the dispatcher. Therefore, the CHG messages (extended flight plan update) need to mention these reasons. There may be several for one update.

The Flight Dispatcher fills in the RMK field with one or more of the following values, when applicable:

- DISPSID
- DISPSTAR
- DISPTTA
- DISPARWY
- DISPDRWY
- DISPTAXI

C.1.1.3. Exercise Planning and management

C.1.1.3.a. Activities and Exercise planning

	Preparatory Activity	Oct 18	Nov. 18	Dec. 18	Jan 19	Feb. 19	Mar 19	Apr 19	May 19	Jun 19	July 19	Aug 19	Sept 19
TVALP	**1.1 – Validation Objectives Definition**	🟩											
Exercise Plan	**2.1 – Validation Scenarios Definition**							🟩	🟩				
	2.2 – LSY Systems Development	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩			
	2.3– Integration & testing								🟩	🟩			
	2.4 – Validation Platform preparation								🟩	🟩			
	2.5 – Metrics Definition, Data collection specification							🟩	🟩				
	2.6 – Exercise Organisation							🟩	🟩	🟩			

Exercise Execution	3.1 Exercise days 18,19 June 2019									🟩			
	3.2 Output savings									🟩			
Post analysis	4.1 Tools for KPI data extraction, data analysis										🟩	🟩	
	4.2 Result analysis										🟩	🟩	
TVALR	5.1 TVALR writing										🟩	🟩	🟩
	5.2 TVALR review												🟩

Table 18: Detailed time planning - EXE-18.02c-TRL6-TVALP-002 – Preparatory activities

C.1.1.3.b. Roles & Responsibilities in the exercise

Activities		Tasks	Effort (Leader/Contributor/Reviewer)			
			LSY	ECTRL DNM	ECTRL NET	AUs
TVALP	**1.1 Validation Objectives Definition**	▫ Define validation Objectives. ▫ Develop corresponding section in TVALP.	Contribute	Contribute	Lead	Contribute
Preparatory	**2.1 Validation Scenarios Definition**	▫ Develop validation scenarios. ▫ Develop corresponding section in TVALP.	Contribute	Contribute	Lead	
	2.2 Systems Development	▫ Develop prototypes (CFSPs).	Lead for FOC Syst.			
	2.3 Integration & testing	▫ Smoke test ▫ Dry Run.	Contribute	Contribute	Lead	
	2.4 Validation Platform preparation	▫ Define Validation Platform needs. ▫ Install and configure NMVP Platform (including Environment Data …). ▫ CFSPs Platform Configuration. ▫ B2B Connection.	Lead for FOC Syst. Contribute	Lead for NM Systems Contribute	Lead	
	2.5 – Metrics Definition, Data collection specification	▫ Define all metrics/indicators/questionnaires and how they can be obtained in order to guarantee that they can be measured. ▫ Data collection specification	Contribute	Contribute	Lead	
	2.6 – Exercise Organisation	▫ Organise AU Flight Dispatcher planning ▫ Organise exercise at LSY premises.	Lead		Contribute	
Exercise Execution	**3.1 – Exercise Execution**	▫ Run NMVP in Shadow mode ▫ Run the LIDO prototype	Lead for FOC Syst. Contribute	Lead for NM Systems Contribute	Lead	

ACTIVITIES		TASKS	EFFORT (LEADER/CONTRIBUTOR/REVIEWER)			
			LSY	ECTRL DNM	ECTRL NET	AUs
	3.2 – Output saving	▫ Save and consolidate all the exercise outputs needed for result analysis.	Lead for FOC prototype data Contribute	Lead for NM Systems data Contribute	Lead	
Post analysis	**4.1 Tools for KPI data extraction, data analysis**	▫ Tools for post analysis	Contribute Lead for FOC prototype data		Lead Lead for NM Systems data	
	4.2 - Result analysis		Contribute	Contribute	Lead	Contribute
Post-Exercise	**5.1 TVALR writing**	▫ Write Validation Report Document.	Contribute	Contribute	Lead	
	5.2 TVALR review		Review	Review	Lead	Review

Table 19: Roles & Responsibilities in the exercise

0

C.1.2 Summary of Exercise #03 Technical Validation Objectives and success criteria

The Technical Validation Objectives of the Solution have been apportioned into three iterations and validated only by one iteration. The table below gives the list of the Exercise Validation Objective validated by the Exercise #03, each Exercise Validation Objective having the same description than the Solution Validation Objective (available in 3.2.2.3 and 3.2.2.4). The Exercise Success criteria have in the same way the same description of the Solution Success criteria (available in 3.2.2.3 and 3.2.2.4).

SESAR Solution Validation Objective	SESAR Solution Success criteria	Coverage and comments on the coverage of SESAR Solution Validation Objective in Exercise #03	Exercise Validation Objective	Exercise Success criteria
OBJ-18.02c-TRL6-TVALP-TF3	CRT-18.02c-TRL6-TVALP-TF3-001	FULLY COVERED	EX3-OBJ-18.02c-TRL6-TVALP-TF3 Same description as OBJ-18.02c-TRL6-TVALP-TF3	EX3-CRT-18.02c-TRL6-TVALP-TF3-001 Same description as CRT-18.02c-TRL6-TVALP-TF3-001
OBJ-18.02c-TRL6-TVALP-TF4	CRT-18.02c-TRL6-TVALP-TF4-001	FULLY COVERED	EX3-OBJ-18.02c-TRL6-TVALP-TF4 Same description as OBJ-18.02c-TRL6-TVALP-TF4	EX3-CRT-18.02c-TRL6-TVALP-TF4-001 Same description as CRT-18.02c-TRL6-TVALP-TF4-001
OBJ-18.02c-TRL6-TVALP-TF5	CRT-18.02c-TRL6-TVALP-TF5-001	FULLY COVERED	EX3-OBJ-18.02c-TRL6-TVALP-TF5 Same description as OBJ-18.02c-TRL6-TVALP-TF5	EX3-CRT-18.02c-TRL6-TVALP-TF5-001 Same description as CRT-18.02c-TRL6-TVALP-TF5-001
OBJ-18.02c-TRL6-TVALP-OF10	CRT-18.02c-TRL6-VALP-OF10-001	FULLY COVERED	EX3-OBJ-18.02c-TRL6-TVALP-OF10 Same description as OBJ-18.02c-TRL6-TVALP-OF10	EX3-CRT-18.02c-TRL6-VALP-OF10-001 Same description as CRT-18.02c-TRL6-VALP-OF10-001
OBJ-18.02c-TRL6-TVALP-OF10	CRT-18.02c-TRL6-VALP-OF10-002	FULLY COVERED	EX3-OBJ-18.02c-TRL6-TVALP-OF10	EX3-CRT-18.02c-TRL6-VALP-OF10-002

SESAR Solution Validation Objective	SESAR Solution Success criteria	Coverage and comments on the coverage of SESAR Solution Validation Objective in Exercise #03	Exercise Validation Objective	Exercise Success criteria
			Same description as OBJ-18.02c-TRL6-TVALP-OF10	Same description as CRT-18.02c-TRL6-VALP-OF10-002
OBJ-18.02c-TRL6-TVALP-OF22	CRT-18.02c-TRL6-VALP-OF22-001	FULLY COVERED	EX3-OBJ-18.02c-TRL6-TVALP-OF22 Same description as OBJ-18.02c-TRL6-TVALP-OF22	EX3-CRT-18.02c-TRL6-VALP-OF22-001 Same description as CRT-18.02c-TRL6-VALP-OF22-001
OBJ-18.02c-TRL6-TVALP-OF22	CRT-18.02c-TRL6-VALP-OF22-002	FULLY COVERED	EX3-OBJ-18.02c-TRL6-TVALP-OF22 Same description as OBJ-18.02c-TRL6-TVALP-OF22	EX3-CRT-18.02c-TRL6-VALP-OF22-002 Same description as CRT-18.02c-TRL6-VALP-OF22-002
OBJ-18.02c-TRL6-TVALP-OF11	CRT-18.02c-TRL6-VALP-OF11-001	FULLY COVERED	EX3-OBJ-18.02c-TRL6-TVALP-OF11 Same description as OBJ-18.02c-TRL6-TVALP-OF11	EX3-CRT-18.02c-TRL6-VALP-OF11-001 Same description as CRT-18.02c-TRL6-VALP-OF11-001

For each Exercise Success criteria, the metrics have been described inside part C.3.2 for each Exercise Validation results.

C.1.3 Summary of Technical Validation Exercise #03 Validation scenarios

C.1.3.1. Reference Scenarios

C.1.3.1.a. Description

The Reference scenario corresponds to EFPL trajectories submitted to NMVP systems without any consideration of the SID/STAR/TTA updates by the Flight dispatcher:

- Via B2B services, the FOC system of Lufthansa System submits to NMVP EFPL trajectories without any SID/STAR/TTA information updates.

- NMVP ETFMS recomputes the 4D trajectory (sector and point profiles) and if they exist any SID/STAR/TTA information. The update information is provided to the Flight dispatcher via the AU flight list for trajectory update as decided by the flight dispatcher.

C.1.3.1.b. Phase 1: Reference dataset for Trajectory Alignment

The Reference dataset corresponds to AU EFPL trajectories submitted to NMVP systems ***before*** any consideration of the SID/STAR/TTA updates:

- The flights that will have a trajectory update done by the Flight Dispatcher during the Solution scenario to include the SID/STAR/TTA information are part of the Reference dataset.

The Reference traffic sample is based on a flight list arriving and departing from several major hubs in Europe as listed in C.1.3.2.d and having one or more flight plan updates from the AU flight dispatcher due to SID/STAR/TTA/Runway updates (Solution scenario). The use of operational flights is compulsory (Shadow mode).

The Reference metrics for Trajectory Alignment are deviations of Estimated Elapsed Time (EET), Flight levels (FL), Sector Entry Times and Fuel between:

- The last AU EFPL 4D trajectory ***before*** the Flight dispatcher update (Solution dataset) due to the use of SID/STAR/TTA information in the FOC system.
- The 4D trajectory computed by ETFMS using those SID/STAR/TTA updates.

For one given flight, the metrics are computed as many times the flight is updated by the Flight dispatcher due to SID/STAR/TTA updates.

C.1.3.1.c. Phase 2: Reference dataset for NM Traffic Predictability

The Reference dataset for the Predictability phase does not correspond to the current operations: usually the Predictability studies are based on the operational flight data (“actual flown trajectories” versus “planned trajectories”, all computed by ETFMS), but NM OPS system does not currently receive STAR updates nor TTA data.

Furthermore, those operational flights are currently received in ICAO format on NM OPS system. If we would have considered the NM OPS data as the Reference dataset, and if, on NMVP running in shadow mode, we run the Exercise Scenario with trajectories computed with PTRs in EFPL format, we would have measured the improvements not only due to the PTRs integrated in the FOC trajectories, but the improvements due to the EFPL format as well.

Thereby the Reference dataset has to be adapted for the needs of the Validation Objectives:

- The 4D trajectory computed by NMVP ETFMS based on the last CDM Planning Information (PI) replaces the “actual flown trajectory”. For this exercise, the last CDM PI could be:

A-DPI (ATC DPI): the purpose of the A-DPI is to inform ETFMS that the flight has off-blocked, i.e. the flight is "under ATC control" and taxiing to take-off. The A-DPI message shall supply a reliable estimate of the Take-Off Time, in the TTOT-field from AOBT as well as the SID allocated by ATC to the flight. NMVP ETFMS will use the TTOT to update/create the Actual Flight Model (CTFM), including any STAR/TTA information already received by another message.
API (Arrival Planning Information) from the AOP to update the STAR procedure.

- The "planned trajectory" is the 4D trajectory computed by ETFMS based on the AU EFPL trajectory sent ***without*** SID/STAR/TTA updates.

C.1.3.2. Solution Scenarios

C.1.3.2.a. Description

SID/TaxiTime/STAR Scenario

OBJECTIVE

The objective of this scenario is to align the AU trajectory with the runway, SID, TaxiTime and the STAR available in AOP/NOP and improve the network predictability.

SCENARIO

Actors	Activities

Airlines	▪ Monitor the incoming messages regarding the flights receiving SID, TaxiTime and/or STAR, and Runway
	  ▪ The dispatcher sees in the Lido/SESAR prototype environment only those one, which are considered for the exercise. He has only to observe, for which flight an information pop up in case of SID/TaxiTime/STAR/Runway affects a flight.
	▪ If the flight plan needs to be changed, then
	  ▪ Update the flight trajectory in order to comply with the published runway configuration within/derived from the SID, and/or TaxiTime and/or STAR
	  ▪ Update the RMK field of the flight plan with one of the values **DISPSID, DISPSTAR, DISPARWY, DISPDRWY, DISPTAXI**
	  ▪ Use the change (CHG) functionality within Lido, not the file option.
	▪ If not then record the flight data and the reason when there is a change published and the decision is *not* to update

Actors	Activities
Airport **Barcelona** **All CDM Airports**	▪ AOP prototype: Automatically plan SID, TaxiTime and STAR to the flights arriving/departing to LEBL, starting about 3 hours prior to EOBT, Send runway in use ▪ Other CDM airports: automatically plan SID, TaxiTime for the flight departing (operational system), ▪ Some airports (CDM or non CDM) send runway in use information
Network Manager	▪ Make AOP/NOP information available to AUs

TTA Scenario (Small Delay/Big Delay)

OBJECTIVE

The objective of this scenario is to align the AU trajectory with the TTA constraint published by the CDM airport, and improve the network predictability.

SCENARIO

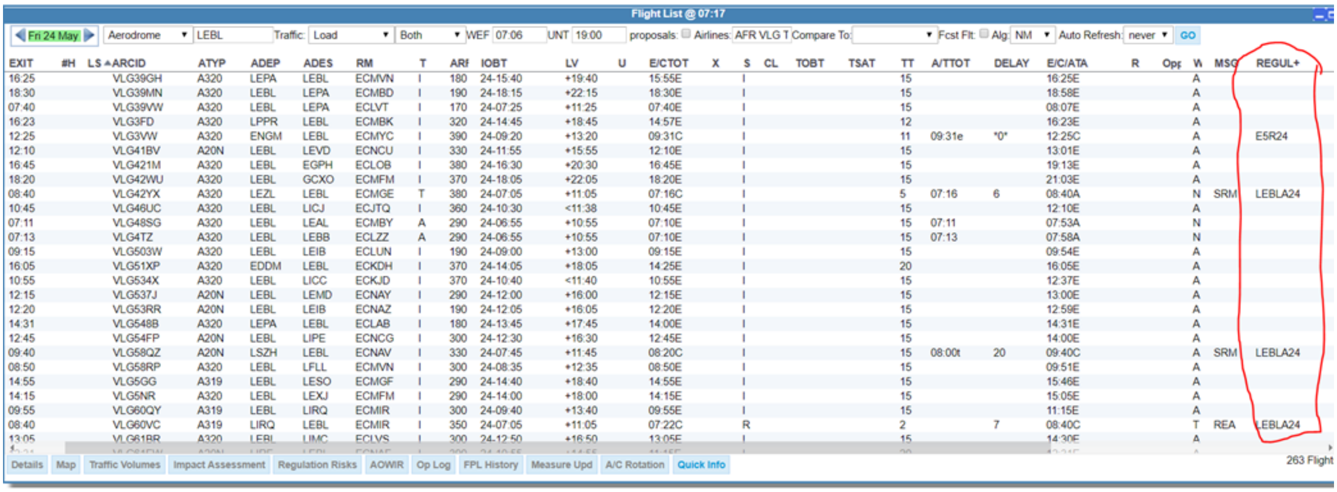
Actors	Activities

Airlines	▪ Monitor the incoming messages regarding the flights arriving to LEBL and receiving TTA, where the most penalising regulation is LEBLxxxx
	▪ The dispatcher sees in the Lido/SESAR prototype environment only those one, which are considered for the exercise. He has only to observe, for which flight an information pop up in case of TTA affects a flight. Dispatcher is also informed about the case of change requirements (SID, TaxiTime, STAR and TTA).
	▪ If the flight plan needs to be changed, then
	    ▪ Update the flight trajectory in order to comply with the published TTA, and SID/TaxiTime/STAR (when applicable) as well
	    ▪ Update the RMK field of the flight plan with **DISPTT**
	    ▪ Use the change (CHG) functionality within Lido, not the file option.
	    ▪ When the ACK is received
	        ○ If the MP regulation remains the same, the result is considered acceptable from the network perspective.
	        ○ If the MP regulation has changed, the updated flight plan becomes not acceptable from the network perspective, as the

Actors	Activities
	impact is too high. Therefore, this flight does not appear in monitoring anymore. ▪ If not, then record the flight data and the reason when there is a TTA published and the decision is *not* to update
Airport **Barcelona**	▪ Decide on the LEBLxxxx regulation. The capacity value will depend on the traffic we have on the exercise run day and we still decide on the spot. ▪ AOP: Automatically allocate SID, TaxiTime, TTA and/or STAR to the flights impacted arriving to LEBL, Send runway in use
Network Manager **Francoise** **Stella**	▪ Create regulation LEBLxxxx, which generates a small or big delay

NETWORK IMPACT ASSESSMENT (FOR TTA SCENARIO)

- Performed by Network Manager Role.
- Use the EUROCONTROL PLANTA tool (https://www.nmvp.nm.eurocontrol.int/pj24b)
- The Flight dispatcher queries the flights with the following criteria:
    - Aerodrome: LEBL
    - Airlines: AFR DLH TRA TVF ELY VLG AEA (according to the role)
- Following a flight plan update, the network manager checks if the REGUL+ field, if it changes to another value than the 'LEBLxxxx' regulation. If so then it means that the network impact of this flight plan change is unacceptable.



EXIT	#H	LS	▲ARCID	ATYP	ADEP	ADES	RM	T	ARI	IOBT	LV	U	E/CTOT	X	S	CL	TOBT	TSAT	TT	A/TTOT	DELAY	E/C/ATA	R	Opp	W	MSG	REGUL+
16:25			VLG39GH	A320	LEPA	LEBL	ECMVN	I	180	24-15:40	+19:40		15:55E		I				15			16:25E			A		
18:30			VLG39MN	A320	LEBL	LEPA	ECMBD	I	190	24-18:15	+22:15		18:30E		I				15			18:58E			A		
07:40			VLG39VW	A320	LEBL	LEPA	ECLVT	I	170	24-07:25	+11:25		07:40E		I				15			08:07E			A		
16:23			VLG3FD	A320	LPPR	LEBL	ECMBK	I	320	24-14:45	+18:45		14:57E		I				12			16:23E			A		
12:25			VLG3VW	A320	ENGM	LEBL	ECMYC	I	390	24-09:20	+13:20		09:31C		I				11	09:31e	"0"	12:25C			A		E5R24
12:10			VLG41BV	A20N	LEBL	LEVD	ECNCU	I	330	24-11:55	+15:55		12:10E		I				15			13:01E			A		
16:45			VLG421M	A320	LEBL	EGPH	ECLOB	I	380	24-16:30	+20:30		16:45E		I				15			19:13E			A		
18:20			VLG42WU	A320	LEBL	GCXO	ECMFM	I	370	24-18:05	+22:05		18:20E		I				15			21:03E			A		
08:40			VLG42YX	A320	LEZL	LEBL	ECMGE	T	380	24-07:05	+11:05		07:16C		I				5	07:16	6	08:40A			N	SRM	LEBLA24
10:45			VLG46UC	A320	LEBL	LICJ	ECJTQ	I	360	24-10:30	<11:38		10:45E		I				15			12:10E			A		
07:11			VLG48SG	A320	LEBL	LEAL	ECMBY	A	290	24-06:55	+10:55		07:10E		I				15	07:11		07:53A			N		
07:13			VLG4TZ	A320	LEBL	LEBB	ECLZZ	A	290	24-06:55	+10:55		07:10E		I				15	07:13		07:58A			N		
09:15			VLG503W	A320	LEBL	LEIB	ECLUN	I	190	24-09:00	+13:00		09:15E		I				15			09:54E			A		
16:05			VLG51XP	A320	EDDM	LEBL	ECKDH	I	370	24-14:05	+18:05		14:25E		I				20			16:05E			A		
10:55			VLG534X	A320	LEBL	LICC	ECKJD	I	370	24-10:40	<11:40		10:55E		I				15			12:37E			A		
12:15			VLG537J	A20N	LEBL	LEMD	ECNAY	I	290	24-12:00	+16:00		12:15E		I				15			13:00E			A		
12:20			VLG53RR	A20N	LEBL	LEIB	ECNAZ	I	190	24-12:05	+16:05		12:20E		I				15			12:59E			A		
14:31			VLG548B	A320	LEPA	LEBL	ECLAB	I	180	24-13:45	+17:45		14:00E		I				15			14:31E			A		
12:45			VLG54FP	A20N	LEBL	LIPE	ECNCG	I	300	24-12:30	+16:30		12:45E		I				15			14:00E			A		
09:40			VLG58QZ	A20N	LSZH	LEBL	ECNAV	I	330	24-07:45	+11:45		08:20C		I				15	08:00t	20	09:40C			A	SRM	LEBLA24
08:50			VLG58RP	A320	LEBL	LFLL	ECMVN	I	300	24-08:35	+12:35		08:50E		I				15			09:51E			A		
14:55			VLG5GG	A319	LEBL	LESO	ECMGF	I	290	24-14:40	+18:40		14:55E		I				15			15:46E			A		
14:15			VLG5NR	A320	LEBL	LEXJ	ECMFM	I	290	24-14:00	+18:00		14:15E		I				15			15:05E			A		
09:55			VLG60QY	A319	LEBL	LIRQ	ECMIR	I	300	24-09:40	+13:40		09:55E		I				15			11:15E			A		
08:40			VLG60VC	A319	LIRQ	LEBL	ECMIR	I	350	24-07:05	+11:05		07:22C		R				2		7	08:40C			T	REA	LEBLA24
13:05			VLG61BR	A320	LEBL	LIMC	ECLVS	I	300	24-12:50	+16:50		13:05E		I				15			14:30E			A		

TTA SCENARIO SPECIFIC

According to exercise setup, the following changes can be applied alone or together for a flight plan in order to comply with a TTA, according to the AU business:

- Shift the departure time (ETD)
- Adapt the cost index (CI) with the objective of giving a different duration to the trajectory
- Choose a different trajectory
- Do nothing, accept the CTOT

API (ARRIVAL PLANNING INFORMATION) REGULATION CHARACTERISTICS

Steps:

1) Lower the capacity of TV LEBLARR to create an overload situation

e.g. Period from 0700 to 0900 UTC capacity= 15 mov/h

2) Create an arrival regulation (cherry picked) in TV LEBLARR to which AOP will send the API TargetTakeOff

e.g.

Regulation name: LEBLA06V (LEBLA+dd+V or W or Y or Z)
TfV name: LEBLARR
Applicability: 0700 to 0930 UTC
constraintPeriod: 0700 to 0900 UTC
Rate: 45 mov/h (3 times more than capacity rate , so AOP will use 45/3)

C.1.3.2.b. Phase 1: Scenario dataset for Trajectory Alignment

The Scenario dataset corresponds to AU EFPL trajectories submitted to NMVP systems ***with*** any consideration of the SID/STAR/TTA updates:

- The flights have a trajectory update done by the Flight Dispatcher during the Solution scenario to include the SID/STAR/TTA information are part of the Scenario dataset.

The Scenario traffic sample is based on a flight list arriving and departing from several major hubs in Europe as listed in C.1.3.2.d and having one or more flight plan updates from the AU flight dispatcher due to SID/STAR/TTA/Runway updates (Solution scenario). The use of operational flights is compulsory (Shadow mode).

The Solution metrics for Trajectory Alignment are deviations of Estimated Elapsed Time (EET), Flight levels (FL), Sector Entry Times and Fuel between:

- The AU EFPL 4D trajectory ***including*** Flight dispatcher update (Solution dataset) due to the use of SID/STAR/TTA information in the FOC system (RMK field – see C.1.3.1.a).
- The 4D trajectory computed by ETFMS using those AU EFPL 4D trajectory update.

For one given flight, the metrics are computed as many times the flight is updated by the Flight dispatcher due to SID/STAR/TTA updates.

C.1.3.2.c. Phase 2: Scenario dataset for NM Traffic Predictability

As for the Reference dataset for Phase 2 (C.1.3.1.c), the Scenario dataset has to be adapted for the needs of the Validation Objectives:

- The 4D trajectory computed by NMVP ETFMS based on the last CDM Planning Information (PI) replaces the "actual flown trajectory". For this exercise, the last CDM PI could be:

A-DPI (ATC DPI): the purpose of the A-DPI is to inform ETFMS that the flight has off-blocked, i.e. the flight is "under ATC control" and taxiing to take-off. The A-DPI message shall supply a reliable estimate of the Take-Off Time, in the TTOT-field from AOBT. NMVP ETFMS will use the TTOT to update/create the Actual Flight Model (CTFM), including any SID/STAR/TTA information received.
API (Arrival Planning Information) from the AOP to update the STAR procedure.

- The "planned trajectory" is the 4D trajectory computed by ETFMS based on the AU EFPL trajectory sent ***with*** SID/STAR/TTA updates (CHG message).

C.1.3.2.d. Traffic

The Lido prototype provides the EFPLs and related messages for the airlines and city pairs as in the following table:

Lufthansa		Transavia		El Al		Vueling		Air Europa		Air France	
EDDF	LEMD	EHAM	LEBL	LLBG	LEMD	LEBL	LEMD	LEBL	LEMD	LFPG	LEBL
EDDF	LEBL	EHAM	LEPA	LLBG	LEBL	LEBL	LEPA	LEBL	LEPA	LFML	LEBL
EDDF	LIRF	EHEH	LEBL	LLBG	EBBR	LEBL	LFPG			LFBD	LEBL
EDDF	EBBR	EHRD	LEBL	LLBG	EDDF	LEBL	EHAM			LFBO	LEBL
EDDF	LIMC	LFPG	LEBL	LLBG	EDDM	LEBL	EBBR			LFPG	LEMD
EDDF	LSZH	LFPO	LEBL			LEBL	EDDM			LFPG	LEBB
EDDF	LFPG	EHAM	EFHK			LEBL	EGKK			LFPG	EDDF
EDDF	EHAM	EHAM	LFPO			LEBL	EGPH			LFPG	EBBR
EDDM	LEMD	EHAM	LEAL			LEBL	LEAL			LFPG	EGLL
EDDM	LEBL	EHAM	LEPA			LEBL	LEBB			LFPG	EHAM

EDDM	LIRF	EHAM	LFMN			LEBL	LEIB			LFPG	EDDM
EDDM	LFPG					LEBL	LEMG			LFPG	LSZH
						LEBL	LEMH				
						LEBL	LEZL				
						LEBL	LFPO				
						LEBL	LIMC				
						LEBL	LIRF				
						LEBL	LPPT				
						LEBL	EFHK				
						LEBL	ESSA				
						LEBL	LGAV				
						LEBL	LHBP				

C.1.4 Summary Technical Validation Exercise #03 Assumptions

Refer to 3.2.3.3

C.2 Deviation from the planned activities

The Technical Validation Plan ([22]) delivered in due time does not include the part 5 ("Technical Validation Exercises") for this exercise #3 as we didn't know if the iteration #03 could performed due to delays in development and testing of the FOC prototype. As soon as the level of confidence with the tool has been reached, an Exercise Plan has been developed internally. The deviations below are based on it.

Below are listed the deviations with the impact for the data analysis of the exercise. The deviation for the preparation and execution of the exercise are listed in 3.3.2.3.

No.	Deviation	Mitigating actions	Expected consequences for Exercise Results
1	The FOC prototype has experienced delay in doing the planned developments and testing. Exercise #03 has been postponed from February 2019 to June 2019.	New planning for AU Dispatcher Availability.	N/A
2	Due to timely constraints during the development phase, the level of	More manual manipulation on Flight Dispatcher tasks.	Less than expected SID/STAR/Taxitime/TTA updates could be analysed and managed

No.	Deviation	Mitigating actions	Expected consequences for Exercise Results
	automation for the AU FOC prototype has been limited.		by the Flight Dispatcher (time-out). The improvement on the Predictability could be less significant (Results for Validation Objectives C.3.2.5, C.3.2.6) Higher than expected Flight Dispatcher workload.
3	In addition to the SID/Departure Runway updates available for the Flight Dispatcher, the *departure taxi time* updates from DPI messages have been made available to update the AU trajectory.	N/A	The impact of the departure taxi time update will be taken into account in the metrics to validate the Alignment due to SID updates (C.3.2.4). Expected results: Improvement of the Alignment for the AU trajectory with NM systems. Improvement of the Predictability.
4	The CDM Airport Data SID updates ETFMS filed demand (update of SID and/or runway in use). After a SID update, if the AU flight plan needs to be changed, then the Flight Dispatcher updates the flight trajectory in order to comply with the published runway configuration and derives the SID. The Flight Dispatcher may propose either the same SID as ETFMS (as initially plan in the TVALP), either his preferred SID compliant with the planned runway in the NOP. Same proposition for STAR procedure.	N/A	Current success criteria and metrics for the Alignment (C.3.2.4), as well as for the Predictability (C.3.2.5, C.3.2.6) remain unchanged. Impact on the Scenario Dataset: Only the AU trajectory and NM Systems trajectory that are aligned for the SID/STAR Procedures.
5	As explained for the Exercise Scenario (refer to C.1.3.2.c) for DCB Traffic Predictability, the usual “Flown	Use the NM Systems trajectory computed from the last Procedure Information available for the flight in ETFMS, that could be either:	In C.3.2.5, C.3.2.6, we measure the DCB Traffic Predictability of the NM / ATC trajectories planned with AU trajectory updates, versus the last NM trajectory computed

No.	Deviation	Mitigating actions	Expected consequences for Exercise Results
	trajectory" cannot be used for the metrics.	Last Departure Procedure Information from the Airport CDM process (mainly A-DPI, T-DPI-s). Last Arrival Procedure Information available in the AOP/NOP from A-CDM airports (API from LEBL in the exercise).	with Procedure Information for off-block. It is considered as the First Flown Trajectory available in the NM systems. The DCB Traffic Predictability is not compared to the last Flown Trajectory.
6	NMVP continuously received updates from OPS, including CHG done by the airline, that could impact what the AU Flight Dispatcher has done during the exercise.	To mitigate the impact on our validation objectives • Mitigation for the Impact on DCB Traffic Predictability for SID/STAR updates: we use ETFMS trajectory before (Reference dataset, computed without the update) and after (Scenario Dataset, computed with the update) the last update done by the Flight Dispatcher (SID/STAR/TTA updates). This trajectory is compared the to the ETFMS trajectory computed with the last DPI (see above). If an OPS CHG message arrives on NMVP after the last update from the AU, the flight is removed from the Scenario Dataset. • Mitigation for the Impact on Alignment for SID/STAR updates: no mitigation required. The analysis is done with trajectories computed with the Flight Dispatcher updates of the exercise.	Reduced Exercise dataset for the Validation objectives relative DCB Traffic Predictability (C.3.2.5, C.3.2.6). No impact for the Validation Objective relative to Alignment (C.3.2.4).

