IOP+i4D Validation Report

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Abstract

This document describes the results of the validation activities of the IOP+i4D exercise (EXE-04.03-VP-030) conducted under the SESAR SWP 04.03.

To be able to validate the ground-ground (IOP) and air-ground (i4D) concept, these enablers were used in context of an AMAN Extended Horizon concept with a Controlled Time of Arrival (CTA) at the Initial Approach Fix (IAF).

Because of issues related to other SWP4.3 IOP exercises, difficulties observed in the first factory verifications of the Validation Platform and the short timeframe available to resolve them in time for the execution of VP-030, resulted in a downscaling of the exercise from an E-OCVM V3 validation to a technical validation.

As result of the VP-030 exercise, the VP-030 implementation of the CTA+i4D related ground-ground interoperability via the Flight Object is a technically realistic option that can be taken into account as input for SESAR2020 PJ18.
Although it was not the concept under test but an enabler, the validations showed that aircraft data can be passed between ground units and that there is a need to further mature the AMAN Extended Horizon concept in the context of an IOP environment and its interaction with the aircraft exchanges. The aircraft could use the arrival systems time constraints to accurately fly over the Initial Approach Fix.

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Executive summary

The focus of the SESAR Project P04.03 was integrated and pre-operational validation & cross validation.

The "Initial Integration of IOP+i4D" exercise (EXE-04.03-VP-030) as described in the WP04.03 PIR (ref.[6]) was seen as the successor of the independent IOP and i4D validation exercises, in which the ground-ground and air-ground functionality would be integrated.

Because the i4D and IOP concepts are enablers for SESAR Step 1 an ATM service was required to demonstrate the performance benefits of the two concepts.

Sharing of trajectory information between Controlling ATSU and Destination ATSU as part of AMAN Extended Horizon concept was used as the ATM service to demonstrate that sharing of this information via i4D and IOP would generate benefits.

This required the integration of EPP data, trajectory information of the aircraft, in the FO. This extension of the IOP software was built on the IOP baseline as used in EXE-04.03-VP-711, which at the end constrained the IOP-functionality to the same level as VP-711 (V2) including a sub-set of the software bugs as well, but the integration of the EPP data was achieved.

As described in the VP-030 VALP (ref.[7]), the VP-030 validation exercise was planned as a V3 validation and to be executed in Release 5. Because of issues related with other SWP4.3 IOP validation exercises (VP-711 and VP-799[1]) it was decided, in consultation with the SJU, that VP-030 would be postponed beyond the Release 5 timeframe and for this reason changed into a V2 validation. It was later downscaled to a technical validation because of the difficulties (primarily related to the IOP layer) observed in the first factory verifications of the Validation Platform and the short timeframe available to resolve all the found issues and the VP-030 validation exercise itself.

The focus of the technical validation was on the behaviour of the controller's HMI as described in the AMAN Extend Horizon concept, by using the validation set-up consisting of an integrated environment of the MUAC and LVNL IBPs.

It can be concluded that the VP-030 implementation of the CTA+i4D related ground-ground interoperability via the Flight Object is a technically realistic option that can be taken into account as input for SESAR2020 PJ18 and Pilot Common Project (PCP) deployment later.

Although it was not the concept under test it can be concluded based on the technical validation that aircraft data can be passed between ground units and that there is a need to further mature the AMAN Extended Horizon concept in the context of an IOP environment and its interaction with the aircraft exchanges. The aircraft could then use the arrival systems time constraints to accurately fly over the IAF.

[1] VP-799 was cancelled on 08/03/2016 (Change Request 2388)

1 Introduction

1.1 Purpose of the document

This document provides the Validation Report for ground-ground (IOP) and air-ground (i4D) interoperability, PAC03 Moving from Airspace to Trajectory Management, 4D Trajectory Management Sub Package, Trajectory Management Framework and System Interoperability with air and ground data sharing (ENB03.01.01) and PAC04 End to End Traffic Synchronization, Enhanced Arrival & Departure Management in TMA and En Route (OFA04.01.02).

The exercise EXE-04.03-VP-030 is a cross validation exercise, and can be described as an i4D+CTA implementation in an AMAN Extended Horizon environment using TMF services to exchange trajectory data (iRBT) and IOP services to exchange data between ATSUs.

Original (see VP-030 VALP (ref.[7]), the VP-030 validation exercise was planned as a V3 validation and to be executed in Release 5. Because of issues related with other SWP4.3 IOP validation exercises (VP-711 and VP-799) it was decided, in consultation with the SJU, that VP-030 would be postponed beyond the Release 5 timeframe and for this reason changed into a V2 validation. It was later downscaled to a technical validation because of the difficulties observed in the first factory verifications of the Validation Platform and the short timeframe available to resolve the found issues and the VP-030 validation exercise itself.

1.2 Intended readership

Primary projects:

04.03	- Integrated and Pre-operational validation& Cross Validation
04.05/05.05.01	- Trajectory Management Framework
09.01	- Airborne Initial 4D Trajectory Management
10.02.01	- ATC Trajectory Management Design
10.02.05	- Flight Object IOP System Requirement & Validation
14.02.09	- SWIM Platform development and Demonstrator delivery (Flight Object Server)

Coordinating Federating Projects:

04.02	- Consolidation of operational concept definition and validation including operating mode and air-ground task sharing.
05.02	- Consolidation of Operational Concept Definition and Validation

1.3 Structure of the document

The document is structured in six sections:

- Section 1 presents the purpose of the document, the intended audience and the terminology used within the document;
- Section 2 presents the validation context and provides the general background of the validation;
- Section 3 summarises the different steps and methods used to perform the validations. It also highlights the deviations from the initial plans, and the issues encountered.
- Section 4 summarises the validation results
- Section 5 provides thee detailed conclusions of the validations and lists the associated recommendations.
- Section 6 lists the applicable and reference documents

1.4 Glossary of terms

Not applicable

1.5 Acronyms and Terminology

Term	Definition
ACC	Area Control Centre
ADS-C	Automatic dependent Surveillance
AMA	Arrival Management Message (OLDI)
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider
AOI	Area of Interest
AOR	Area of Responsibility
APP	Approach
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATSU	Air Traffic Service Unit
CC	Coordinating Controller
C-LVNL	Consortium LVNL
CPDLC	Controller-pilot data link
CTA	Controlled Time of Arrival
CWP	Controller Working Position
DOD	Detailed Operational Description
EAT	Estimate Approach Time
EC	Executive Controller
ENAV	Società Nazionale per l'Assistenza al Volo – Italian Company for Air Navigation Services
E-OCVM	European Operational Concept Validation Methodology
EPP	Extended Projected Profile

Term	Definition
EUROCAE	European Organization for Civil Aviation Equipment
ETA	Estimated Time of Arrival
ETO	Estimated Time Over
E-TMA	Extended Trajectory Manoeuvring Area
FDP	Flight Data Processor
FDPS	Flight Data Processor System
FIR	Flight Information Region
FMP	Flow Management Position
FMS	Flight Management System
FO	Flight Object
HMI	Human Machine Interface
i4D	Initial 4D
IAF	Initial Approach Fix
IBP	Industrial Based Platform
IOP	Interoperability
iRBT	Initial Reference Business Trajectory
iRMT	Initial Reference Mission Trajectory
KPA	Key Performance Area
LVNL	Luchtverkeersleiding Nederland – Air traffic Control Netherlands
MUAC	Maastricht Upper Area Control Centre
OFA	Operational Focus Area
OLDI	Online Data Interchange
PCP	Pilot Common Project
PIR	Project Initiation Report
R/T	Radio Telephony
RTA	Required Time of Arrival
RTCA	Radio Technical Commission for Aeronautics

Term	Definition
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
SWIM	System Wide Information Management
TMA	Terminal Manoeuvring Area
TMF	Trajectory Management Framework
TOD	Top Of Descent
TP	Trajectory Prediction
VALP	Validation Plan

2 Context of the Validation

The scope of this exercise is the sharing of information from the aircraft between a Controlling ATSU and Destination ATSU in an AMAN Extended Horizon application. In this exercise the Destination ATSU will use an AMAN, which will calculate a CTA, based amongst others on the trajectory data of the aircraft and the RTA Reliable Interval at IAF. This CTA is communicated, using the Flight Object between ATC-centers and uplinked via the Controlling ATSU to the aircraft.

The exercise contains concept elements of the following two OFAs:

ENB03.01.01 Trajectory Management Framework and System Interoperability with air and ground data sharing.

OFA04.01.02 Enhanced Arrival & Departure Management in TMA and En Route

The enablers addressed are coming from these OFAs.

The validation exercise is intended to confirm that the use of an integrated ground-ground and air-ground interoperability, as defined by IOP and i4D+CTA, in an AMAN Extended Horizon context and associated HMI is technical achievable.

IBPs of MUAC and LVNL were used for the validation.

The exercise was performed within the framework of the integrated roadmap dataset DS16 (ref [18]).

In this exercise the ATM operational functions were the sharing of trajectory information of the aircraft between Controlling ATSU and Destination ATSU as part of the AMAN Extended Horizon concept.

2.1 Concept Overview

Validation Exercise ID and Title	EXE-04.03-VP-030: Ground-ground and air-ground interoperability.
Leading organization	C-LVNL
Validation exercise objectives	Validate that the use of an integrated ground-ground and air-ground interoperability, as defined by IOP and i4D+CTA, in an AMAN Extended Horizon context and associated HMI is confirmed to be technical achievable.
Rationale	Next step after the verification of the validation environment is the technical validation of the integrated ground-ground and air-ground interoperability, as defined by IOP and i4D+CTA, in an AMAN Extended Horizon context and associated HMI as it was described in the use cases.
Supporting DOD / Operational Scenario / Use Case	DOD WP4.2/ OS-4-01 Trajectory Management in En Route/ TM-UC-03-01
OFA addressed	ENB03.01.01 - Trajectory Management Framework and System Interoperability with air and ground data sharing;
OI steps addressed	AUO-0205-A - ATC-ATC, ATC/Aircraft and ATC/NM Update and Revision of the Initial Reference Business/Mission Trajectory (iRBT/iRMT); IS-0303-A - Downlink of onboard 4D trajectory data to enhance ATM ground system performance: initial and time based implementation ; TS-0103 - Controlled Time of Arrival (CTA).
Enablers addressed	A/C-11 - Flight management and guidance for improved single time constraint achievement (CTA/CTO); A/C-31a – Data link communication exchange for ATN baseline 2 (FANS 3/C)

	A/C-37a – Downlink of trajectory data according to contract terms (ADS-C) compliant to ATN baseline 2 (FANS 3/C) ER APP ATC 82 - Enhance FDP to use SBT/SMT, RBT/RMT; ER APP ATC 100 - 4D Trajectory Management in Step 1 - Synchronization of Air and Ground Trajectories ; ER APP ATC 149a - Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP) ; ER APP ATC 149c -Air-Ground Datalink Exchange to Support i4D - Controlled Time of Arrival/Overflight (CTA/CTO) ; ER APP ATC 160 - ATC to ATC Flight Data Exchange Using The Flight Object; PRO-118 - ATC Procedures for use of CTA across several AoRs SWIM-APS-05a - Provision and Consumption of Flight Object Sharing services for Step 1; SWIM-INFR-01a - High Criticality SWIM Services infrastructure Support and Connectivity; SWIM-NET-01a - SWIM Network Point of Presence; SWIM-STD-01 - AIRM; SWIM-STD-02 - SWIM Service.
Applicable Operational Context	En-route, TMA, Execution phase
Expected results per KPA	Not applicable
Validation Technique	Real-time simulation with IBPs
Dependent Validation Exercises	Not applicable

Table 1: Concept Overview

2.2 Summary of Validation Exercise/s

2.2.1 Summary of Expected Exercise/s outcomes

For ground industry:

- Prove that it is possible to connect MUAC and LVNL via IOP with the same maturity level than VP-711
- Prove that it is possible to upgrade the flight object to embed the ADS-C data and services
- Prove that it is possible to use the IOP data to feed the AMAN with extended horizon information and ADS-C data

For ANSPs:

- Preliminary assessment of ADS-C dynamic behavior, taking this into account for AMAN algorithm
- Preliminary assessment of the impacts of the IOP-G technology for an extended AMAN horizon context.

2.2.2 Benefit mechanisms investigated

Not applicable, because no KPA's were addressed.

2.2.3 Summary of Validation Objectives and success criteria

Not applicable. because no validation objectives were validated.

2.2.3.1 Choice of metrics and indicators

The technical validation was focusing on behaviour of the controller's HMI based of the AMAN Extended Horizon concept, the exchange of aircraft data using the flight object and the aircraft flying to an RTA. For this reason an overview of operational test cases was made of all the concept specific changes in the controller's HMIs which confirmed the exchange and processing of the data.

During the exercise the participants sitting behind each controller CWP were asked to verify the behaviour by using this overview (see Appendix B).

2.2.4 Summary of Validation Scenarios

In the VP-030 VALP two scenarios were defined, a reference and solution scenario. Because of the change in scope of the validation only the solution scenario has been used and the traffic load went from high to low.

Identifier	SCN-04.03-VALP-VP30.0002
Scenario	Solution scenario: inbound peak (high), controlled aircraft via MUAC (Sector RUHR/MUNSTER and JEVER), all aircraft i4D equipped, AMAN Extended Horizon, use of ground-ground and air-ground operability, and standard handover conditions.

The solution scenario was based the following use case: TM-UC-03-01 (ref.[10]).

2.2.5 Summary of Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value	Owner	Impact
ASS-04.03-VALP-VP30.1001	Downlink of EPP by simulated aircraft	Aircraft equipage	All simulated aircraft shall be able to downlink EPP data on regular basis (e.g. 10 minutes) or event driven as foreseen in SESAR	All simulated aircraft shall be i4D equipped	En-route & TMA	N/A	WP4.3 VP-030 Project Team	N/A	P03.03.03	High
ASS-04.03-VALP-VP30.1002	Downlink of RTA Reliable Interval by simulated aircraft	Aircraft equipage	All simulated aircraft shall be able to downlink RTA Reliable Interval at a waypoint on request of an ATSU	All simulated aircraft shall be able to downlink their RTA Reliable Interval on request of an ATSU	En-route & TMA	N/A	WP4.3 VP-030 Project Team	N/A	P03.03.03	High
ASS-04.03-VALP-VP30.1003	EPP and RTA Reliable Interval updates by simulated aircraft	Aircraft equipage	If the aircraft trajectory is changed because of for example an instruction of an ATCO, all simulated aircraft shall be able to update EPP and RTA Reliable Interval accordingly and downlink this updated data according the contract to the Controlling ATSU	When an aircraft trajectory of a simulated aircraft is changed than the EPP and RTA Reliable Interval shall be updated accordingly and downlink according the contract with the Controlling ATSU	En-route & TMA	N/A	WP4.3 VP-030 Project Team	N/A	P03.03.03	High

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value	Owner	Impact
ASS-04.03-VALP-VP30.1004	RTA accuracy simulated aircraft	Aircraft equipage	The simulated aircraft shall be able to meet the RTA assumed accuracy of +/-10 sec: 95% of the time	The simulated aircraft shall meet the RTA assumed accuracy	En-route & TMA	N/A	WP4.3 VP-030 Project Team	+/-10 sec: 95% of the time	P03.03.03	High
ASS-04.03-VALP-VP30.1005	CPDLC equipped simulated aircraft	Aircraft equipage	The simulated aircraft shall be CPDLC equipped	The communication in upper area airspace will be via CPDLC	En-route	N/A	WP4.3 VP-030 Project Team	N/A	P03.03.03	High
ASS-04.03-VALP-VP30.1006	CPDLC equipped ATSU	Ground system equipage	The upper area ATSU shall be CPDLC equipped	The communication in upper area airspace will be via CPDLC	En-route	N/A	WP4.3 VP-030 Project Team	N/A	P03.03.03	High
ASS-04.03-VALP-VP30.1007	Use of TP data in AMAN	Ground system equipage	AMAN Extended Horizon shall be able to use aircraft trajectory data instead of TP data to build the arrival sequence. This shall be implemented in the LVNL IBP	The "aircraft trajectory (EPP data)" information will be used by AMAN Extended Horizon to calculate a CTA at IAF	TMA	N/A	WP4.3 VP-030 Project Team	N/A	P04.03	High
ASS-04.03-VALP-VP30.1008	Use of RTA Reliable Interval in AMAN	Ground system equipage	AMAN Extended Horizon shall be able to use RTA Reliable Interval over IAF data to calculate the RTA of an aircraft. This shall be implemented in the LVNL IBP	The RTA Reliable Interval information will be used by AMAN Extended Horizon to calculate a CTA at IAF	TMA	N/A	WP4.3 VP-030 Project Team	N/A	P04.03	High