No.	Deviation	Mitigating actions	Expected consequences for Exercise Results
7	No pilots will attend the validation exercise.	N/A	The validation objective EX3- OBJ-18.02c-TRL6-TVALP-OF14 is not assessable.
8	Only LEBL Airport uses the AOP prototype and sends STAR updates and runway in use. During the exercise, Flight Dispatcher made flight plan updates (tagged “STAR update” or “Arrival Runway Update”) on arrival airports different from LEBL.		The validation objective EX3-OBJ-18.02c-TRL6-TVALP-OF22 (refer to C.3.2.6) assesses the NM Traffic Predictability due to STAR/Runway update. The results are considered as less reliable operationally (not coming from AOP updates), but technically reliable (coming from the monitoring of ETFMS flight lists). It extends the exercise dataset.

C.3 Technical Validation Exercise #03 Validation Results

C.3.1 Summary of Technical Validation Exercise #03 Results

Technical Validation Exercise #03 Validation Objective ID	Technical Validation Exercise #03 Validation Objective Title	Technical Validation Exercise #03 Success Criterion ID	Technical Validation Exercise #03 Success Criterion	Technical Validation Exercise #03 Results	Technical Validation Exercise #03 Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-TF3	Integration of the Runway Configuration in FOC System	EX3-CRT-18.02c-TRL6-TVALP-TF3-001	Solution 18.02c provides evidence of the integration of Runway Configuration by FOC System in the eFPL.	The integration of the available B2B services for the Runway Configuration into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.	OK
EX3-OBJ-18.02c-TRL6-TVALP-TF4	Integration of the SID in FOC System	EX3-CRT-18.02c-TRL6-TVALP-TF4-001	Solution 18.02c provides evidence of the integration of SID by FOC System in the eFPL.	The integration of the available B2B services for assigned SID information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.	
EX3-OBJ-18.02c-TRL6-TVALP-TF5	Integration of the STAR in FOC System	EX3-CRT-18.02c-TRL6-TVALP-TF5-001	Solution 18.02c provides evidence of the integration of STAR by FOC System in the eFPL.	The integration of the available B2B services for assigned STAR information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.	

Technical Validation Exercise #03 Validation Objective ID	**Technical Validation Exercise #03 Validation Objective Title**	**Technical Validation Exercise #03 Success Criterion ID**	**Technical Validation Exercise #03 Success Criterion**	**Technical Validation Exercise #03 Results**	**Technical Validation Exercise #03 Validation Objective Status**
EX3-OBJ-18.02c-TRL6-TVALP-OF11	Impact of the SID/STAR on the AU Trajectory Alignment	EX3-CRT-18.02c-TRL6-VALP-OF11-001	Solution 18.02c provides evidence that the integration of the dynamic SID/STAR on the eFPL reduces the difference in 4 dimensions: the AU EFPL 4D planned trajectory computed with dynamic SID/STAR is closer to the NM planned trajectory (ETFMS) than the AU EFPL 4D planned trajectory computed without dynamic SID/STAR.	The integration of the dynamic SID/STAR on the eFPL demonstrated a significant improvement on the AU Trajectory Alignment with NM systems in three dimensions as well as the time dimension.	PARTIALLY OK (Low representativeness)
EX3-OBJ-18.02c-TRL6-TVALP-OF10	Impact of the SID on the NM Traffic Predictability	EX3-CRT-18.02c-TRL6-VALP-OF10-001	Solution 18.02c provides evidence that the integration of the dynamic SID on the eFPL reduces the difference in 4 dimensions: the NM / ATC trajectory planned with dynamic SID included in eFPL trajectory is closer to the flown trajectory than the NM / ATC trajectory planned without dynamic SID.	The integration of the dynamic SID on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension	PARTIALLY OK (Low representativeness)

Technical Validation Exercise #03 Validation Objective ID	Technical Validation Exercise #03 Validation Objective Title	Technical Validation Exercise #03 Success Criterion ID	Technical Validation Exercise #03 Success Criterion	Technical Validation Exercise #03 Results	Technical Validation Exercise #03 Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF10	Impact of the SID on the NM Traffic Predictability	EX3-CRT-18.02c-TRL6-VALP-OF10-002	Solution 18.02c provides evidence that the Integration of the updated SID within the operational flight plan improves the predictability of the estimated landing time ELDT hence the airport planning is improved	The integration of the dynamic SID on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability of the estimated landing time ELDT.	PARTIALLY OK (Low representativeness)
EX3-OBJ-18.02c-TRL6-TVALP-OF22	Impact of the STAR on the NM Traffic Predictability	EX3-CRT-18.02c-TRL6-VALP-OF22-001	Solution 18.02c provides evidence that the integration of the dynamic STAR on the eFPL reduces the difference in 4 dimensions: the NM / ATC trajectory planned with dynamic STAR included in eFPL trajectory is closer to the flown trajectory than the NM / ATC trajectory planned without dynamic STAR.	The integration of the dynamic STAR on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension.	PARTIALLY OK (Low representativeness)
EX3-OBJ-18.02c-TRL6-TVALP-OF22	Impact of the STAR on the NM Traffic Predictability	EX3-CRT-18.02c-TRL6-VALP-OF22-002	Solution 18.02c provides evidence that the Integration of the updated STAR within the operational flight plan improves the predictability of the estimated	The integration of the dynamic STAR on the eFPL demonstrated a significant improvement on the NM	PARTIALLY OK

Technical Validation Exercise #03 Validation Objective ID	Technical Validation Exercise #03 Validation Objective Title	Technical Validation Exercise #03 Success Criterion ID	Technical Validation Exercise #03 Success Criterion	Technical Validation Exercise #03 Results	Technical Validation Exercise #03 Validation Objective Status
			landing time ELDT hence the airport planning is improved.	DCB Traffic Predictability of the estimated landing time ELDT.	(Low representativeness)
EX3-OBJ-18.02c-TRL6-TVALP-OF12	Impact of the SID/STAR on the Fuel efficiency	EX3-CRT-18.02c-TRL6-VALP-OF12-001	Solution 18.02c performs a qualitative assessment on the fuel decision making (planned and extra fuel) related to the real time SID/STAR planning confidence.	The fuel assessment with the decision process for updating SID/STAR was done by the flight dispatchers during the exercise. They did not show us explicitly a scenario, where the flight dispatcher declined to use another STAR due to fuel reason. In general, the more precise SID/STAR information however leads to an overall more precise fuel calculation. Nevertheless, the questionnaire highlighted a good level of confidence for the fuel decision making (planned and extra fuel) related to the SID planning, but a low level of confidence for the STAR planning.	OK for SID PARTIALLY OK for STAR

Technical Validation Exercise #03 Validation Objective ID	Technical Validation Exercise #03 Validation Objective Title	Technical Validation Exercise #03 Success Criterion ID	Technical Validation Exercise #03 Success Criterion	Technical Validation Exercise #03 Results	Technical Validation Exercise #03 Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF13	Impact of the SID/STAR on FOC workload	EX3-CRT-18.02c-TRL6-VALP-OF13-001	Solution 18.02c provides evidence that the increase of FOC workload due to FOC action is acceptable.	Details listed in the survey report. Automation for future dispatch use is required. Such an automation functionality was not foreseen for the validation exercise.	PARTIALLY OK
EX3-OBJ-18.02c-TRL6-TVALP-OF14	Impact of the SID/STAR on the Safety	EX3-CRT-18.02c-TRL6-VALP-OF14-001	Solution 18.02c provides evidence that the integration of real time SID/STAR updates in the eFPL reduces or at least does not increase the pilot workload.	As no pilots have attended the validation exercise, this objective has not been assessed during the exercise.	🟥
EX3-OBJ-18.02c-TRL6-TVALP-TF6	Integration of the TTA in FOC System	EX3-CRT-18.02c-TRL6-TVALP-TF6-001	Solution 18.02c provides evidence of the integration of TTAs by FOC System in the eFPL.	The integration of the available B2B services for TTA from LEBL airport into FOC Systems was not used satisfactorily by the Flight Dispatchers and was not fully demonstrated. The Validation Objective has not been demonstrated at TRL6 level (No proper technical requirements to propose).	🟥

Technical Validation Exercise #03 Validation Objective ID	Technical Validation Exercise #03 Validation Objective Title	Technical Validation Exercise #03 Success Criterion ID	Technical Validation Exercise #03 Success Criterion	Technical Validation Exercise #03 Results	Technical Validation Exercise #03 Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF16	To validate that the TTA/TTO integration in the AU trajectory eFPL improves the AU cost efficiency.	EX3-CRT-18.02c-TRL6-VALP-OF16-001	Solution 18.02c provides evidence that the CTOT slot influenced by the FOC reduces the extra operating costs (flight cost delay related) compared to the initial CTOT provided by the NM	The overall costs always increased due to the additional TTA requirement. A delay impact assessment in reference to costs have not been performed by the flight dispatchers	🟥
EX3-OBJ-18.02c-TRL6-TVALP-OF16	To validate that the TTA/TTO integration in the AU trajectory eFPL improves the AU cost efficiency.	EX3-CRT-18.02c-TRL6-VALP-OF16-002	Solution 18.02c provides evidence that the difference of total planned fuel is reduced between the trajectory taking the NM given CTOT and the trajectory taking the influenced CTOT (trajectory before and after TTA)	Not assessable due to lack of data. No evidence of impact on the total planned fuel has been highlighted.	🟥
EX3-OBJ-18.02c-TRL6-TVALP-OF17	Impact of the TTA/TTO on FOC workload	EX3-CRT-18.02c-TRL6-VALP-OF17-001	Solution 18.02c provides evidence that the number of manual FOC updates does not increase.	Due to missing any automation in the FOC prototype for TTA management, the dispatchers rate the workload as not acceptable to manage their tasks.	🟥
EX3-OBJ-18.02c-TRL6-TVALP-OF18	Impact of the TTA/TTO on the Departure time	EX3-CRT-18.02c-TRL6-VALP-OF18-001	Solution 18.02c provides evidence that TTA integration in the AU trajectory improves the flexibility	From PJ9.3.2 Not assessable due to very limited data and due to prototype limitations.	🟥

Technical Validation Exercise #03 Validation Objective ID	Technical Validation Exercise #03 Validation Objective Title	Technical Validation Exercise #03 Success Criterion ID	Technical Validation Exercise #03 Success Criterion	Technical Validation Exercise #03 Results	Technical Validation Exercise #03 Validation Objective Status
			on Departure Time by at least 10% of the cases.		🟥
EX3-OBJ-18.02c-TRL6-TVALP-CO1	To Assess Operational acceptability of the eFPL use in TTA management from DCB perspective.	EX3-CRT-18.02c-TRL6-VALP-CO1-001	Solution 18.02c assesses the operational acceptability – from a DCB perspective - of the management of Target times in conjunction with eFPLs integrating AOP/NOP information and provides evidence that the NMF actors/experts do not identify any side effect – e.g instability of the demand or Target Time – impacting negatively network or local DCB performances.	From PJ9.3.2 Not enough data to draw conclusions but no negative effects were observed in the AOP/NOP and DCB with the TTA updated flights	🟩

Table 20: Technical Validation Results Exercise #03

C.3.1.1. Results on technical feasibility

The exercise proved that it is technically feasible to detect the SID/STAR updates and to include into the AU 4D trajectory.

The results of Technical Validation Objectives demonstrated the technical feasibility – see C.3.2.1, C.3.2.2, C.3.2.3.

C.3.1.2. Results per KPA

Not applicable – KPAs have not been defined for solution PJ.18-02c.

C.3.2 Analysis of Exercise 1 Results per Technical Validation objective

C.3.2.1. EX3-OBJ-18.02c-TRL6-TVALP-TF3 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-TF3	To Assess Technical Feasibility of the Runway Configuration integration in the FOC system	EX3-CRT-18.02c-TRL6-TVALP-TF3-001	Solution 18.02c provides evidence of the integration of Runway Configuration by FOC System in the eFPL.	The integration of the available B2B services for the Runway Configuration into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019	OK

DATA COLLECTION

On the FOC prototype, the operational messages have been retrieved from logs.

METRICS

- Logs extraction and analysis

RESULTS EX3-CRT-18.02C-TRL6-TVALP-TF3-001

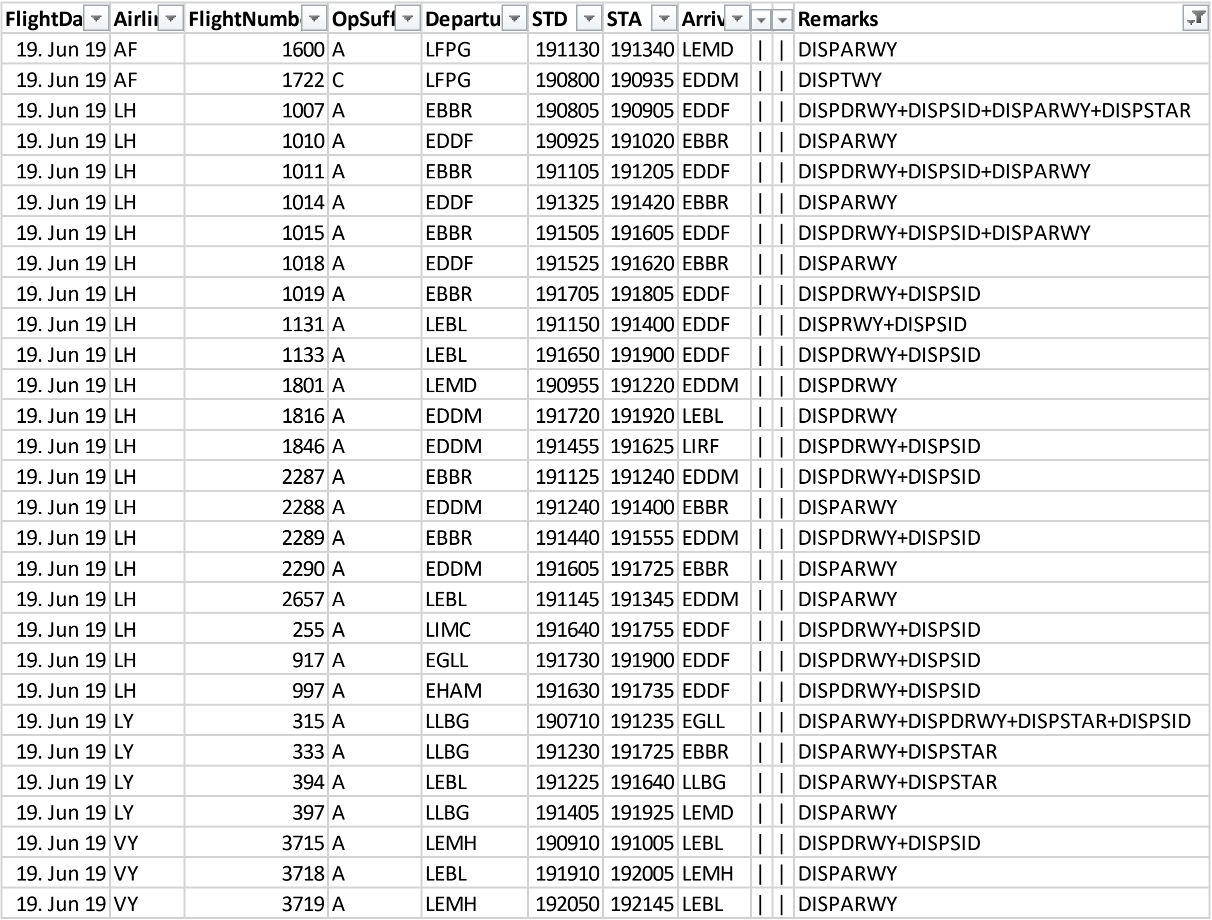
The details number of flights used during the exercise validation, where information from the Runway configuration was actively used from dispatchers is following:

Exercise day 1 - 18 June 2019:

FlightDa	Airli	FlightNumb	OpSuff	Departu	STD	STA	Arriv			Remarks
18. Jun 19	AF	1100	A	LFPG	181510	181720	LEMD	|	|	DISPARWY
18. Jun 19	AF	1140	A	LFPG	181445	181555	EHAM	|	|	DISPARWY
18. Jun 19	AF	1241	A	EHAM	180730	180845	LFPG	|	|	DISPDRWY
18. Jun 19	AF	1300	A	LFPG	180710	180920	LEMD	|	|	DISPARWY
18. Jun 19	HV	5134	A	LEBL	181945	182210	EHAM	|	|	DISPARWY
18. Jun 19	HV	5193	B	EHAM	181745	181905	LFPO	|	|	DISPSTAR+DISPRWY
18. Jun 19	HV	5194	A	LFPO	181945	182100	EHAM	|	|	DISPSID+DISPDRWY+DISPARWY
18. Jun 19	HV	5586	A	LFMN	181455	181655	EHAM	|	|	DISPDRWY+DISPSID
18. Jun 19	HV	5630	A	LEPA	182000	182230	EHAM	|	|	DISPARWY
18. Jun 19	HV	6062	A	LEBL	181335	181550	EHRD	|	|	DISPARWY
18. Jun 19	LH	1010	A	EDDF	180925	181020	EBBR	|	|	DISPDRWY
18. Jun 19	LH	1029	B	LFPG	180830	180945	EDDF	|	|	DISPDRWY
18. Jun 19	LH	1034	A	EDDF	181025	181135	LFPG	|	|	DISPDRWY
18. Jun 19	LH	1041	A	LFPG	181630	181740	EDDF	|	|	DISPDRWY
18. Jun 19	LH	1113	A	LEMD	181055	181325	EDDF	|	|	DISPDRWY
18. Jun 19	LH	1121	A	LEMD	180410	180640	EDDF	|	|	DISPDWY
18. Jun 19	LH	1125	A	LEBL	180830	181040	EDDF	|	|	DISPARWY
18. Jun 19	LH	1130	A	EDDF	180905	181105	LEBL	|	|	DISPDRWY
18. Jun 19	LH	1184	A	EDDF	180540	180635	LSZH	|	|	DISPDRWY
18. Jun 19	LH	1802	A	EDDM	180945	181225	LEMD	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
18. Jun 19	LH	1804	A	EDDM	181320	181600	LEMD	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	1805	A	LEMD	181645	181910	EDDM	|	|	DISPARWY
18. Jun 19	LH	1810	C	EDDM	180700	180900	LEBL	|	|	DISPARWY+DISPSTAR
18. Jun 19	LH	1811	B	LEBL	180955	181155	EDDM	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1814	A	EDDM	181345	181545	LEBL	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	1816	A	EDDM	181720	181920	LEBL	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1844	A	EDDM	181055	181225	LIRF	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1846	A	EDDM	181455	181625	LIRF	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1847	A	LIRF	181715	181845	EDDM	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1848	A	EDDM	181725	181855	LIRF	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	2230	A	EDDM	181010	181145	LFPG	|	|	DISPDRWY+DISPARWY+DISPSTAR
18. Jun 19	LH	2231	A	LFPG	181230	181355	EDDM	|	|	DISPDRWY+DISPTAXI
18. Jun 19	LH	2234	A	EDDM	181335	181510	LFPG	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	2238	B	EDDM	181700	181835	LFPG	|	|	DISPARWY+DISPSTAR
18. Jun 19	LH	2288	A	EDDM	181240	181400	EBBR	|	|	DISPARWY
18. Jun 19	LH	2656	A	EDDM	180855	181055	LEBL	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
18. Jun 19	LH	232	A	EDDF	180845	181035	LIRF	|	|	DISPDRWY
18. Jun 19	LH	234	A	EDDF	181005	181155	LIRF	|	|	DISPDRWY
18. Jun 19	LH	901	A	EGLL	180830	181000	EDDF	|	|	DISPARWY
18. Jun 19	LH	903	A	EGLL	180930	181100	EDDF	|	|	DISPARWY
18. Jun 19	LH	905	A	EGLL	181030	181200	EDDF	|	|	DISPARWY
18. Jun 19	LH	906	A	EDDF	181000	181140	EGLL	|	|	DISPDRWY+DISPTAXI
18. Jun 19	LH	992	A	EDDF	181040	181150	EHAM	|	|	DISPDRWY
18. Jun 19	LY	351	A	LLBG	181425	181830	EDDM	|	|	DISPARWY+DISPSTAR
18. Jun 19	LY	355	A	LLBG	181145	181615	EDDF	|	|	DISPARWY+DISPSTAR
18. Jun 19	LY	394	A	LEBL	181225	181640	LLBG	|	|	DISPARWY+DISPSTAR
18. Jun 19	LY	396	A	LEMD	180945	181425	LLBG	|	|	DISPARWY+DISPSTAR
18. Jun 19	LY	396	B	LEMD	180945	181425	LLBG	|	|	DISPDRWY+DISPSID
18. Jun 19	LY	397	A	LLBG	181405	181925	LEMD	|	|	DISPARWY+DISPSTAR
18. Jun 19	TO	3239	A	LEBL	181840	182035	LFPO	|	|	DISPSTAR+DISPRWY
18. Jun 19	VY	1500	A	LEMD	181300	181420	LEBL	|	|	DISPDRWY+DISPSID
18. Jun 19	VY	2257	B	LEZL	182040	182220	LEBL	|	|	DISPARWY
18. Jun 19	VY	3701	A	LEMH	181735	181830	LEBL	|	|	DISPARWY

Figure 14: Exercise day 1 - list of flights with Departure/Arrival Runway updates

Exercise day 2 - 19 June 2019 – 29 updates

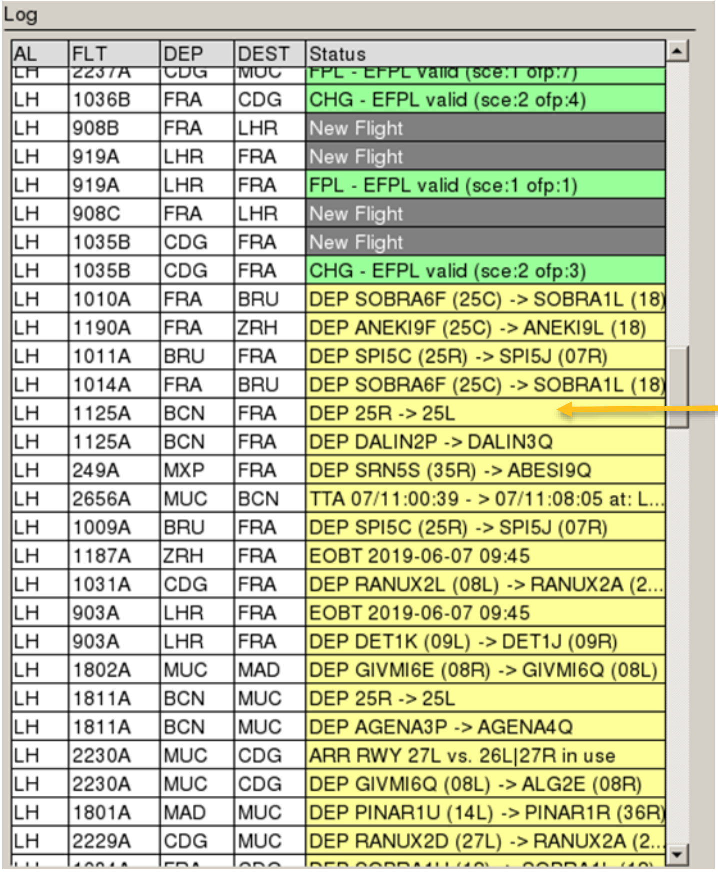


FlightDa	Airli	FlightNumb	OpSuff	Departu	STD	STA	Arriv			Remarks
19. Jun 19	AF	1600	A	LFPG	191130	191340	LEMD	|	|	DISPARWY
19. Jun 19	AF	1722	C	LFPG	190800	190935	EDDM	|	|	DISPTWY
19. Jun 19	LH	1007	A	EBBR	190805	190905	EDDF	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
19. Jun 19	LH	1010	A	EDDF	190925	191020	EBBR	|	|	DISPARWY
19. Jun 19	LH	1011	A	EBBR	191105	191205	EDDF	|	|	DISPDRWY+DISPSID+DISPARWY
19. Jun 19	LH	1014	A	EDDF	191325	191420	EBBR	|	|	DISPARWY
19. Jun 19	LH	1015	A	EBBR	191505	191605	EDDF	|	|	DISPDRWY+DISPSID+DISPARWY
19. Jun 19	LH	1018	A	EDDF	191525	191620	EBBR	|	|	DISPARWY
19. Jun 19	LH	1019	A	EBBR	191705	191805	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	1131	A	LEBL	191150	191400	EDDF	|	|	DISPRWY+DISPSID
19. Jun 19	LH	1133	A	LEBL	191650	191900	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	1801	A	LEMD	190955	191220	EDDM	|	|	DISPDRWY
19. Jun 19	LH	1816	A	EDDM	191720	191920	LEBL	|	|	DISPDRWY
19. Jun 19	LH	1846	A	EDDM	191455	191625	LIRF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	2287	A	EBBR	191125	191240	EDDM	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	2288	A	EDDM	191240	191400	EBBR	|	|	DISPARWY
19. Jun 19	LH	2289	A	EBBR	191440	191555	EDDM	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	2290	A	EDDM	191605	191725	EBBR	|	|	DISPARWY
19. Jun 19	LH	2657	A	LEBL	191145	191345	EDDM	|	|	DISPARWY
19. Jun 19	LH	255	A	LIMC	191640	191755	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	917	A	EGLL	191730	191900	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	997	A	EHAM	191630	191735	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LY	315	A	LLBG	190710	191235	EGLL	|	|	DISPARWY+DISPDRWY+DISPSTAR+DISPSID
19. Jun 19	LY	333	A	LLBG	191230	191725	EBBR	|	|	DISPARWY+DISPSTAR
19. Jun 19	LY	394	A	LEBL	191225	191640	LLBG	|	|	DISPARWY+DISPSTAR
19. Jun 19	LY	397	A	LLBG	191405	191925	LEMD	|	|	DISPARWY
19. Jun 19	VY	3715	A	LEMH	190910	191005	LEBL	|	|	DISPDRWY+DISPSID
19. Jun 19	VY	3718	A	LEBL	191910	192005	LEMH	|	|	DISPARWY
19. Jun 19	VY	3719	A	LEMH	192050	192145	LEBL	|	|	DISPARWY

Figure 15: Exercise day 2 - list of flights with Departure/Arrival Runway updates

The dispatcher changed according to the Departure/Arrival runway information the original operational flight plan based on new runway configuration information. As displayed in the remark field of the FOC prototype, which was the trigger to change the flight plan: for many of the flights the flight dispatcher has adapted additional information like SID, STAR and taxi time .

In a detailed view for the incoming RWY information, an additional screen in the LIDO AU prototype was implemented for the dispatcher to monitor the relevant updates:


Log

AL	FLT	DEP	DEST	Status
LH	2237A	CDG	MUC	FPL - EFPL valid (sce:1 ofp:7)
LH	1036B	FRA	CDG	CHG - EFPL valid (sce:2 ofp:4)
LH	908B	FRA	LHR	New Flight
LH	919A	LHR	FRA	New Flight
LH	919A	LHR	FRA	FPL - EFPL valid (sce:1 ofp:1)
LH	908C	FRA	LHR	New Flight
LH	1035B	CDG	FRA	New Flight
LH	1035B	CDG	FRA	CHG - EFPL valid (sce:2 ofp:3)
LH	1010A	FRA	BRU	DEP SOBRA6F (25C) -> SOBRA1L (18)
LH	1190A	FRA	ZRH	DEP ANEKI9F (25C) -> ANEKI9L (18)
LH	1011A	BRU	FRA	DEP SPI5C (25R) -> SPI5J (07R)
LH	1014A	FRA	BRU	DEP SOBRA6F (25C) -> SOBRA1L (18)
LH	1125A	BCN	FRA	DEP 25R -> 25L
LH	1125A	BCN	FRA	DEP DALIN2P -> DALIN3Q
LH	249A	MXP	FRA	DEP SRN5S (35R) -> ABESI9Q
LH	2656A	MUC	BCN	TTA 07/11:00:39 - > 07/11:08:05 at: L...
LH	1009A	BRU	FRA	DEP SPI5C (25R) -> SPI5J (07R)
LH	1187A	ZRH	FRA	EOBT 2019-06-07 09:45
LH	1031A	CDG	FRA	DEP RANUX2L (08L) -> RANUX2A (2...
LH	903A	LHR	FRA	EOBT 2019-06-07 09:45
LH	903A	LHR	FRA	DEP DET1K (09L) -> DET1J (09R)
LH	1802A	MUC	MAD	DEP GIVMI6E (08R) -> GIVMI6Q (08L)
LH	1811A	BCN	MUC	DEP 25R -> 25L
LH	1811A	BCN	MUC	DEP AGENA3P -> AGENA4Q
LH	2230A	MUC	CDG	ARR RWY 27L vs. 26L|27R in use
LH	2230A	MUC	CDG	DEP GIVMI6Q (08L) -> ALG2E (08R)
LH	1801A	MAD	MUC	DEP PINAR1U (14L) -> PINAR1R (36R)
LH	2229A	CDG	MUC	DEP RANUX2D (27L) -> RANUX2A (2...

Departure runway change at Barcelona from 25R to 25L

Figure 16: LIDO AU prototype - monitoring screen

In the example above the dispatcher adapted within Lido/Flight the originally planned runway 25R into 25L and send an updated flight plan to the NMVP. An exemplary graphic of the relevant Lido/Flight frame which was used by the dispatchers is displayed below. As in the ATS flight plan no runway is displayed, no ATS flight plan is added at this point here.

Planning Parameter

Airline: LH
Flight: 1115
OS: A
ATC C/S: DLH34C
Date of Origin: 07-JUN-2019
DEP: LEMD
STD: 071500
DEST: EDDF
STA: 071730
PIC: E
Priority: Load
Initialization Time: 071119
Operator: LH
Registration: DAIUP
RWY: 14L
ETD: 071500
RWY: 25L
ETA: 071730
PET/ETOPS: ☐

Alternate Information
TKOF ALTN:
DEST ALTN: EDFH, EDDK, EDDS, ELLX

ICAO	Quality	Status	PA
LEMD	TKOF	Suitable 14L(TKOF)CFR Category (ICAO CFR 10) Unspecified NOTAM! (071517 -> 071617)	
LEMD	TKOF_DEST	Suitable 18R(CAT3B)CFR Category (ICAO CFR 10) Unspecified NOTAM! (071417 -> 071617)	
EDDF	DEST	Suitable 25L(CAT3B)CFR Category (ICAO CFR 10) Unspecified NOTAM! (071630 -> 071830)	

ALTN Cruise & Holding
Procedure: LRC
MN: 0.780
IAS: 300 kt
CI: 22

Fuel Section
Sequence: Minimum ALTN Fuel
CONT Policy: 5%(3%+ERA)
CONT Percent: 5.00 %
Protect CONT: ☐
Performance Corr.: 1.020
Taxi Out Fuel: 204 kg
Taxi Out Time: 17 min

Figure 17: LIDO AU prototype - screen to update Runway

CONCLUSION

Success criteria EX3-CRT-18.02C-TRL6-TVALP-TF3-001:

The integration of the available B2B services for the Runway Configuration into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.

C.3.2.2. EX3-OBJ-18.02c-TRL6-TVALP-TF4 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-TF4	To Assess Technical Feasibility of the SID integration in the FOC system	EX3-CRT-18.02c-TRL6-TVALP-TF4-001	Solution 18.02c provides evidence of the integration of SID by FOC System in the eFPL.	The integration of the available B2B services for assigned SID information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019	OK

DATA COLLECTION

On the FOC prototype, the operational messages have been retrieved from logs.

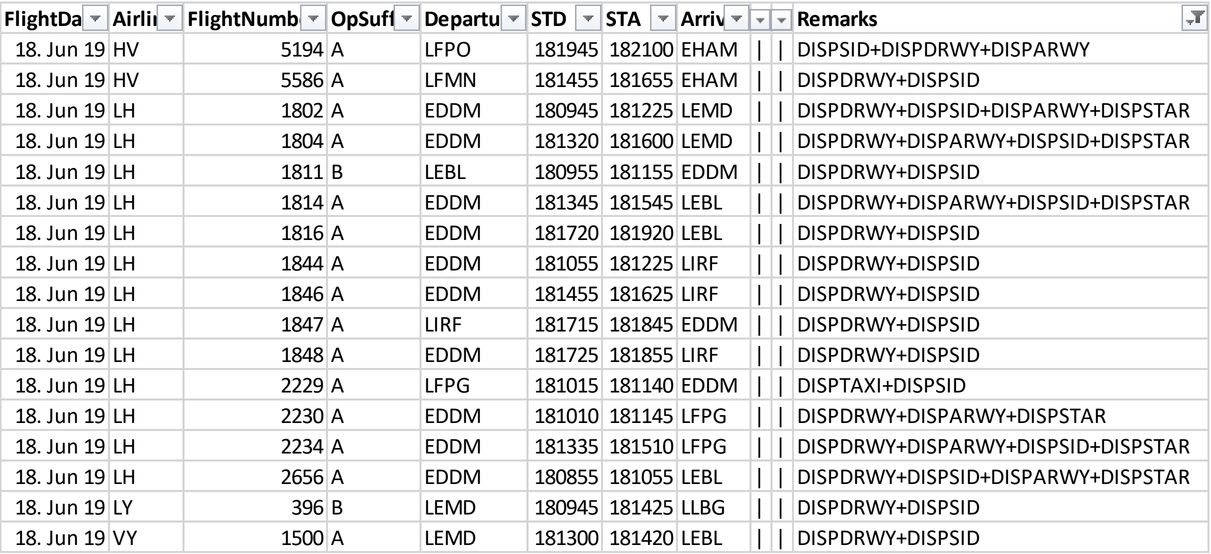
METRICS

- Logs extraction and analysis

RESULTS EX3-CRT-18.02C-TRL6-TVALP-TF4-001

The details number of flights used during the exercise validation, where information through B2B information lead to actively SID changes from dispatchers is following:

<u>Exercise day 1 - 18 June 2019 – 17 updates</u>



FlightDa	Airli	FlightNumb	OpSuf	Departu	STD	STA	Arriv			Remarks
18. Jun 19	HV	5194	A	LFPO	181945	182100	EHAM	|	|	DISPSID+DISPDRWY+DISPARWY
18. Jun 19	HV	5586	A	LFMN	181455	181655	EHAM	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1802	A	EDDM	180945	181225	LEMD	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
18. Jun 19	LH	1804	A	EDDM	181320	181600	LEMD	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	1811	B	LEBL	180955	181155	EDDM	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1814	A	EDDM	181345	181545	LEBL	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	1816	A	EDDM	181720	181920	LEBL	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1844	A	EDDM	181055	181225	LIRF	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1846	A	EDDM	181455	181625	LIRF	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1847	A	LIRF	181715	181845	EDDM	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	1848	A	EDDM	181725	181855	LIRF	|	|	DISPDRWY+DISPSID
18. Jun 19	LH	2229	A	LFPG	181015	181140	EDDM	|	|	DISPTAXI+DISPSID
18. Jun 19	LH	2230	A	EDDM	181010	181145	LFPG	|	|	DISPDRWY+DISPARWY+DISPSTAR
18. Jun 19	LH	2234	A	EDDM	181335	181510	LFPG	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	2656	A	EDDM	180855	181055	LEBL	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
18. Jun 19	LY	396	B	LEMD	180945	181425	LLBG	|	|	DISPDRWY+DISPSID
18. Jun 19	VY	1500	A	LEMD	181300	181420	LEBL	|	|	DISPDRWY+DISPSID

In high resolution, a single example for the change looks like following:

18. Jun 19 LH 1844 A EDDM 181055 181225 LIRF

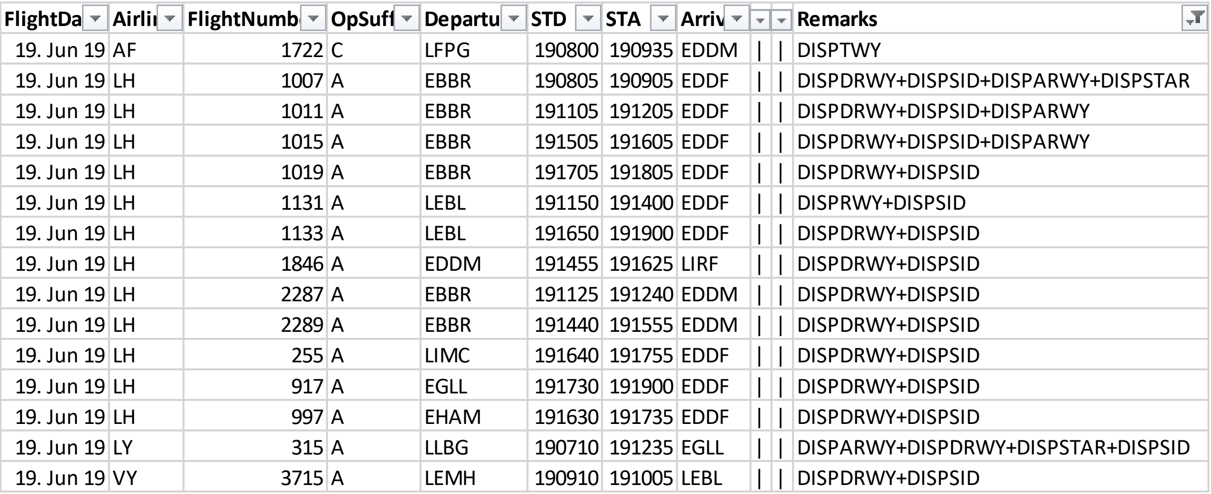
N0445F290 TURBU7S TURBU Y107 BAKOR/N0448F310 DCT VESAL/N0449F330 DCT GAVRA/N0443F290 Y345 RITEB RITEB2A

Adapted flight plan after dispatcher interaction:

N0448F290 TURBU6N TURBU Y107 BAKOR/N0452F370 DCT SOVUB DCT RITEB RITEB2A

The SID was changed from TURBU7S to TRUBU6N as published from the B2B service incorporated into the FOC system Lido/Flight from Lufthansa Systems.

Exercise day 2 - 19 June 2019 – 15 updates



FlightDa	Airli	FlightNumb	OpSuf	Departu	STD	STA	Arriv			Remarks
19. Jun 19	AF	1722	C	LFPG	190800	190935	EDDM	|	|	DISPTWY
19. Jun 19	LH	1007	A	EBBR	190805	190905	EDDF	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
19. Jun 19	LH	1011	A	EBBR	191105	191205	EDDF	|	|	DISPDRWY+DISPSID+DISPARWY
19. Jun 19	LH	1015	A	EBBR	191505	191605	EDDF	|	|	DISPDRWY+DISPSID+DISPARWY
19. Jun 19	LH	1019	A	EBBR	191705	191805	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	1131	A	LEBL	191150	191400	EDDF	|	|	DISPRWY+DISPSID
19. Jun 19	LH	1133	A	LEBL	191650	191900	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	1846	A	EDDM	191455	191625	LIRF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	2287	A	EBBR	191125	191240	EDDM	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	2289	A	EBBR	191440	191555	EDDM	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	255	A	LIMC	191640	191755	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	917	A	EGLL	191730	191900	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LH	997	A	EHAM	191630	191735	EDDF	|	|	DISPDRWY+DISPSID
19. Jun 19	LY	315	A	LLBG	190710	191235	EGLL	|	|	DISPARWY+DISPDRWY+DISPSTAR+DISPSID
19. Jun 19	VY	3715	A	LEMH	190910	191005	LEBL	|	|	DISPDRWY+DISPSID

In high resolution, a single example for the change looks like following:

Original flight plan from OPS

19. Jun 19 LH 1011 A EBBR 191105 191205 EDDF
N0372F230 SPI5Q SPI UT180 PESOV T180 UNOKO UNOKO2L

Adapted flight plan after dispatcher interaction:

N0372F230 SPI5J SPI UT180 PESOV T180 UNOKO UNOKO2L

Besides the SID change from SPI5Q to SPI5J, the arrival runway was changed in that case as well.

CONCLUSION

Success criteria EX3-CRT-18.02c-TRL6-TVALP-TF4-001:

The technical integration of the available B2B services for assigned SID information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.

C.3.2.3. EX3-OBJ-18.02c-TRL6-TVALP-TF5 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-TF5	To Assess Technical Feasibility of the STAR integration in the FOC system	EX3-CRT-18.02c-TRL6-TVALP-TF5-001	Solution 18.02c provides evidence of the integration of STAR by FOC System in the eFPL.	The integration of the available B2B services for assigned STAR information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from	OK

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
				18-19 June 2019.	🟩

DATA COLLECTION

On the FOC prototype, the operational messages have been retrieved from logs.

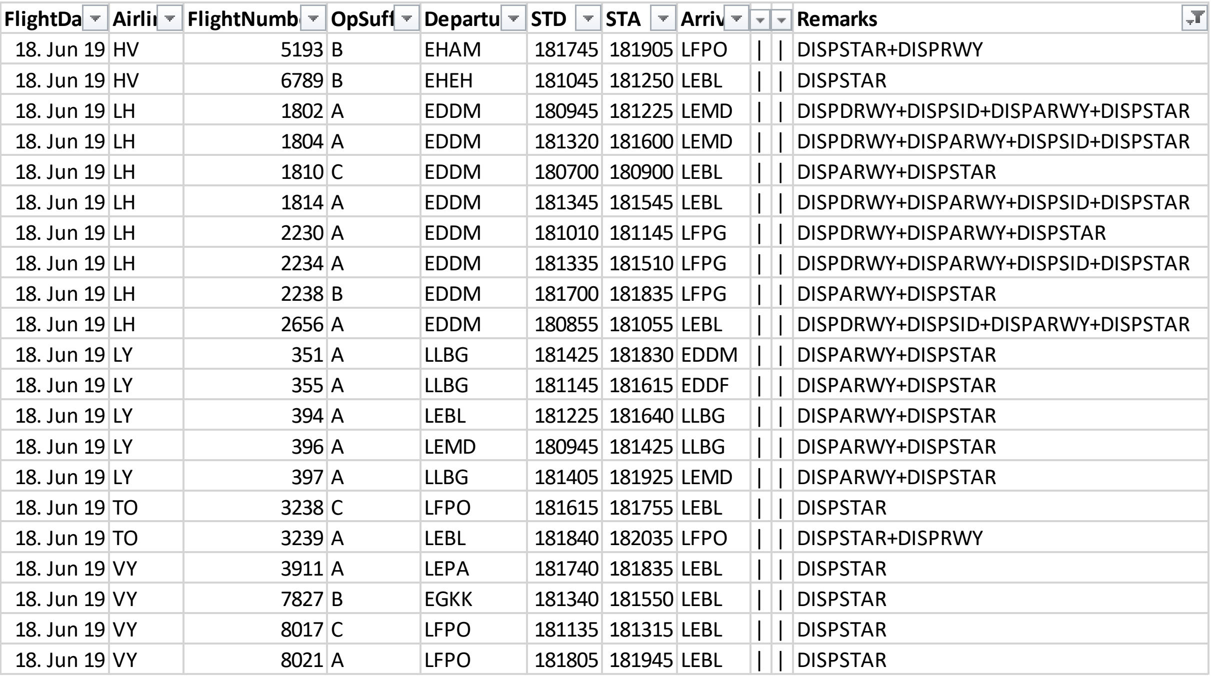
METRICS

- Logs extraction and analysis

RESULTS EX3-CRT-18.02C-TRL6-TVALP-TF5-001

The details number of flights used during the exercise validation, where information through B2B information lead to actively STAR changes from dispatchers is following:

Exercise day 1 - 18June2019- 21 updates



FlightDa	Airli	FlightNumb	OpSuff	Departu	STD	STA	Arriv			Remarks
18. Jun 19	HV	5193	B	EHAM	181745	181905	LFPO	|	|	DISPSTAR+DISPRWY
18. Jun 19	HV	6789	B	EHEH	181045	181250	LEBL	|	|	DISPSTAR
18. Jun 19	LH	1802	A	EDDM	180945	181225	LEMD	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
18. Jun 19	LH	1804	A	EDDM	181320	181600	LEMD	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	1810	C	EDDM	180700	180900	LEBL	|	|	DISPARWY+DISPSTAR
18. Jun 19	LH	1814	A	EDDM	181345	181545	LEBL	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	2230	A	EDDM	181010	181145	LFPG	|	|	DISPDRWY+DISPARWY+DISPSTAR
18. Jun 19	LH	2234	A	EDDM	181335	181510	LFPG	|	|	DISPDRWY+DISPARWY+DISPSID+DISPSTAR
18. Jun 19	LH	2238	B	EDDM	181700	181835	LFPG	|	|	DISPARWY+DISPSTAR
18. Jun 19	LH	2656	A	EDDM	180855	181055	LEBL	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
18. Jun 19	LY	351	A	LLBG	181425	181830	EDDM	|	|	DISPARWY+DISPSTAR
18. Jun 19	LY	355	A	LLBG	181145	181615	EDDF	|	|	DISPARWY+DISPSTAR
18. Jun 19	LY	394	A	LEBL	181225	181640	LLBG	|	|	DISPARWY+DISPSTAR
18. Jun 19	LY	396	A	LEMD	180945	181425	LLBG	|	|	DISPARWY+DISPSTAR
18. Jun 19	LY	397	A	LLBG	181405	181925	LEMD	|	|	DISPARWY+DISPSTAR
18. Jun 19	TO	3238	C	LFPO	181615	181755	LEBL	|	|	DISPSTAR
18. Jun 19	TO	3239	A	LEBL	181840	182035	LFPO	|	|	DISPSTAR+DISPRWY
18. Jun 19	VY	3911	A	LEPA	181740	181835	LEBL	|	|	DISPSTAR
18. Jun 19	VY	7827	B	EGKK	181340	181550	LEBL	|	|	DISPSTAR
18. Jun 19	VY	8017	C	LFPO	181135	181315	LEBL	|	|	DISPSTAR
18. Jun 19	VY	8021	A	LFPO	181805	181945	LEBL	|	|	DISPSTAR

In high resolution, a single example for the change looks like following:

18. Jun 19 LY 355 A LLBG 181145 181615 EDDF

Original Flight plan from OPS:

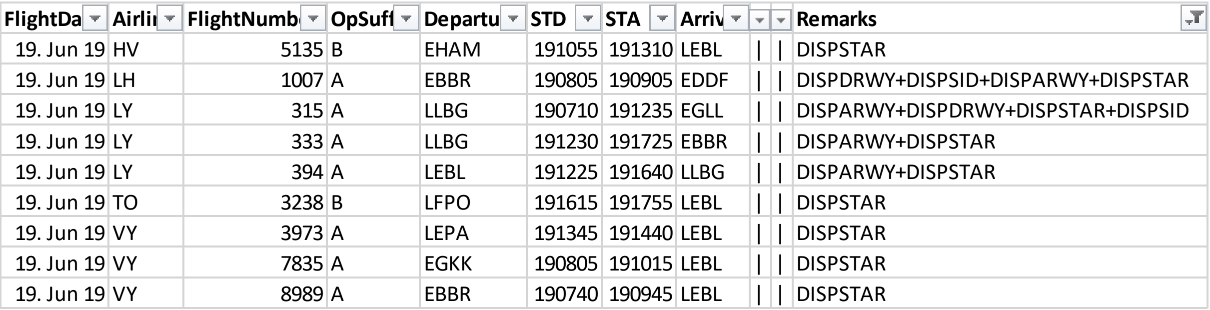
N0467F360 SUVAS UL53 KAROL UL995 KOSEG/N0462F380 UL995 RDS UN128 RIKSO/N0454F380 UN128 LMO DCT EVIVI DCT OKANA DCT BABIT DCT SUNIS DCT NURMI DCT LIMRA DCT MATIG/N0444F370 DCT SUBEN/N0448F380 T161 ASPAT/N0384F240 T161 PSA PSA3L

Adapted flight plan after dispatcher interaction:

N0467F360 SUVAS UL53 KAROL UL995 KOSEG/N0462F380 UL995 RDS UN128 RIKSO/N0454F380 UN128 LMO DCT EVIVI DCT OKANA DCT BABIT DCT SUNIS DCT NURMI DCT LIMRA DCT MATIG/N0444F370 DCT SUBEN/N0448F380 T161 ASPAT/N0384F240 T161 PSA PSA3M

The STAR was changed from PSA3L to PSA3M

Exercise day 2- 19 June 2019 – 9 updates



FlightDa	Airli	FlightNumb	OpSuff	Departu	STD	STA	Arriv			Remarks
19. Jun 19	HV	5135	B	EHAM	191055	191310	LEBL	|	|	DISPSTAR
19. Jun 19	LH	1007	A	EBBR	190805	190905	EDDF	|	|	DISPDRWY+DISPSID+DISPARWY+DISPSTAR
19. Jun 19	LY	315	A	LLBG	190710	191235	EGLL	|	|	DISPARWY+DISPDRWY+DISPSTAR+DISPSID
19. Jun 19	LY	333	A	LLBG	191230	191725	EBBR	|	|	DISPARWY+DISPSTAR
19. Jun 19	LY	394	A	LEBL	191225	191640	LLBG	|	|	DISPARWY+DISPSTAR
19. Jun 19	TO	3238	B	LFPO	191615	191755	LEBL	|	|	DISPSTAR
19. Jun 19	VY	3973	A	LEPA	191345	191440	LEBL	|	|	DISPSTAR
19. Jun 19	VY	7835	A	EGKK	190805	191015	LEBL	|	|	DISPSTAR
19. Jun 19	VY	8989	A	EBBR	190740	190945	LEBL	|	|	DISPSTAR

In high resolution, a single example for the change looks like following:

19. Jun 19 VY 8989 A EBBR 190740 190945 LEBL

Original Flight plan from OPS:

N0452F330 CIV4C CIV UN872 KOVIN UM728 RESMI UN857 DISAK/N0450F370 UN857 DIRMO UN855 ETAMO UZ271 ADEKA UT18 BADAM UZ151 FJR UY25 SALIN/N0449F310 M731 DIVKO UN975 BISBA

Adapted flight plan after dispatcher interaction:

N0452F330 CIV4C CIV UN872 KOVIN UM728 RESMI UN857 DISAK/N0450F370 UN857 DIRMO UN855 DEGOL/N0444F310 UN855 PPG UP84 ALBER

The arrival change of the STAR is obvious, as a different routing for the approach was defined by the dispatcher.

CONCLUSION

Success criteria EX3-CRT-18.02c-TRL6-TVALP-TF5-001:

The technical integration of the available B2B services for assigned STAR information into Lido/Flight from Lufthansa Systems was successfully demonstrated during the exercise from 18-19 June 2019.

C.3.2.4. EX3-OBJ-18.02c-TRL6-TVALP-OF11 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF11	Impact of the SID/STAR on the AU Trajectory Alignment	EX3-CRT-18.02c-TRL6-VALP-OF11-001	Solution 18.02c provides evidence that the integration of the dynamic SID/STAR on the eFPL reduces the difference in 4 dimensions: the AU EFPL 4D planned trajectory computed with dynamic SID/STAR is closer to the NM planned trajectory (ETFMS) than the AU EFPL 4D planned trajectory computed without dynamic SID/STAR.	The integration of the dynamic SID/STAR on the eFPL demonstrated a significant improvement on the AU Trajectory Alignment with NM systems in three dimensions as well as the time dimension. Due to the low number of flight dispatcher updates, the results are not representative.	PARTIALLY OK (Low representative ness)

DATA COLLECTION

On NMVP, ETFMS flight plans have been collected via the Operational Logs: these logs include the trajectory updates computed by ETFMS *for any events*.

The AU 4D trajectories (Flight plan Creation FPL, Flight plan Update CHG) sent via the B2B services have been collected.

For any trajectories, SID/STAR procedures have been identified.

Because the SID/STAR updates have been mainly performed during "the SID/TaxiTime/STAR Scenario (18/06/2019 10:00 - 12:30)", and to a lesser extent during the second TTA Scenario (small delay – 18/06/2019 14:30 – 17:00), we focused the analysis of the Validation Objectives on the day 18/06/2019. All flights have an EOBT on the 18/06/2019.

DATA LOGGING EXTRACTION

We identified the reason/purpose of an update sent by the dispatcher, via the CHG messages (extended flight plan update) mentioning the reason (RMK field), and the timestamp of the message.

From this timestamp, we identified the Reference and Scenario dataset for each flight:

- Reference dataset: we extracted the AU 4D trajectory and the ETFMS computed trajectory, both before the timestamp of the update message. See C.1.3.1.b
- Scenario dataset: in addition to the AU 4D trajectory with Flight Dispatcher update, we identified the ETFMS computed trajectory based on the given AU 4D trajectory. See C.1.3.2.b

METRICS FOR ALIGNMENT EX3-CRT-18.02C-TRL6-VALP-OF11-001

We computed the following quantitative metrics for the Reference (before SID/STAR updates) and Scenario Datasets (with SID/STAR updates): for each flight, for each SID/STAR Updates from the flight dispatcher,

Alignment in Altitude:

- M1.1 Difference of Flight levels at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory.
- M1.2 Difference of Flight levels at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS trajectory.
- M1.3 Considering all named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Flight levels.

Alignment in Elapsed Time:

- M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory.
- M2.2 Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS trajectory.
- M2.3 Considering all points in common between the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Estimated Elapsed Time (EET)
- M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the AU 4D Trajectory and the ETFMS trajectory

Alignment in named trajectory points

- M3.1 Number of named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory

Counts according to Duration of the flight

- Number of “Short Haul flights” (duration up to 90 minutes)
- Number of “Medium/Long Haul flights” (duration above 90 minutes)

For all these metrics, we analyse of the Deviation of the EET/FL differences for Reference vs Scenario Datasets.

We focused the analysis on the SID/STAR updates and Departure / Arrival Runway updates done by the Flight Dispatcher, with the following filters according to the situation:

- Filter 1: SID update only (including Runway update at Departure airport only and Taxitime at Departure airport – No STAR update done by the Flight Dispatcher)
- Filter 2: STAR update only (including Runway update at Arrival airport - No SID update done by the Flight Dispatcher)
- Filter 3: SID & STAR updates, including Runway updates.

RESULTS EX3-CRT-18.02C-TRL6-VALP-OF11-001

Limitation on the Scenario Dataset:

In the exercise, the Flight Dispatcher considers the planned departure runway information in the NOP coming from A-CDM airports as soon as the DPI messages are sent to NM (from EOBT -3H). The Flight Dispatcher could consider that the planned SID in the NOP is not accurate for the AU aircraft performance. Therefore, the AU Flight Dispatcher could include his preferred SID in the flight plan compliant with the planned runway in the NOP. This preferred SID could be different from the planned SID in the NOP, leading to a proposed AU trajectory with a new SID and to the computation of an ETFMS trajectory aligned with the AU proposed SID.

On the other side, the current CDM process requires that only a DPI message can modify a SID received by ETFMS via a DPI message. Even if the AU is proposing a new preferred SID, the planned SID in the NOP remains unchanged.

For the metrics, this limitation requires that we limit the Scenario Dataset to the flight updates, when the Flight Dispatcher updates the AU 4D trajectory with a SID identical to the planned SID in the NOP.

This limitation applies as well for the STAR procedure update.

Limitation for the Taxi time updates

No Flight Dispatcher update includes an update due to Taxi time update only. These updates (5 for the exercise day 1) have been done in conjunction with the SID updates (Filter 1). The impact of the Taxi

Time update cannot be analysed as such. Additional feedback about the Taxi time were requested to the Flight Dispatcher via a questionnaire (Refer to F.1.1.2).