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value	Owner	Impact
ASS-04.03-VALP-VP30.1009	Enhancement CWP/HMI of E-TMA with aircraft trajectory and intent information.	Ground system equipage	CWP/HMI of the E-TMA EC shall be enhanced with aircraft trajectory and intent information. This shall be implemented in the LVNL IBP	The aircraft trajectory and intent information used by AMAN Extended Horizon shall be made available to the E-TMA EC	TMA	N/A	WP4.3 VP-030 Project Team	N/A	P04.03	Medium
ASS-04.03-VALP-VP30.1010	Traffic realistically separated	Simulation set-up	All traffic will be realistically separated	In SESAR all traffic is pre-deconflicted which is not the case in the current way of operation. To be able to compare both scenarios all traffic will be realistically separated	En-route & TMA	N/A	WP4.3 VP-030 Project Team	N/A	P04.03	High
ASS-04.03-VALP-VP30.1013	Landing runway for RTA Reliable Interval request.	Simulation set-up	The landing runway shall be known by the aircraft before the request for RTA Reliable Interval is requested	An airport with multiple runways has the possibility to assign a runway to an aircraft just for approaching the IAF. To the late change of a runway is not part of the concept under evaluation and to simplify the simulation they landing runway shall be known by the aircraft before the RTA Reliable Interval request.	En-route & TMA	N/A	WP4.3 VP-030 Project Team	N/A	P04.03	High
ASS-	No	Simulation	No trajectory	Not possible because	TMA	N/A	WP4.3	N/A	P04.03	Low

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value	Owner	Impact
04.03-VALP-VP30.1014	trajectory negotiation between aircraft in LVNL airspace	Set-up	negotiation between aircraft and ATSU in LVNL airspace	of simulation set-up			VP-030 Project Team			
ASS-04.03-VALP-VP30.1015	No pop-up traffic	Simulation set-up	No pop-up traffic	Pop-up traffic is outside scope exercise	En-route & TMA	N/A	WP4.3 VP-030 Project Team	N/A	P04.03	High
ASS-04.03-VALR-VP30.1000	No Weather simulated	Simulation set-up	Weather will not be simulated	Change in weather was outside scope of the exercise.	En-route & TMA	N/A	WP4.3 VP-030 Project Team	N/A	P04.03	High
ASS-04.03-VALR-VP30.1001	No ADS-C latency	Simulation set-up	ADS-C latency will not be simulated	Tthe methods used in the generation of the ADS-C messages and interconnection of the platform did not allow the inclusion of ADS-C delays.	En-route & TMA	N/A	WP4.3 VP-030 Project Team	N/A	P04.03	Medium

Table 2: Validation Assumptions

2.2.6 Choice of methods and techniques

No quantitative or qualitative methods were used.

Each participant had an overview (see Appendix B) to verify the behaviour of the HMIs, see section 2.2.3.1 for more information.

2.2.7 Validation Exercises List and dependencies

Not applicable: there is only one exercise addressed within the frame of this report.

3 Conduct of Validation Exercises

3.1 Exercises Preparation

The VP-030 exercise was original planned as a V3 validation to be executed in Release 5. Because of issues with VP-711 and the parallel preparation of exercise VP-030 and VP-799, involving the same industry partners, it was decided, in consultation with the SJU, that because of the limited time and resources by the partners, VP-030 would be postponed beyond the Release 5 timeframe and for this reason was changed into a V2 validation.

A new planning was made in coordination with VP-799 to assure the availability of the required resources, with the execution of VP-030 planned in the last week of May 2016.

New functionality required for VP-030, was the availability of the EPP data, trajectory information of the aircraft, in the FO. This extension of the IOP software, built on top of the IOP baseline as used in EXE-04.03-VP-711, was under development by WP10.02.05.during the drafting of the new planning and its availability for the first integration tests was foreseen at the end of 2015.

To minimize the risks it was decided to start as soon as possible the integration activities of the MUAC and LVNL IBPs, based on the VP-711 s/w, which was successfully accomplish in November 2015.

In parallel, at INDRA premises, a high fidelity copy of the complete MUAC-LVNL end-to-end set-up (only the network was different) was configured to verify the VP-030 specific software, before it would be installed on the MUAC and LVNL IBPs. This set-up was also used to verify the integration of the AMAN, which was not part of SESAR, but essential for the execution of the VP-030 exercise. This AMAN version consisted of an extension of the new AMAN of LVNL currently under development by DFS under assignment of LVNL.

The big advantage of this set-up was that an integrated team composed of industry and ANSPs partners were able to verify the whole set-up together, which helped to get a faster understanding and resolving of the issues that appeared during testing.

After successful integration and adaptation of the VP-030 software the first technical dry-run was performed in the first week of March 2016. Unfortunately not all tests could be performed because the basic functionally was not working correctly, which made it also impossible to test the VP-030 specific software during this technical dry-run.

All these issues seemed to be solvable with the help of all the partners, but looking at the time and resources required to solve and to test these issues it was concluded that it would be impossible to execute VP-030 in the planned timeframe.

For this reason, it was decided and agreed to reduce the ambition level of VP-030 to a technical validation and to postpone the execution of VP-030 to the third week of July 2016.

A weekly WebEx was organized, between industry and ANSPs partners, to monitor and to discuss the progress.

Testing of the solved issues and the VP-030 specific software took first place at INDRA premises on the high fidelity copy of the validation environment, followed by testing on the MUAC-LVNL validation platform which resulted in a conditional acceptance of the validation platform on July 18th (M6-milestones).

The validation platform was technical accepted under the following conditions:

- It is not mature enough to support operational validation, but it is able to support the technical validation.
- It still contains limitations and workarounds as described SESAR P10.02.05 – D00.01.00 – VP030 Verification Report (ref.[11]), which can affect the outcome of the technical validation.
- It shall be noted that the functional IOP-baseline of VP030 is based on the exercise VP711, which was executed as a E-OVCM V2 Validation in the end. This implies that this VP030 is w.r.t. the IOP-functionality constrained to the same level as the VP711, still including a sub-set of the software bugs as well.

3.1.1 Validation Platform configuration

The exercise took place on the two IBPs (Industrial Based Platforms), hosted by MUAC (see Figure 1) and LVNL (see Figure 2). The MUAC IBP was situated at their premises at Maastricht Airport and the LVNL IBP at Schiphol Airport.

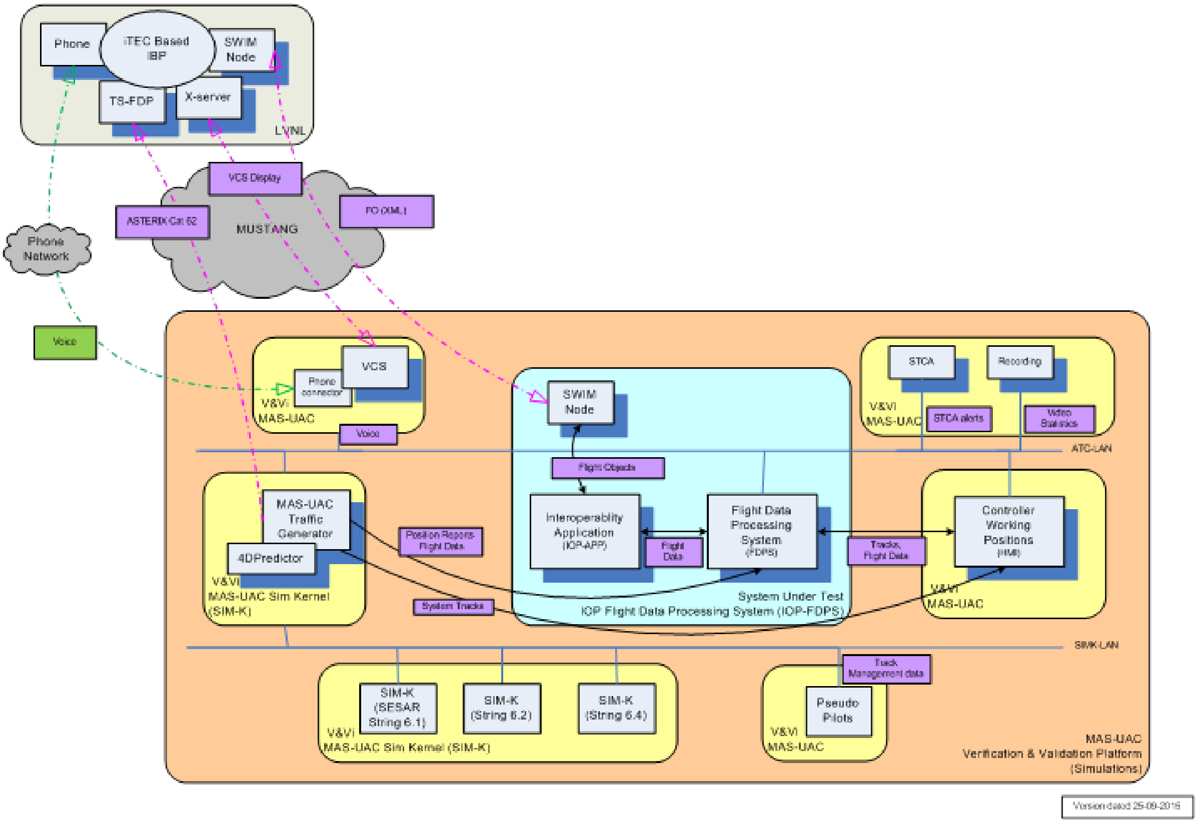


Figure 1: MUAC IBP Description

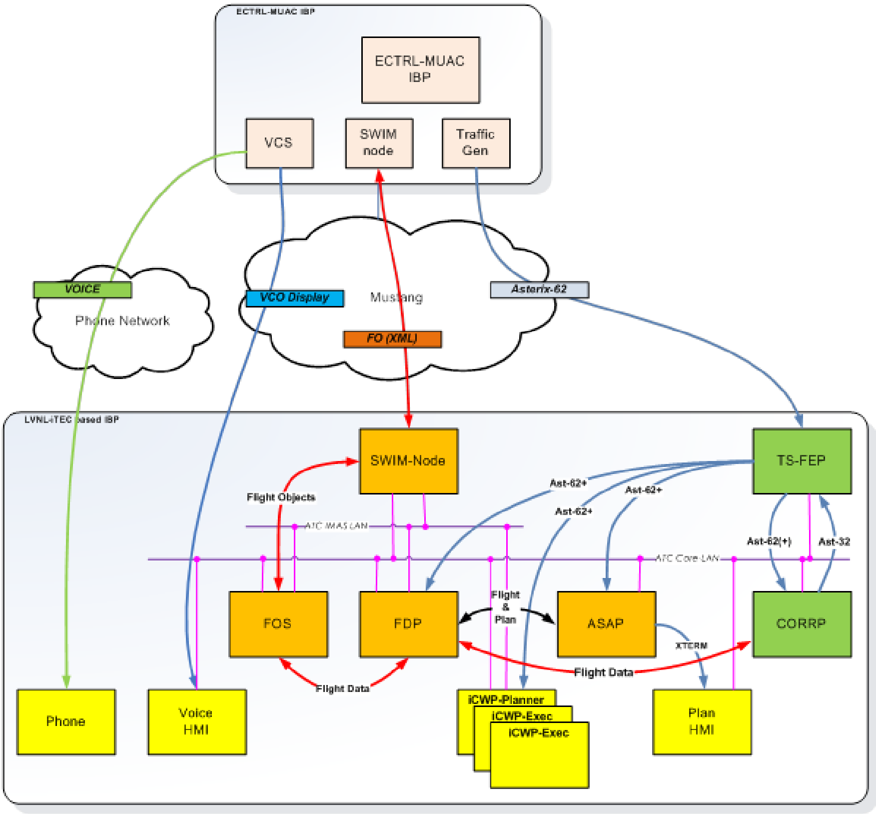


Figure 2: LVNL IBP description

These IBPs were connected via the “PENS (Pan-European Network Services) look-alike” MUSTANG Network for exchange of FO data (via IOP and SWIM), ATFCM (Asterix-62) data and standard communication between two adjacent ATSUs. Furthermore the IBPs were connected via a simulation environment (SIM-K and 4D Predictor) for managing the exercise and generating the traffic. All traffic was generated by MUAC which, because of the simulator limitations, implied that the flights would not fly down to the runway, but be stopped at the IAF, approximately 10 minutes beyond MUAC’s boundary. This set-up was successfully tested and verified in the third week of October 2015.

The VCS (Voice Communication System) was also prepared and successfully tested in the same period, but due to the change in validation scope not needed for the validation. Furthermore because of the change in the validation scope only one Executive Controller position at MUAC side and one Executive Controller and APP planner position at LVNL side were needed.

3.1.2 Validation exercise preparation

In parallel with the development and testing of the validation platform, the project team had defined the scenarios and data (qualitative and quantitative) recording and analysing specifications in more detail, and was busy with the development of the scenarios and data recording and analysing tools at the time that issues with the validation platform appeared (March 2016).

The validation exercise preparation changed completely, because of the change in the scope of the validation. The foreseen and developed scenarios, data recording and analysing tools were not useful anymore and needed to be changed.

Furthermore, because of the instability of the validation platform (basic functionality was not working correctly), the impossibility to perform an operational validation and the fact that active controllers should be scheduled months in advance, it was decided to use system and/or operational experts to perform the validation, and not active controllers, as originally planned. Because of this it was decided to use only three CWPs, the MUAC EC CWP, LVNL EC and APP planner CWP.

For developing a new set-up based on the new criteria, the question “Are we building the right system?” needed to be answered. This meant for a technical validation that the focus would be on the

HMIs of the controllers, and especially the behaviour of the HMIs based on the changes of the system and/or inputs made by the controllers.

For VP-030 the focus is on the exchange of EPP data between partners using the flight object and its use in the AMAN Extended Horizon concept and the aircraft flying to the RTA, which was defined within the project.

After the deliverance of the VALP, more effort was put into the defining of the AMAN Extended Horizon concept with the help of operational controllers and system experts of LVNL and MUAC. This resulted in Use Case descriptions (see Appendix C), describing sequences of interaction between systems and users for the new concept and HMIs description for MUAC and LVNL. The MUAC HMI was used in previous i4D-CTA validations (VP-029, VP-323, V-330, VP-463 and VP-472) and LVNL incorporated the same philosophy in their HMI. See Appendix D for detailed description of the MUAC HMI and Appendix E for the LVNL HMI.

From these use cases 17 unique operational test cases could be defined (Appendix F), from very simple ones to more complex ones.

An action (automatic or manual) is required to move from one step in a sequence to another, and for each action the expected changed on the MUAC EC CWP, LVNL EC CWP and the APP Planner CWP was determined (if applicable), resulting in one overview of all test cases (see Appendix B).

To record the results of the exercise, after each CWP description a column ‘result’ was added, to be filled in during the exercise.

In preparation of the exercise all the 17 test cases were verified. It turned out that the test case 15 and 16 could not be executed because of integration issues (see VP-030 Verification report, ref.[11]), which made it not possible for the Lower Airspace Controller to take action as required (Use Case 2.8).

Because the focus was on the behaviour of HMI’s supporting the new concept only a solution scenario was developed. This scenario was based on the scenarios used during the verification tests, and contained all the flights with the right characteristics to overcome the observed IOP problems. Appendix G contains an overview of all the flights used in the solution scenario.