Criteria for assessment:

For each metric, the impact is assessed operationally according to the Deviation of the EET/FL differences for Reference dataset (after the SID/STAR updates) vs Scenario Datasets (after the SID/STAR updates) as:

Impact on the criteria	**Negative impact** **(Degradation)**	**Neutral impact**	**Positive impact** **(Improvement)**
EET	> 60s Deviation increases by at least 60s	[-60s, 60s] Deviation decreases/increases by less than 60s	< -60 s Deviation decreases by at least 60s OR No difference after the CHG message with SID/STAR update
FL	> 10FL Deviation increases by at least 10 FL	[-10FL, 10FL] Deviation decreases/increases by less 10 FL	<-10FL Deviation decreases by at least 10 FL OR No difference after the CHG message with SID/STAR update

Filter 1: "SID update only" (including Departure Runway updates and Taxi time)

RMK field	"SID update only" (including Departure Runway updates and Taxitime)
Reference dataset	Same last SID point in AU 4D trajectory vs ETFMS trajectory (SID procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory) Same first STAR point in AU 4D trajectory vs ETFMS trajectory
Scenario dataset	SID procedure *identical* in AU 4D trajectory vs ETFMS trajectory (same last SID point) Same first STAR point in AU 4D trajectory vs ETFMS trajectory

Average values [18 flight plan updates for 18 flights (9 Short Haul / 9 Medium/Long Haul)]	Before SID Update	After SID Update	Deviation	Impact on the Val. Obj
M1.1 Difference of Flight levels at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory	16 FL	14 FL	-2FL -13%	=
SID procedure **aligned before CHG**	12 FL	13 FL	+1FL +8%	=
SID procedure ***not aligned*** **before CHG**	20 FL	16 FL	-4FL -20%	=
M1.2 Difference of Flight levels at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS trajectory	17 FL	18 FL	+1FL +6%	=
SID procedure **aligned before CHG**	18 FL	18 FL	0FL	=
SID procedure ***not aligned*** **before CHG**	16 FL	18 FL	+2FL +13%	=
M1.3 Considering all named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Flight levels	9 FL	9 FL	0%	=
SID procedure **aligned before CHG**	8 FL	8 FL	0%	=
SID procedure ***not aligned*** before **CHG**	9FL	10 FL	+1FL +11%	=
M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory	67 s	36 s	-31s -46%	=
SID procedure **aligned before CHG**	40 s	32 s	-8s -20%	=
SID procedure ***not aligned*** **before CHG**	100 s	41 s	-59s -59%	=

Average values [18 flight plan updates for 18 flights (9 Short Haul / 9 Medium/Long Haul)]	Before SID Update	After SID Update	Deviation	Impact on the Val. Obj
M2.2 Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS	119 s	91 s	-28s -24%	=
SID procedure **aligned before CHG**	105 s	86 s	-19s -18%	=
SID procedure ***not aligned*** **before CHG**	136 s	97 s	-39s -29%	=
M2.3 Considering all points in common between the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Estimated Elapsed Time (EET)	82 s	53 s	-29s -35%	=
SID procedure **aligned before CHG**	61 s	51 s	-10s -16%	=
SID procedure ***not aligned*** **before CHG**	107 s	56 s	-51s -48%	=
M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the AU 4D Trajectory and the ETFMS trajectory	251 s	190 s	-61s -24%	+
SID procedure **aligned before CHG**	224 s	229 s	+5s +2%	=
SID procedure ***not aligned*** **before CHG**	286 s	142 s	-144s -50%	+
M3.1 Number of named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory	31	30	-1 3%	=
SID procedure **aligned before CHG**	36	33		
SID procedure ***not aligned*** **before CHG**	25	27		

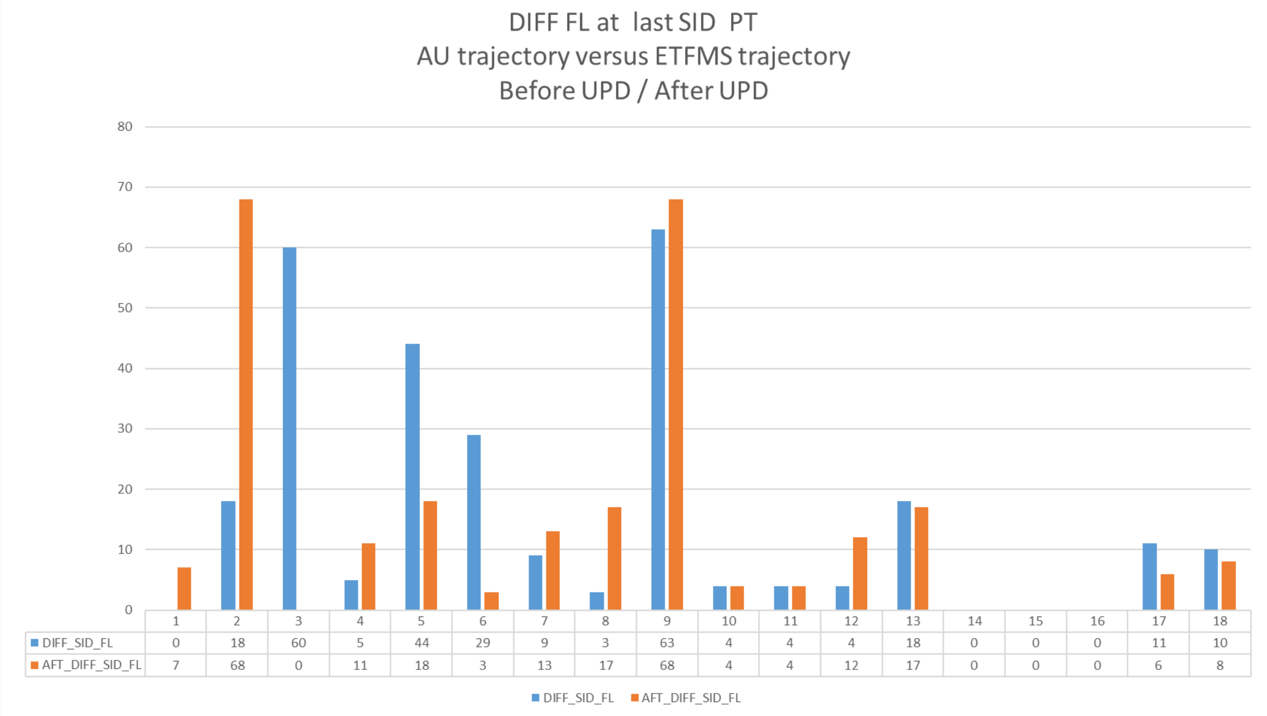
With the "SID update only", between the AU 4D Trajectory and the NM planned trajectory (ETFMS),

Due to the low number of updates, the results are not representative.

The average results are not significant for the alignment of the EET / FL in the SID & STAR procedures neither for the points in common on the trajectory.

The trend is a significant improvement for the alignment of the Arrival Time, in particular when the SID procedure before the CHG update was not aligned.

In average, the results are not significant while some flight plan updates illustrate significant improvements. In next figures, for 18 SID updates (15 flights), for each metric, *the left bar* is the metric **before** the flight plan change with SID update, *the right bar* is the metric **after** the flight plan change with SID update.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
■ DIFF_SID_FL	0	18	60	5	44	29	9	3	63	4	4	4	18	0	0	0	11	10
■ AFT_DIFF_SID_FL	7	68	0	11	18	3	13	17	68	4	4	12	17	0	0	0	6	8

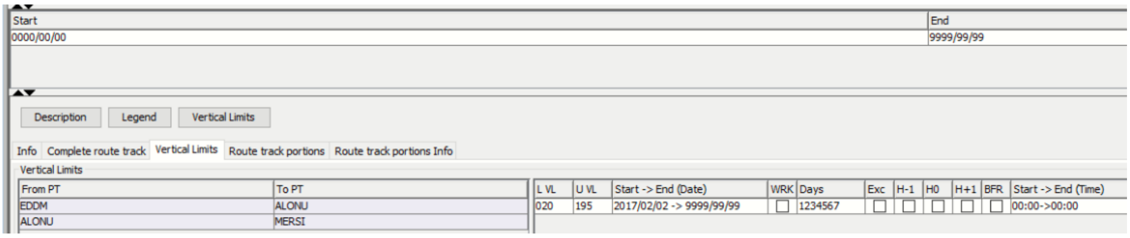
Figure 18: Before/After SID update, FL difference at last SID point between AU trajectory and ETFMS trajectory

The difference of Flight levels at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory is slightly reduced:

- Case 3: full reduction of the difference of Flight Levels.
- Cases 5,6: significant reduction of the difference of Flight Levels (-70% in average).
- Cases 14, 15, 16: No difference of Flight Level before and after the SID Update.

For case 2: degradation of the Flight level difference

The difference of Flight levels at the last point (MERSI) of the SID procedure is due to a FL level restriction not implemented in the AU trajectory (SID MERSI4E - MERSI max FL195). Before the SID update, the AU trajectory requests FL213 on point MERSI for SID MERSI6N. After the SID update, the AU trajectory requests FL265 on point MERSI for SID MERSI4E.



Start	End
0000/00/00	9999/99/99

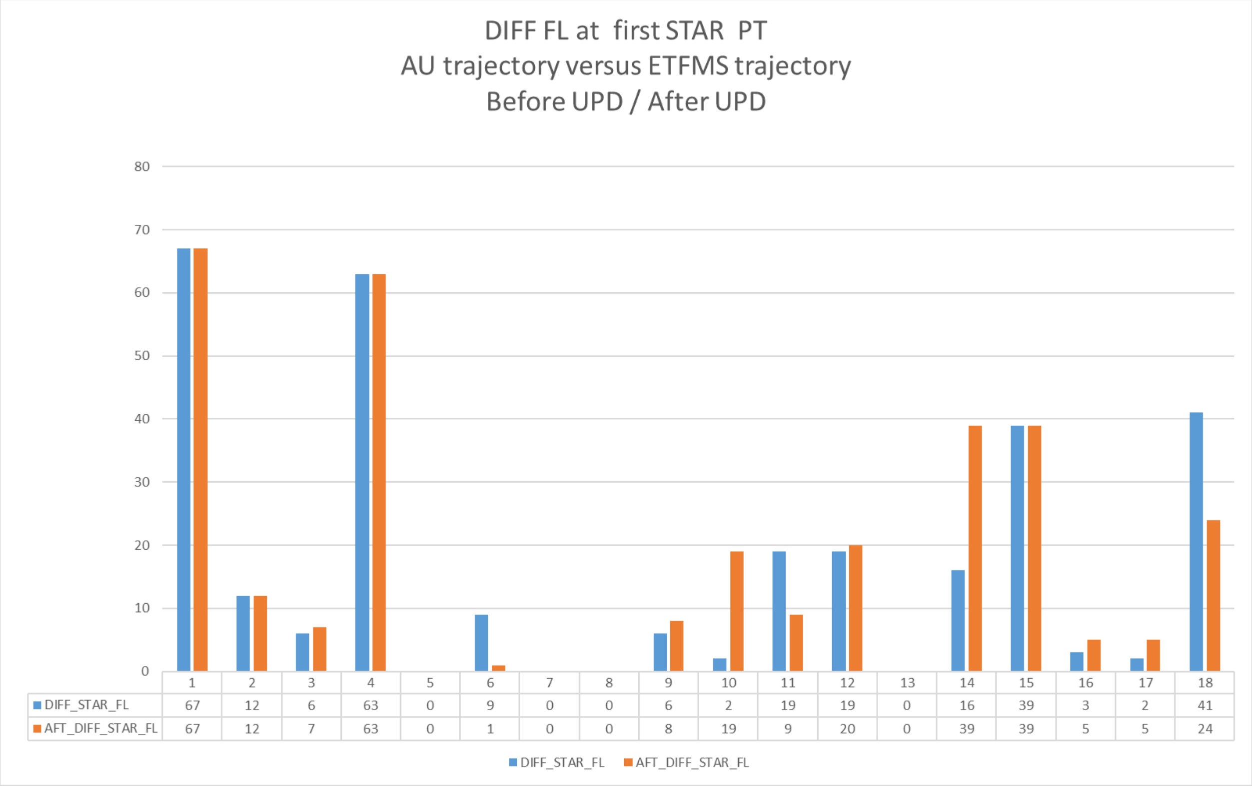
Vertical Limits

From PT	To PT
EDDM	ALONU
ALONU	MERSI

L VL	U VL	Start -> End (Date)	WRK	Days	Exc	H-1	H0	H+1	BFR	Start -> End (Time)
020	195	2017/02/02 -> 9999/99/99	☐	1234567	☐	☐	☐	☐	☐	00:00->00:00

Figure 19: SID restriction definition for SID procedure MERSI4E

	For the other cases (11 flight plan updates), no significant improvement / degradation of Flight Level difference between AU trajectory and ETFMS trajectory at the last SID point.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
DIFF_STAR_FL	67	12	6	63	0	9	0	0	6	2	19	19	0	16	39	3	2	41
AFT_DIFF_STAR_FL	67	12	7	63	0	1	0	0	8	19	9	20	0	39	39	5	5	24

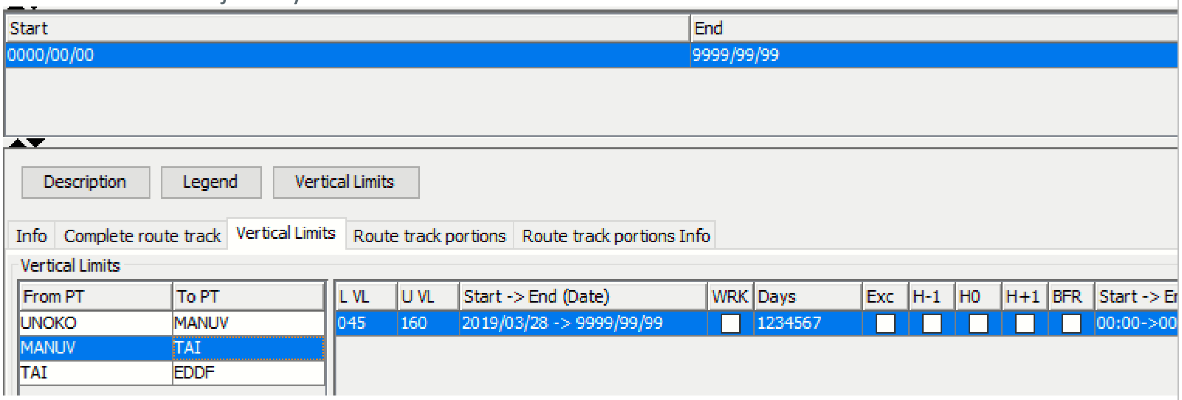
Figure 20: Before/After SID update, FL difference at first STAR point between AU trajectory and ETFMS trajectory

No significant improvement / degradation of FL difference at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS trajectory.

Only case 14 shows an degradation of the FL difference due to Vertical Limits in the STAR definition not implemented:

Non-implementation of the Vertical Limits in the STAR definition UNOKO3M – Point MANUV FL max 160. AU trajectory requested level FL194 on the point MANUV and FL230 on point UNOKO.

ETFMS trajectory → UNOKO FL191.



Start	End
0000/00/00	9999/99/99

From PT	To PT
UNOKO	MANUV
MANUV	TAI
TAI	EDDF

L VL	U VL	Start -> End (Date)	WRK	Days	Exc	H-1	H0	H+1	BFR	Start -> E
045	160	2019/03/28 -> 9999/99/99	☐	1234567	☐	☐	☐	☐	☐	00:00->00

Figure 21: SID restriction definition for SID procedure UNOKO3M

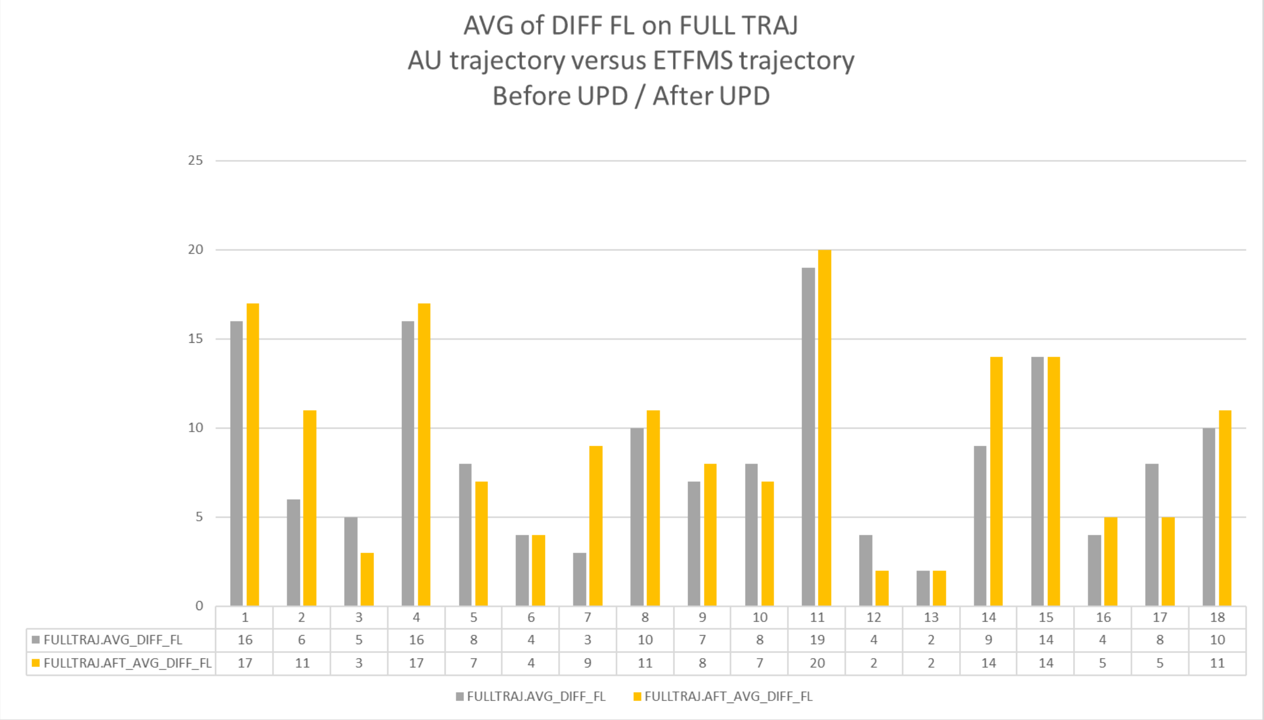


Figure 22: Before/After SID update, Average of the FL difference for named trajectory points both in AU and ETFMS trajectories

Considering all named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory, no significant improvement / degradation of FL difference.

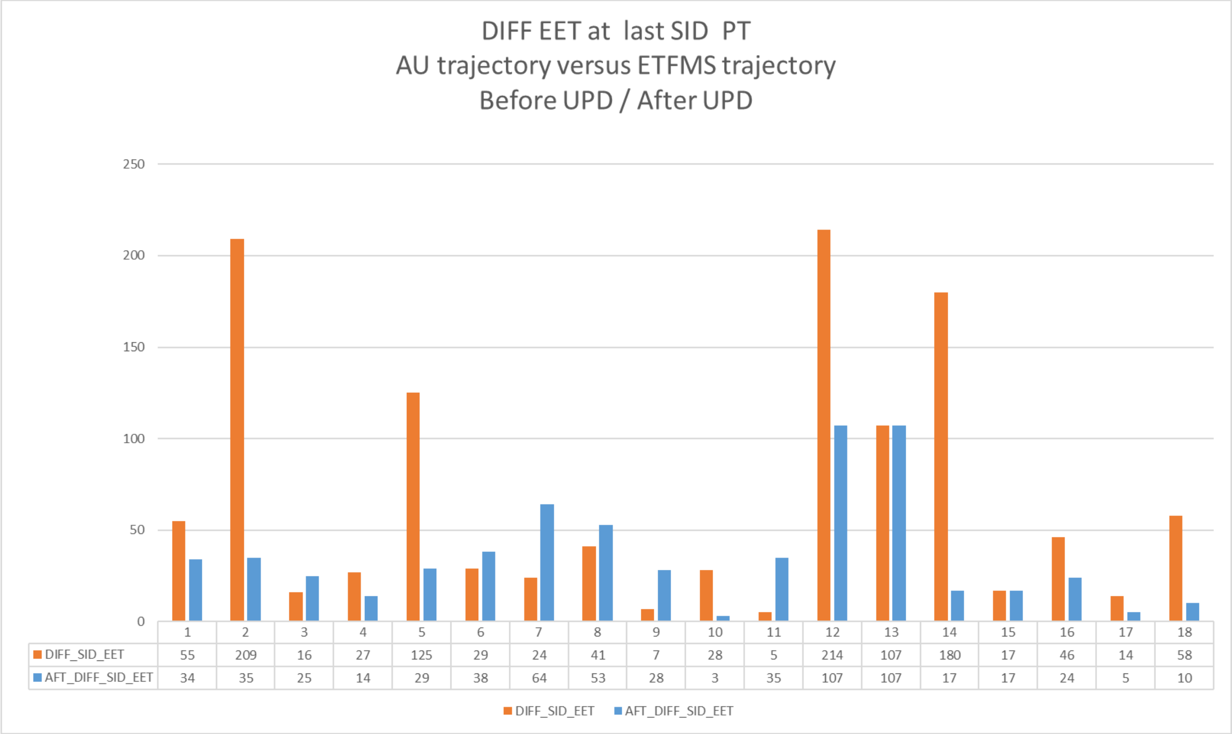
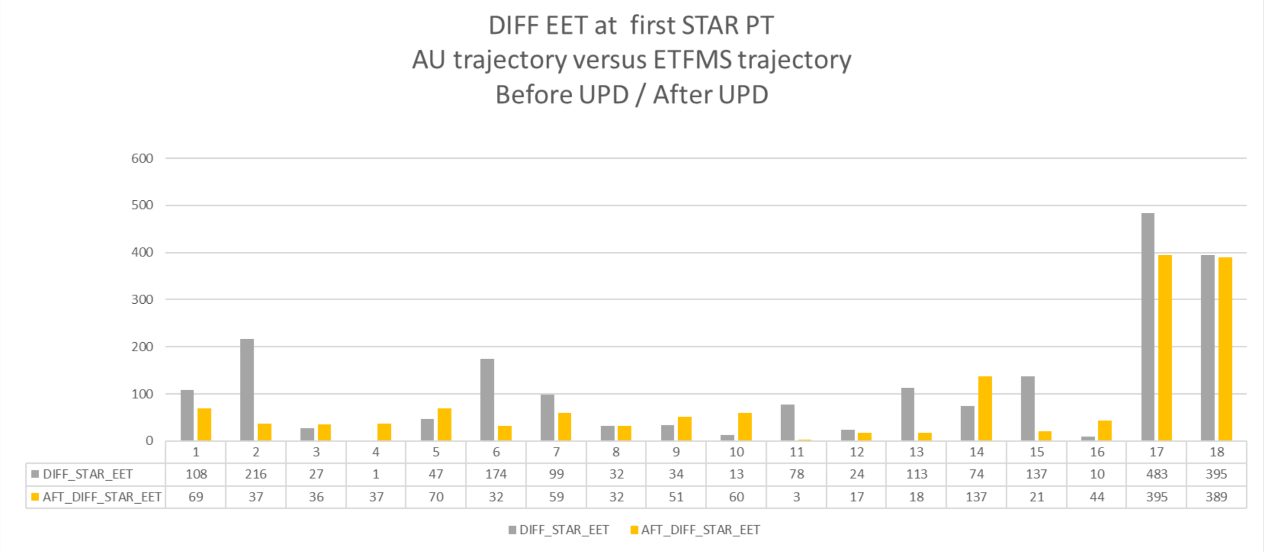


Figure 23: Before/After SID update, EET difference at last SID point between AU trajectory and ETFMS trajectory

The Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS is reduced:

- In 22% of the cases (Cases 2, 5, 12, 14), significant reduction (above 60s) of the difference of EET (-75% in average)
- For the other cases, no significant improvement / degradation.

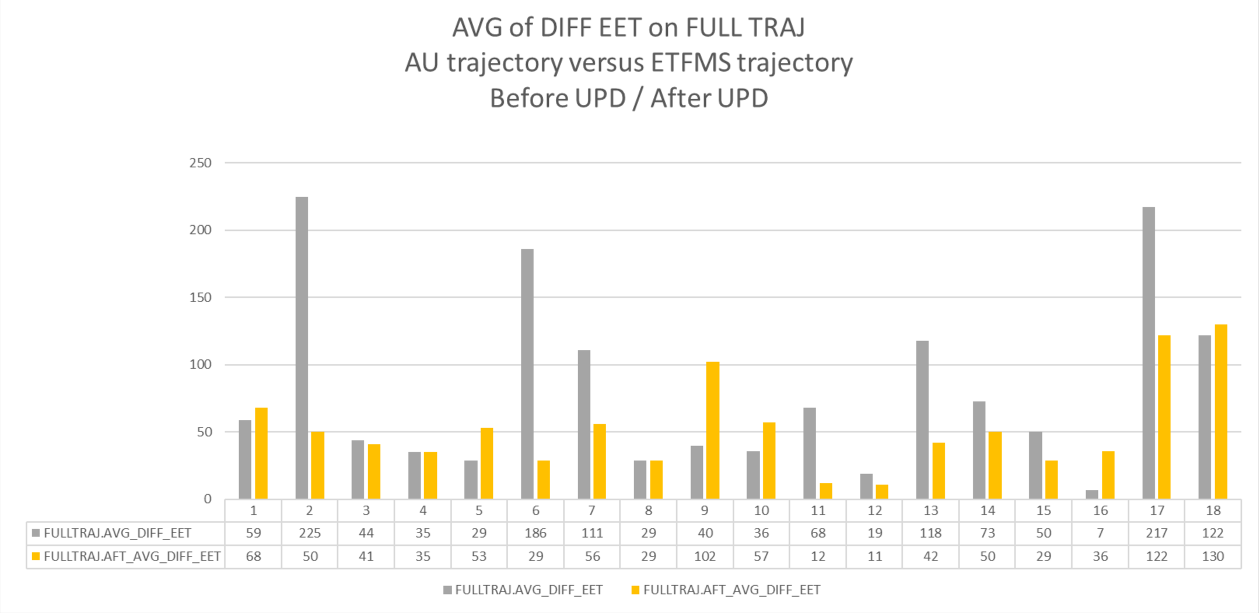


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
■ DIFF_STAR_EET	108	216	27	1	47	174	99	32	34	13	78	24	113	74	137	10	483	395
■ AFT_DIFF_STAR_EET	69	37	36	37	70	32	59	32	51	60	3	17	18	137	21	44	395	389

Figure 24: Before/After SID update, EET difference at first STAR point between AU trajectory and ETFMS trajectory

The Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS is reduced:

- In 33% of the cases (Cases 2, 6, 11, 13, 15, 17), significant reduction of the difference of EET (-75% in average)
- For the other cases, no significant improvement / degradation.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
FULLTRAJ.AVG_DIFF_EET	59	225	44	35	29	186	111	29	40	36	68	19	118	73	50	7	217	122
FULLTRAJ.AFT_AVG_DIFF_EET	68	50	41	35	53	29	56	29	102	57	12	11	42	50	29	36	122	130

Figure 25: Before/After SID update, Average of the EET difference for named trajectory points both in AU trajectory and ETFMS trajectory

Considering all points in common between the AU 4D Trajectory and the ETFMS trajectory, the Difference of Estimated Elapsed Time (EET) is reduced:

- In 27% of the cases (Cases 2, 6, 7, 13, 17), significant reduction of the difference of EET (-64% in average)
- For the other cases, no significant improvement / degradation (except case 9)

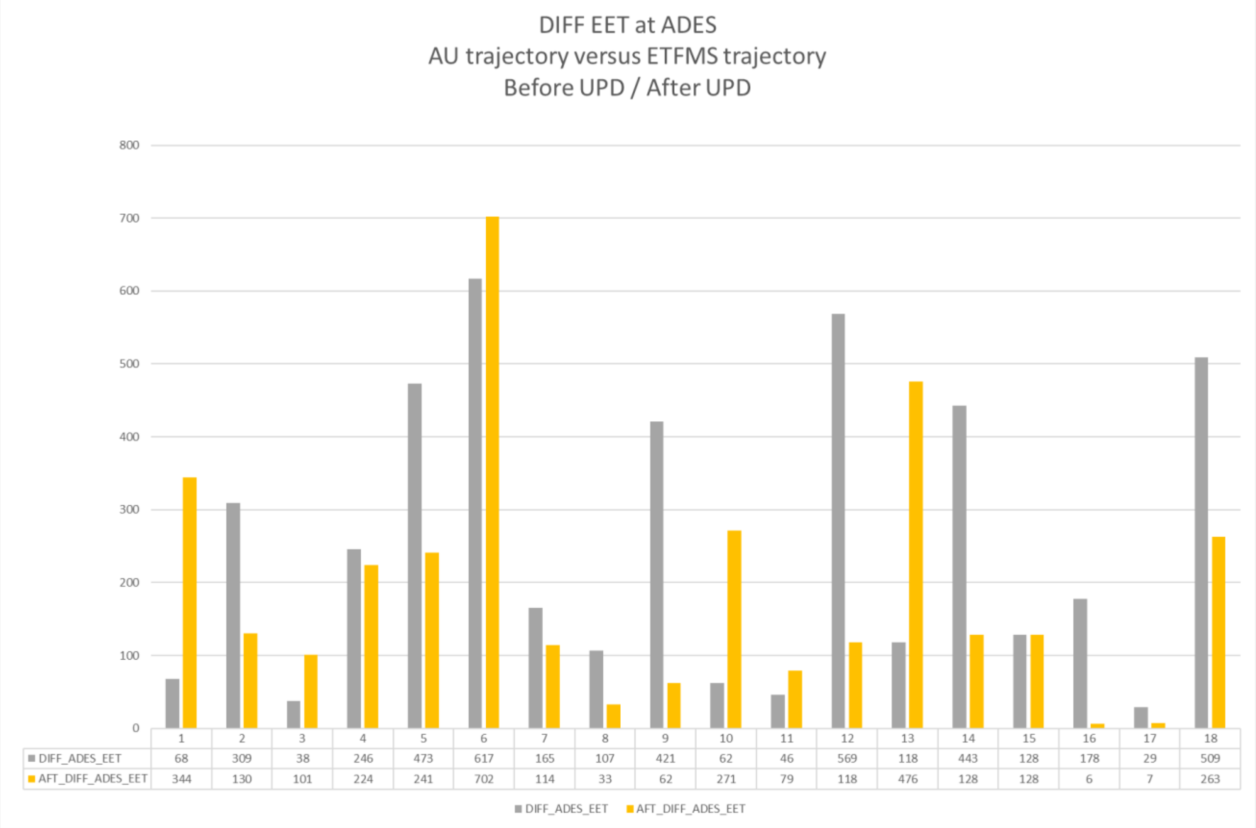


Figure 26: Before/After SID update, EET difference at ADES between AU trajectory and ETFMS trajectory

The Difference of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the AU 4D Trajectory and the ETFMS trajectory is reduced in 39% of the cases (cases 2, 5, 9, 12, 14, 16, 18) by -70% in average.

The Difference of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the AU 4D Trajectory and the ETFMS trajectory is degraded in the following cases:

Case 1 & 10: part of the EFPL trajectory in the B2B request message has been discarded by ETFMS ("Scaling trajectory" Error message returned to FOC).
Case 6: STAR procedure mis-alignment.
Case 13: part of the EFPL trajectory in the B2B request message has been discarded by ETFMS (points not on route).

Filter 2: "STAR update only" (including Arrival Runway updates)

RMK field	"STAR update only" (including Arrival Runway updates)
Reference dataset	Same first STAR point in AU 4D trajectory vs ETFMS trajectory (STAR procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory) Same last SID point in AU 4D trajectory vs ETFMS trajectory (SID procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory)
Scenario dataset	STAR procedure *identical* in AU 4D trajectory vs ETFMS trajectory (same first STAR point) Same last SID point in AU 4D trajectory vs ETFMS trajectory (SID procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory)

Average values [20 updates for 20 flights (5 Short Haul / 15 Medium/Long Haul]	Before STAR Update	After STAR Update	Variation	Impact on the Val. Obj
M1.1 Difference of Flight levels at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory	24 FL	25 FL	+1FL +4%	=
M1.2 Difference of Flight levels at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS trajectory	37 FL	42 FL	+5FL +14%	=
M1.3 Considering all named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Flight levels	10 FL	12 FL	+2FL +20%	=
M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS	58 s	55 s	-3s -5%	=
M2.2 Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS	104 s	123 s	+19s +18%	=
M2.3 Considering all points in common between the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Estimated Elapsed Time (EET)	89 s	80 s	-9s -10%	=
M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the AU 4D Trajectory and the ETFMS trajectory	211 s	229 s	+18s +8%	=

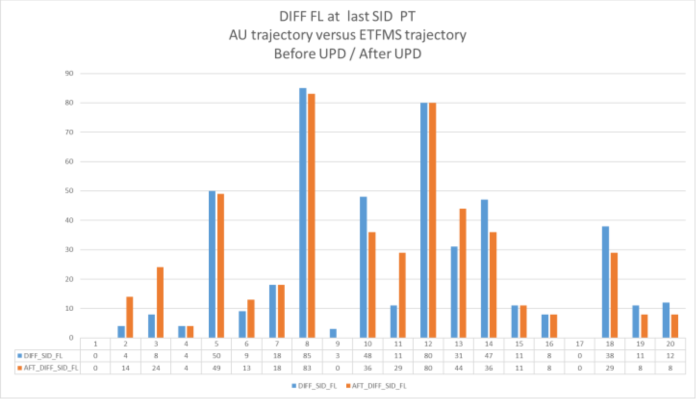
M3.1 Number of named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory	36	36	0%	=

With the "STAR update only", between the AU 4D Trajectory and the NM planned trajectory (ETFMS),

> ***Due to the low number of updates, the results are not representative.***
>
> ***The average results are not significant for the alignment of the EET / FL in the SID & STAR procedures neither for the points in common on the trajectory.***
>
> ***The average results are not significant for the alignment of the Arrival Time.***

With the filter 2, the STAR procedure is aligned in AU 4D trajectory vs ETFMS trajectory *after* the Flight Dispatcher update. No specific filter is applied on the STAR procedure *before* the update (STAR procedure is *aligned* **or** *not aligned*). The average results are not significant. The filter 2.1 in the next part focuses on the STAR procedure *not aligned* in common in AU 4D trajectory vs ETFMS trajectory *before* the Flight Dispatcher update, demonstrating the interest to include the STAR procedure update.

In average the results are not significant while some flight plan updates illustrate significant improvements and degradations: in next figures, for 20 STAR updates (20 flights), for each metric, *the left bar* is the metric **before** the flight plan change with STAR update, *the right bar* is the metric **after** the flight plan change with STAR update.

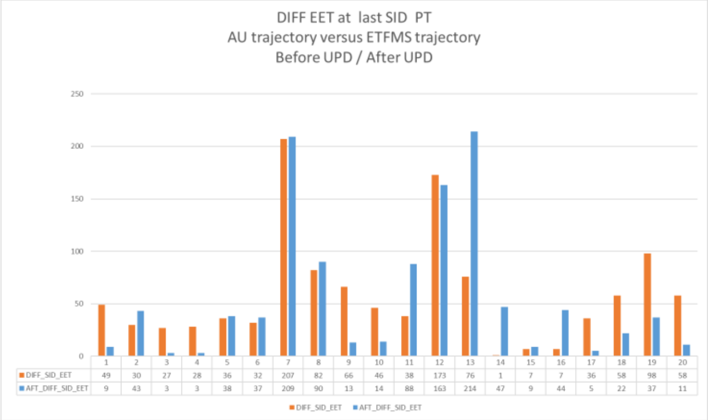


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
■ DIFF_SID_FL	0	4	8	4	50	9	18	85	3	48	11	80	31	47	11	8	0	38	11	12
■ AFT_DIFF_SID_FL	0	14	24	4	49	13	18	83	0	36	29	80	44	36	11	8	0	29	8	8

Figure 27: Before/After STAR update, FL difference at last SID point between AU trajectory and ETFMS trajectory

Improvement: In 10 % of the cases, significant reduction (above 10FL) of the difference for FL on SID procedure (-24% in average)

Degradation: For cases2, 3, 13, the Vertical Limits in the SID definition at the last SID point has not been implemented.

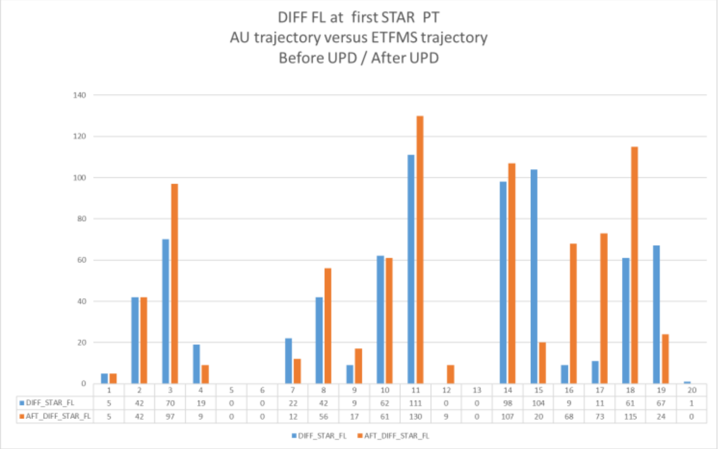


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
■ DIFF_SID_EET	49	30	27	28	36	32	207	82	66	46	38	173	76	1	7	7	36	58	98	58
■ AFT_DIFF_SID_EET	9	43	3	3	38	37	209	90	13	14	88	163	214	47	9	44	5	22	37	11

Figure 28: Before/After STAR update, EET difference at last SID point between AU trajectory and ETFMS trajectory

Improvement: No significant cases.

Degradation: For Case 13, deviation (138 FL at SID point) is due to a misalignment of the SID.

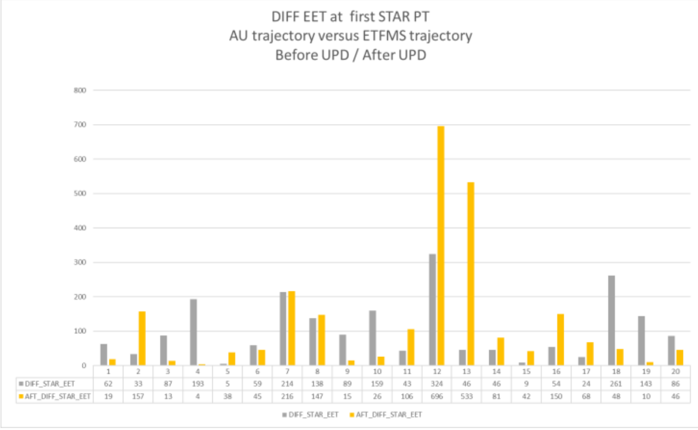


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
■ DIFF_STAR_FL	5	42	70	19	0	0	22	42	9	62	111	0	0	98	104	9	11	61	67	1
■ AFT_DIFF_STAR_FL	5	42	97	9	0	0	12	56	17	61	130	9	0	107	20	68	73	115	24	0

Figure 29: Before/After STAR update, FL difference at first STAR point between AU trajectory and ETFMS trajectory

Improvement: In 20 % of the cases, significant reduction (above 10FL) of the difference for FL on STAR procedure (-61% in average).

Degradation: For Case 18, deviation (54 FL at first STAR point) is due to the non-implementation of the Flight restriction at the STAR first point.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
■ DIFF_STAR_EET	62	33	87	193	5	59	214	138	89	159	43	324	46	46	9	54	24	261	143	86
■ AFT_DIFF_STAR_EET	19	157	13	4	38	45	216	147	15	26	106	696	533	81	42	150	68	48	10	46

Figure 30: Before/After STAR update, EET difference at first STAR point between AU trajectory and ETFMS trajectory

Improvement: In 30 % of the cases, significant reduction (above 60s) of the difference for EET on STAR procedure (-87% in average).

Degradation: For Case 12, 13, deviation (372s for EET at first STAR point) is due to a misalignment of the SID

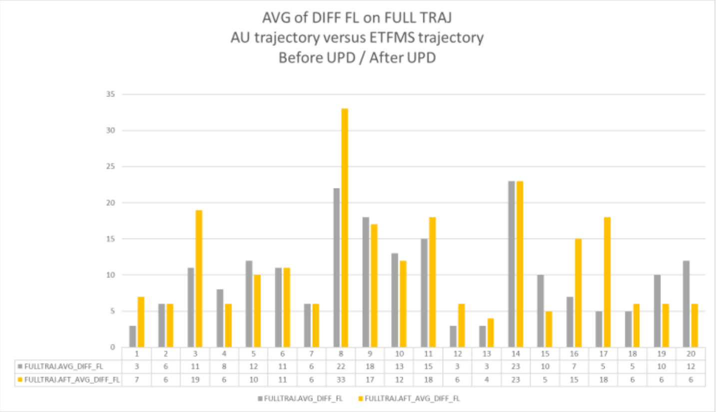


Figure 31: Before/After STAR update, Average of the FL difference for named trajectory points both in AU and ETFMS trajectories

Improvement: No significant cases.

Degradation:

For Case 3 and 8, deviation (Avg FL differences for full trajectory) is due to part of the trajectory discarded by ETFMS (points not on route);

For Cases 16, 17, the Vertical Limits in the STAR definition at the first point of the STAR is not implemented.

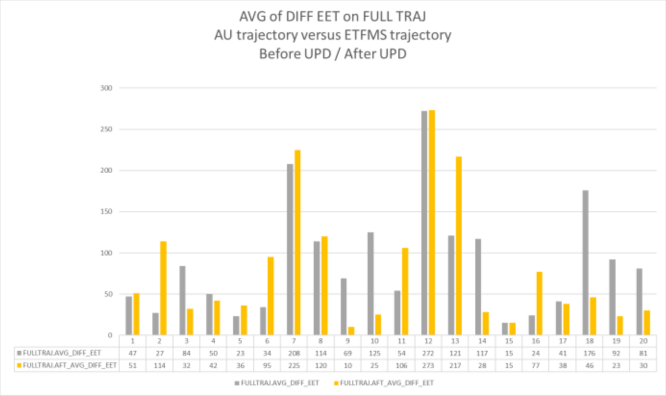


Figure 32: Before/After STAR update, Average of the EET difference for named trajectory points both in AU trajectory and ETFMS trajectory

Improvement: In 25% of the cases, significant reduction (above 60s) of the difference for average EET differences for named points in common on the trajectories (-78% in average).

Degradation: In 20% of the cases, increase by +200% of the Average EET differences for full trajectory. No explanation have been highlighted for those misalignments. Further investigation required.

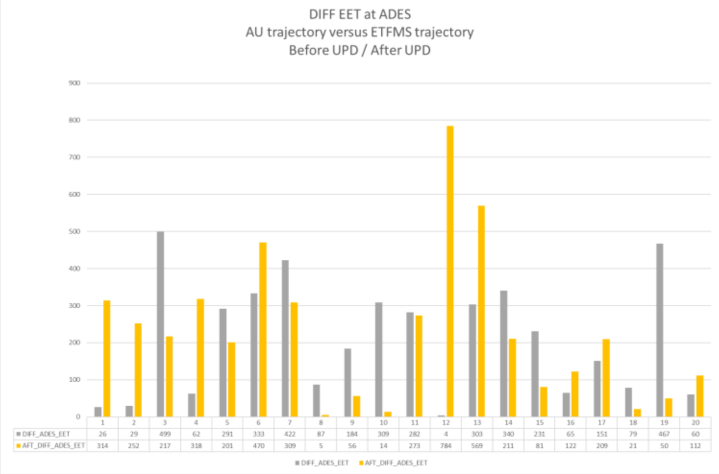


Figure 33: Before/After STAR update, EET difference at ADES between AU trajectory and ETFMS trajectory

Improvement: In 45% of the cases (3, 5, 7, 8, 9, 10, 14, 15, 19), significant reduction (above 60s) of the difference for Arrival Time (-63% in average).

Degradation: for cases 1, 2, 4, 6, 12, 13:

	For case 12 and 13, arrival at LLBG (Tel Aviv). STAR information in ETFMS not relevant to compute the Arrival Time with the right runway as LLBG was not part of the setup exercise. Similar justification of misalignment for the cases 1, 2, 4 with arrival airports like EDDM, EHAM, LFPG.

Filter 2.1: “STAR update with misalignment of the STAR procedure before the Flight Dispatcher update” (including Arrival Runway updates)

COMPARISON WITH FILTER 2:

This filter selects a misalignment on the STAR procedure *before* the update and aligns the STAR procedure in AU 4D trajectory vs ETFMS trajectory *after* the Flight Dispatcher update.

RMK field	**“STAR update only” (including Arrival Runway updates)**
Reference dataset	STAR procedure *not identical* in AU 4D trajectory vs ETFMS trajectory. Same first STAR point in AU 4D trajectory vs ETFMS trajectory Same last SID point in AU 4D trajectory vs ETFMS trajectory (SID procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory)
Scenario dataset	STAR procedure *identical* in AU 4D trajectory vs ETFMS trajectory (same first STAR point) Same last SID point in AU 4D trajectory vs ETFMS trajectory (SID procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory)

Average values [9 updates for 9 flights (2 Short Haul / 7 Medium/Long Haul)]	Before STAR Update	After STAR Update	Variation	Impact on the Val. Obj
M1.1 Difference of Flight levels at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory	23 FL	24 FL	+1FL +4%	=
M1.2 Difference of Flight levels at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS trajectory	59 FL	56 FL	-3FL -5%	=
M1.3	12 FL	11 FL	-1FL	=

Average values [9 updates for 9 flights (2 Short Haul / 7 Medium/Long Haul)]	Before STAR Update	After STAR Update	Variation	Impact on the Val. Obj
Considering all named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Flight levels			-8%	
M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS	59 s	52 s	-7s -12%	=
M2.2 Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS	99 s	67 s	-32 s -32%	=
M2.3 Considering all points in common between the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Estimated Elapsed Time (EET)	94 s	60 s	-34 s -36%	=
M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the AU 4D Trajectory and the ETFMS trajectory	297 s	164 s	-133 s -45%	+
M3.1 Number of named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory	30	33	+10%	+

With the "alignment of the STAR procedure after the CHG" (STAR procedure not aligned before the CHG), between the AU 4D Trajectory and the NM planned trajectory (ETFMS),

> ***Due to the low number of updates, the results are not representative.***
>
> ***The trend is a significant improvement for the alignment of the Arrival Time. The average results for the FL alignment are not significant (neither SID/STAR procedures, neither points in common on the full trajectory).***
>
> ***Compared to the filter 2, this filter demonstrates the benefit of the EET alignment of the STAR procedure in AU 4D trajectory vs ETFMS trajectory.***

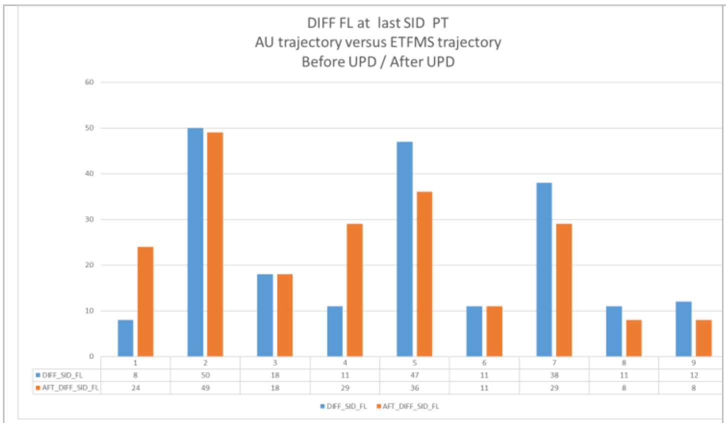
In average the results are not significant while some flight plan updates illustrate significant improvements: in next figures, for 9 STAR updates (9 flights), for each metric, *the left bar* is the metric **before** the flight plan change with STAR update, *the right bar* is the metric **after** the flight plan change with STAR update.

- Figure 37: in 33% of the cases, significant reduction (above 60s) of the difference for EET on STAR procedure (-87% in average)

- Figure 39: in 33% of the cases, significant reduction (above 60s) of the difference for average EET on the full trajectory (-75% in average)
- Figure 40: In 78% of the cases, significant reduction (above 60s) of the difference for Arrival Time (-54% in average).

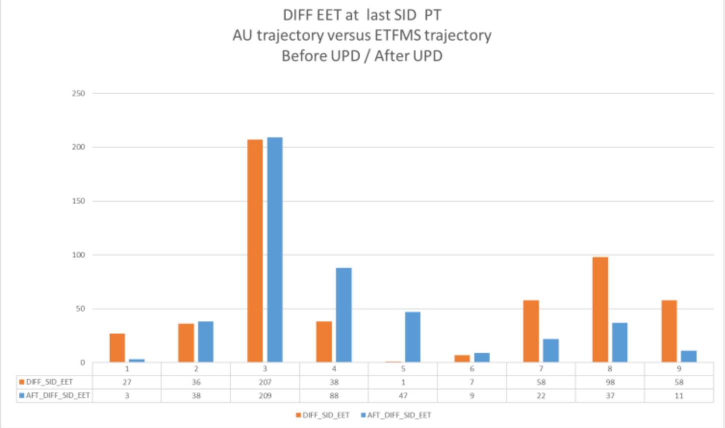
No major negative deviations for the EET success criteria are visible in this dataset.

Some negative deviations for the FL success criteria have their origin in the non-implementation of the Vertical Limits in the STAR definition at the first STAR point.



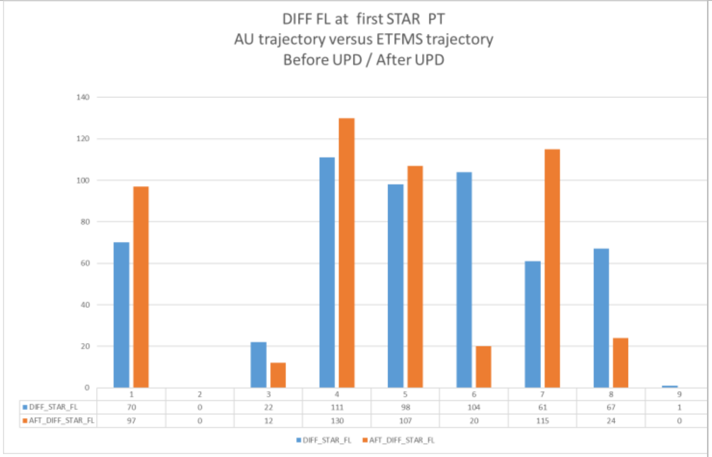
	1	2	3	4	5	6	7	8	9
■ DIFF_SID_FL	8	50	18	11	47	11	38	11	12
■ AFT_DIFF_SID_FL	24	49	18	29	36	11	29	8	8

Figure 34: Before/After SID update, FL difference at last SID point between AU trajectory and ETFMS trajectory



	1	2	3	4	5	6	7	8	9
■ DIFF_SID_EET	27	36	207	38	1	7	58	98	58
■ AFT_DIFF_SID_EET	3	38	209	88	47	9	22	37	11

Figure 35: Before/After SID update, EET difference at last SID point between AU trajectory and ETFMS trajectory



	1	2	3	4	5	6	7	8	9
■ DIFF_STAR_FL	70	0	22	111	98	104	61	67	1
■ AFT_DIFF_STAR_FL	97	0	12	130	107	20	115	24	0

Figure 36: Before/After SID update, FL difference at first STAR point between AU trajectory and ETFMS trajectory

Degradation: For cases 1, 6, 7, the Vertical Limits in the STAR definition at the first point of the STAR is not implemented.

	1	2	3	4	5	6	7	8	9
■ DIFF_STAR_EET	87	5	214	43	46	9	261	143	86
■ AFT_DIFF_STAR_EET	13	38	216	106	81	42	48	10	46

Figure 37: Before/After SID update, EET difference at first STAR point between AU trajectory and ETFMS trajectory

Improvement: in 33% of the cases, significant reduction (above 60s) of the difference for EET on STAR procedure (-87% in average)

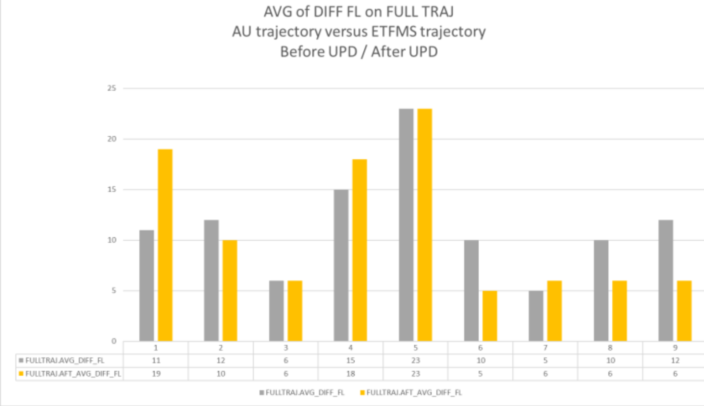


Figure 38: Before/After SID update, Average of the FL difference for named trajectory points both in AU and ETFMS trajectories

Figure 39: Before/After SID update, Average of the EET difference for named trajectory points both in AU trajectory and ETFMS trajectory

Improvement : in 33% of the cases, significant reduction (above 60s) of the difference for average EET on the full trajectory (-75% in average)

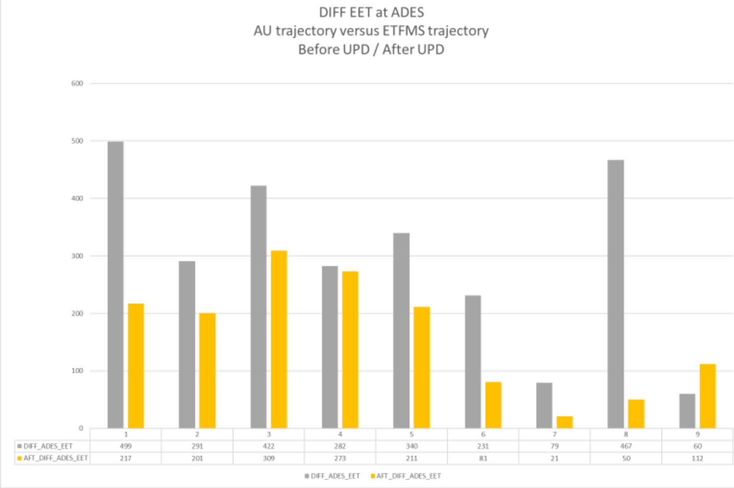


Figure 40: Before/After SID update, EET difference at ADES between AU trajectory and ETFMS trajectory

Improvement: In 78% of the cases, significant reduction (above 60s) of the difference for Arrival Time (-54% in average).

Filter 3: "SID / STAR updates" including Runway updates

This filter focuses on AU Flight Dispatcher Updates managing SID and STAR updates in the same CHG message. It does not represent the general results for the SID & STAR updates, as these both updates could be done with two consecutives AU 4D trajectory updates by the Flight Dispatcher.

The analysis is provided here because some “SID & STAR” updates have been done in the same AU 4D Trajectory Update by Flight Dispatchers.

Representativeness of the results filter 3: only two AU flight Dispatcher Updates are available in the Dataset. The results are provided for information only.

RMK field	“SID / STAR updates” including Runway updates of Departure and Arrival airports
Reference dataset	SID procedure *identical or not* in AU 4D trajectory vs ETFMS trajectory, with same last SID point STAR procedure *identical or not* in AU 4D trajectory vs ETFMS trajectory, with same first STAR point
Scenario dataset	SID procedure *identical* in AU 4D trajectory vs ETFMS trajectory, with same last SID point STAR procedure *identical* in AU 4D trajectory vs ETFMS trajectory (same first STAR point)

Average values [2 updates for 2 flights]	Before SID / STAR Update	After SID / STAR Update	Variation	Impact on the Val. Obj
M1.1 Difference of Flight levels at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory	9 FL	2 FL	-7FL -77%	=
M1.2 Difference of Flight levels at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS trajectory	1 FL	13 FL	+12FL (+1200%)	-
M1.3 Considering all named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Flight levels	14 FL	9 FL	-3FL -36%	=
M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS	62 s	13 s	-49 s -79%	=
M2.2	98 s	10 s	-88 s -90%	+

Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS				
M2.3 Considering all points in common between the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Estimated Elapsed Time (EET)	97 s	36 s	-61 s -63%	+
M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the AU 4D Trajectory and the ETFMS trajectory	249 s	209 s	-40 s -16%	=
M3.1 Number of named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory	26	28	+2 +7%	+

With the “SID/STAR updates” including Departure and Arrival Runway updates,

Due to the low number of updates, the results are not representative.

The improvement is significant for the EET alignment of the STAR procedure, as well as the full trajectory.

The average results are not significant for the FL deviation for the SID/STAR procedures and the Arrival Time.

In next figures below, for 2 SID/STAR updates (2 flights), for each metric, *the left bar* is the metric **before** the flight plan change with Arrival Runway update, *the right bar* is the metric **after** the flight plan change with Arrival Runway update

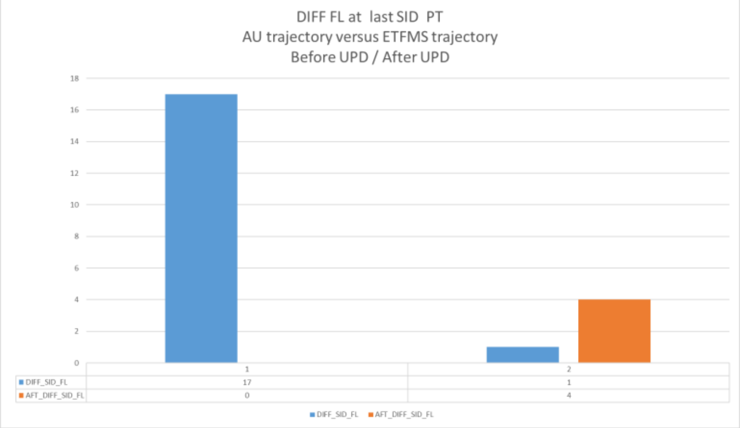


Figure 41: Before/After SID update, FL difference at last SID point between AU trajectory and ETFMS trajectory

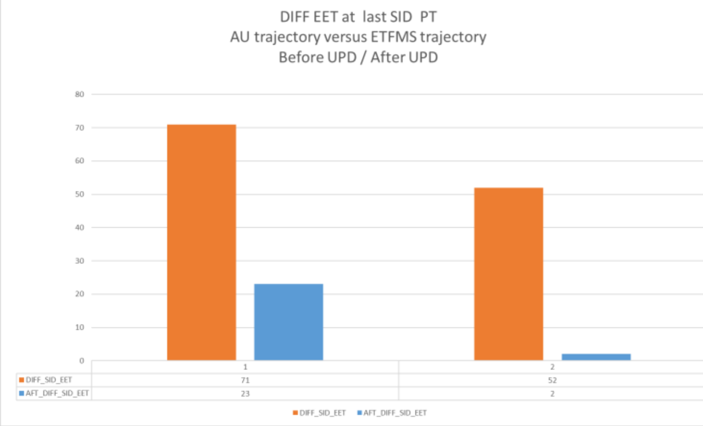


Figure 42: Before/After SID update, EET difference at last SI point between AU trajectory and ETFMS trajectory

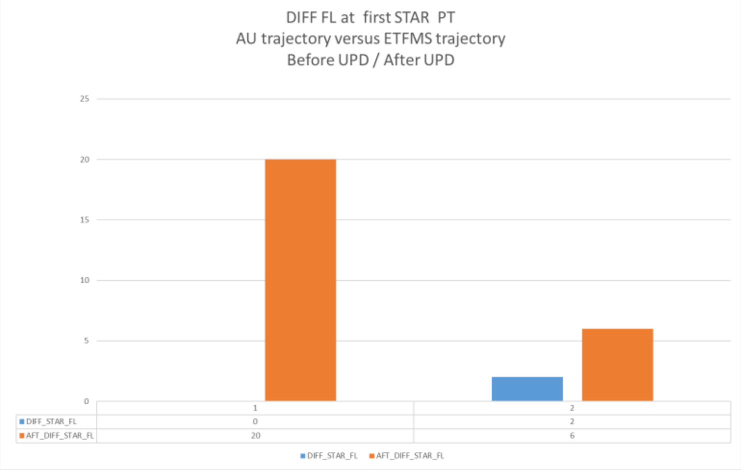


Figure 43: Before/After SID update, FL difference at first STAR point between AU trajectory and ETFMS trajectory

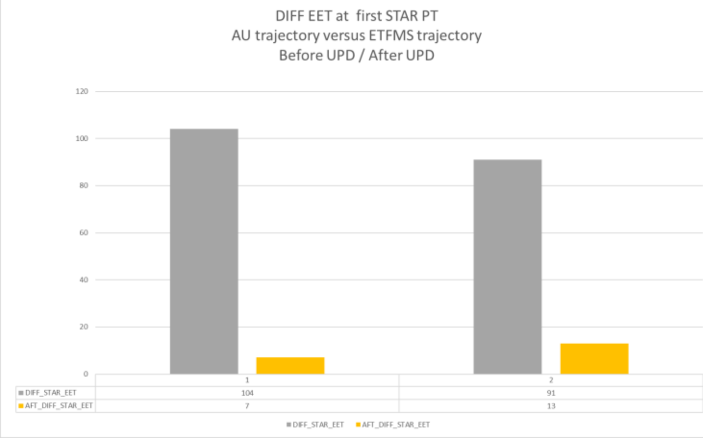


Figure 44: Before/After SID update, EET difference at first STA point between AU trajectory and ETFMS trajectory

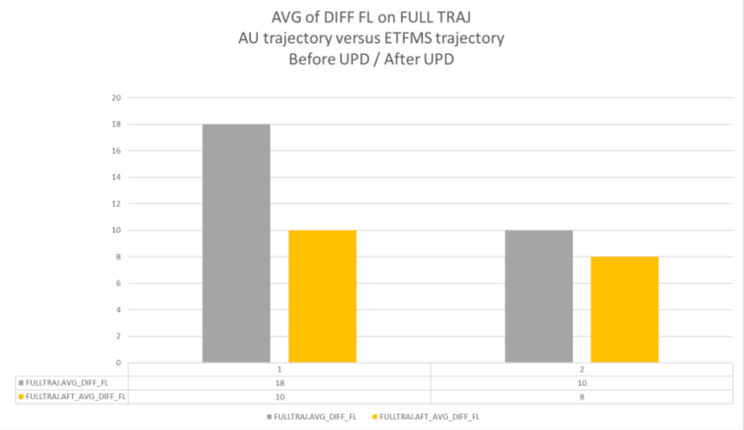


Figure 45: Before/After SID update, Average of the FL difference for named trajectory points both in AU and ETFMS trajectories

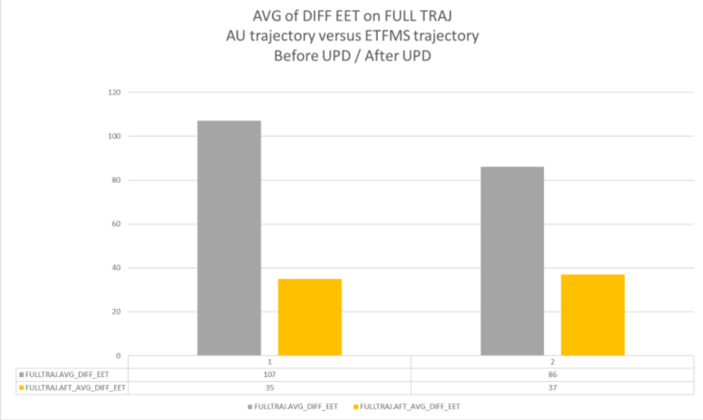


Figure 46: Before/After SID update, Average of the EET differenc for named trajectory points both in AU trajectory and ETFM trajectory

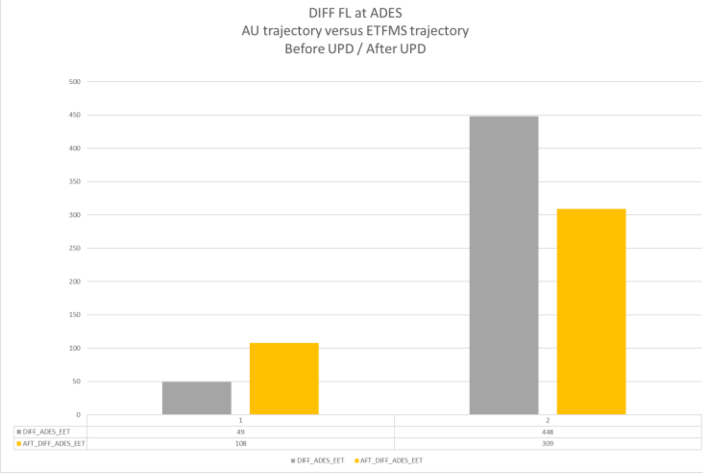


Figure 47: Before/After SID update, EET difference at ADE between AU trajectory and ETFMS trajectory

CONCLUSION

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF11-001:

Due to the low number of flight dispatcher updates, the results are not representative. Below are expressed first the results in average for the full dataset (low significance) and then the results for individual cases with positive impact for the success criteria.