At the start of a run (execution of a scenario) a flight would be assigned to a sequence and this flight would be followed throughout the execution of this sequence. During the testing of the scripts it was determined that five/six test cases could be executed per run, which resulted into the following schedule for the execution of the validation:

Date	**Time**	**Activity**	**Sequence**
Wednesday July 20th	9:00	Welcome	
	9:30	Run 1	1, 2, 3, 4, 5, 6
	10:30	Debrief	
	10:45	Run 2	7, 8, 9, 10, 11
	11:45	Debrief	
	12:00	Lunch	
	13:00	Run 3	12 ,13 ,14 ,17
	14:00	Debrief	
	14:15	Run 4	Spare

	15:15	Debrief	
	15:30	Wrap-up	

Table 3: Schedule VP-030 validation

3.2 Exercises Execution

Only one exercise is attached to this validation.

Exercise ID	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date	Actual Exercise start analysis date	Actual Exercise end date
EXE-04.03-VP-030	Exercise #1 Title	20/07/2016	20/07/2016	20/07/2016	30/09/2016

Table 4: Exercises execution/analysis dates

3.3 Deviations from the planned activities

At the start of SESAR the SWP4.3 VP-030 exercise was planned as the last exercise in a series of several IOP and i4D exercises, making VP-030 depending on the planning and results of these exercises.

VP-030 was planned and accepted (green status) as a Release 5 exercise.

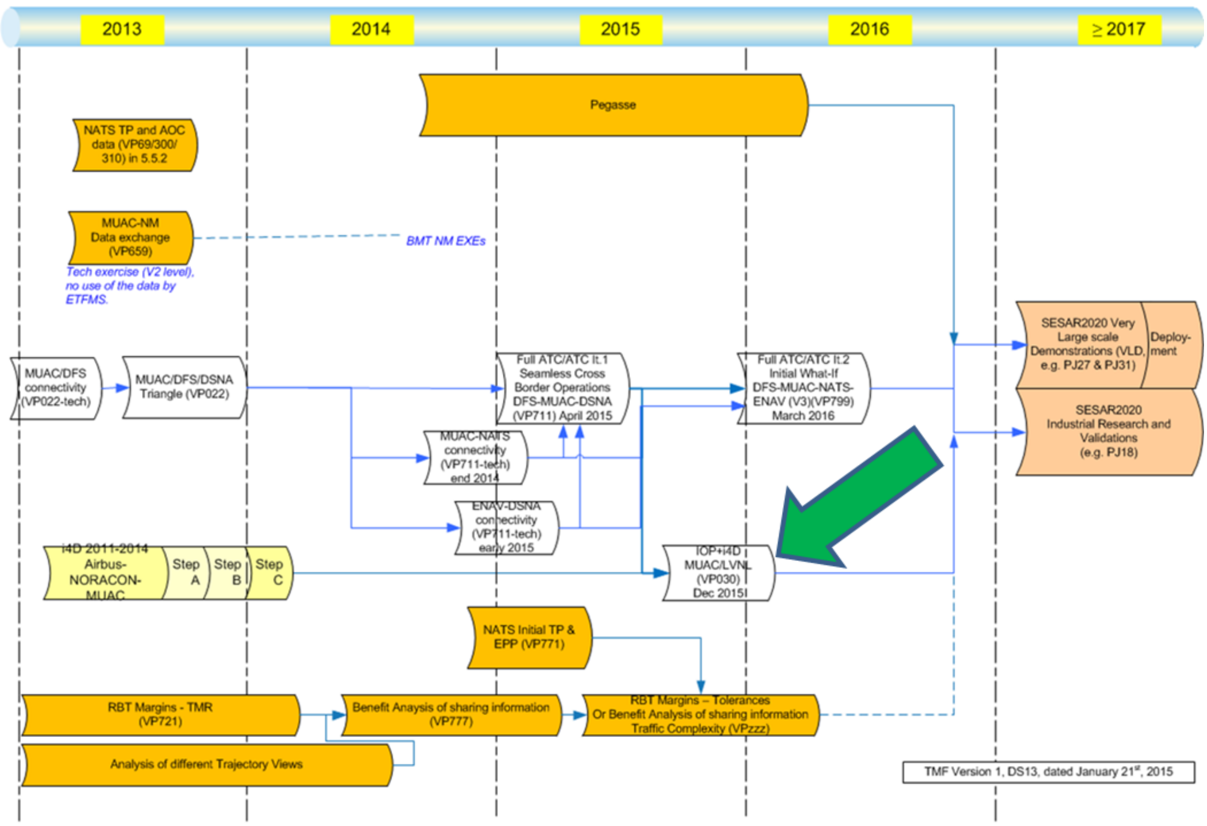


Figure 3: Validation roadmap – January 2015

Because of issues with SWP4.3 VP-711 (IOP) a new exercise IOP exercise VP-799 (later renamed to VP-841) was planned by SWP4.3 in the same timeframe as VP-030. Because of the limited resources and time available of the VP-030 partners MUAC and INDRA, who were also involved in VP-799 it was decided at the end of November 2015, in consultation with the SJU, to give priority to VP-799 and to postpone VP-030 till June 2016 and for this reason the ambition level was reduced from E-OCVM V3 to E-OCVM V2. Because the impact on the VALP was limited no update of the VALP was made.

A new VP-030 planning with several technical and operational dry-runs was made with M8 Exercise Completed planned for the first week of June 2016 and the preparation of the VP-030 exercise continued following the new planning.

During the first technical dry-run on this system in the beginning of March 2016 at INDRA premises, using the high fidelity copy, it was found that the basic functionality was not working correctly, because of various reasons, which made it also quite challenging to test the VP-030 specific software during this technical dry-run.

Looking at the time and resources required to solve these issues and the time available till the execution of VP-030, it was agreed to downscale the VP-030 to a technical validation, focusing on the primary functionalities of the this exercise, i.e. the CTA issuing process and the exchange of ADS-C related data (EPP &RTA reliable interval) via the FO, and to postpone the execution to the week of July 18th.

This change in scope and the limited time available to prepare the validation have led to considerable deviations from the foreseen plan as described in the VP-030 VALP.

3.3.1 Deviations with respect to the Validation Strategy

EXE-04.03-VP-030 was a cross validation covering en-route (WP4) and TMA (WP5). The exercise validation objectives were in line with the WP4.2 (ref. [12]) and WP5.2 VALS (ref. [13]) objectives. Because these validation strategy objectives were high-level, EXE-04.03-VP-030 would only validate a part of the reference validation strategy objective.

Because the validation strategy objectives are focusing on performance benefits and the ambition level of VP-030 went from an operational validation (E-OCVM V3) to a technical validation, VP-030 is not able to contribute to the validation strategy objectives.

3.3.2 Deviations with respect to the Validation Plan

As described in the introduction of this subchapter 3.3, the scope of the exercise changed from E-OCVM V3 validation to a technical validation. This change resulted in several deviations from the VP-030 VALP (ref.[7]).

The context of the validation (see chapter 2) changed considerable compared with the VALP.

The focus went from operational improvements to enablers to validate that the used of an integrated ground-ground and air-ground interoperability was technical achievable.

So compared with the VALP the expected benefits (KPA) per OI, including the benefit mechanisms, were not addressed. Also the validation objectives were not assessed.

Despite that the OIs were not the focus anymore of the validation; they contribute considerable to the concept development (Use Cases) of the exercise, which was strengthen by the late change of the context.

Also the number of stakeholders and the expectations of the stakeholders were reduced considerable because their needs and expectations as described in the VALP could not be addressed.

Other important deviations were:

- The validation platform: Foreseen was a validation platform covering the following CWPs (see Figure 4):
    - MUAC
        - Executive controller Jever

- Coordinating controller Jever
- Executive controller Ruhr/Munster
- Coordinating controller Ruhr/Munster

- LVNL
  - Executive controller sector 1
  - Executive controller sector 2
  - Coordinating controller
  - APP Planner

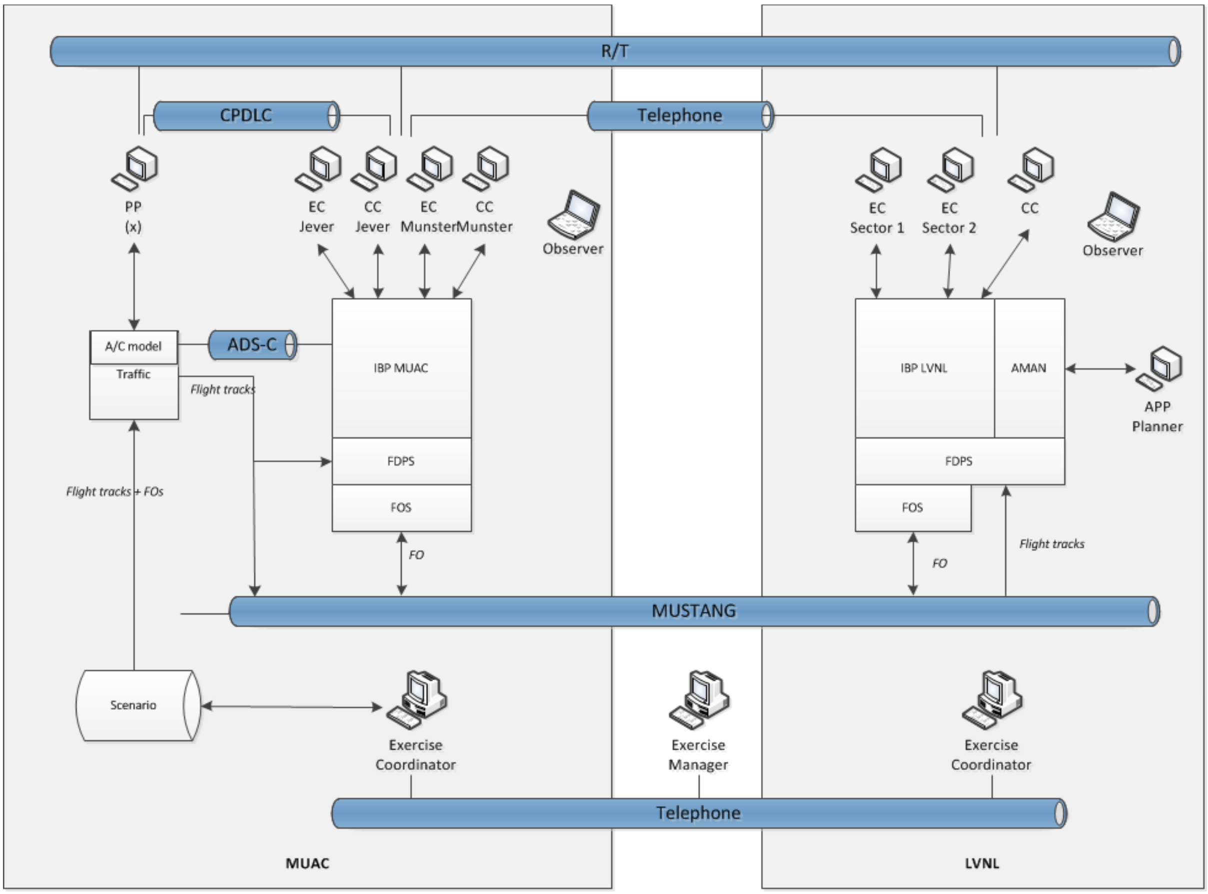


Figure 4: Original VP-030 validation set-up

For the exercise the number of CWPs was reduced to a CWP for the MUAC EC, LVNL EC and APP Planner depicted in Figure 5.

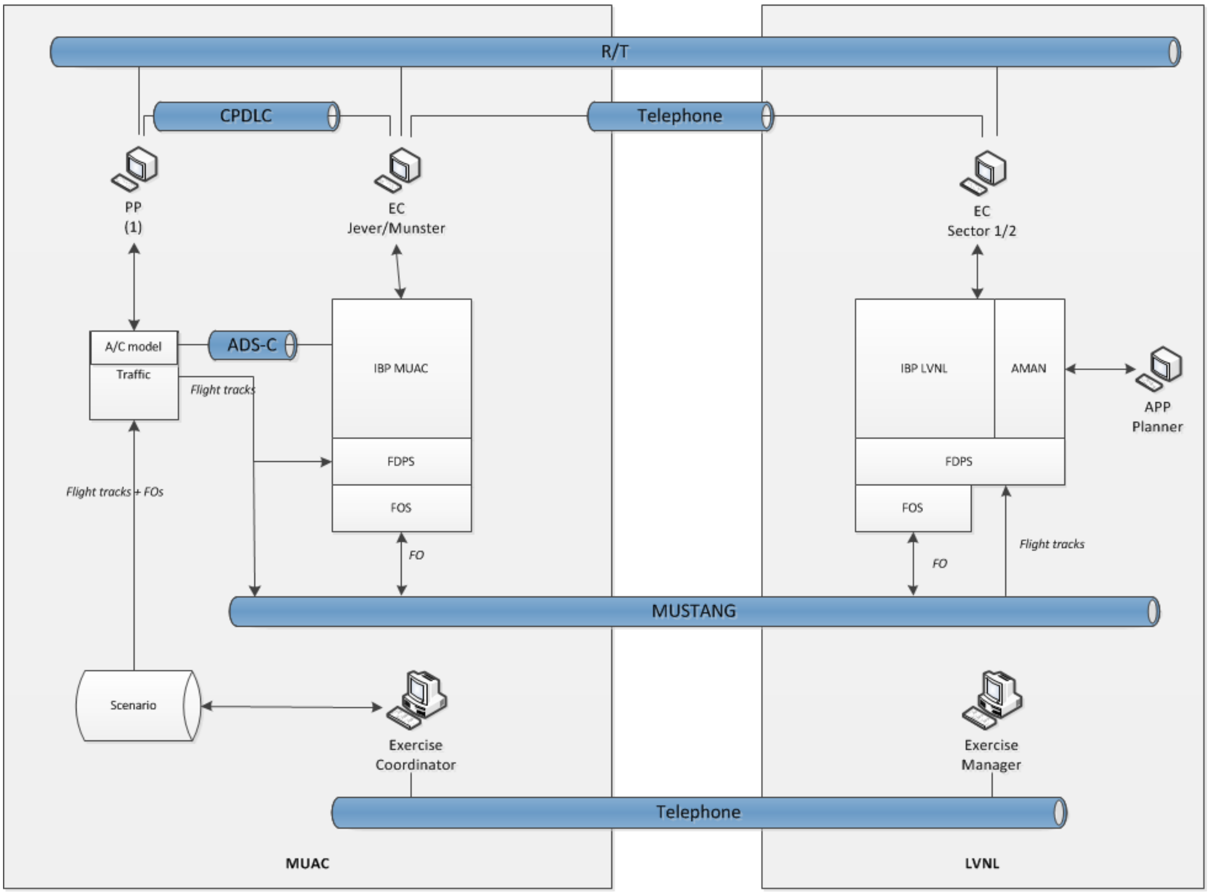


Figure 5: VP-030 validation set-up

- Experiment participants: Foreseen were active controllers, but the validation was performed by operational and system experts familiar with the validation environment and systems.
- Scenario: One solution scenario was developed based on the verification scenarios and containing all the flights that had the right characteristic to overcome the observed IOP problems (see Appendix G). The traffic load was low instead of high, and no events were scripted. No reference scenario was developed.
- No data logging tools, briefing and debriefing material was developed.
- And the duration of the exercise went from two days to one day.

VP-030 was in Release 5 part of SESAR Solution #06 (Controlled Time of arrival in medium density, medium complexity) and would contribute to the maturity of OI TS-0103 (Controlled Time of Arrival). Because of the downscaling of VP-030 WP05.06.01, managing Solution #06, concluded in November 2015 that VP-030 did not impact the operational aspects of SESAR Solution #06, and was focusing only on interoperability and for this reason no contribution was expected (see SESAR Dependency List ID 48018 ref.[17]).