With metrics computed in average,

The integration of the dynamic SID / Runway updates on the eFPL demonstrated the following trend in the improvement of the AU Trajectory Alignment with NM systems:

For the situations with SID/Departure Runway updates,

- The average results are not significant for the alignment of the EET / FL in the SID & STAR procedures neither for the points in common on the trajectory.
- The trend is a significant improvement for the alignment of the Arrival Time, especially when the SID procedure before the CHG update was not aligned (Up to 24% of reduction of the Arrival Time difference at ADES – 61s in average).

For the situations with STAR / Arrival Runway updates,

- The average results are not significant for the alignment of the EET / FL in the SID & STAR procedures neither for the points in common on the trajectory.

- The average results are not significant for the alignment of the Arrival Time.

With the study of individual cases (those with positive impact with improvement above 10 FL / 60 seconds),

The integration of the dynamic SID/STAR on the eFPL demonstrated a significant trend in the improvement of the AU Trajectory Alignment with NM systems. The AU EFPL 4D planned trajectory computed with dynamic SID/STAR is closer to the NM planned trajectory (ETFMS) than the AU EFPL 4D planned trajectory computed without dynamic SID/STAR - It reduces the difference in four dimensions for multiple individual cases:

For the situations with SID/Departure Runway updates:

- Up to 70% of reduction of the difference of Flight Levels at last SID point (16% of the cases)
- Up to 75% of reduction of EET difference at last SID point (22% of the cases)
- Up to 76% of reduction of EET difference at last STAR point (33% of the cases)
- Up to 64% of reduction of EET difference for the trajectory point in common (27% of the cases).
- Up to 70% of reduction of Arrival Time difference at ADES (39% of the cases).

For the situations with STAR / Arrival Runway updates (especially when AU and NM trajectories are not aligned before the flight dispatcher update):

- Up to 61% of reduction of the difference of Flight Levels at first STAR point (22% of the cases).
- Up to 87% of reduction of the of EET difference on the first STAR point (33% of the cases).
- Up to 54% of reduction of Arrival Time difference at ADES (78% of the cases).

For the other individual cases,

Some degradation of the Alignment have been explained by the lack of implementation for Vertical Limits in the SID/STAR definition or the non-correctness of the AU 4D trajectory or the mis-alignment of the “other” procedure (SID misaligned when STAR is updated, STAR misaligned when the SID is updated).

For the remaining cases, the results of the metrics, analysed in average, does not demonstrate neither an improvement nor a degradation of the AU Trajectory alignment with NM systems.

C.3.2.5. EX3-OBJ-18.02c-TRL6-TVALP-OF10 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF10	To validate that the integration of dynamic SID updates in the eFPL improves NM DCB Traffic Predictability	EX3-CRT-18.02c-TRL6-VALP-OF10-001	Solution 18.02c provides evidence that the integration of the dynamic SID on the eFPL reduces the difference in 4 dimensions: the NM / ATC trajectory planned with dynamic SID included in eFPL trajectory is closer to the flown trajectory than the NM / ATC trajectory planned without dynamic SID.	The integration of the dynamic SID on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension. Due to the low number of flight dispatcher updates, the results are not representative.	PARTIALLY OK (Low representativeness)
		EX3-CRT-18.02c-TRL6-VALP-OF10-002	Solution 18.02c provides evidence that the Integration of the updated SID within the operational flight plan improves the predictability of the estimated landing time ELDT hence the airport planning is improved	The integration of the dynamic SID on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability of the estimated landing time ELDT. Due to the low number of flight dispatcher updates, the results are not representative.	PARTIALLY OK (Low representativeness)

DATA COLLECTION

On NMVP, ETFMS flight plans have been collected via the Operational Logs: these logs include the trajectory updates computed by ETFMS *for any events*.

The AU 4D trajectories (Flight plan Creation FPL, Flight plan Update CHG) sent via the B2B services have been collected.

For any trajectories, SID/STAR procedures have been identified.

Because the SID/ updates have been mainly performed during "the SID/TaxiTime/STAR Scenario (18/06/2019 10:00 - 12:30)", and to a lesser extent during the second TTA Scenario (small delay – 18/06/2019 14:30 – 17:00), we focused the analysis of the Validation Objectives on the day 18/06/2019. All flights have an EOBT on the 18/06/2019.

DATA LOGGING EXTRACTION

We identified the reason/purpose of an update sent by the dispatcher, via the CHG messages (extended flight plan update) mentioning the reason (RMK field), and the timestamp of the message.

From this timestamp, we identified the Reference and Scenario dataset for each flight:

- Reference dataset: we extracted the ETFMS computed trajectory, before the timestamp of the last SID update message done by the Flight Dispatcher. See C.1.3.1.b
- Scenario dataset: in addition to the AU 4D trajectory with Flight Dispatcher update, we identified the ETFMS computed trajectory based on the given AU 4D trajectory (CHG message). See C.1.3.2.b

The ETFMS trajectories from Reference and Scenario Datasets are compared to the ETFMS trajectory computed with the last CDM DPI message (seen as Flown trajectory, called *"ETFMS A-DPI Trajectory"*). See C.1.3.1.b, C.1.3.2.b

METRICS FOR PREDICTABILITY

We computed the following quantitative metrics for the Reference (before SID updates) and Scenario Datasets (with SID updates): for each flight, for each SID Updates from the flight dispatcher,

Predictability in altitude:

- M1.1 Difference of Flight levels at the last point of the SID procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.

- M1.2 Difference of Flight levels at the first point of the STAR procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.
- M1.3 Considering all named trajectory points both in the ETFMS trajectory and the ETFMS A-DPI trajectory, Average of the Difference of Flight levels.

Predictability in Elapsed Time:

- M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.
- M2.2 Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.
- M2.3 Considering all points in common between the ETFMS trajectory and the ETFMS A-DPI trajectory, Average of the Difference of Estimated Elapsed Time (EET)
- M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the ETFMS trajectory and the ETFMS A-DPI trajectory.

Predictability in named trajectory points

- M3.1 Number of named trajectory points both in the ETFMS trajectory and the ETFMS A-DPI trajectory.

Counts according to Duration of the flight

- Number of “Short Haul flights” (duration up to 90 minutes)
- Number of “Medium/Long Haul flights” (duration above 90 minutes)

For all these metrics, we analyse of the Deviation of the EET/FL differences for Reference / Scenario Datasets.

Success criteria	Metrics	Qualitative / quantitative
EX3-CRT-18.02c-TRL6-VALP-OF10-001	M1.1, M1.2 M2.1, M2.2 M3.1	Quantitative
EX3-CRT-18.02c-TRL6-VALP-OF10-002	M1.3, M2.3	Quantitative

We focused the analysis on the SID and Departure Runway updates done by the Flight Dispatcher:

- SID update only (including Runway update at Departure airport only and Taxitime at Departure airport – No STAR update done by the Flight Dispatcher)

RESULTS EX3-CRT-18.02C-TRL6-VALP-OF10-001 / EX3-CRT-18.02C-TRL6-VALP-OF10-002

Limitation on the Scenario Dataset:

In the exercise, The Flight Dispatcher considers the planned departure runway information in the NOP coming from A-CDM airports as soon as the DPI messages are sent to NM (from EOBT -3H). The Flight Dispatcher could consider that the planned SID in the NOP is not accurate for the AU aircraft performance. Therefore, the AU Flight Dispatcher could include his preferred SID in the flight plan compliant with the planned runway in the NOP. This preferred SID could be different from the planned SID in the NOP, leading to a proposed AU trajectory with a new SID and to the computation of an ETFMS trajectory aligned with the AU proposed SID.

Unfortunately, the current CDM process requires that only a DPI message can modify a SID received by ETFMS via a DPI message. Even if the AU is proposing a new preferred SID, the planned SID in the NOP remains unchanged.

For the metrics, this limitation requires that we limit the Scenario Dataset to the flight updates, when the Flight Dispatcher updates the AU 4D trajectory with a SID identical to the planned SID in the NOP.

Criteria for assessment:

For each metric, the impact is assessed operationally according to the Deviation of the EET/FL differences for Reference dataset (after the SID updates) vs Scenario Datasets (after the SID updates) as:

Impact on the criteria	Negative impact (Degradation)	Neutral impact	Positive impact (Improvement)
EET	> 60s Deviation increases by at least 60s	[-60s, 60s] Deviation decreases/increases by less than 60s	< -60 s Deviation decreases by at least 60s OR No difference after the CHG message with SID update
FL	> 10FL Deviation increases by at least 10 FL	[-10FL, 10FL] Deviation decreases/increases by less 10 FL	<-10FL Deviation decreases by at least 10 FL

Impact on the criteria	**Negative impact** **(Degradation)**	**Neutral impact**	**Positive impact** **(Improvement)**
			OR No difference after the CHG message with SID update

RMK field	“SID update only” (including Departure Runway updates and Taxitime)
Reference dataset	Same last SID point in AU 4D trajectory vs ETFMS trajectory (SID procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory) Same first STAR point in AU 4D trajectory vs ETFMS trajectory
Scenario dataset	SID procedure *identical* in AU 4D trajectory vs ETFMS trajectory (same last SID point) Same first STAR point in AU 4D trajectory vs ETFMS trajectory

Average values [14 flight plan updates for 14 flights (9 short haul / 5 Medium/Long Haul)]	Before SID Update	After SID Update	Deviation	Impact on the Val. Obj
M1.1 Difference of Flight levels at the last point of the SID procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.	6 FL	0 FL	-6FL -100%	+ (no difference)
M1.2 Difference of Flight levels at the first point of the STAR procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.	6FL	0 FL	-6FL -100%	+(no difference)
M1.3 Considering all named trajectory points both in the ETFMS trajectory and the ETFMS A-DPI trajectory, Average of the Difference of Flight levels.	5 FL	0 FL	-5FL -100%	+(no difference)
M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.	23 s	0 s	-23s -100%	+(no difference)
M2.2	31 s	4 s	-27s -90%	=

Average values [14 flight plan updates for 14 flights (9 short haul / 5 Medium/Long Haul)]	Before SID Update	After SID Update	Deviation	Impact on the Val. Obj
Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.				
M2.3 Considering all points in common between the ETFMS trajectory and the ETFMS A-DPI trajectory, Average of the Difference of Estimated Elapsed Time (EET).	33 s	3 s	-30s -91%	=
M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the ETFMS trajectory and the ETFMS A-DPI trajectory.	96 s	5 s	-91s -95%	+
M3.1 Number of named trajectory points both in the ETFMS trajectory and the ETFMS A-DPI trajectory.	29	29	0	=

With the "SID update",

Due to the low number of updates, the results are not representative.

The trend is an improvement for the EET/FL predictability in the SID and STAR procedures as well as the points in common on the trajectory (much lower deviation for all updates or no deviation).

The trend is a significant improvement for the EET predictability of the Arrival Time.

In next figures, for 14 SID updates (14 flights), for each metric, the left bar is the metric before SID update, the right bar is the metric after SID update.

In average, the results are significant. The figures below illustrate significant improvements for each updates.

The figures below includes a 15th case to illustrate the impact of the OPS update receives on NMVP, after the last update from the Flight Dispatcher. The Case 15 has to be discarded (not included in the average computation:

> As explained in Deviation 6 (C.2), ETFMS receives from OPS a CHG message, after the last update of the SID done by the flight dispatcher. As the Flight Dispatcher has published no later update of the flight plan after the OPS change to include the SID update, the AU Trajectory is not aligned with the SID procedure, but not for the FL/EET of the last SID point nor the Runway configuration.

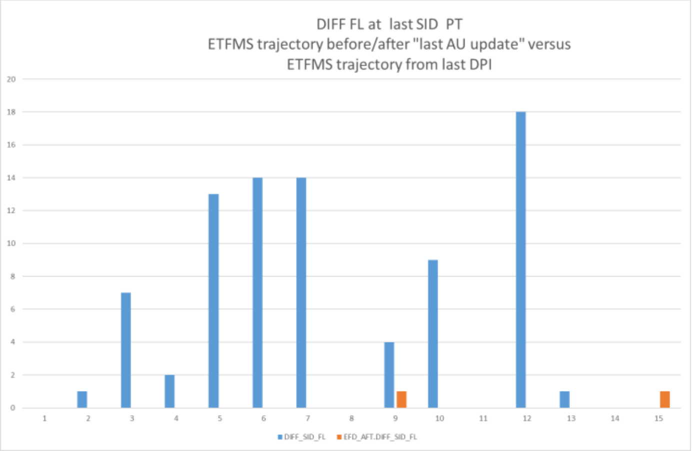


Figure 48: Before/After SID update, FL difference at last SID point between ETFMS and ETFMS ADPI trajectories

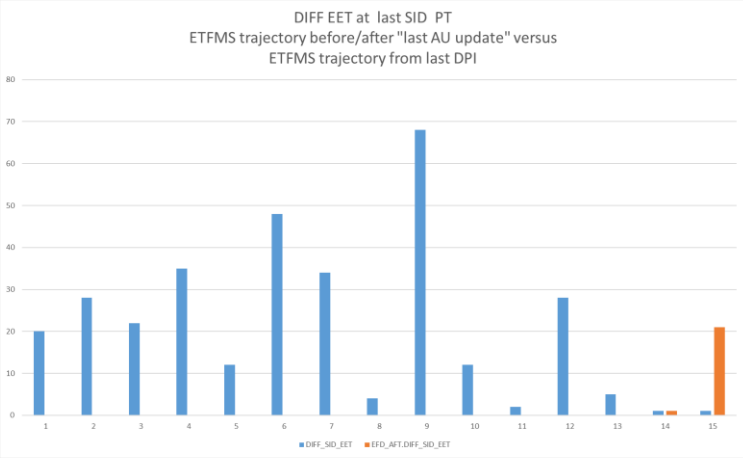


Figure 49: Before/After SID update, EET difference at last SID point between ETFMS and ETFMS ADPI trajectories

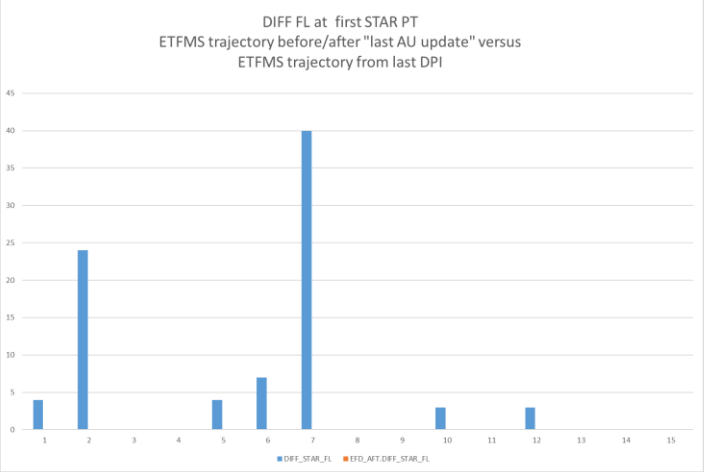


Figure 50: Before/After SID update, FL difference at first STAR point between ETFMS and ETFMS ADPI trajectories

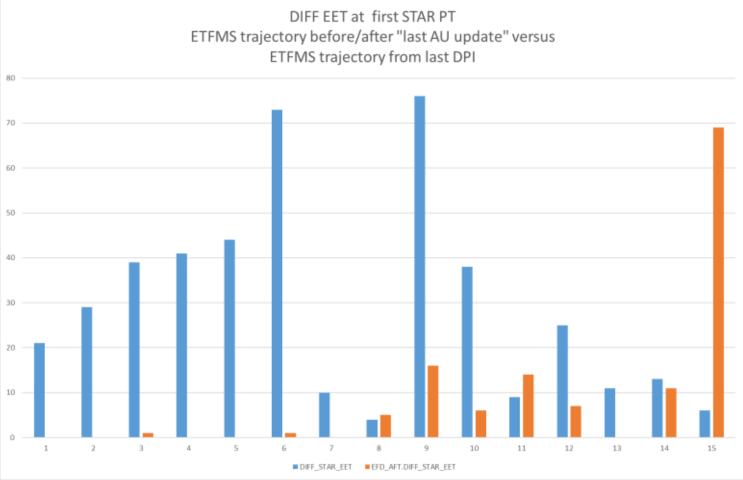


Figure 51: Before/After SID update, EET difference at first STAR point between ETFMS and ETFMS ADPI trajectories

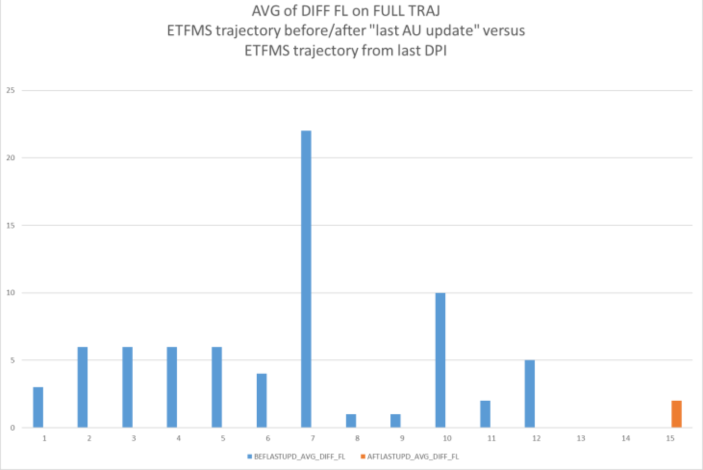


Figure 52: Before/After SID update, Average of the FL difference for named trajectory points both in ETFMS and ETFMS ADPI trajectories

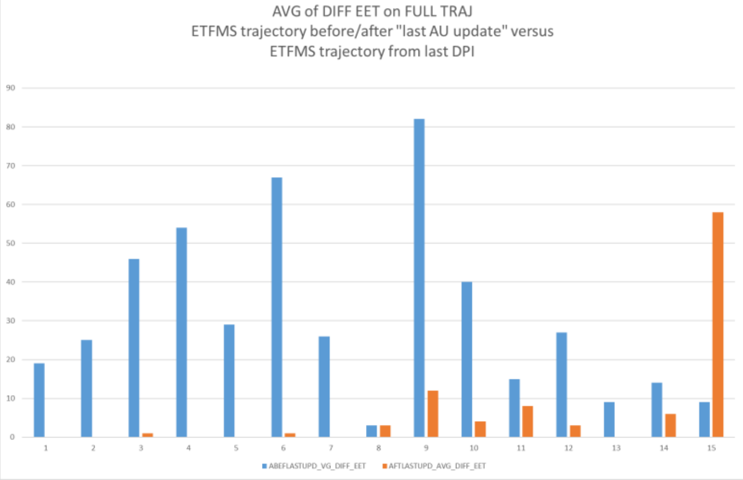


Figure 53: Before/After SID update, Average of the EET differenc for named trajectory points both in ETFMS and ETFMS ADP trajectories

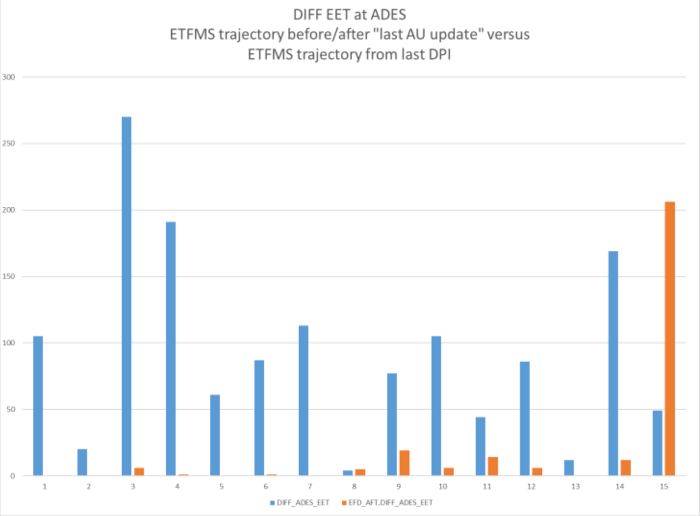


Figure 54: Before/After SID update, EET difference at ADES betwee ETFMS and ETFMS ADPI trajectories

The dataset for Predictability does not include cases of Flight dispatcher with SID & STAR updates in the same message – only STAR updates.

CONCLUSION

Due to the low number of flight dispatcher updates, the results are not representative.

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF10-001

The integration of the dynamic SID on the eFPL demonstrated a significant trend for improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension:

For the time dimension,

- Up to 100% of EET improvement on the last SID point;
- Up to 90% of EET improvement on the first STAR point;
- Up to 91% of EET improvement for the points in common on the trajectory;
- Up to 95% of improvement for the Arrival Time.

For the altitude dimension,

- Full predictability (0 FL difference) in the SID & STAR procedures either for the points in common on the trajectory;

Nevertheless,

Due to the low number of updates, the results are not representative.

The Predictability is not based on the last real flown trajectory.

Because all the necessary updates have not been done by the flight dispatcher, for example when the FOC prototype receives an OPS update following an update done by the AU Flight Dispatcher, some AU trajectories have been discarded from the analysis. We could assume that other AU Trajectory updates (including the SID update) could be missing (not done neither by the Flight dispatcher, neither automatically by the FOC prototype) and that could continuously improve the trend for improvement of the predictability.

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF10-002

The integration of the dynamic SID on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability of the estimated landing time ELDT.

C.3.2.6. EX3-OBJ-18.02c-TRL6-TVALP-OF22 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF22	Impact of the STAR on the NM Traffic Predictability	EX3-CRT-18.02c-TRL6-VALP-OF22-001	Solution 18.02c provides evidence that the integration of the dynamic STAR on the eFPL reduces the difference in 4 dimensions: the NM / ATC trajectory planned with dynamic STAR included in eFPL trajectory is closer to the flown trajectory than the NM / ATC trajectory planned without dynamic STAR.	The integration of the dynamic STAR on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension.	PARTIALLY OK (Low representativeness)
		EX3-CRT-18.02c-TRL6-VALP-OF22-002	Solution 18.02c provides evidence that the Integration of the updated STAR within the operational flight plan improves the predictability of the estimated landing time ELDT hence the airport planning is improved.	The integration of the dynamic STAR on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability of the estimated landing time ELDT.	PARTIALLY OK (Low representativeness)

DATA COLLECTION

On NMVP, ETFMS flight plans have been collected via the Operational Logs: these logs include the trajectory updates computed by ETFMS *for any events*.

The AU 4D trajectories (Flight plan Creation FPL, Flight plan Update CHG) sent via the B2B services have been collected.

For any trajectories, SID/STAR procedures have been identified.

Because the STAR updates have been mainly performed during “the SID/TaxiTime/STAR Scenario (18/06/2019 10:00 - 12:30)”, and to a lesser extent during the second TTA Scenario (small delay – 18/06/2019 14:30 – 17:00), we focused the analysis of the Validation Objectives on the day 18/06/2019. All flights have an EOBT on the 18/06/2019.

DATA LOGGING EXTRACTION

We identified the reason/purpose of an update sent by the dispatcher, via the CHG messages (extended flight plan update) mentioning the reason (RMK field), and the timestamp of the message.

From this timestamp, we identified the Reference and Scenario dataset for each flight:

- Reference dataset: we extracted the ETFMS computed trajectory, before the timestamp of the last STAR update message done by the Flight Dispatcher. See C.1.3.1.b
- Scenario dataset: in addition to the AU 4D trajectory with Flight Dispatcher update, we identified the ETFMS computed trajectory based on the given AU 4D trajectory (CHG message). See C.1.3.2.b

The ETFMS trajectories from Reference and Scenario Datasets are compared to the ETFMS trajectory computed with the last CDM DPI message (seen as Flown trajectory, called *“ETFMS A-DPI Trajectory”*). See C.1.3.1.b, C.1.3.2.b

METRICS FOR PREDICTABILITY

We computed the following quantitative metrics for the Reference (before STAR updates) and Scenario Datasets (with STAR updates): for each flight, for each STAR Updates from the flight dispatcher,

Predictability in altitude:

- M1.1 Difference of Flight levels at the last point of the SID procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.
- M1.2 Difference of Flight levels at the first point of the STAR procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.
- M1.3 Considering all named trajectory points both in the ETFMS trajectory and the ETFMS A-DPI trajectory, Average of the Difference of Flight levels.

Predictability in Elapsed Time:

- M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.
- M2.2 Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the ETFMS trajectory and the ETFMS A-DPI trajectory.

- M2.3 Considering all points in common between the ETFMS trajectory and the ETFMS A-DPI trajectory, Average of the Difference of Estimated Elapsed Time (EET)
- M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the ETFMS trajectory and the ETFMS A-DPI trajectory.

Alignment in named trajectory points

- M3.1 Number of named trajectory points both in the ETFMS trajectory and the ETFMS A-DPI trajectory.

Counts according to Duration of the flight

- Number of “Short Haul flights” (duration up to 90 minutes)
- Number of “Medium/Long Haul flights” (duration above 90 minutes)

For all these metrics, we analyse of the Deviation of the EET/FL differences for Reference / Scenario Datasets.

Success criteria	Metrics	Qualitative / quantitative
EX3-CRT-18.02c-TRL6-VALP-OF22-001	M1.1, M1.2 M2.1, M2.2 M3.1	Quantitative
EX3-CRT-18.02c-TRL6-VALP-OF22-002	M1.3, M2.3	Quantitative

We focused the analysis on the STAR and Arrival Runway updates done by the Flight Dispatcher:

- STAR update only (including Runway update at Arrival airport only – No SID update done by the Flight Dispatcher)

RESULTS EX3-CRT-18.02C-TRL6-VALP-OF22-001 / EX3-CRT-18.02C-TRL6-VALP-OF22-002

Limitation on the Scenario Dataset:

In the exercise, The Flight Dispatcher considers the planned arrival runway information in the NOP coming from LEBL airport as soon as the API messages are sent to NM. The Flight Dispatcher could consider that the planned STAR in the NOP is not accurate for the AU aircraft performance. Therefore, the AU Flight Dispatcher could include his preferred STAR in the flight plan compliant with the planned runway in the NOP. This preferred STAR could be different from the planned STAR in the NOP, leading to a proposed AU trajectory with a new STAR and to the computation of an ETFMS trajectory aligned with the AU proposed STAR.

The CDM process is not yet officially published for the STAR update. Here we are making the same assumption as explained for the SID update in C.3.2.5:

> Assumption: "The current CDM process requires that only an API message can modify a STAR received by ETFMS via an API message. Even if the AU is proposing a new preferred STAR, the planned STAR in the NOP remains unchanged".

For the metrics, this limitation requires that we limit the Scenario Dataset to the flight updates, when the Flight Dispatcher updates the AU 4D trajectory with a STAR identical to the planned STAR in the NOP.

As explained in the deviation 8 (refer to C.2), only LEBL was planned as arrival airport publishing API messages (STAR and Runway updates). During the exercise, some flight plans have been updated due to Arrival Runway updates / STAR updates for airports not only LEBL. Those update messages have not been removed from the dataset as they extend the setup of the exercise.