OFA03.01.01 Trajectory Management Framework was not a stakeholder in the VP-030 context, but was interested in the outcome of VP-030 to cover their validation needs as described in WP05.05.01 TMF IOP V&V Needs for 2015 (see ref.[14]). Some of their validation needs were connected with some of the VP-030 validation objectives (see ref.[14]). The postponement of VP-030 to June 2016 made it impossible to contribute in time to the TMF IOP V&V Needs and the downscaling of the validation scope made the VP-030 results not relevant. For this reason VP-030 was not able to contribute to OFA03.01.01 as was foreseen in the VP-030 VALP.

4 Exercises Results

4.1 Summary of Exercises Results

Given the change in scope of the validation three tables with results are presented. First table (Table 5) contains the summary of validation exercises results referring to the original VALP, the second table (Table 6) a summary of the functional achievements of the exercise, followed by a third table (Table 7) presenting the TRL per enabler before and after the exercise.

In the SESAR Validation Report template two options for the Validation Objective Status are foreseen OK (validation objective achieves the expectations) and NOK (validation objective does not achieve the expectations).

But because the objective was not assessed in this exercise N/A is used as Validation Objective Status, because NOK can also be interpreted as that the objective was assessed, but didn't meet the expectations.

The following table gives a summary of the results referring to the original VALP.

Exercise ID	Validation Objective ID	Validation Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Validation Objective Status
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.1001	Reduction workload of E-TMA	CRT-04.03-VALP-VP30.1001	The experience level of workload of the E-TMA EC at the Destination ATSU is reduced	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.1100	Level of workload APP Planner	CRT-04.03-VALP-VP30.1100	The experience level of workload is acceptable for the APP Planner.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.1110	Level of workload of En-route EC	CRT-04.03-VALP-VP30.1110	The experience level of workload is acceptable for the En-route EC.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.1120	Level of workload of CC	CRT-04.03-VALP-VP30.1120	The experience level of workload is acceptable for the E-TMA and En-route CC.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.1130	Workload impact E-TMA EC, because of	CRT-04.03-VALP-VP30.1130	The experience level of workload of the E-TMA EC is	Not able to validate because of change in	N/A

Exercise ID	Validation Objective ID	Validation Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Validation Objective Status
		extensions of the HMI by intent information		not negatively impacted by the extension of the HMI with intent information.	scope exercise	
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.1140	Workload impact E-TMA EC, because of extension of the HMI by trajectory information	CRT-04.03-VALP-VP30.1140	The experience level of workload of the E-TMA EC is not negatively impacted by the extension of the HMI with trajectory information.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2010	Maintaining separation by EC	CRT-04.03-VALP-VP30.2010	The EC maintain the minimal applicable separation for all aircraft.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2020	Prediction of conflicts in AOI of EC	CRT-04.03-VALP-VP30.2020	The EC (E-TMA and En-route) is able to predict conflicts in their AOI.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2030	Prediction of conflicts in AOI of APP Planner	CRT-04.03-VALP-VP30.2030	The APP Planner is able to predict conflicts in their AOI.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2040	Prediction of conflicts in AOI of CC	CRT-04.03-VALP-VP30.2040	The CC (E-TMA and En-route) is able to predict conflicts in their AOI.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2050	Detection discrepancies in routing by EC	CRT-04.03-VALP-VP30.2050	The EC (E-TMA and En-route) is able to detect discrepancies between the actual routing	Not able to validate because of change in scope exercise	N/A

Exercise ID	Validation Objective ID	Validation Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Validation Objective Status
				of an aircraft and any routing instructions given to that aircraft.		
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2060	Detection discrepancies in routing by APP Planner	CRT-04.03-VALP-VP30.2060	The APP Planner is able to detect discrepancies between the actual routing of an aircraft and any routing instructions given to that aircraft.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2070	Detection discrepancies in routing by CC	CRT-04.03-VALP-VP30.2070	The CC (E-TMA and En-route) is able to detect discrepancies between the actual routing of an aircraft and any routing instructions given to that aircraft.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2080	Detection inaccurate flight information by EC	CRT-04.03-VALP-VP30.2080	The EC (TMA and En-route) is able to detect inaccurate flight information	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2090	Detection inaccurate flight information by APP Planner	CRT-04.03-VALP-VP30.2090	The APP Planner is able to detect inaccurate flight information.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.2100	Detection inaccurate flight information by CC	CRT-04.03-VALP-VP30.2100	The CC (E-TMA and En-route) is able to detect inaccurate flight information.	Not able to validate because of change in scope exercise	N/A

Exercise ID	Validation Objective ID	Validation Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Validation Objective Status
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.3001	Sharing EPP data between Controlling and Destination ATSUs	CRT-04.03-VALP-VP30.3001	The EC will respect more often the intention of the aircraft	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.3002	Sharing CTAs earlier with en-route controllers	CRT-04.03-VALP-VP30.3002	The en-route EC will comply with AMAN sequencing more efficiently	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.4001	Environmental sustainability improved	CRT-04.03-VALP-VP30.4001	The extension of the AMAN planning horizon using aircraft trajectory data will make it possible that part of the delay absorption, if required, can take place in the sector of the Controlling ATSU.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.4010	Bunching effect reduction	CRT-04.03-VALP-VP30.4010	The average fuel burn per aircraft will be reduced.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.4020	Earlier approach speed adjustments	CRT-04.03-VALP-VP30.4020	The speed of more aircraft in approach is adjusted earlier.	Not able to validate because of change in scope exercise	N/A
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.4030	Holding of aircraft	CRT-04.03-VALP-VP30.4030	The number of aircraft in a holding is decreased.	Not able to validate because of change in scope	N/A

Exercise ID	Validation Objective ID	Validation Objective Title	Success Criterion ID	Success Criterion	Exercise Results	Validation Objective Status
					exercise	
EXE-04.03-VP-030	OBJ-04.03-VALP-VP30.5001	Predictability increasement	CRT-04.03-VALP-VP30.5001	AMAN enhanced with aircraft trajectory data will enable more customer-preferred trajectories to be flown.	Not able to validate because of change in scope exercise	N/A

Table 5: Summary of Validation Exercises Results

The following tables contain the exercise results that were accomplished.

Exercise ID	Validation Achievement ID	Validation Achievement Title	Description
EXE-04.03-VP-030	ACH-04.03-VALP-VP30.0001	Connectivity	The exercise succeeded in connecting MUAC and LVNL via IOP with the same maturity level than VP-711.
EXE-04.03-VP-030	ACH-04.03-VALP-VP30.0002	End-to-end Connection	The exercises succeeded in demonstrating the end-to-end (aircraft to AMAN and back) transmission of data using ADS-C and IOP.
EXE-04.03-VP-030	ACH-04.03-VALP-VP30.0003	ADS-C in AMAN	The exercise succeeded in the basic integration of ADS-C data in the LVNL IBP AMAN.
EXE-04.03-VP-030	ACH-04.03-VALP-VP30.0004	FO to Distribute ADS-C Data	The exercise succeeded in demonstrating the suitability of the Flight Object as a mechanism to distribute ADS-C information, including the EPP, RTA window and CTA constraint.
EXE-04.03-VP-030	ACH-04.03-VALP-VP30.0005	ADS-C Dynamic Behaviour	The exercise succeeded in the preliminary assessment of ADS-C dynamic behavior, taking this into account for AMAN algorithm.
EXE-04.03-VP-030	ACH-04.03-VALP-VP30.0006	IOP-G and the Extended AMAN	The exercise succeeded in the preliminary assessment of the impacts of the IOP-G technology for an extended AMAN horizon context.

Exercise ID	Validation Achievement ID	Validation Achievement Title	Description
EXE-04.03-VP-030	ACH-04.03-VALP-VP30.0007	Technology Feasibility	The exercise succeeded in confirming the need for further development of the concept of integrating ADS-C and IOP technology in order to assist arrival management.

Table 6: Summary of functional achievements

Enabler Code	Name	Project Contribution	MUAC System		LVNL System	
			Maturity at project start	Maturity at project end	Maturity at project start	Maturity at project end
A/C-11	Flight management and guidance for improved single time constraint achievement (CTA/CTO)	The exercise showed that the exchange of time constraints can be managed efficiently between ground and air.	TRL-5	TRL-5	TRL-3	TRL-5 (via FO)
A/C-31a	Data link communication exchange for ATN baseline 2 (FANS 3/C)	The exercise showed that the data-link communication for ATN Baseline-2 draft H can be managed efficiently between ground and air.	TRL-5	TRL-5	N/A	N/A
A/C-37a	Downlink of trajectory data according to contract terms (ADS-C) compliant to ATN baseline 2 (FANS 3/C)	The exercise showed trajectory data was downlink according to ADS-C contract terms and compliant with data-link communication for ATN Baseline-2 draft H	TRL-4	TRL-5	N/A	TRL-5 (via FO)
ER APP ATC 82	Enhance FDP to use SBT/SMT, RBT/RMT	The exercises demonstrate that the exchange of downstream constraints to the controlling unit by the use of the Flight Object enhance the	TRL-4	TRL-5	TRL-3	TRL-5

Enabler Code	Name	Project Contribution	MUAC System		LVNL System	
			Maturity at project start	Maturity at project end	Maturity at project start	Maturity at project end
		ATCOs awareness and allow preplanning of the proposed trajectory.				
ER APP ATC 100	4D Trajectory Management in Step 1 - Synchronization of Air and Ground Trajectories	The exercises showed that the use of the Extended Projected Profile provided via the ADS-C datalink increased safety and ensured air and ground had the same view of the trajectory. Also the exercise showed If some 2D discrepancy exist between air and ground trajectories that can be synchronized by a modification of air or ground trajectory via CPDLC messages	TRL-4	TRL-5	TRL-3	TRL-5 (via FO)
ER APP ATC 149a	Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)	The exercises showed that the use of the Extended Projected Profile provided via the ADS-C datalink increased safety and ensured air and ground had the same view of the trajectory. It showed that certain elements of the EPP can be used to enhance the accuracy of the ground trajectory and therefore increase the performance of the ground tools.	TRL-4	TRL-5	N/A	TRL-4 (via FO)
ER APP ATC	Air-Ground Datalink Exchange to	The exercise showed that the exchange of time	TRL-4	TRL-5	N/A	TRL-5 (via FO)

Enabler Code	Name	Project Contribution	MUAC System		LVNL System	
			Maturity at project start	Maturity at project end	Maturity at project start	Maturity at project end
149c	Support i4D - Controlled Time of Arrival/Overflight (CTA/CTO)	constraints can be managed efficiently between ground and air.				
ER APP ATC 160	ATC to ATC Flight Data Exchange Using The Flight Object	The exercise showed that the use of the Flight Object to support coordination and transfer shows significant benefits over OLDI due to a continuous update of information and increased flexibility in exchange of data. Also the exercise showed the feasibility in the usage of two new cluster in the FO (EPP cluster an RTA window)	TRL-5	TRL-5	TRL-4	TRL-5
PRO-118	ATC Procedures for use of CTA across several AoRs	The exercises proved that it is possible to use CTA across two AORs (e,g.: connect MUAC and LVNL via IOP with an improvement of the FO clusters and using CTA data from upstream)	TRL-4	TRL-5	TRL-4	TRL-5
SWIM-APS-05a	Provision and Consumption of Flight Object Sharing services for Step 1	The exercises showed that ground-ground coordination and transfer functions between en-route systems based on the Flight Object are possible and effective. Also the possibility to use the IOP data to feed the AMAN with extended horizon information and	TRL-5	TRL-5	TRL-3	TRL-5

Enabler Code	Name	Project Contribution	MUAC System		LVNL System	
			Maturity at project start	Maturity at project end	Maturity at project start	Maturity at project end
		ADS-C data.				
SWIM-INFR-01a	High Criticality SWIM Services infrastructure Support and Connectivity	The exercises proved that it is possible to connect MUAC and LVNL via IOP with the same maturity level than VP-711	TRL-5	TRL-5	TRL-3	TRL-5
SWIM-NET-01a	SWIM Network Point of Presence	The exercises proved that it is possible to connect MUAC and LVNL via IOP with the same maturity level than VP-711	TRL-5	TRL-5	TRL-3	TRL-5
SWIM-STD-01	AIRM	The exercises proved that it is possible to connect MUAC and LVNL via IOP with an AIRM 4.0 version	TRL-4	TRL-5	TRL-3	TRL-5
SWIM-STD-02	SWIM Service	The exercises proved that it is possible to connect MUAC and LVNL via IOP with an ISRM 1.4 version	TRL-4	TRL-5	TRL-3	TRL-5

Table 7: Summary of TRL levels enablers

4.1.1 Results on concept clarification

Because of the change in scope of the validation and the still existing limitations and workarounds of the validation platform, it was not possible to assess the IOP + i4D concept as developed within VP-030.

In addition, some issues related to the integration of AMAN in the concept were raised during the preparation and execution of the exercise. It should be realized that the AMAN system was not the system under test in this exercise, but the use of AMAN provided valuable lessons for a future design and integration of using airborne EPP and RTA data in an AMAN applications. The usage of IOP instead of OLDI in an extended AMAN horizon environment raises questions that should be studied in further exercises. More information of the lessons learned can be found in the VP-030 Verification Report (subchapter 4.2.1.2.5, ref. [11]), and the recommendations can be found in chapter 5.2 of this document. It should be realized that the recommendations are focusing on the IOP and i4D part of the AMAN concept.

4.1.2 Results per KPA

Because of the change in scope of the validation and the still existing limitations and workarounds of the validation platform, the results per KPA have not been assessed and thus cannot be presented.

However there were no issues found during the exercise that for the moment would affect the expected results per KPA.

Please refer to Appendix A for more details about the management of the KPA requests from the transversal areas.

4.1.3 Results impacting regulation and standardisation initiatives

N/A.

4.2 Analysis of Exercises Results

In accordance with the downscaling of the scope of the exercise also the metrics to measure the results were changed. After the expected HMI changes in the overview of all the sequences a "result" column was added in which the expert could indicate if the change had taken place as described. The results per HMI can be found in the "result" columns of Appendix B.

During the preparation phase it was discovered that two test cases (15 and 16) containing use case 2.8 "Change 4D trajectory by Lower Area ATCO" could not be performed because of limitations of the validation platform (see VP-030 Verification Report ref.[11]).

All other test cases were tested and executed successfully.

Furthermore it was noticed, during the preparation phase, that when the CTA was accepted by the pilot, the @ symbol, informing the upper airspace execute controller about the status of RTA uplink, at the MUAC HMI was changing from light green into orange, instead of dark green. This issue was reported as one of the Open system issues in the VP-030 Verification Report ref.[11].

During the VP-030 exercise all concept depended HMI changes were checked successfully (see Table 8), with the exception of the @ symbol at the MUAC HMI which changed into the wrong colour. Because this was in line with the expectations it can be concluded that the HMI behaviour was as expected and was working as described in the AMAN Extended Horizon concept.

Sequence	MUAC changes	Pass/Fail	LVNL EC changes	Pass/Fail	LNVL APP changes	Pass/Fail
1	0	0/0	1	1/0	1	1/0
2	1	1/0	2	2/0	2	2/0
3	1	1/0	2	2/0	2	2/0
4	4	4/0	3	3/0	4	4/0
5	5	5/1	3	3/0	4	4/0
6	5	5/1	3	3/0	4	4/0
7	7	7/1	7	7/0	7	7/0
8	6	6/1	4	4/0	5	5/0
9	6	6/1	4	4/0	5	5/0
10	6	6/1	4	4/0	5	5/0
11	6	6/1	4	4/0	5	5/0
12	6	6/1	4	4/0	5	5/0
13	5	5/1	4	4/0	4	4/0
14	6	6/1	5	5/0	6	6/0

15	n/a		n/a		n/a	
16	n/a		n/a		n/a	
17	5	5/1	3	3/0	4	4/0
Total	**69**	**58/11**	**53**	**53/0**	**63**	**63/0**

Table 8: Overview results per sequence

At technical and functional level, the exercise enabled the identification of topics of interest that should be studied in the frame of future exercises. Although they are not directly reported as a part of the validation because they limited the validation scope, they were reported in the verification report and should be taken into account for future exercises related to the IOP+i4D concept, but also for the exercises related to the extended AMAN horizon (see ref.[11]).

4.2.1 Unexpected Behaviours/Results

During the conditional acceptance of the validation platform (VP-030 M6 milestone) it was known that the validation platform contained limitations and that IOP-functionality was constrained to the same level as VP711, including a sub-set of the VP-711 software bugs, which could result into unexpected behaviours during the execution of a scenario. Description of these unexpected behaviours can be found in the VP-711 Verification Report (ref.[15]), VP-711 Validation Report (ref.[16]) and the VP-030 Verification Report (ref.[11]).

Also during the execution of the test cases these unexpected behaviours were sometimes noted, especially during the execution of test case 14 (Run 3), which was repeated again in Run 4. But at the end all test cases were executed without any noticeable unexpected behaviour.

There were no unexpected results.

4.3 Confidence in Results of Validation Exercises

4.3.1 Quality of Validation Exercises Results

Knowing the limitations of the validation platform and taking in account the downscaling of the validation scope, the quality of the exercise results were good.

4.3.2 Significance of Validation Exercises Results

Because no quantitative and qualitative data was recorded, due to the downscaling of the validation scope, and because the simulation setup allowed a limited number of actions on the flights, the operational significance of the validation exercises results is limited regarding scope of the controller activities.

However, at a technical and functional level, significant results have been obtained: the exercise enabled the identification of topics of interest that should be studied in the frame of future exercises (e.g. the integration of the IOP data in an extended AMAN horizon environment). These recommendations can be found in subchapter 5.2.

5 Conclusions and recommendations

5.1 Conclusions

The VP-030 validation ambition was downscaled because of a change of priority in the overall IOP roadmap, but also because of the difficulties observed during the first factory verifications of the validation platform (see VP-030 Verification Report ref.[11]), and the short timeframe available before the validation exercise should be performed to solve all these issues. Although the maturity level of the validation platform was low when compared to the initial ambition of the validation, it was concluded that the maturity of the validation platform was good enough to perform the downscaled validation exercise, for this reason the validation platform was conditionally accepted.

VP-030 was in the end downscaled from an E-OCVM V3 validation to a technical validation, concentrating on the capability of the FO to convey i4D related data, and on the behaviour of the controller's HMI, as defined in the AMAN Extended Horizon concept, which was built on top of the IOP and CTA+i4D concept.

It can be concluded that the behaviour of the different HMIs was working as expected.

The performance benefits of the IOP+i4D concept, enabled by the AMAN Extended Horizon environment could not be validated, but there were no issues found that contradict the expected performance benefits, which were identified by controllers and operational/system experts during the concept development phase.

It can be concluded that the flight object can be used to share aircraft derived data between ground partners and output from arrival management systems to be used transmitted to the flights.

The VP-030 implementation of the CTA+i4D related ground-ground interoperability via the Flight Object proved to be a technically realistic option and can be seen as a valuable input for future developments under e.g. SESAR2020 or PCP deployment later.

This exercise showed the need to further integrate the data conveyed by the IOP enabler into the systems using it (e.g. FDPS, AMAN, etc…). Several functional topics have been raised, for which the current dynamics based on the provision of data via the OLDI enabler is not optimal in the frame of IOP. These topics not only relate to the IOP+i4D concept, but also to the extension of the AMAN horizon in an IOP environment.

5.2 Recommendations

During the preparation and execution of VP-030 some issues were found and lessons were learned, which are not directly related with the scope of the VP-030 validation, but which required more studying and can be of use as input for future projects.

The functional IOP-baseline of VP-030 was based on the VP-711 exercise, which was executed as a V2 validation. This constrained the VP-030 validation, which was further affected by a sub-set of VP-711 IOP software bugs (see VP-711 Verification Report, subchapter 4.4.2, ref.[15]) that were not resolved. Furthermore during the verification phase an IOP flaw was detected that lead to loss of information on a specific system request involving an ATCO decision. It is recommended that a study should be performed to analyse and resolve this flaw in the IOP concept. To be able to perform a V3 validation of the IOP+i4D concept, the IOP concept itself should be on V3 level and all bugs and flaws should be resolved. It is recommended that the IOP concept (as enabler) will be brought up to V3 level, before it is used by other ATM applications using the IOP concept as enabler.

ADS-C latency was not taken in to account as the methods used in the generation of the ADS-C messages and interconnection of the platform did not allow the inclusion of delays. The impact of this latency on for the IOP-related issues (e.g. RTA window obsolete) is not known. It is recommended to study the impact of the ADS-C latency on the CTA+i4D concept.

Even though the AMAN system itself was not the system under test, the integration of airborne EPP and RTA Reliable Interval data in AMAN resulted in some issues that were not foreseen during the development. These issues may be specific for an AMAN, but may affect also other future CTA+i4D applications. It concerns the following issues:

- Sometimes the EPP time at a point (for AMAN the Initial Approach Fix) was lying outside RTA interval times of the same point. This was caused by the requirements of the airborne definition of the EPP and the RTA Reliable Interval (as defined by EUROCAE/RTCA) which resulted in different type of calculations at the aircraft side. This was not expected by the APP Planner and requires more study how this will be represented in a more logical way to the APP Planner.
- Update of EPP data. The update of EPP data is independent of the RTA Reliable Interval update. Sometimes this interval between both updates was too large, impacting the AMAN planning. A study should be made how the ground system can use the available ADS-C Contract to manage the supply of timely data.
- The refresh rate of EPP data as used during the validation (periodic every 5 minutes and after each 2D trajectory, speed and level change) was deemed to be too low, a higher refresh rate was preferred. A study should be performed to find out what the preferred refresh rate would be for the AMAN Extended Horizon environment as tested within VP-030, taken into account the load on SWIM and costs involved by updating the EPP data.
- Time and speed over IAF. After the CTA is accepted by the pilot, the airborne system can/will use speed to be in time over IAF. Looking at an arrival sequence in a busy TMA, such as the Schiphol TMA as used in VP-030, the aircraft will be time separated (indirectly distance) over IAF, but can have very different speeds, which can cause separation issues directly after the IAF that need to be resolved by the controller affecting the arrival sequence. This topic, may be specific for the Schiphol situation, but should be studied in more detail, to ensure that this will not happen.

To display TP and EPP data of an aircraft correctly on a controller display all the waypoints should be known. Currently each ATSU system, using its own database, knows all the waypoints in its own AOR and some nearby waypoints of adjacent ATSUs. In the new concept it is possible that an aircraft under control of an adjacent ATSU can be directed to a waypoint in the adjacent ATSU AOR that is not known in the destination ATSU system, causing a wrong representation of the TP and EPP data on the controller's HMI of the destination ATSU. Because this is an implementation issue, it is recommended to study how this can be overcome.

During the preparation phase there were some concerns about the possibility of an overflow of messages in the D/L window. Despite that this concern was related to the limitation of the validation platform and didn't happen during the VP-030 exercise, it is advised, realising the increase in D/L messages in the future, to study possible Human Performance issues related to the increase of the number of D/L messages displayed to the ATCO.

The following table lists the recommendations elaborated in this exercise and described in detail in the previous sections.

It should be realised that the recommended studies mentioned in the table can be combined, and despite that several issues were found as part of the AMAN concept, they are applicable for all other possible ATM applications using the same data (EPP and RTA Reliable Interval), and for this reason the description in the table is kept general.

Recommendation reference	Recommendation details	Classification
REC-04.03-IOP+i4D-VP030.0001	*Consider a study that industry performs to analyse and to solve the IOP flaw found. (See also REC-10.02.05-IOP-VP030.0005 in the VP-030 verification report (ref. [11]).*	*Post Exercise Issue Analysis & Bug Fixing*
REC-04.03-IOP+i4D-VP030.0002	*Consider that industry and ANSPs will bring the IOP concept, as enabler, up to E-OCVM maturity level V3, before it will be use by other ATM applications that will use this IOP concept as enabler.*	Post Exercise Issue Analysis & Bug Fixing

REC-04.03-IOP+i4D-VP030.0003	*Consider a study by operational and system experts to study the impact of the ADS-C latency on the IOP and CTA+i4D concept.*	IOP and CTA+i4D Concept Improvement
REC-04.03-IOP+i4D-VP030.0004	*Consider a study by operational and system experts how the time differences in EPP and RTA Reliable Interval can be represented in a more logical way for the controller. (See also REC-10.02.05-IOP-VP030.0002 and REC-10.02.05-IOP-VP030.0009 in the VP-030 verification report (ref. [11]).*	CTA+i4D Concept Improvement
REC-04.03-IOP+i4D-VP030.0005	*Consider a study by operational and system experts how the ground system can manage the use of the ADS-C contract in combination of the RTA Reliable Interval update in a timely data. (See also REC-10.02.05-IOP-VP030.0009 in the VP-030 verification report (ref. [11]).*	CTA+i4D Concept Improvement
REC-04.03-IOP+i4D-VP030.0006	*Consider a study by operational and system experts to determine what the preferred refresh of EPP data is, when this data is use in an AMAN Extended Horizon environment as used within VP-030.*	i4D Concept Improvement
REC-04.03-IOP+i4D-VP030.0007	*Consider a study of operational and system experts to find out what the effect is of speed differences between aircraft time separated over CTA point, on the distance separation after the CTA point. (See also REC-10.02.05-IOP-VP030.0009 in the VP-030 verification report (ref. [11]).*	CTA Standardisation
REC-04.03-IOP+i4D-VP030.0008	*Consider a study to extend the dataset and HMI capabilities to take into account waypoints outside of the AOR that are relevant in an extended AMAN horizon environment using the IOP enabler.*	Post Exercise Issue Analysis & Bug Fixing
REC-04.03-IOP+i4D-VP030.0009	*Consider a study to analyse the HP impact related to the increase of the number of D/L messages displayed to the ATCO.*	CTA+i4D Concept Improvement

Table 9: Recommendations

6 References

6.1 Applicable Documents

[1] Template Toolbox 03.00.00
https://extranet.sesarju.eu/Programme%20Library/SESAR%20Template%20Toolbox.dot

[2] Requirements and V&V Guidelines 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Requirements%20and%20VV%20Guidelines.doc

[3] Templates and Toolbox User Manual 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Templates%20and%20Toolbox%20User%20Manual.doc

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

[5] EUROCONTROL ATM Lexicon
https://extranet.eurocontrol.int/http://atmlexicon.eurocontrol.int/en/index.php/SESAR

6.2 Reference Documents

[6] SESAR WP04.03 Project Initiation Report, Edition 00.02.00, May 2010

https://extranet.sesarju.eu/WP_04/Project_04.03/Project%20Management/Forms/AllItems.aspx

[7] SESAR WP04.03 D112 IOP+i4D Validation Plan, Edition 00.01.00, December 2013

https://extranet.sesarju.eu/WP_04/Project_04.03/Project%20Plan/Deliverables/04%2003-D112%20EXE-04%2003-VP-030%20Validation%20plan%2000%2001%2000.docx

[8] SESAR ENB03.01.01 TMF and S-IOP with Air and Ground Data Sharing Safety Plan, Edition 00.01.00, October 2014

https://extranet.sesarju.eu/WP_16/Project_16.06.01/Other%20Documentation/2015%20Safety%20Plans%20and%20SARs%20(latest%20versions)/Quarter%204/TMF-ENB_Safety_Plan_Ed00.01.00_2014-10-08(clean).docx

[9] ATM Master Plan
https://www.atmmasterplan.eu

[10] SESAR WP04.02 D07 WP4 Detailed Operational Description (DOD) Step 1, Edition 00.06.00, May 2013

https://extranet.sesarju.eu/WP_04/Project_04.02/Project%20Plan/Latest%20Version%204.2%20STEP1%20DOD/04%2002-D07-WP4%20detailed%20operational%20description%20Step%201-00%2006%2000.%20doc.doc

[11] SESAR WP10.02.05 D49 VP030 Verification Report, Edition 00.01.01, June 2016

https://extranet.sesarju.eu/WP_10/Project_10.02.05/Project%20Plan/Deliverables/(VP030)%20Verification%20Test%20Report.docx

[12] SESAR WP04.02 D59 Validation Strategy, Edition 00.03.00, August 2012

https://extranet.sesarju.eu/WP_04/Project_04.02/Project%20Plan/Latest%20Version%204.2%20STEP1%20VALS/04.02%20D59%20Validation%20Strategy%2000.03.00.doc

[13] SESAR WP05.02 D51 Validation Strategy for Concept Step 1, Edition 00.00.05, December 2012

https://extranet.sesarju.eu/WP_05/Project_05.02/Project%20Plan/STEP%201%20Deliverables/T18-T50%20Validation%20Strategy%20Step%201/5%202%20D51%20WP5%20Validation%20Strategy%20for%20Concept%20Step1%20Time%20Based%20Operations.v00.05.doc

[14]SESAR WP05.05.01 TMF IOP V&V Needs for 2015, Edition 00.01.01, March 2015

https://extranet.sesarju.eu/WP_05/Project_05.05.01/Project%20Plan/D841%20-%20TMF%20IOP%20VV%20Needs%20for%202015/Latest%20version/05.05.01%20-%20D841%20-%20TMF%20IOP%20VV%20Needs%20for%202015%2000.01.01.docx

[15]SESAR WP10.02.05 D42 (VP-711) Verification Report, Edition 00.03.00, 27-01-2016

https://extranet.sesarju.eu/WP_10/Project_10.02.05/Project%20Plan/Deliverables/10%2002%2005%20D42%20-VP-711%20Verification%20Report.doc

[16]SESAR WP04.03 D77 Validation report EXE-04.03-VP-711, Edition 00.02.00, 30-11-2015

https://extranet.sesarju.eu/WP_04/Project_04.03/Project%20Plan/Deliverables/04.03-D77_Validation%20report%20EXE-04.03-VP-711%20%20(Consolidated%20deliverable%2005.03%20-%20T119).docx

[17]SESAR Dependency List

https://extranet.sesarju.eu/WP_04/Project_04.03/_layouts/sju/DependencyList.aspx

[18]WPB.01 Integrated Roadmap version DS16 Release Note 1.1, D84, 00.01.01, 21-06-2016
https://extranet.sesarju.eu/WP_B/Project_B.01/Project%20Plan/B.1.4%20Integrated%20Roadmap/Integrated%20Roadmap%20Versions/DS16/B.01-D84-Integrated_Roadmap_DS16_Release_Note.doc

Appendix A KPA Assessment

Safety Assessment:

See TMF and S-IOP with Air and Ground Data Sharing Safety Plan produced by P16.6.1 (ref.[8])

Security Assessment:

Not Applicable (For VP-030 no inputs received from P16.6.2 with regard to Security).