For each metric, the impact is assessed operationally according to the Deviation of the EET/FL differences for Reference dataset (after the STAR updates) vs Scenario Datasets (after the STAR updates) as:

Impact on the criteria	**Negative impact** **(Degradation)**	**Neutral impact**	**Positive impact** **(Improvement)**
EET	> 60s Deviation increases by at least 60s	[-60s, 60s] Deviation decreases/increases by less than 60s	< -60 s Deviation decreases by at least 60s OR No difference after the CHG message with STAR update
FL	> 10FL Deviation increases by at least 10 FL	[-10FL, 10FL] Deviation decreases/increases by less 10 FL	<-10FL Deviation decreases by at least 10 FL OR

Impact on the criteria	Negative impact (Degradation)	Neutral impact	Positive impact (Improvement)
			No difference after the CHG message with STAR update

RMK field	“STAR update only” (including Arrival Runway updates)
Reference dataset	Same first STAR point in AU 4D trajectory vs ETFMS trajectory (STAR procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory) Same last SID point in AU 4D trajectory vs ETFMS trajectory (SID procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory)
Scenario dataset	STAR procedure *identical* in AU 4D trajectory vs ETFMS trajectory (same first STAR point) Same last SID point in AU 4D trajectory vs ETFMS trajectory (SID procedure *identical* or *not identical* in AU 4D trajectory vs ETFMS trajectory)

Average values [10 flight plan updates for 10 flights (3 Short haul / 7 Medium/Long Haul]	Before STAR Update	After STAR Update	Deviation	Impact on the Val. Obj
M1.1 Difference of Flight levels at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory	3FL	0FL	-3FL -100%	+ (no difference)
M1.2 Difference of Flight levels at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS trajectory	5FL	0FL	-5FL -100%	+ (no difference)
M1.3 Considering all named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Flight levels	4FL	0FL	-4FL -100%	+ (no difference)
M2.1 Difference of Estimated Elapsed Time (EET) at the last point of the SID procedure between the AU 4D Trajectory and the ETFMS trajectory	43s	10s	-33s -76%	=
M2.2	116s	19s	-97s	+

Average values [10 flight plan updates for 10 flights (3 Short haul / 7 Medium/Long Haul]	Before STAR Update	After STAR Update	Deviation	Impact on the Val. Obj
Difference of Estimated Elapsed Time (EET) at the first point of the STAR procedure between the AU 4D Trajectory and the ETFMS			-84%	
M2.3 Considering all points in common between the AU 4D Trajectory and the ETFMS trajectory, Average of the Difference of Estimated Elapsed Time (EET)	59s	15s	-44s -75%	=
M2.4 Deviation of Estimated Elapsed Time (EET) for Arrival Time (EET at ADES) between the AU 4D Trajectory and the ETFMS trajectory	181s	46s	-135s -75%	+
M3.1 Number of named trajectory points both in the AU 4D Trajectory and the ETFMS trajectory	28	29	+1	=

With the "STAR update",

The trend is an improvement for the EET/FL predictability in the STAR procedures, in the SID procedures as well as the points in common on the trajectory (much lower deviation for all updates or no deviation).

The trend is a significant improvement for the EET predictability of the Arrival Time.

In next figures, for 10 STAR updates (10 flights), for each metric, the left bar is the metric before STAR update, the right bar is the metric after STAR update.

In average, the results are significant. The figures below illustrate significant improvements for each updates.

The figures include two additional cases (5th and 12th) to illustrate the impact of the OPS update receives on NMVP, after the last update from the Flight Dispatcher. The cases 5 and 12 have to be discarded (not included in the average computation):

> As explained in Deviation 6 (C.2), ETFMS receives from OPS a CHG message, after the last update of the STAR done by the flight dispatcher. As the Flight Dispatcher has published no later update of the flight plan after the OPS change to include the STAR update, the AU Trajectory is aligned with the STAR procedure, but not for the FL/EET of the first STAR point nor the Runway configuration.

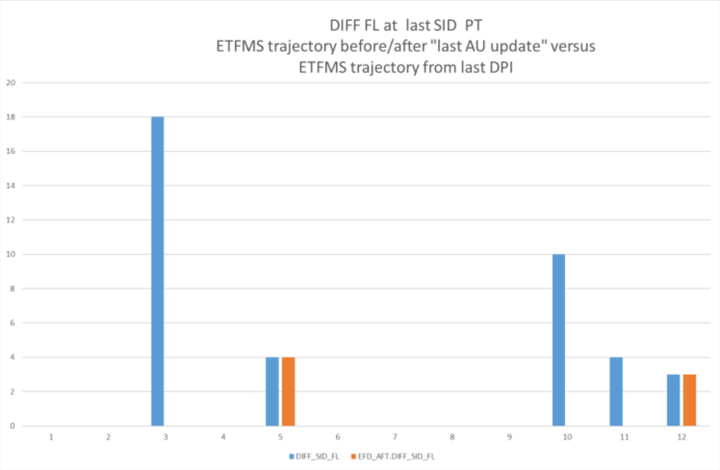


Figure 55: Before/After STAR update, FL difference at last SID STAR point between ETFMS and ETFMS ADPI trajectories

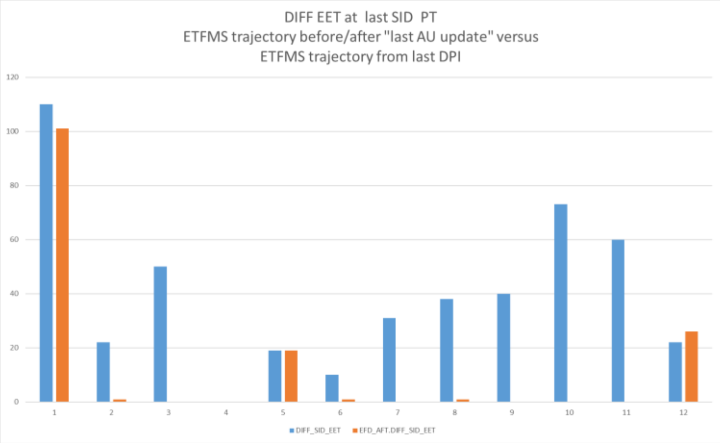


Figure 56: Before/After STAR update, EET difference at last SID point between ETFMS and ETFMS ADPI trajectories

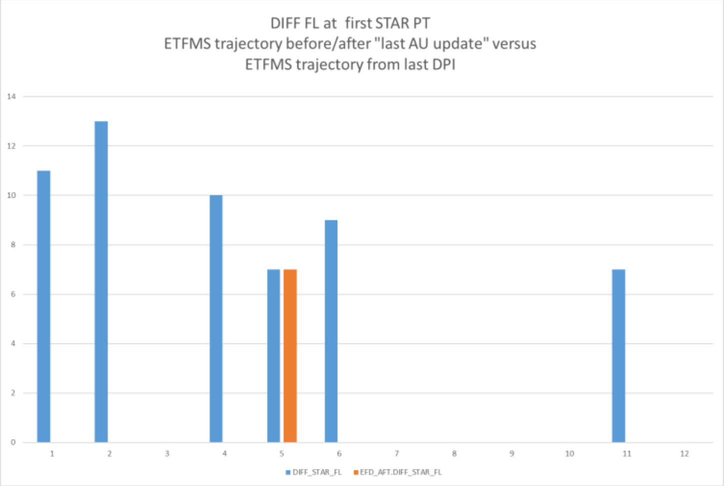


Figure 57: Before/After STAR update, FL difference at first STAR point between ETFMS and ETFMS ADPI trajectories

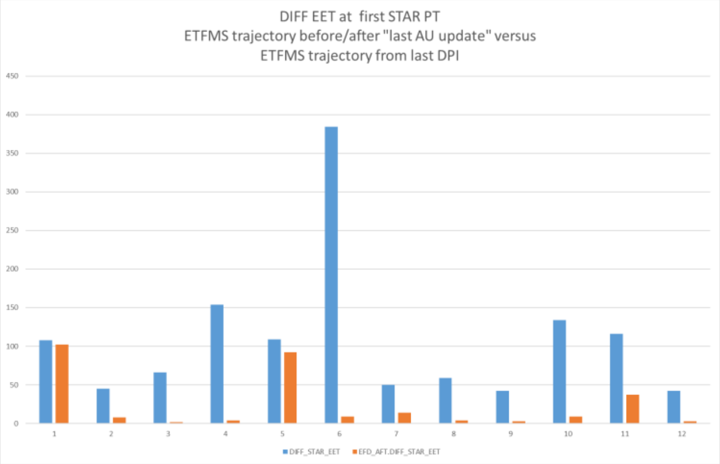


Figure 58: Before/After STAR update, EET difference at first STAR point between ETFMS and ETFMS ADPI trajectories

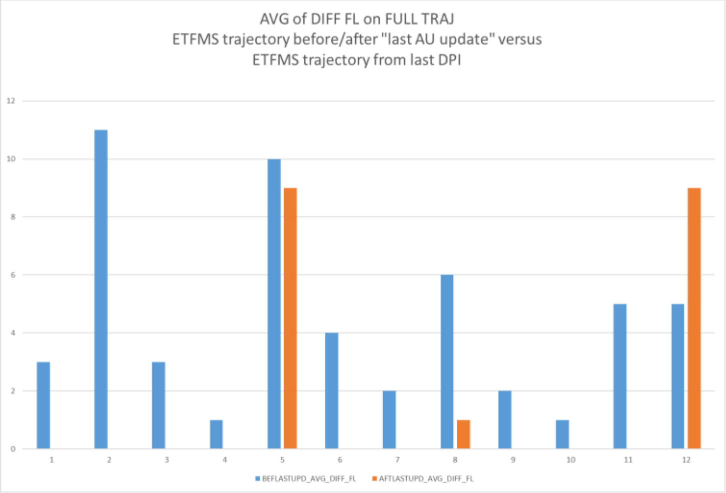


Figure 59: Before/After STAR update, Average of the FL difference for named trajectory points both in ETFMS and ETFMS ADPI trajectories

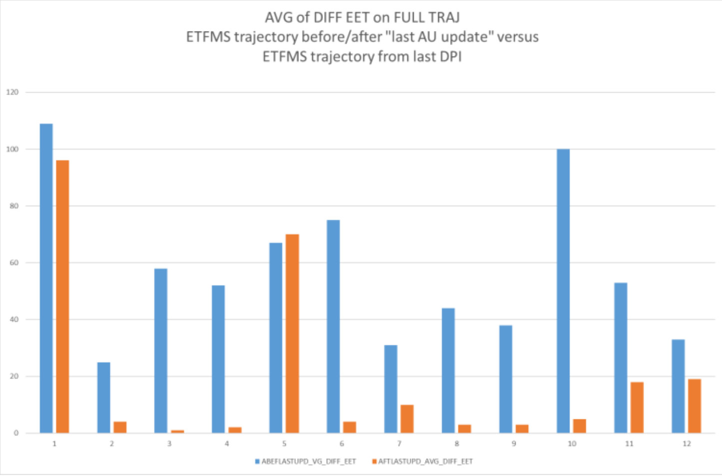


Figure 60: Before/After STAR update, Average of the EET difference for named trajectory points both in ETFMS and ETFMS ADPI trajectories

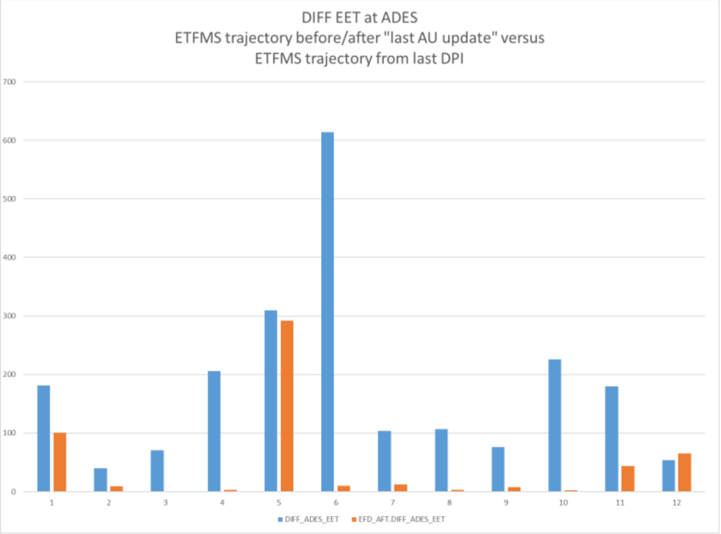


Figure 61: Before/After STAR update, EET difference at ADES between ETFMS and ETFMS ADPI trajectories

The dataset for Predictability does not include cases of Flight dispatcher with SID & STAR updates in the same message – only STAR updates.

CONCLUSION

Due to the low number of flight dispatcher updates, the results are not representative.

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF22-001

The integration of the dynamic STAR on the eFPL demonstrated a significant trend for improvement on the NM DCB Traffic Predictability in three dimensions as well as the time dimension:

For the time dimension,

- Up to 84% of EET improvement on the first STAR point;
- Up to 75% of improvement for the Arrival Time.

For the altitude dimension,

- Full predictability (0 FL difference) in the SID & STAR procedures either for the points in common on the trajectory;

Nevertheless,

Due to the low number of updates, the results are not representative.

The Predictability is not based on the last real flown trajectory.

Because all the necessary updates have not been done by the flight dispatcher, for example when the FOC prototype receives an OPS update following an update done by the AU Flight Dispatcher, some AU trajectories have been discarded from the analysis. We could assume that other AU Trajectory updates (including the SID update) could be missing (not done neither by the Flight dispatcher, neither automatically by the FOC prototype) and that could continuously improve the trend for improvement of the NM Traffic predictability.

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF22-002

The integration of the dynamic STAR on the eFPL demonstrated a significant improvement on the NM DCB Traffic Predictability of the estimated landing time ELDT.

C.3.2.1. EX3-OBJ-18.02c-TRL6-TVALP-OF12 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF12	Impact of the SID/STAR on the Fuel efficiency	EX3-CRT-18.02c-TRL6-VALP-OF12-001	Solution 18.02c performs a qualitative assessment on the fuel decision making (planned and extra fuel) related to the real time SID/STAR planning confidence.	The fuel assessment with the decision process for updating SID/STAR was done by the flight dispatchers during the exercise. They did not show us explicitly a scenario, where the flight dispatcher declined to use another STAR due to fuel reason. In general, the more precise SID/STAR information however leads to an overall more precise fuel calculation. Nevertheless, the questionnaire highlighted a good level of confidence for the fuel decision making (planned and extra fuel) related to the SID planning, but a low level of confidence for the STAR planning.	OK for SID PARTIALLY OK for STAR

DATA COLLECTION

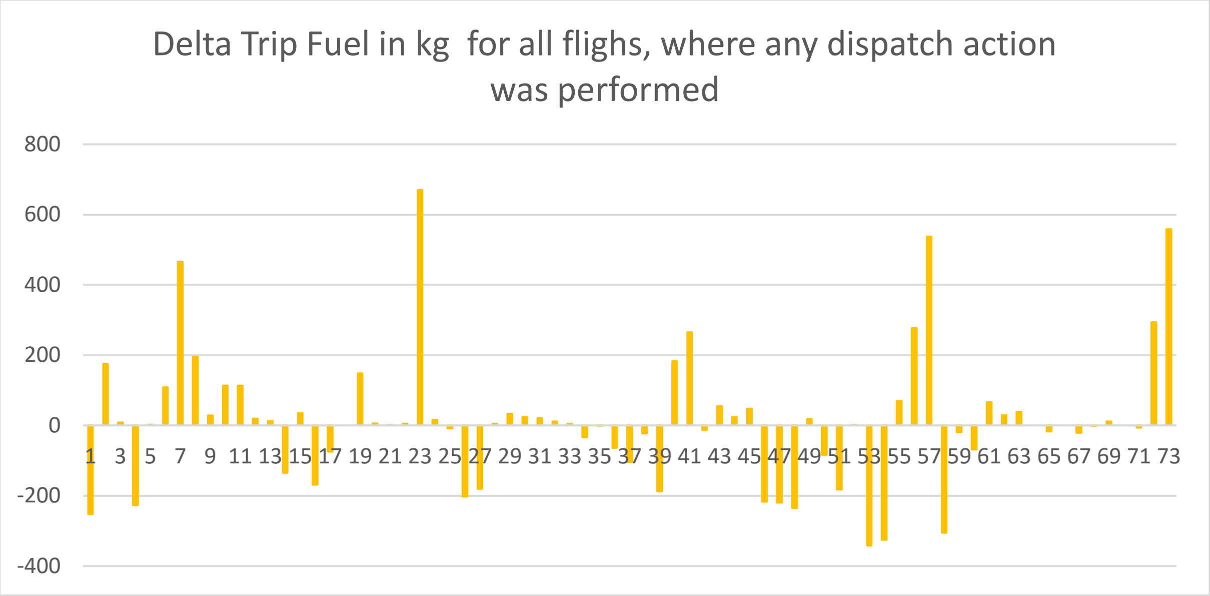
On the FOC prototype, the operational messages have been retrieved from logs.

METRICS

- Logs extraction and analysis

RESULTS EX3-CRT-18.02C-TRL6-VALP-OF12-001

For all flights into account the change in trip fuel is displayed in following graph:



Even besides some outliners the graph demonstrates, that besides some further trip fuel is required after dispatch action, there are also flights where less fuel is required due to improved available arrival or departure procedure. For many activities, primarily the taxi time changes or the runway changes, the fuel impact is negligible.

CONCLUSION

Success criteria EX3-CRT-18.02C-TRL6-VALP-OF12-001

The fuel assessment with the decision process for updating SID/STAR was done by the flight dispatchers during the exercise. There did not show us explicitly a scenario, where the flight dispatcher declined to use another STAR due to fuel reason. In general, the more precise SID/STAR information however leads to an overall more precise fuel calculation.

Nevertheless, the questionnaire highlighted a good level of confidence for the fuel decision making (planned and extra fuel) related to the SID planning, but a low level of confidence for the STAR planning.

C.3.2.2. EX3-OBJ-18.02c-TRL6-TVALP-OF13 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF13	To assess the impact of dynamic SID/STAR updates in the eFPL on the FOC workload	EX3-CRT-18.02c-TRL6-VALP-OF13-001	Solution 18.02c provides evidence that the increase of FOC workload due to FOC action is acceptable.	Details listed in the survey report. Automation for future dispatch use is required. Such an automation functionality was not foreseen for the validation exercise.	PARTIALLY OK

DATA COLLECTION

The flight dispatchers had to fill a survey.

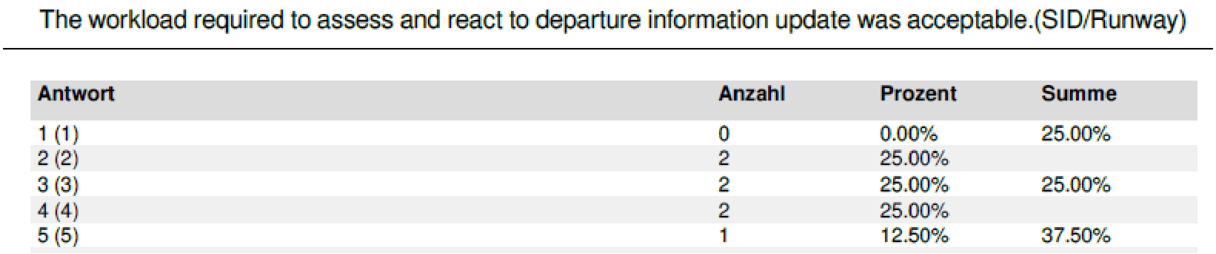
METRICS

List of questions:

- The workload required to assess and react to departure information update was acceptable (SID/Runway).
- The workload required to assess and react to departure information update was acceptable (Taxitime).
- The workload required to assess and react to departure information update was acceptable (STAR/Runway)

RESULTS EX3-CRT-18.02C-TRL6-VALP-OF13-001

The feedback from dispatchers is in the attached survey results. The individual opinions differ, so that a general conclusion is difficult. The extract from the survey provides for the SID/runway processing:



The workload required to assess and react to departure information update was acceptable.(SID/Runway)

Antwort	Anzahl	Prozent	Summe
1 (1)	0	0.00%	25.00%
2 (2)	2	25.00%	
3 (3)	2	25.00%	25.00%
4 (4)	2	25.00%	
5 (5)	1	12.50%	37.50%

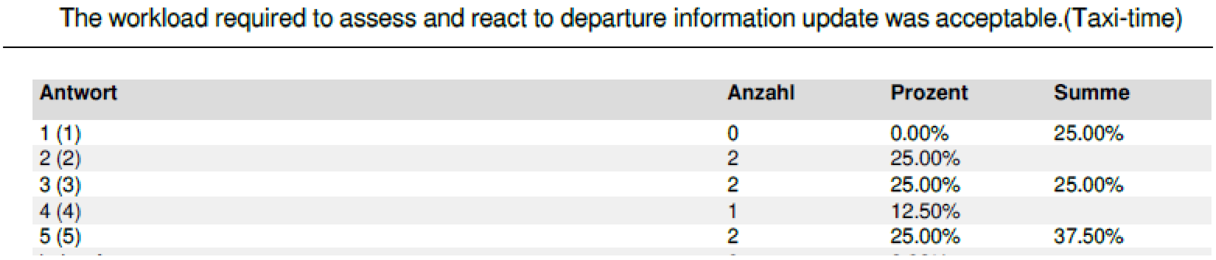
One dispatcher of the eight dispatchers did not finalized his answer to this section, so the overall sum was delivering only 87,5% completeness. That means, only 7 of 8 dispatchers' opinion were included in the above statistics and below following statistics.

The answer options are

1) Strongly agree
2) Agree
3) Neutral
4) disagree
5) strongly disagree

Two flight dispatchers agree, that workload was acceptable; two flight dispatchers were ok with the workload, two dispatchers stated that the workload was rather not ok; one dispatcher could not accept the amount of work to perform all required action within a given timeframe.

The workload survey result for the taxi time following looks like following

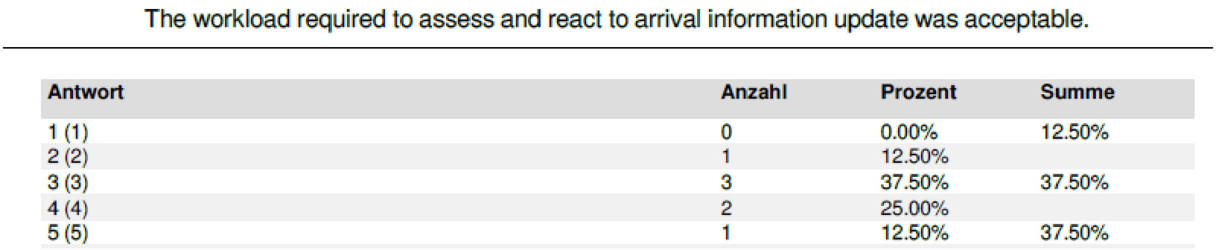


The workload required to assess and react to departure information update was acceptable.(Taxi-time)

Antwort	Anzahl	Prozent	Summe
1 (1)	0	0.00%	25.00%
2 (2)	2	25.00%	
3 (3)	2	25.00%	25.00%
4 (4)	1	12.50%	
5 (5)	2	25.00%	37.50%

Due to the amount of taxi time changes during the exercise, where no automation was offered, the dispatcher rates the actual workload rather high; it is rather difficult for them to cope with all messages.

The feedback from the dispatchers for processing arrival information looks like:

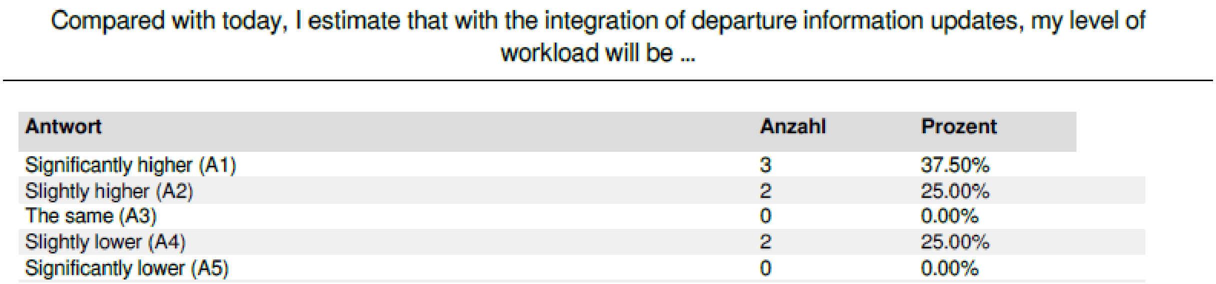


The workload required to assess and react to arrival information update was acceptable.

Antwort	Anzahl	Prozent	Summe
1 (1)	0	0.00%	12.50%
2 (2)	1	12.50%	
3 (3)	3	37.50%	37.50%
4 (4)	2	25.00%	
5 (5)	1	12.50%	37.50%

In general, there is an major acceptance for the STAR information given, as 3 of 8 dispatchers either strongly agree to have enough time to adapt and 3 of 8 dispatchers can accept the available time to make the required changes. As already mentioned, there was no automation used within validation exercise; a deployment of an operational solution would in any case take over the changes more less automatically, where the dispatcher will take over pure monitoring activities.

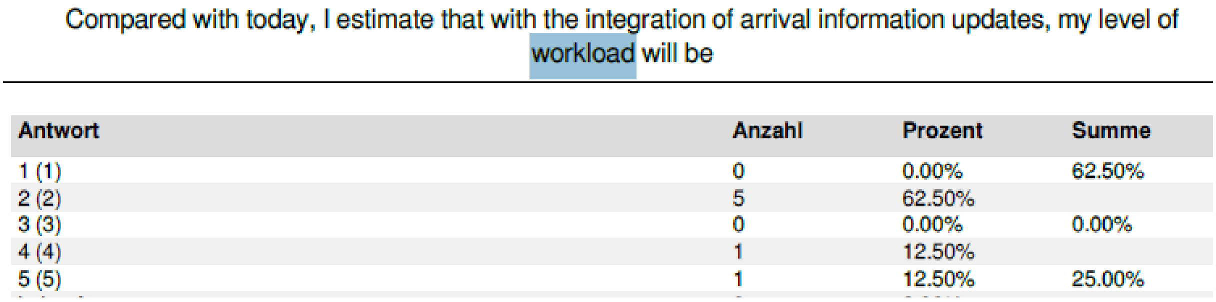
In summary, the dispatchers rate the workload like following:



Compared with today, I estimate that with the integration of departure information updates, my level of workload will be ...

Antwort	Anzahl	Prozent
Significantly higher (A1)	3	37.50%
Slightly higher (A2)	2	25.00%
The same (A3)	0	0.00%
Slightly lower (A4)	2	25.00%
Significantly lower (A5)	0	0.00%

It is obvious that dispatcher rate the overall situation based on the available functions during the validation exercise. Therefore the increase of expected workload is obvious to be in general more than in today's operation. This opinion is also expressed for the arrival management processing displayed in below table.



Compared with today, I estimate that with the integration of arrival information updates, my level of workload will be

Antwort	Anzahl	Prozent	Summe
1 (1)	0	0.00%	62.50%
2 (2)	5	62.50%	
3 (3)	0	0.00%	0.00%
4 (4)	1	12.50%	
5 (5)	1	12.50%	25.00%

CONCLUSION

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF13-001

The integration of the dynamic SID/STAR on the eFPL demonstrated partially that the increase of FOC workload due to FOC action is acceptable.

Automation for future dispatch use in the FOC prototype is required. Such an automation functionality was not foreseen for the validation exercise.

C.3.2.3. EX3-OBJ-18.02c-TRL6-TVALP-OF14 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF14	To validate that the integration of dynamic SID/STAR updates in eFPL improves the safety	EX3-CRT-18.02c-TRL6-VALP-OF14-001	Solution 18.02c provides evidence that the integration of real time SID/STAR updates in the eFPL reduces or at least does not increase the pilot workload.	As no pilots have attended the validation exercise, this objective has not been assessed during the exercise.	NOK

C.3.2.4. EX3-OBJ-18.02c-TRL6-TVALP-TF6 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-TF6	To Assess Technical Feasibility of the TTA integration in the FOC system	EX3-CRT-18.02c-TRL6-TVALP-TF6-001	Solution 18.02c provides evidence of the integration of TTAs by FOC System in the eFPL.	The integration of the available B2B services for TTA from LEBL airport into FOC Systems was not used satisfactorily by the Flight Dispatchers and was not fully	NOK

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
				demonstrated. The Validation Objective has not been demonstrated at TRL6 level (No proper technical requirements to propose).	🟥

Data collection

On the FOC prototype, the operational messages have been retrieved from logs.