Environment assessment:

Not Applicable (Non-regression validation)

Human Performance assessment:

Not Applicable (Non-regression validation)

Appendix B Overview operational test cases

Test case 1:

Call sign:	KLM88J									
	Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*									
1	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
1.1	2.1	Distribute EPP data via Flight Object			None		None		None	
1.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
		End: *No discrepancies, flight continues*								

Test case 2:

Call sign:	KLM417									
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
2	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
2.1	2.1	Distribute EPP data via Flight Object			None		None		None	
2.2				Pilot creates discrepancy						
2.3	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	Discrepancies in Upper Area Airspace		The route discrepancy symbol is display if needed as a purple diamond.	Pass	Blue arrow when the EPP is not in conformance with the MUAC ground trajectory. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
2.4				UA EC resolves discrepancies						
2.5	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
		End: *No discrepancies, flight continues*								

Test case 3:

Call sign: KLM1822										
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
3	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
3.1	2.1	Distribute EPP data via Flight Object			None		None		None	
3.2				Pilot creates discrepancy						
3.3	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	Resolved by FMS		The route discrepancy symbol is displayed if needed as a purple diamond.	Pass	Blue arrow when the EPP is not in conformance with the MUAC ground trajectory. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
3.4				Pilot (by FMS) resolves discrepancies						
3.5	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
		End: *No discrepancies, flight continues*								

Test case 4:

Call sign: KLM417										
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
4	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
4.1	2.1	Distribute EPP data via Flight Object			None		None		None	
4.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
4.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
4.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
4.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
4.6				UA EC rejects CTA						
4.7	2.4	Freezing a flight	CTA rejected by ATCO		After rejection by the ATCO, the orange @ symbol is removed	Pass	Red @ in label, Red CTA time in arrival list window	Pass	"PRO" status removed	Pass
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 5:

Call sign:		BTI16RV								
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
5	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
5.1	2.1	Distribute EPP data via Flight Object			None		None		None	
5.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
5.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
5.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
5.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
5.6				UA EC accepts CTA						
5.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
5.8				Pilot accepts CTA						
5.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
		End: *CTA accepted, flight continues*								

Test case 6:

Call sign:		KZR903								
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
6	UC	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
6.1	2.1	Distribute EPP data via Flight Object			None		None		None	
6.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
6.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
6.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
6.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
6.6				UA EC accepts CTA						
6.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
6.8				Pilot rejects CTA						
6.9	2.4	Freezing a flight	CTA not accepted by pilot		The @ symbol is removed from the track label and the CTA value is removed from the EPP window.	Pass	Red @ in label, Red CTA time in arrival list window	Pass	"PRO" status removed	Pass
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 7:

Call sign:	CSN345										
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*									
7	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
7.1	2.1	Distribute EPP data via Flight Object			None		None		None	
7.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
7.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
7.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
7.5				UA EC change 4D trajectory			New ground trajectory	Pass	New EAT in in stack list	Pass
7.6				Pilot accepts change			The trajectory can also be shown in blue with EPP times on route points.	Pass	None	
7.7				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
7.8	2.3	Change 4D trajectory outside freeze horizon (by UA controller)			None	Pass	Green arrow, when the EPP is in conformance with the MUAC ground trajectory, Blue arrow when the EPP is not in conformance with the MUAC ground trajectory. The trajectory can also be shown in blue with EPP times on route points. EPP is triggered.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
7.9				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
7.10				UA EC accepts CTA						
7.11	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
7.12				Pilot accepts CTA						
7.13	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
		End: *CTA accepted, flight continues*									

Test case 8:

Call sign:	KLM28K									
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
8	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
8.1	2.1	Distribute EPP data via Flight Object			None		None		None	
8.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
8.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
8.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
8.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
8.6				UA EC accepts CTA						
8.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
8.8				Pilot accepts CTA						
8.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
8.10				UA EC cancels CTA						
8.11	2.5	Cancel a CTA in Upper Area Airspace (by UA controller)			The @ symbol is removed from the track label and the CTA value is removed from the EPP window	Pass	Purple @ in label, Purple CTA time arrival list window	Pass	"ACP" status removed	Pass
8.12				Pilot accepts cancellation by Wilco						
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 9:

Call sign:	CSN345										
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*									
9	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
9.1	2.1	Distribute EPP data via Flight Object			None		None		None	
9.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
9.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
9.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
9.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
9.6				UA EC accepts CTA						
9.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
9.8				Pilot accepts CTA						
9.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
9.10				LA EC cancels CTA, when a/c is in UA						
9.11	2.5	Cancel a CTA in Upper Area Airspace (by LA controller)			The @ symbol is removed from the track label and the CTA value is removed from the EPP window	Pass	Purple @ in label, Purple CTA time arrival list window	Pass	"ACP" status removed	Pass
9.12				Pilot accepts cancellation by Wilco						
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 10:

Call sign:	KLM417									
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
10	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
10.1	2.1	Distribute EPP data via Flight Object			None		None		None	
10.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
10.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
10.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
10.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
10.6				UA EC accepts CTA						
10.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
10.8				Pilot accepts CTA						
10.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
10.10				Pilot cancels CTA in UA						
10.11	2.5	Cancel a CTA in Upper Area Airspace (by pilot)			The @ symbol is removed from the track label and the CTA value is removed from the EPP window	Pass	Purple @ in label, Purple CTA time arrival list window	Pass	"ACP" status removed	Pass
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 11:

Call sign:	KLM1764								
	Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
11	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
11.1	2.1	Distribute EPP data via Flight Object			None		None		None	
11.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
11.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
11.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
11.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
11.6				UA EC accepts CTA						
11.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
11.8				Pilot accepts CTA						
11.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
11.10				LA EC cancels CTA when a/c is in LA. (via UC EC)						
11.11	2.5	Cancel a CTA in Upper Area Airspace (by LA EC)			The @ symbol is removed from the track label and the CTA value is removed from the EPP window	Pass	Purple @ in label, Purple CTA time arrival list window	Pass	"ACP" status removed	Pass
11.12				Pilot accepts cancellation by cancellation						
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 12:

Call sign:	KLM1822								
	Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
12	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
12.1	2.1	Distribute EPP data via Flight Object			None		None		None	
12.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
12.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
12.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
12.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
12.6				UA EC accepts CTA						
12.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
12.8				Pilot accepts CTA						
12.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
12.10				Pilot cancels CTA when a/c is in LA.						
12.11	2.6	Cancel a CTA in Lower Area Airspace (Pilot)			The @ symbol is removed from the track label and the CTA value is removed from the EPP window	Pass	Purple @ in label, Purple CTA time arrival list window	Pass	"ACP" status removed	Pass
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 13:

Call sign:	KLM28K								
	Start: Flight under controls of UA ATSU Aircraft is logged in via ADS-C								
13	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
13.1	2.1	Distribute EPP data via Flight Object			None		None		None	
13.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
13.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
13.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
13.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	
13.6				UA EC accepts CTA						
13.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
13.8				Pilot accepts CTA						
13.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
13.10				UA EC changes 4D trajectory (recalculating of 4D and CTA still valid = small change)						
13.11	2.7	Change 4D trajectory initiated by Upper Area ATCO within freeze horizon			None		Green arrow, when the EPP is in conformance with the MUAC ground trajectory, Blue arrow when the EPP is not in conformance with the MUAC ground trajectory. The trajectory can also be shown in blue with EPP times on route points. EPP is triggered.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass

Test case 14:

Call sign:	KLM417								
	Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
14	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
14.1	2.1	Distribute EPP data via Flight Object			None		None		None	
14.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
14.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
14.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
14.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
14.6				UA EC accepts CTA						
14.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
14.8				Pilot accepts CTA						
14.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
14.10				UA EC changes 4D trajectory (recalculating of 4D but CTA not valid = large change)						
14.11	2.7	Change 4D trajectory initiated by Upper Area ATCO within freeze horizon			None		Green arrow, when the EPP is in conformance with the MUAC ground trajectory, Purple arrow when the EPP is not in conformance with the MUAC ground trajectory. The trajectory can also be shown in blue with EPP times on route points. EPP is triggered.	Pass	In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	Pass
14.12				Pilot cancels CTA in UA						
14.13	2.5	Cancel a CTA in Upper Area Airspace (by pilot)			The @ symbol is removed from the track label and the CTA value is removed from the EPP window	Pass	Purple @ in label, Purple CTA time arrival list window	Pass	"ACP" status removed	Pass
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 15:

Call sign:	Not executed								
	Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*									
15	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
15.1	2.1	Distribute EPP data via Flight Object			None		None		None	
15.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.		In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	
15.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.		None		None	
15.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.		None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	
15.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.		Yellow @ in label, Yellow in CTA time arrival list window		"Pro" status in ACC Stacklist	
15.6				UA EC accepts CTA						
15.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.		None		None	
15.8				Pilot accepts CTA						
15.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window		Green @ in label, Green in CTA time arrival list window		"ACP" status in ACC Stacklist	
15.10				LA EC changes 4D trajectory (recalculating of 4D and CTA still valid = small change)						
15.11	2.8	Change 4D trajectory initiated by Lower Area ATCO within freeze horizon			None		Green arrow, when the EPP is in conformance with the MUAC ground trajectory, Blue arrow when the EPP is not in conformance with the MUAC ground trajectory. The trajectory can also be shown in blue with EPP times on route points. EPP is triggered.		In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	
		End: *CTA status not changed, flight continues*								

Test case 16:

Call sign:	Not executed								
	Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
16	UC	UC Description	UC option	Action	MUAC EC Display	Result	LVNL EC Display	Result	LVNL APP display	Result
16.1	2.1	Distribute EPP data via Flight Object			None		None		None	
16.2	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found		None		Green arrow. The trajectory can also be shown in blue with EPP times on route points.		In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	
16.3				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.		None		None	
16.4				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.		None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	
16.5				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.		Yellow @ in label, Yellow in CTA time arrival list window		"Pro" status in ACC Stacklist	
16.6				UA EC accepts CTA						
16.7	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.		None		None	
16.8				Pilot accepts CTA						
16.9	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window		Green @ in label, Green in CTA time arrival list window		"ACP" status in ACC Stacklist	
16.10				LA EC changes 4D trajectory (recalculating of 4D but CTA not valid = large change)						
16.11	2.8	Change 4D trajectory initiated by Lower Area ATCO within freeze horizon			None		Green arrow, when the EPP is in conformance with the MUAC ground trajectory, Blue arrow when the EPP is not in conformance with the MUAC ground trajectory. The trajectory can also be shown in blue with EPP times on route points. EPP is triggered.		In AMAN the EPP on the IAF is shown as the ETO IAF in the flightlist	
16.12				Pilot cancels CTA when a/c is in LA.						
16.13	2.6	Cancel a CTA in Lower Area Airspace (Pilot)			The @ symbol is removed from the track label and the CTA value is removed from the EPP window		Purple @ in label, Purple CTA time arrival list window		"ACP" status removed	
		End: *CTA cancelled, no new CTA issued, flight continues*								

Test case 17:

Call sign:		**KLM28K**								
		Start: *Flight under controls of UA ATSU* *Aircraft is logged in via ADS-C*								
17	**UC**	**UC Description**	**UC option**	**Action**	**MUAC EC Display**	**Result**	**LVNL EC Display**	**Result**	**LVNL APP display**	**Result**
17.1	2.1	Distribute EPP data via Flight Object			None		None		None	
17.2				AMAN request RTA Reliable Interval	The RTA reliable interval request from the AMAN to the aircraft is displayed in the Datalink Window.	Pass	None		None	
17.3				Aircraft downlinked RTA Reliable Interval	The RTA reliable interval from the A/C is displayed in the Datalink Window.	Pass	None		The answer on the RTA Reliable interval is shown as min-max values in the timewindow when mouse-over	Pass
17.4				AMAN freeze EAT, calculate CTA, send CTA request	The @ symbol is displayed in orange colour in the track label and the CTA value is displayed in the EPP window.	Pass	Yellow @ in label, Yellow in CTA time arrival list window	Pass	"Pro" status in ACC Stacklist	Pass
17.5				UA EC accepts CTA						
17.6	2.4	Freezing a flight	CTA accepted by ATCO		The @ symbol is displayed in light green.	Pass	None		None	
17.7				Pilot accepts CTA						
17.8	2.4	Freezing a flight	CTA accepted by pilot		The @ symbol is displayed in dark green. (orange colour, known bug) The RTA is displayed in the EPP window	Fail	Green @ in label, Green in CTA time arrival list window	Pass	"ACP" status in ACC Stacklist	Pass
17.9				APP planner change EAT within ETA min/max timeframe						
17.10	2.9	Change EAT (by APP planner)			None		New EAT in flight label	Pass	New EAT in stack list	Pass
		End: *CTA status not changed, flight continues*								

Appendix C VP-030 use case description

During the preparation for the VALP, several meetings with controllers and system experts from MUAC and LVNL were organised to make a high-level description of the AMAN Extended Horizon concept, to determine the expectations of the stakeholders, which were "translated" into validation objectives. After the deliverance of the VALP, more effort was put into the detailing of the AMAN Extended Horizon concept in the form of use cases, with the help of operational controllers and system experts of LVNL, MUAC and INDRA. This was an iterative process resulting in several versions of the use case description. The team of experts have tried to cover all uses cases to "draw" a complete picture, even though not all sequences of interaction would be used in VP-030. Appendix F contains all the use case (elements) that were validated in the exercise. This appendix contains an integral copy of the final version of this document, agreed by all partners as an input to system implementation, integration and validation. This document, a working document for internal (project team) usage, has not be updated after it was finished at the beginning of 2015.So it should be realized that for the use case (elements) that were not validated the sequence of interaction can be different because at the time of writing working methods used in other validation exercises were still being developed and were not necessarily suitable for the different environment under which the i4D+CTA validation was conducted..

1 Introduction

Exercise VP 030 combines in an operational validation three important SESAR concepts: IOP, i4D and AMAN Extended horizon. The main focus of the exercise will not be on the further development of the individual concepts: the exercise will focus on the validation of the integration of these three concepts.

VP 030 will be executed by MUAC and LVNL; both ATSUs will have an Industry Based Platform (IBP) at their disposal. The combined upper and lower airspace of MUAC and LVNL will be used to simulate an inbound peak on Schiphol. Simulated traffic will be handled by ATCO's from both organizations, both groups working on their own IBP.

The IBPs of both MUAC and LVNL will contain functionality representing the current state of affairs of the three main concepts IOP, i4D and AMAN Extended Horizon. Furthermore, advancements in the coming period on either of these three concepts will be included as far as possible. For instance with regard to the IOP concept, further improvements on 2D and 3D synchronization may be implemented. The LVNL IBP will be equipped with the newest version of AMAN, the version that will be included in LVNL's ATM machine in 2015. This version will be enriched with functionality to support the SESAR concept. The MUAC IBP will be equipped with a CPDLC and ADS-C component to support the i4D concept.

MUAC's airspace is positioned above LVNL's airspace, which makes it possible to generate traffic in a very pragmatic way. In VP 030 the MUAC simulator will be used to generate traffic in both upper and lower airspace. Interconnectivity between the simulators of MUAC and LVNL does not have to be realized for this exercise.

All parties acknowledge that some details have to be worked out in the development phase(e.g. in an addendum to the Specs document) and that INDRA can make a proposal if during the development phase an issue is detected that is not covered by the Use Cases. Furthermore the parties acknowledge that during the test-phase it may be necessary to make adjustments/ exceptions to the software based on test-results.

2 Operational Scenario: AMAN Extended Horizon

The IOP+i4D will be executed in MUAC airspace and the Amsterdam FIR. MUAC airspace will be referred to as upper area airspace; MUAC is the upper area ATSU. The Amsterdam FIR is the lower area airspace, LVNL is the destination ATSU.

In the inbound planning process two phases can be distinguished for each flight:

1. At entrance of the upper area airspace, the 4D trajectory and the RTA Reliable Interval is shared between aircraft, upper area ATSU and destination ATSU. Based on this information the flight is added to the inbound planning and a provisional EAT is calculated, taking into account the ETO IAF and RTA Reliable Interval of this flight and all other inbounds. The provisional EAT is not communicated with the aircraft, a request to loose or gain time is not made yet. The inbound planning sequence is shown in detail to the APP planner and globally to the ACC controller. The

EAT is only shown to the ACC controller once the flight is within the freeze horizon.
In general, a change to the 4D trajectory caused by an instruction of the upper area ATCO will result in an update of the EPP data shared via the flight object. This will trigger AMAN to request an update of the RTA reliable interval and might result in an update of the provisional EAT for the flight.

2. 25 minutes before IAF the aircraft crosses the freeze horizon. At this moment the AMAN of the destination ATSU will freeze the EAT. A CTA is derived from the EAT and proposed to the Upper area ATSU and the aircraft. If the proposed CTA is accepted, it will be the primary responsibility of the aircraft to realize the CTA at the metering fix. If the CTA is not accepted, by Upper area ATSU or aircraft, it will be the responsibility of the Lower area ATCO to incorporate the flight in the inbound planning.
After freezing the EAT, changes to the 4D trajectory can still be initiated by both the Upper area and Destination ATSU, to maintain separation.

The strategy of AMAN in the VP 030 exercise will be to accommodate customer preferred trajectories as much as possible. This means that the inbound planning algorithm will take the ETO IAF of the flight, which takes into account the aircraft intent, as a starting point for its EAT calculation. Rules on how to incorporate the RTA Reliable interval in inbound planning algorithm need to be established. Aircraft intent, consisting of Mach Cruise and Descent CAS is also provided to AMAN. The figure below demonstrates a nominal situation.

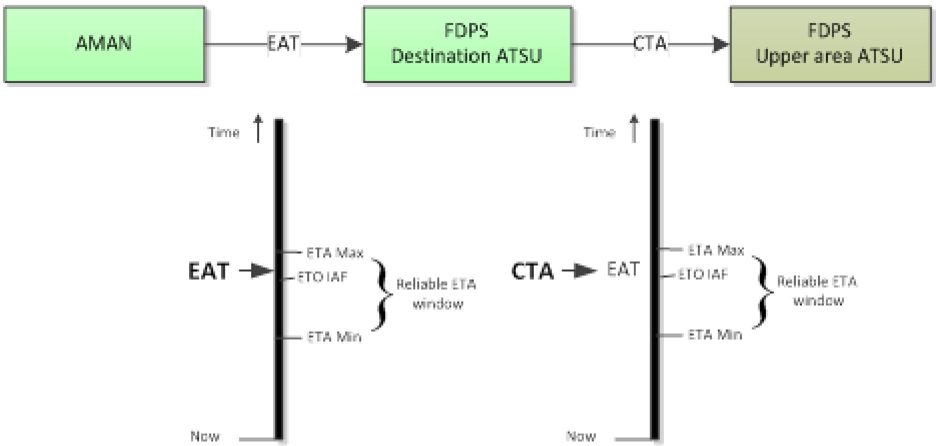


Figure 1: Nominal calculation of CTA

Starting from entrance of Upper area airspace AMAN will calculate an EAT as close as possible to the provided ETO IAF, taking into account the known RTA Reliable Interval and ETO IAF's of all other inbounds. The CTA, equal to the EAT, is proposed to the upper area ATSU and aircraft.

In a non-nominal situation the EAT can differ from the CTA. The EAT being the planned time over IAF calculated by AMAN, and the CTA the time within the RTA Reliable Interval that will be requested to the aircraft. The EAT will never be earlier than ETA min. However, it may be later than ETA max, because of high density traffic. In this situation the EAT is communicated to the FDPS of the destination ATSU. Triggered by an AMAN proposal, the FDPS communicates the CTA (the minimum value of EAT and ETA max) to the upper area FDPS, the controlling ATSU at that moment in time, where it will be uplinked to the aircraft. Additional time to loose, the difference between EAT and ETA max, will be realized with instructions in the airspace of the destination ATSU.

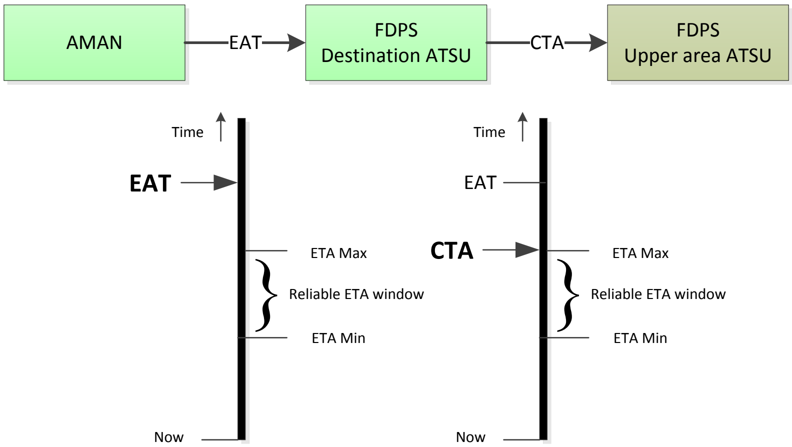


Figure 2: Scenario with EAT outside the RTA Reliable Interval

As time goes by and the aircraft gets closer to its destination, the RTA interval will become smaller. Therefore the RTA interval available to AMAN at the moment it makes its EAT/CTA decision will be larger than the RTA interval of the aircraft at the moment it decides whether or not the CTA can be accepted. This timing issue must be taken into account by AMAN, otherwise the CTA will never be accepted when it is too close to ETA Max (see also paragraph 4.3).

At entrance of upper area airspace the trajectory calculated by the aircraft (the FMS trajectory) and the trajectory calculated by the ground based system (the ground TP trajectory) will be synchronized. The 2D route discrepancy detection will be automatic, the detected discrepancies will be solved manually by the ATCO. The vertical profile (3D) will be synchronized manually and the time dimension (4D) will not be synchronized.

The exercise will simulate an inbound peak with two landing runways. In Amsterdam FIR the sectors 1 and 2 will be simulated in this exercise. However, also traffic from sector 3, 4 and 5 will be automated to build up a realistic inbound sample. All traffic from sector 1 and 2 will be assigned to one runway (f.i. 36R), all traffic from sector 4 and 5 will be assigned to the other runway (f.i. 06). Traffic from sector 3 will be divided between the two runways: this decision is made by the APP planner based on load balancing.

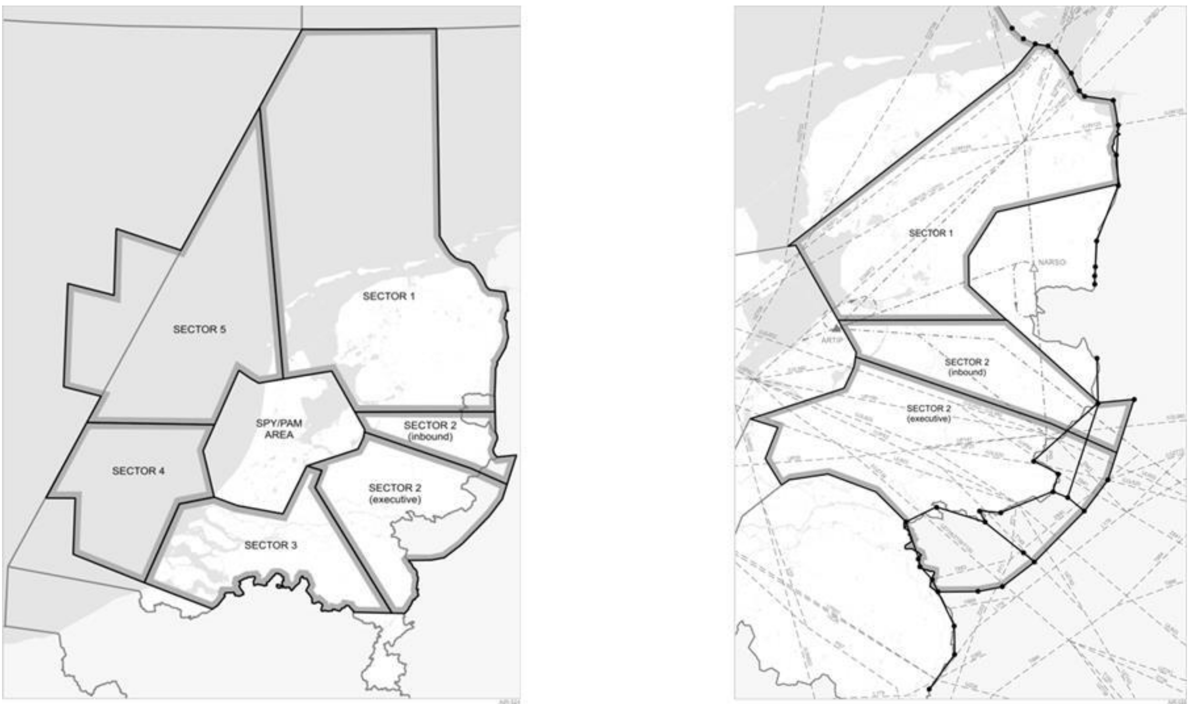


Figure 3: Amsterdam FIR and Sector 1, 2 in Amsterdam FIR

If, within the freeze horizon, the CTA is no longer feasible for an aircraft due to f.i. changing weather conditions or instructions from the upper area or destination ATSU, it is assumed that the flight crew contacts the controlling ATSU on frequency to state that the RTA is not achievable. In this exercise the pseudo pilot is not able to initiate the RTA cancellation, it is executed by the Upper Area ATCO (see paragraph 4.4). Also, a new CTA will not be issued in this exercise. The upper and lower area ATCO will give instructions to this and other aircraft to maintain an efficient inbound planning.

The use cases below describe the behavior of the operational system including the aircraft and both the Upper and Lower Area ATSU. It focuses on the interaction between ATCO and ATM System and the interfaces between the systems (between air and ground and in between ground based systems).

Furthermore these use cases focus on the behavior necessary for the VP 30 exercise. For instance, they do not intend to describe the behavior in situations with more than two ATSU's involved in the inbound planning for a certain airport.

Presentation actions are, in general, not described in these use cases. Chapter 3 describes generically the presentation requirements for the VP 30 exercise.

General Conditions to all use cases in the paragraphs below:

A. The aircraft is ADS-C equipped.
B. An ADS-C contract is agreed upon between aircraft and ATSU's.
C. CPDLC is available for the upper area ATSU.

In specific situations the behaviour of the simulator will not reflect the envisaged operational behaviour of for instance the FMS. The use cases will take into account the limitations of the simulator. In chapter 4 all limitations are summarized. If a use case has to be adapted a reference to the according paragraph describing the limitation in chapter 4 is made.

2.1 Use case: Distribute EPP data via Flight Object

Trigger for this use case is the downlink of EPP data by an aircraft. Since in this exercise only the Upper Area ATSU is using datalink, this use case can only be triggered in Upper Area airspace.

A special case of this use case is the first downlink of EPP data. In an operational environment the downlink is performed when the a/c logs on, when the ADS-C contracts are established. This is at pilot discretion and usually performed a short time before the AOR entry. See paragraph 4.5 for the implementation of this process in this exercise.

As part of this use case an automatic 2D check is performed. For the moment a 3D check, let alone a 4D check, is not part of the process. This is mainly because the specification of this activity is not mature enough. If progress is being made, adding this functionality will be considered at a later stage.

2.1.1 Pre-Conditions

A. The flight has been assumed by the upper area ATSU (Upper area ATCO is allowed to change the Flight Object).
B. Flight plan for the flight exists in IBP Upper Area ATSU. (Generated by simulator.)
C. The flight is planned to cross AOR of Upper and Lower Area ATSU.
D. Aircraft is logged in.

2.1.2 Post Condition

A. ADS-C connection is established.
B. FMS and IBPs are 2D synchronized.
C. EPP data is distributed to Lower Area ATSU.

2.1.3 Operating Method

The table below contains the description of the operating method:

Step	***Aircraft***	***ATS Unit Upper Area (Current controlling)***	***ATS Unit Lower Area***	
			iCAS (IOP/FDP/CWP)	***AMAN***
1	Aircraft "logged in".			
2	Downlink EPP data			
3		If applicable resolve discrepancies between EPP and Ground trajectory in Upper and Lower Area airspace. (Refer to use case 2.10)		
4		Update EPP data in the Flight Object and share with downstream ATSU.		
5			Provide AMAN with EPP data (ETO-IAF and intent (Mach cruise and CAS Descent)	
6				Request RTA Reliable Interval (refer to use case 2.2). Repeat this request periodically (to be determined, see paragraph 4.6), until the flight crosses the freeze horizon.

The operating method is visualised in the figure below.

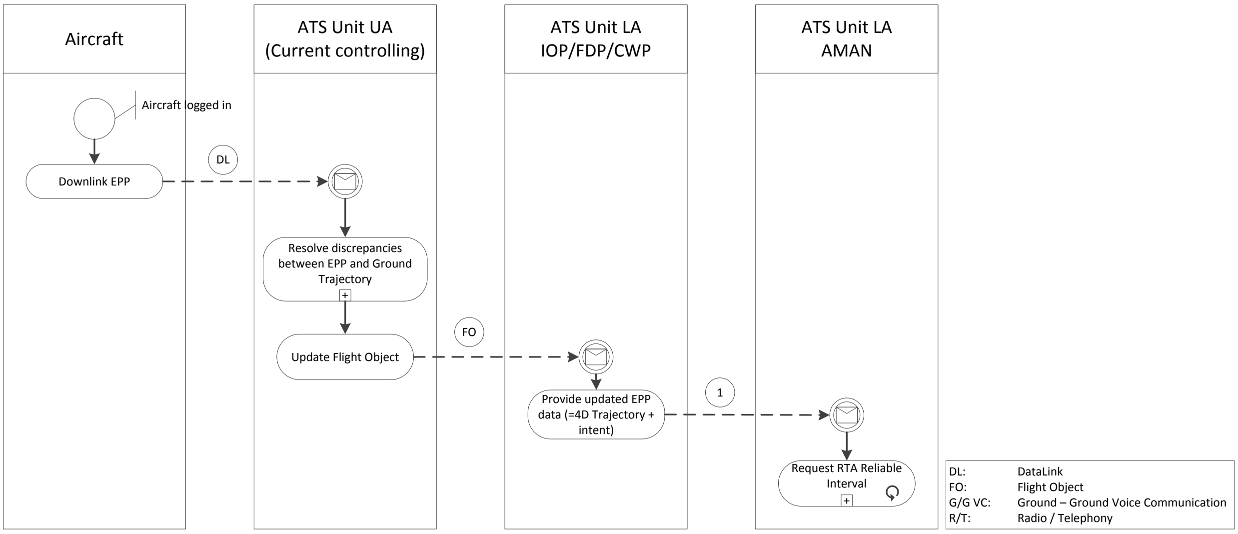


Figure 4: use case First contact

2.1.4 AMAN interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	EPP-data	iCAS-FDP	AMAN	• Flight identification • ETO-IAF (FMS) • Aircraft intent: LastCruiseSpeedatTOD, MachDescentSpeed, CasDescentSpeed. (Since this information can not be provided by the simulator used in exercise VP 030, this part of the AMAN interface will not be validated in the exercise.) • Timestamp

2.2 Use case: Request RTA Reliable Interval for IAF

This use case is initially triggered when an aircraft enters the upper area airspace and the FMS is 2D synchronized with the ground TP´s. After the first request a process will be initiated to request the RTA Reliable Interval periodically. This process is terminated when the aircraft crosses the freeze horizon and a CTA is requested. The update rate is a parameter, which value will be decided later. The period of requesting RTA interval will have to be tuned during the integration phase to reach an acceptable load for the Simulator (see paragraph 4.6).

Note 1: This use case should be future proof. Although not an objective of this exercise, also the upper area ATCO can request an RTA Reliable interval for IAF. In that situation the information should be propagated via the FO and shared with AMAN. AMAN will use the information as if it was requested by AMAN.

Note 2: To be future proof, requests of an RTA Reliable interval for any other point will also be propagated via the FO and shared with AMAN. This information will be neglected by AMAN.

Note 3: AMAN does not check whether an answer is received on every request, AMAN just initiates the next request as planned. When one or more requests are not answered, because somewhere in the chain from AMAN to the aircraft and back something goes wrong, this will of course reduce the quality of the inbound planning. In the logging all information on requests going through the chain must be available. Therefore, one of the outcomes of the exercise can be the percentage of successful requests.

2.2.1 Pre-Conditions

A. The flight is an inbound to the downstream ATSU.
B. FMS and ground TP trajectories are 2D synchronized.
C. The flight is in upper area airspace.
D. The controller of the upstream ATSU has the flight under control.
E. The EAT for the flight is not frozen.
F. CTA is not assigned.

2.2.2 Post Condition

A. RTA Reliable Interval is provided.
B. The EAT for the flight is calculated/updated and the inbound planning sequence outside the freeze horizon is recalculated.

2.2.3 Operating Method

The table below contains the description of the operating method:

Step	***Aircraft***	***Upper area ATSU***	***Destination ATSU***	
			iCAS	***AMAN***
1				Request RTA Reliable Interval.
2			Request RTA Reliable Interval via Flight Object.	
3		Automatic uplink to request RTA Reliable Interval. (This might have some impact on the MUAC CWP Datalink window, see paragraph 4.7).		
4	RTA Reliable Interval is downlinked.			
5		RTA Reliable Interval is updated in the Flight Object (and shared via IOP)		
6			Provide AMAN with RTA Reliable Interval.	
7				Update inbound planning with RTA Reliable Interval.
In parallel after Step 5				
8		Request for EPP data.		