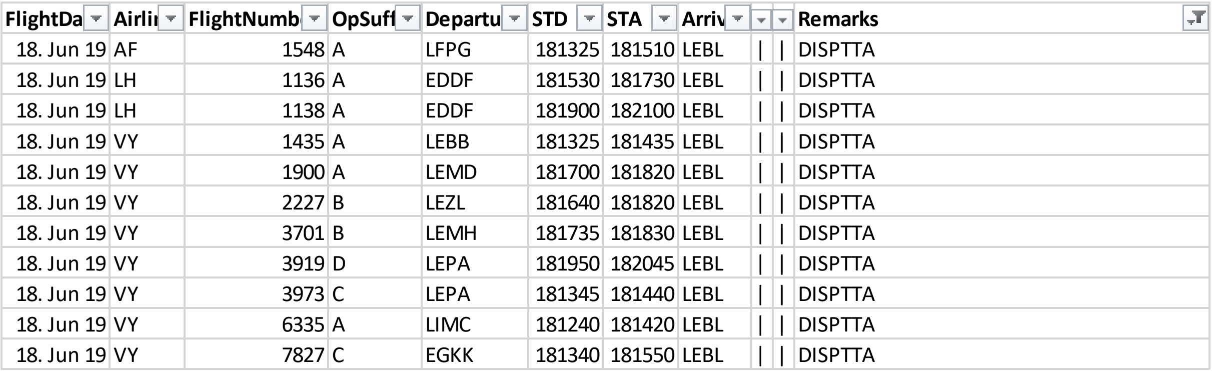
Metrics

- Logs extraction and analysis

Results EX3-CRT-18.02c-TRL6-TVALP-TF6-001

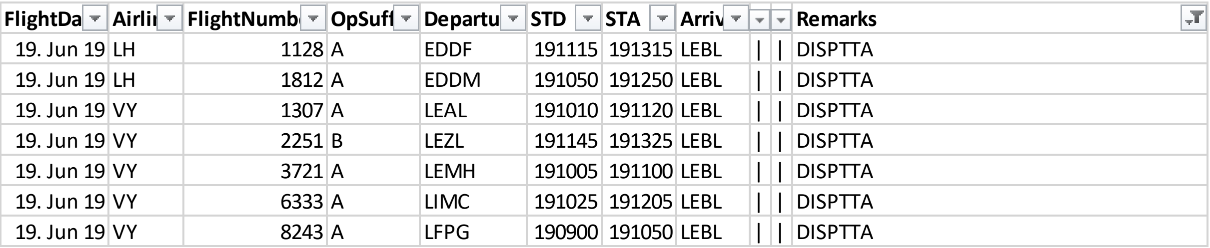
The details number of flights used during the exercise validation, where information through B2B information lead to actively TTA changes from dispatchers is following:

Exercise day 1 - 18 June 2019



FlightDa	Airli	FlightNumb	OpSuff	Departu	STD	STA	Arriv			Remarks
18. Jun 19	AF	1548	A	LFPG	181325	181510	LEBL	|	|	DISPTTA
18. Jun 19	LH	1136	A	EDDF	181530	181730	LEBL	|	|	DISPTTA
18. Jun 19	LH	1138	A	EDDF	181900	182100	LEBL	|	|	DISPTTA
18. Jun 19	VY	1435	A	LEBB	181325	181435	LEBL	|	|	DISPTTA
18. Jun 19	VY	1900	A	LEMD	181700	181820	LEBL	|	|	DISPTTA
18. Jun 19	VY	2227	B	LEZL	181640	181820	LEBL	|	|	DISPTTA
18. Jun 19	VY	3701	B	LEMH	181735	181830	LEBL	|	|	DISPTTA
18. Jun 19	VY	3919	D	LEPA	181950	182045	LEBL	|	|	DISPTTA
18. Jun 19	VY	3973	C	LEPA	181345	181440	LEBL	|	|	DISPTTA
18. Jun 19	VY	6335	A	LIMC	181240	181420	LEBL	|	|	DISPTTA
18. Jun 19	VY	7827	C	EGKK	181340	181550	LEBL	|	|	DISPTTA

Exercise day 2 - 19 June 2019



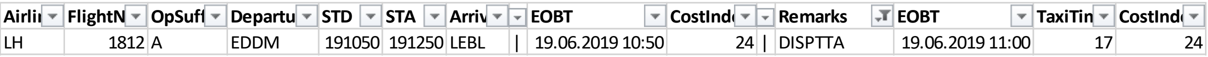
FlightDa	Airli	FlightNumb	OpSuff	Departu	STD	STA	Arriv			Remarks
19. Jun 19	LH	1128	A	EDDF	191115	191315	LEBL	|	|	DISPTTA
19. Jun 19	LH	1812	A	EDDM	191050	191250	LEBL	|	|	DISPTTA
19. Jun 19	VY	1307	A	LEAL	191010	191120	LEBL	|	|	DISPTTA
19. Jun 19	VY	2251	B	LEZL	191145	191325	LEBL	|	|	DISPTTA
19. Jun 19	VY	3721	A	LEMH	191005	191100	LEBL	|	|	DISPTTA
19. Jun 19	VY	6333	A	LIMC	191025	191205	LEBL	|	|	DISPTTA
19. Jun 19	VY	8243	A	LFPG	190900	191050	LEBL	|	|	DISPTTA

In high resolution e.g. the following flight was planned with Cost Index 20:

FlightDate	Airline	FlightNumber	OpSuffix	Departure	STD	STA	Arrival	|	TaxiTime	CostIndex
19. Jun 19	VY	8243	A	LFPG	190900	191050	LEBL	|	15	20

After an arriving TTA requirement, the dispatcher changed the Cost Index 300 to achieve the need of a delayed arrival time, the EOBT itself was not changed.

In the following extract an example is displayed, where the dispatcher changed the EOBT time from 10:50 to the new EOBT of 11:00 to achieve the TTA requirement. The Cost Index itself was not changed at all.



Airli	FlightN	OpSuff	Departu	STD	STA	Arriv		EOBT	CostInd		Remarks	EOBT	TaxiTin	CostInd
LH	1812	A	EDDM	191050	191250	LEBL	|	19.06.2019 10:50	24	|	DISPTTA	19.06.2019 11:00	17	24

Nevertheless,

> The questionnaire to Flight Dispatchers did not demonstrate a good level of confidence for the TTA update (refer to F.1.3), due to, for example, missing information to analyse the need to update.
>
> Functionalities in the FOC prototype have been proposed to the Flight Dispatchers for this exercise like time shifting functionality, or the capability to change fully the route. But those functionalities were not used satisfactorily by the Flight Dispatchers.
>
> The right mechanism assessed by the Flight Dispatchers to apply for the TTA concept cannot be specified: no TS requirements are writable as such.

CONCLUSION

Success criteria EX3-CRT-18.02c-TRL6-TVALP-TF6-001

The integration of the available B2B services for TTA from LEBL airport into FOC Systems was not used satisfactorily by the Flight Dispatchers and was not fully demonstrated. The Validation Objective has not been demonstrated at TRL6 level (No proper technical requirements to propose).

C.3.2.5. EX3-OBJ-18.02c-TRL6-TVALP-OF16 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF16	To validate that the TTA/TTO integration in the AU trajectory eFPL improves the AU cost efficiency.	EX3-CRT-18.02c-TRL6-VALP-OF16-001	Solution 18.02c provides evidence that the CTOT slot influenced by the FOC reduces the extra operating costs (flight cost delay related) compared to the initial CTOT provided by the NM	The costs trajectory oriented always increased due to the additional TTA requirement. A delay impact assessment in reference to costs have not been performed by the flight dispatchers	NOK
EX3-OBJ-18.02c-TRL6-TVALP-OF16	To validate that the TTA/TTO integration in the AU trajectory eFPL improves the AU cost efficiency.	EX3-CRT-18.02c-TRL6-VALP-OF16-002	Solution 18.02c provides evidence that the difference of total planned fuel is reduced between the trajectory taking the NM given CTOT and the trajectory taking the influenced CTOT (trajectory before and after TTA)	Not assessable due to lack of data.	NOK

DATA COLLECTION

On the FOC prototype, the operational messages have been retrieved from logs.

METRICS

- Logs extraction and analysis

RESULTS EX3- CRT-18.02c-TRL6-VALP-OF16-002

For the flights on the 18th of June 2019, all flight routes were kept and only the EOBT was shifted. In this case the recalculated costs were according to the Lido/Flight accuracy criteria the same like the costs from the initial flight plan. There was no comparison to any operational regulated flight plan from NM performed during the exercise. Only in one case a dispatcher has chosen a different routing, where significant additional costs show up due to a de-tour.

CONCLUSION

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF16-001

No assessment is possible, no data are available.

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF16-002

No assessment is possible, no data are available.

C.3.2.6. EX3-OBJ-18.02c-TRL6-TVALP-OF17 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF17	To assess the impact of TTA integration into the eFPL on the FOC workload	EX3-CRT-18.02c-TRL6-VALP-OF17-001	Solution 18.02c provides evidence that the number of manual FOC updates does not increase.	Due to missing any automation in the FOC prototype for TTA management, the dispatchers rate the workload as not acceptable	NOK

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
				to manage their tasks.	🟥

DATA COLLECTION

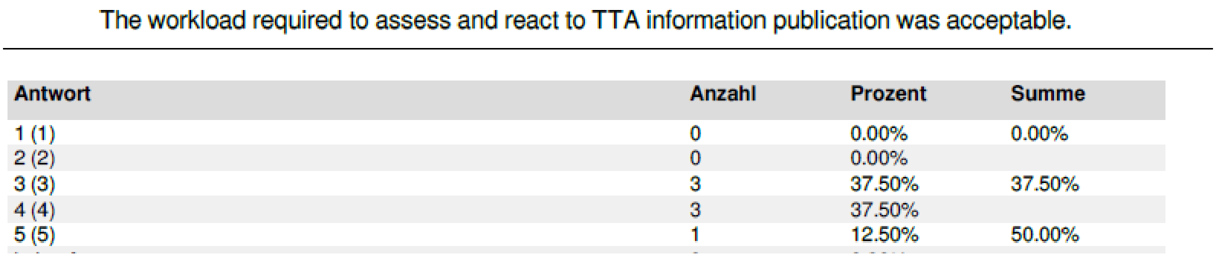
The flight dispatchers had to fill a survey.

METRICS

List of questions:

- The workload required to assess and react to TTA information publication was acceptable.
- Compared with today, I estimate that with the integration of published TTA information, my level of workload will be: significantly higher, slightly higher, the same, slightly lower, significantly lower

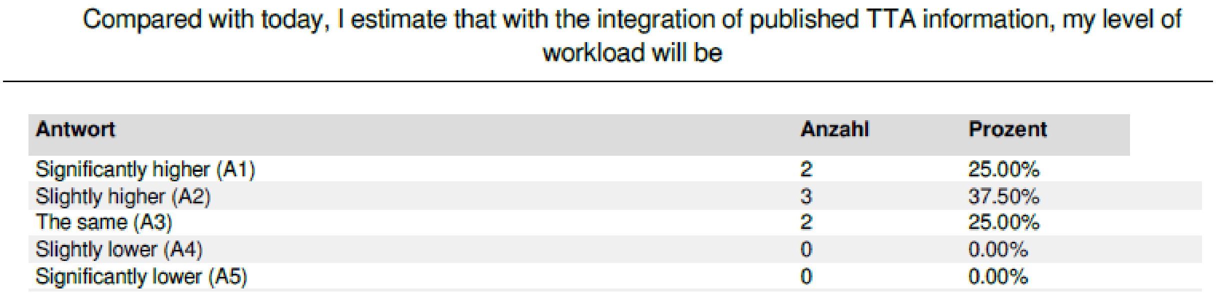
The survey result in reference to TTA looks like following:



The workload required to assess and react to TTA information publication was acceptable.

Antwort	Anzahl	Prozent	Summe
1 (1)	0	0.00%	0.00%
2 (2)	0	0.00%	
3 (3)	3	37.50%	37.50%
4 (4)	3	37.50%	
5 (5)	1	12.50%	50.00%

Due to missing any automation in the FOC prototype for TTA management, the dispatchers rate the workload as not acceptable to manage their tasks.



Compared with today, I estimate that with the integration of published TTA information, my level of workload will be

Antwort	Anzahl	Prozent
Significantly higher (A1)	2	25.00%
Slightly higher (A2)	3	37.50%
The same (A3)	2	25.00%
Slightly lower (A4)	0	0.00%
Significantly lower (A5)	0	0.00%

CONCLUSION

Success criteria EX3-CRT-18.02c-TRL6-VALP-OF17-001

Due to missing any automation in the FOC prototype for TTA management, the dispatchers rate the workload as not acceptable to manage their tasks.

C.3.2.7. EX3-OBJ-18.02c-TRL6-TVALP-OF18 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-OF18	Impact of the TTA/TTO on the Departure time	EX3-CRT-18.02c-TRL6-VALP-OF18-001	Solution 18.02c provides evidence that TTA integration in the AU trajectory improves the flexibility on Departure Time by at least 10% of the cases.	Not assessable due to very limited data and due to prototype limitations.	NOK

C.3.2.8. EX3-OBJ-18.02c-TRL6-TVALP-CO1 Results

Technical Validation Objective ID	Technical Validation Objective Title	Success Criterion ID	Success Criterion	Iteration #03 Validation Results	Technical Validation Objective Status
EX3-OBJ-18.02c-TRL6-TVALP-CO1	To Assess Operational acceptability of the eFPL use in TTA management from DCB perspective.	EX3-CRT-18.02c-TRL6-VALP-CO1-001	Solution 18.02c assesses the operational acceptability – from a DCB perspective - of the management of Target times in conjunction with eFPLs integrating AOP/NOP	Not enough data to draw conclusions but no negative effects were observed in the AOP/NOP and DCB with	Partially OK

			information and provides evidence that the NMF actors/experts do not identify any side effect – e.g instability of the demand or Target Time – impacting negatively network or local DCB performances.	the TTA updated flights	

This validation objective has been assessed by PJ9.3.2.

DATA COLLECTION

The analysis is based on observations done by the PJ9.3.2 team during the exercise on:

- The AOP/NOP tool;
- The traffic counts on Arrival LEBL Traffic Volumes.

RESULTS EX3-CRT-18.02C-TRL6-VALP-CO1-001

Limited number of flight plans have been updated due to a TTA.

Before and after the TTA publication and flight plans updates, no specific variation of the traffic loads, traffic counts have been observed.

CONCLUSION

Success criteria EX3-CRT-18.02C-TRL6-VALP-CO1-001

Not enough data to draw conclusions but no negative effects were observed in the AOP/NOP and DCB with the TTA updated flights.

C.3.3 Unexpected Behaviours/Results

As Technical Validation exercise, no unexpected Behaviours or results.

C.3.4 Confidence in Results of Validation Exercise 3

C.3.4.1. Level of significance/limitations of Technical Validation Exercise Results

For the SID/STAR updates,

The exercise proved the technical feasibility for the FOC prototype and the flight dispatcher to update the AU trajectory with SID/STAR updates. NM Systems showed a high level of readiness to accept the AU 4D trajectory when compliant.

Nevertheless,

The data processed was rather limited due to prototype constraints that forced to more manual actions by dispatchers than expected, reducing the amount of processed data.

In the case a DPI/API message (by an A-CDM or AOP message) provide a SID or STAR procedure: when the flight dispatcher proposed a SID or STAR compliant with the Runway configuration, but not as planned initially by ETFMS via the DPI/API message, the current rules of the CDM process discarded the use of the proposed SID/STAR, making impossible to conclude on the benefits or risks linked to this usage. Further study will be required.

The non-implementation of some Vertical Limits in the SID/STAR definition reduce the trend for improvement of the AU Trajectory alignment with NM Systems and NM Traffic Predictability.

For the NM Traffic Predictability due to SID/STAR updates,

The Predictability is not based on the last real flown trajectory, but on ETFMS computed trajectory with the last DPI/API message (by an A-CDM or AOP message) before airborne. This profile is assumed as the closest catching all late intentions APT, TWR, FMP… but avoiding the disruption of execution

Because all the necessary updates have not been done by the flight dispatcher, for example when the FOC prototype receives an OPS update following an update done by the AU Flight Dispatcher, some AU trajectories have been discarded from the analysis. We could assume that other AU Trajectory updates (including the SID update) could be missing (not done neither by the Flight dispatcher, neither automatically by the FOC prototype) and that could continuously improve the trend for improvement of the NM Traffic predictability.

For the TTA updates,

The replies to some of the questions of the questionnaire suggest that not all aspects of the EFPL concept were sufficiently made available for them. Therefore some of the replies have to be considered with care.

The Flight Dispatcher fills in the RMK field with one or more of the following values tagging keywords for SID, STAR or TTA updates. If the tagging is not complete, this has a significant impact on the data analysis with the exclusion of the update messages from the results. We have identified some updates, but without the missing tagging keywords; those messages are not part of the metric dataset.

The quantitative results should be taken very cautiously and hence be confirmed with a further runs.

C.3.4.2. Quality of Technical Validation Exercises Results

Refer to 4.3.1.3.1

C.3.4.3. Significance of Technical Validation Exercises Results

Refer to 4.3.1.3.2

C.3.5 Conclusions

C.3.5.1. Conclusions on technical feasibility

Refer to 5.1.2.

C.3.5.2. Conclusions on performance assessments

N/A

C.3.6 Recommendations

Refer to 5.2.1.

Appendix D Safety Assessment Report (SAR)

A Safety Assessment report has been published under [23]. It specifies the safety assessment activities that have been carried out in SESAR2020 Wave 1 by Solution PJ18-02c. As hybrid solution (technological solution associated to OIs), the SAR has been delivered with the *SPR-INTEROP/OSED Part II* [27].

From the *Executive Summary* of the *Safety Assessment report*,

> *"This document contains the Safety Assessment for a typical application of the Solution PJ.18-02c. The report presents the assurance that the Safety Requirements for TRL 6/ Partial V3 are complete, correct and realistic, thereby providing all material to adequately inform the Solution PJ.18-02c SPR-INTEROP/OSED and TS-IRS."*

Appendix E Security Assessment Report (SecAR)

Not Applicable.

Appendix F Human Performance Assessment Report (HPAR)

No Human Performance expert has been planned for the Exercises.

Nevertheless, for the Iteration #3 (Dynamic SID/STAR information in eFPL & Target Time Use in eFPL), the exercise run in Shadow mode with AU Flight Dispatcher has gathered their feedback with a questionnaire. The results are provided below.

F.1 Iteration #3 Questionnaire results

Agree/Strongly Agree ☺
Disagree/Strongly Disagree ☹
Even, half-and-half opposite opinion 😐

F.1.1 Departure

F.1.1.1. SID/Runway

Q1. Information to analyse the need to update is:
- Clear ☺
- Useful ☺
- Complete ☺
- Timely ☺

Q2. Allows elaborating the final flight plan compared to current OPS
- Easier ☺
- Quicker (50-50) 😐
- Accurately☺

Q3. Information to assess situation
- Confidence ☺
- Acceptable workload ☹

F.1.1.2. Taxi Time

Q4. Information to analyse the need to update is
- Clear ☺
- Useful ☺
- Complete (50-50) 😐
- Timely ☺

Q5. Allows elaborating the final flight plan compared to current OPS
- Easier ☹
- Quicker ☹
- Accurately ☺

Q6. Information to assess situation

Confidence ☹

Why not?

- Too many changes in taxi time data.
- It is not clear if this is a prediction or the current taxi time at the time the message is sent.
- TXI & Holding time frequently different than given for LFPG.
- Information flow was a little bit chaotic.
- Taxi time change info less than 10' can be omitted.
- Often changes lead to me feeling unconfident about later changes that might appear after I performed the changes
- Taxi time are to LAB1L, 2 or 3 hours before are quite unpredictable.
- Several RWY changes, back to roiginal RWY, too much confusing information.
- I can't understand the "WHY" (why information updates are provided). I don't see the benefit, weither for Airline and Eurocontrol.

Acceptable workload ☹

F.1.1.3. Overall

Considering the departure information provided to me, I take the decision to update (or not) my Flight Plan Between 2h & 1h before EOBT.

Q7. Situational Awareness

Significantly higher (A1) 1 12.50%
Slightly higher (A2) 4 50.00%
The same (A3) 3 37.50%

Compared to today the workload will be … (50-50) 😐

Workload acceptable to carry out my tasks ☹

Q8. What tasks/processes could be totally automated?

- There is no automation at the moment.
- RWYs associated SIDs should be automated linked
- Taxi time. New procedures for parallel RWYs.
- If there will be departure desigantor change without RWY direction, this should be updated automatically by the system.
- Taxi time change less than 10' should be updated automatically.
- Auto recalculation with the new entreies (RWY, SID/STAR ...)
- RWY Change, Taxi Time, SID Change
- RWY in use inlc SID/STAR if possible.
- Taxi times as soon as we know RWY in use, we can calculate
- Reclaculation of the flight plan and sending out.

Q9. What are the main reasons for non-refiling when receiving a departure information update?

- If RWY change but with the same direction (RWY 27L changed to RWY 27R).
- Taxi time information changed few times. If taxi time is less than the taxi time planned, I will not change the OFP. If taxi time is higher than in the OFP and the A/C is not fueled yet, I will change OFP.
- For example, in case of "small" taxi time changes in comparison with the values previously considered.
- Taxi time with short time difference
- Taxi time is usually used for fuel calculation changes like +/- 10' can be disregarded.
- Taxi time difference no sufficient.
- Some RWY orientation.
- Lack of timr considering our dayly 200 flights operation, it would be impossible to react!
- Unless automated!
- Taxi time, if delta below 15'
- RWY in use if not R -> L with no SID changes.
- New information seem to be minor, I don(t see the benefit to refile / resend a Flight plan for a taxi time change of 2 minutes. There is no benefit for the Airline but there is extra work.

F.1.2 Arrival

F.1.2.1. STAR/Runway

Q10. Information to analyse the need to update is

Clear ☺
Useful ☺
Complete (50-50) 😐
Timely ☺

Q11. Allows elaborating the final flight plan compared to current OPS

Easier ☺
Quicker ☹
Accurately ☺

Q12. Information to assess situation

Confidence (50-50) 😐
Why disagree? ☹

- --
- --
- Same reasons than SID information.
- Information flow was a little bit chaotic.
- Trouble with STAR in spain which were not reliable or suitable for routing.
- STAR changes required sometimes a significant increase in the distance to be overflown (hence more time and fuel); their management created some questioning/mistrust.
- Often changes
- --

  - see 1.4.2.

Considering the arrival information provided to me, I take the decision to update (or not) my Flight Plan Between 2h & 1h before EOBT.

Situational Awareness ☺
Workload acceptable to assess and react ☹
Compared to today the workload will be ... ☺

The level of automation for the arrival information updates was acceptable to carry out my tasks effectively ☹

What tasks/processes could be totally automated?

- STAR calculation.
- RWY need to be checked by the dispatcher.
- --
- Easier if only one RWY proposed.
- Don't know how Lido will calculate with more than 1 RWY proposed.
- If there will be only arrival designator changed (without RWY direction), this should be automatically updated.
- Auto recalculation
- STAR, RWY
- RWY in use
- Taxi in if disruption
- Recalculation and resend of FPL, the dispatcher should have nothing to do with such tasks.

Q13. What are the main reasons for non-refiling when receiving an arrival information update?

- RNAV STAR is longer than standard STAR. If RNAV changed to standard, I will not always change it, it depends on workload.
- Timeline. Parallel RWYs.
- Information received less than 1 hour before departure.
- Same RWY
- Unreliable results (Spanish STAR)
- Lack of time
- Workload, priority is given to dep flights.
- See 1.6.1
- No trust in any benefit.
- There is the "Planning" phase and the "Actual operation" phase. They will always differ and there might be many more reasons why the "planned" status will change, e.g. late push back due to pax missing, etc ...

F.1.3 TTA

Q14. Information to analyse the need to update is

Useful ☹
Complete ☹
Timely ☹

Q15. Allows elaborating the final flight plan compared to current OPS
Easier ☹
Quicker ☹
Accurately ☹

Q16. Considering the TTA information provided to me, I take the decision to update (or not) my Flight Plan … before EOBT.

Between 3h & 2h (A1) 4 50.00%
Between 2h & 1h (A2) 4 50.00%

Q17. Situational Awareness ☺
Slightly higher (A2) 5 62.50%
The same (A3) 2 25.00%
Slightly lower (A4) 1 12.50%

Q18. Confidence to assess a situation 😐

Why disagree?

- We observed often changes in the TTAs received. Some flights were impacted by many TTA changes making their management not so efficient.
- Just an TTA Information is not sufficient to make decisions by the AO. In 99% cases change of trajectory or the speed would not be economically efficient, because usually the FPL Provided is the most efficient one in time, cost and fuel. The direction should be rather to reduce Fuelburn in order to new political challenges that are coming up. TTA might be very useful for Dep Airport, which should assign the plane in the queue and assign CTOT accordingly to fulfill TTA Requirements assignd by arrival airport.
- Operators and CTL or APT views can differ.
- The TTA requires the dispatcher to calculate the required time of departure in order to meet the TTA requirement - it is easier to get a CTOT time and to have the consequences from the CTOT time frame or missing the CTOT.
- If the TTA time is earlier that the Planned Arrival time calculated by the OFP, I don't have any option to advance the flight. in most flights within Europe high speed operation can save up to 3/4 minutes and not more than that.
- What is the consequences of missing the TTA? it is not clear. If I arrive earlier than the TTA I can assume to get Holding over the airport/ what will happen I i'll get later than the TTA?

Workload acceptable ☹

Compared to today the workload will be higher ☹

The level of automation for the arrival information updates was acceptable to carry out my tasks effectively ☹

Q19. What tasks/processes could be totally automated?

- Automization is critical for this, as decision has to be taken HOW to meet a TTA. There are several options, (changing ETD, modifying CostIndex/Speeds etc.), definitions would have to be made how to proceed when. Sometimes the overall operational costs are higher when the aircraft is flying slower, crew costs rise etc. so the company has to decide how to proceed when
- None
- Automation of TTA could create a huge chaos. If it is planned it should be take care very carefully.
- Short TTA shift in future time 3h before flight.
- Auto recalculation
- New Check for weather, Airport closure, NOTAMs....
- an added value would be the reverse engeneering, that i insert the tta and it calculates backwards , re-optimizing the flight.
- delaying flight to match the TTA.

Q20. What are the main reasons for non-refiling when receiving a TTA information publication?

- difference in time less than 10 minutes
- Very time consuming to calculate the TTA in the flight planning system; Cost Index is a fix "Best Option" speed vs crew time costs, and makes no commercial sense to Change; Different longer route would again make no sense environmental or Commercial.
- TTA is subject to improve, EOBT should not be updated unless necessary.
- Trajectory filed originaly usually is the most efficient one, due to economical reasons that sould not be changed too unless it is affected by other regulations.
- Short time notice.
- Workload, low delay
- when the TTA is in the CTOT window
- As mentioned before - if the TTA is earlier than the ETA
- The TTA is a very interesting information that can be used to update the flight plan in an automated way if TTA shifts within a window of aprox 15 to 20 minutes and if higher to basically propose rescheduling the flight. ☺

Appendix G SESAR Technological Solution(s) Maturity Assessment

The technological Solution Maturity Assessment is provided in the enclosed Excel sheet below:

Maturity
Assessment in SESAI

Appendix H High level Economic Appraisal

Disclaimer: 18.02c is a Technological solution without yet clearly defined targeted OIs. Consequently, this annex is only partially applicable; assumptions for the benefits of the service have been initially considered to justify the selection of these Use Cases for the INTEROP and TVAL document.

The high-level economic appraisal focusses on two evolutions/services in the scope of the solutions expected to achieve TRL6 maturity at the end of Wave 1:

- eFPL distribution services allowing ANSPs (both local DCB and ATC functions) to use the new information to improve local processes through in particular through improved trajectory prediction
- AOP/NOP information distribution allowing FOC flight planning system to improve AU flight planning with up-to-date information on planned SID/runway and taxi times from CDM airports.

H.1 Stakeholders identification

There are three stakeholders involved in the deployment of this solution:

- Airspace Users: Flight Operations Centre (FOC)
- Network Manager
- ANSP

Stakeholder	Type of Impact
ANSP	eFPL use in ATC: • Costs: invest to update their systems (Local DCB system and/or ATC) to improve traffic predictionSome operational benefits identified in the BIMAOP/NOP departure info used in AU flight planning: no direct impact.
Network Manager	Costs: Invest to update the NM system to provide the functionalities required by this solution from the eFPL and AOP/NOP distribution services Benefits: Some operational benefits. No quantification.
Scheduled Airlines (Mainline and Regional)	Costs: Invest in the flight operations centre software to use the AOP/NOP information provided by NM. No cost for eFPL use in ATC since the cost for provision of eFPL information to NM is considered in another solution (#37) already in deployment. Benefits: some operational benefits in planning and executions

H.2 Reference Scenario

In the reference scenario the eFPL distribution and AOP/NOM distribution services are not available meaning that:

- ANSPs knowledge of AU demand and traffic predictions is based on ICAO 2012 flight plan information

- AUs perform their flight planning considering rough information they get from airports (e.g. METAR). They do not have an accurate and up-to-date information of planned runway configuration plans at departure airports, planned allocated runway and SID for their flights as well as planned departure taxi times taking as provided by CDM airports to the network manager. This limits the accuracy of AU fuel planning and increase significantly differences between the AU and ATM view of the planned trajectories leading to inefficiencies in various processes (flight plan acceptance, DCB).

H.3 Solution Scenario

In the solution scenario, the two aforementioned services are deployed by the Network Manager and available to end users. More precisely:

- eFPL submission and distribution service are deployed. eFPL information is available for around 80 % of the traffic (deployment scenario for solution #37) and major ANSPs have developed and deployed functions both in local DCB – if any – and ATC (FDPS) systems to connect to B2B eFPL distribution services and use the data to improve traffic prediction

- AUs FOC systems are connected to the AOP/NOP distribution service to retrieve departure data received for CDM airports -around 50 % of the departure traffic in ECAC area - and improve their flight planning using this more accurate information

H.4 Benefit assessment

The following table is derived from the Benefit and impact mechanisms diagrams provided in the INTEROP document (section A.2.1. and A.2.3).

Topic/service	Stakeholder that benefits	Main KPAs impacted positively
eFPL distribution service	ANSPs	Cost efficiency Capacity Safety
eFPL distribution service	AU	AU cost efficiency Fuel efficiency Safety
AOP/NOP data distribution service	NM ANSP (local DCB)	NM Cost efficiency Network capacity Safety
AOP/NOP data distribution service	AU	Predictability Fuel efficiency Safety

H.5 Cost assessment

The following table provide a qualitative assessment of the enablers addressed by the solution.

Enabler code	Enabler description	Stakeholder impacted	Cost assessment
NIMS-21b	Flight Planning extended with eFPL Distribution service	NM	Low cost. The more so that the service is almost developed by NM in the context of FF-ICE services implementation.
SWIM-APS-18	eFPL service consumption in ATC	ASNP	Low cost. Most of the ANSPs have already a good experience of NM B2B services consumptions.
ER APP ATC 82	Enhance EN/APP ACC to use eFPL data	ASNP	Low cost if only a few elements from the eFPL used (like TOW and speed) just for display. High cost if more information used (like the 4D trajectory) and used in core ATC system like FDPS and conflicts detection/resolution.
AOC-ATM-23	SID/STAR and RunwayConfigurationPlan information integration in the FOC trajectory	AU	Medium cost. The presentation of the information to dispatchers as well as some automation related to the flight replanning decisions are needed to be implemented in flight planning systems.
SWIM-APS-17	AOC Consume NMFlightData service FlightListByAO interface via P/S	AU/CFSP	Low cost. CFSP have already a good experience of NM B2B service consumptions.
SVC-003	Enhance the existing NMFlightData service to publish and subscribe SID/STAR data	NM	Low cost. Information is already available in NM systems and provided through a general B2B service (Flight information service) that just needs to be better customised for AUs.

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