9	EPP data is downlinked.			
10		Update EPP data in the Flight Object and share with downstream ATSU. (The information clusters “RTA Reliable Interval” and “EPP data” can only be requested one after the other. There will be a gap of approximately 30 seconds between receiving the two clusters. Both the RTA Reliable interval and EPP are provided with the proper timestamps.)		
11			Provide AMAN with EPP-data. Since RTA Reliable Interval and EPP data are requested one after another to the aircraft, they will also be provided to AMAN one after another, and never be completely in sync.	
12				Update inbound planning with EPP data.

The operating method is visualised in the figure below.

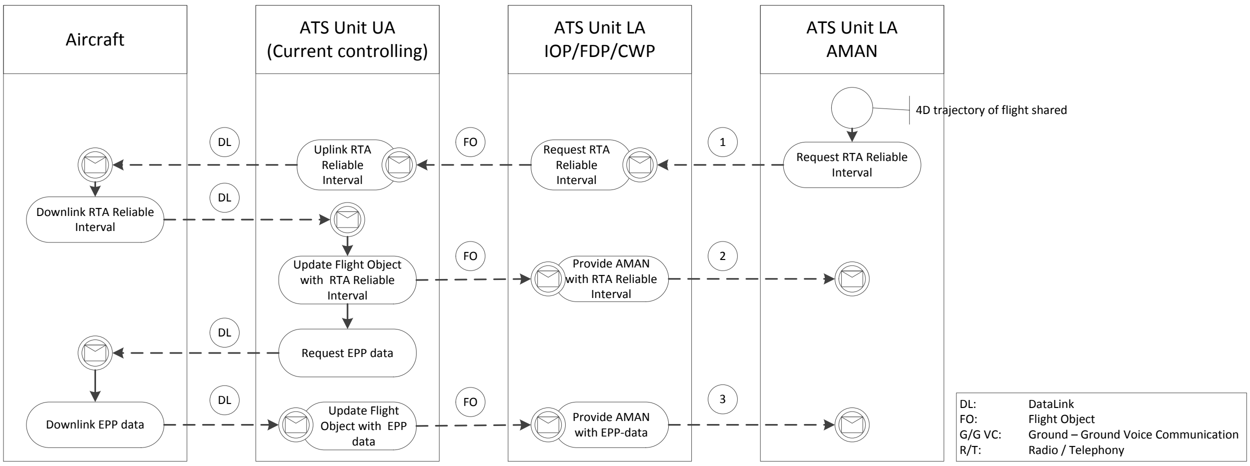


Figure 5: Request RTA Reliable Interval

2.2.4 AMAN Interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	RTA Reliable Interval request	AMAN	iCAS-FDP	• RTA request • Way point (metering fix) • Flight identification
2	RTA Reliable Interval	iCAS-FDP	AMAN	• Flight identification • RTA Reliable Interval for metering fix (ETA Min, ETA Max) • Timestamp
3	EPP data	iCAS-FDP	AMAN	• Flight identification • ETO-IAF (FMS) • Aircraft intent: :

				LastCruiseSpeedatTOD, MachDescentSpeed, CasDescentSpeed. (See remark in 2.1.4) • Timestamp

2.3 Use case: Change 4D trajectory outside freeze horizon

This use case is initiated by an instruction of the Upper Area controller, for instance to maintain separation or to decrease the number of track miles for this flight. In some situations this will trigger an EPP downlink by the aircraft (see paragraph 4.2). This information will be shared with the Lower Area IBP and AMAN, it will not affect the periodical request for an RTA Reliable Interval.

2.3.1 Pre-Conditions

A. FMS trajectory and ground TP trajectories are 2D synchronized.

B. The flight is in upper area airspace.

C. The controller of the upper area ATSU has the flight under control (because freeze horizon is in Upper Area airspace).

D. The EAT for the flight is not frozen.

E. CTA is not assigned.

2.3.2 Post Condition

A. A change in the 4D trajectory of the flight is carried through, FMS and EPP data are updated.

B. FMS and IBPs are 2D synchronized.

C. The EAT for the flight is updated and the inbound planning sequence is changed if applicable (i.e. not frozen yet).

2.3.3 Operating Method

Step	*Aircraft*	*Upper area ATSU*	*Destination ATSU*	
			iCAS	*AMAN*
1		Instruction to aircraft.		
2		Recalculate 4D trajectory (by ground TP)		
In parallel after Step 1 in case the instruction will trigger an EPP downlink (see paragraph 4.2)				
3	Pilot follows the instruction.			
4	Recalculate 4D trajectory (by FMS)			
5	Downlink updated EPP data.			
6		Resolve discrepancies between EPP and Ground trajectory in Upper and Lower Area airspace. (Refer to use case 2.10)		
7		Update EPP data in the Flight Object and share with downstream ATSU.		
8			Provide AMAN with EPP data.	
9				

The operating method is visualised in the figure below.

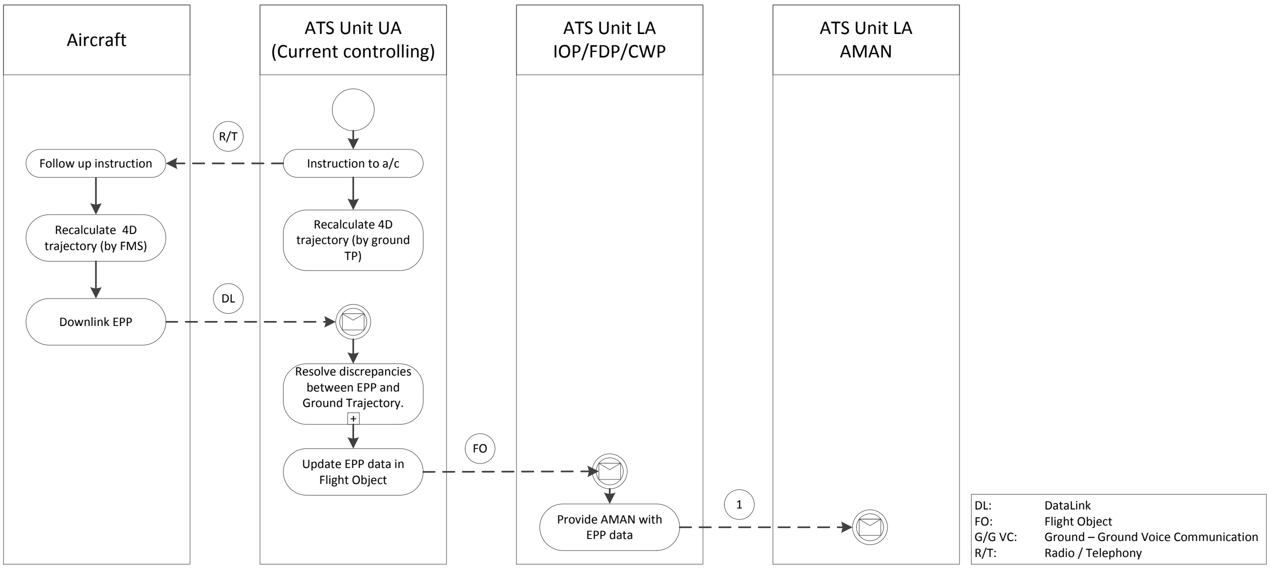


Figure 6: Use case Change 4D trajectory outside freeze horizon

2.3.4 AMAN Interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	EPP data	iCAS-FDP	AMAN	• Flight identification • ETO-IAF (FMS) • Aircraft intent: : LastCruiseSpeedatTOD, MachDescentSpeed, CasDescentSpeed. (See remark in 2.1.4) • Timestamp

2.4 Use case: Freezing a flight

This use case is triggered when an aircraft crosses the freeze horizon, 25 minutes before reaching the metering fix. AMAN determines the optimal EAT for the flight and requests a CTA. When EAT is within the RTA Reliable Interval, the requested CTA is equal to EAT. If EAT is outside this interval, the CTA is as close as possible to the EAT within the interval.

Note 1: The nominal use of the REJECTED status are the situations, where the CTA proposal is rejected by the MUAC ATCO or the pilot. Furthermore the REJECTED status is also used in the non-nominal situation where the MUAC ATCO decides to uplink the CTA proposal and the uplink is not successfully completed. In other non-nominal situations, when the systems do not detect loss of information, the CTA status will remain REQUESTED, and the ATCO’s will have the opportunity to cancel the CTA in use cases 2.5 and 2.6.

Note 2: Because of timing issues, time elapses between the moment the last RTA Reliable Interval was provided by the aircraft and the CTA request is received by the aircraft, AMAN should take into account margins in the determination of the CTA. (Refer to 4.3)

Note 3: The freezing of a flight triggers an AMA message (see AMAN ICD). It is not the first time in the lifecycle of the flight that an AMA message is sent. An earlier message will contain the runway assigned to the flight. However, it is the first AMA message that contains the EAT. The EAT is only determined when passing the freeze horizon. From this moment on the ETO-IAF is determined by AMAN in order to calculate the Delta-T, and communicated via the CFD message.

2.4.1 Pre-Conditions

A. The EAT for the flight is not frozen.
B. The flight is 25 minutes before IAF (and about 10-15 minutes before TOD)
C. FMS trajectory and ground TP trajectories are 2D synchronized.
D. The controller of the upstream ATSU has the flight under control.

2.4.2 Post Condition

A. The EAT for the flight is frozen.
B. A runway is assigned to the flight.
C. A CTA within the RTA Reliable Interval is requested to the upstream center and either accepted or rejected.
D. The 2D synchronized trajectory and the updated EPP-data are shared with the destination ATSU.

2.4.3 Operating Method

The table below contains the description of the operating method:

Step	***Aircraft***	***Upper area ATSU***	***Destination ATSU***	
			iCAS	***AMAN***
1				Freeze EAT. Calculate CTA (= minimum time of EAT and ETA max). Calculate Planning Delay (= difference between EAT and ETO IAF (estimated by AMAN TP with nominal speed))
2				Provide iCAS-FDP with EAT. Provide ETO IAF.
3				Request CTA.
4			Request CTA to Upper area ATSU via Flight Object. Present CTA Requested status to ATCO.	
5		Present CTA request to ATCO.		
6		Update the Flight Object with CTA Requested status and share with Downstream ATSU		
7			Provide AMAN with CTA Requested status.	
If CTA rejected by ATCO.				
8		Present CTA rejection to ATCO.		
9		Update the Flight Object with CTA rejection and share with Downstream ATSU.		
10			Provide AMAN with CTA rejection.	
If CTA accepted by ATCO.				
11		Uplink CTA request.		
12	Present CTA request to Pilot.			
If CTA accepted by Pilot.				
13	Adapt 4D trajectory to comply with CTA (by FMS).			
14	Downlink CTA Acceptance.			
15		Present CTA acceptance to ATCO.		

16	Downlink updated EPP data (with the CTA included as RTA).			
17		Update the Flight Object with CTA acceptance and EPP data, share with Downstream ATSU. (The FMS trajectory and the TP trajectory are still 2D synchronized, so no checking necessary.) (Two conditions have to be met: • The reception of the WILCO, and • The CTA is included as RTA in the EPP data. Otherwise the CTA status will be set to REJECTED.)		
18			Provide AMAN with CTA acceptance and EPP data.	
If CTA not accepted by Pilot.				
19	Downlink CTA Rejection.			
20		Present CTA rejection to ATCO.		
21		Update the Flight Object with CTA rejection and share with Downstream ATSU.		
22			Provide AMAN with CTA rejection.	

The operating method is visualised in the figure below.

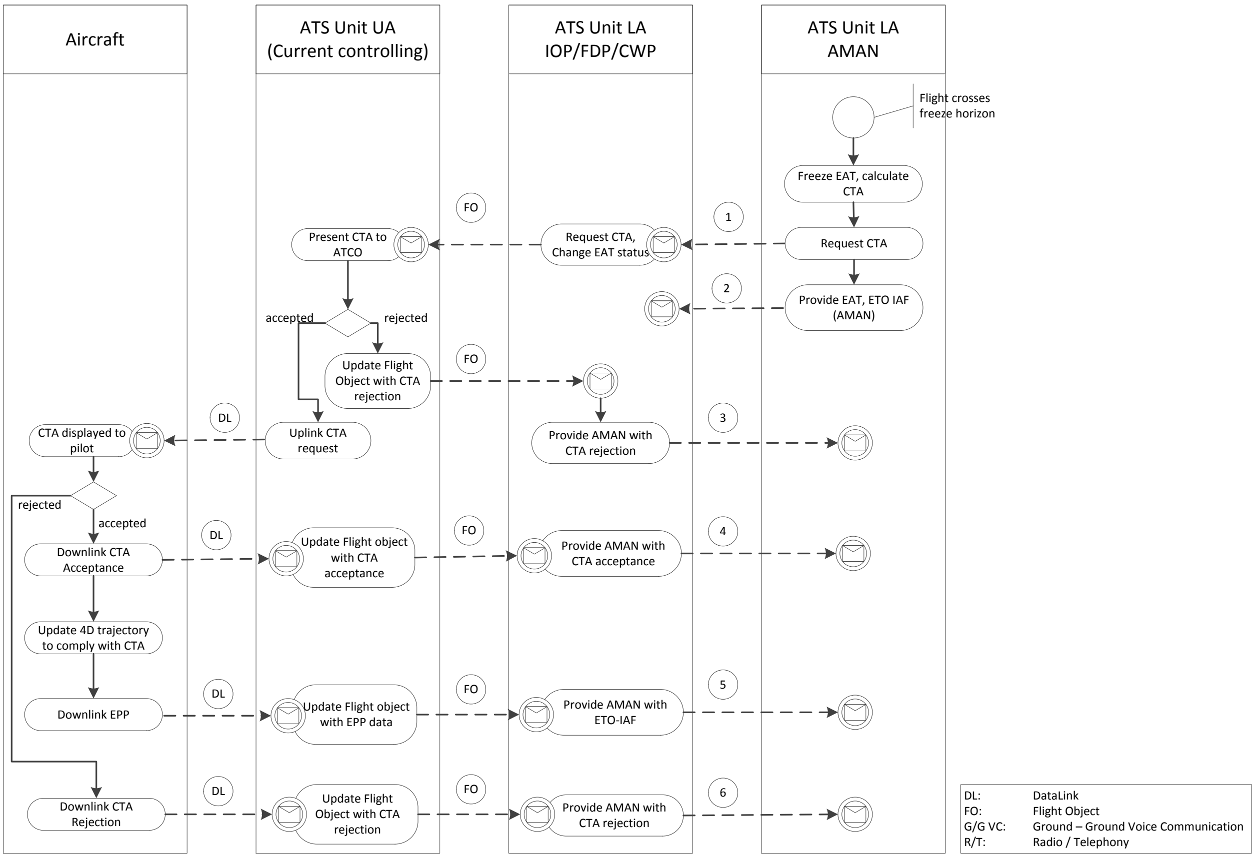


Figure 7: Freezing a flight

2.4.4 AMAN Interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	Request CTA			• Flight identification • CTA request • Route point (= metering fix)
2	Provide EAT, ETO IAF	AMAN	iCAS-FDP	• Flight identification • EAT • ETO IAF (AMAN)
3	CTA rejection	iCAS-FDP	AMAN	• Flight identification • CTA rejection
4	CTA acceptance	iCAS-FDP	AMAN	• Flight Identification • CTA acceptance •
5	EPP data	iCAS-FDP	AMAN	• Flight identification • ETO-IAF (FMS) • Aircraft intent: : LastCruiseSpeedatTOD, MachDescentSpeed, CasDescentSpeed. (See remark in 2.1.4) • Timestamp
6	CTA rejection	iCAS-FDP	AMAN	• Flight identification • CTA rejection

2.5 Use case: Cancel a CTA in Upper Area Airspace

This use case can have different initiators, the pilot, the lower and upper area controller. It can also have different causes, for instance unforeseen conflicts with other traffic or changed weather conditions.

2.5.1 Pre-Conditions

A. The EAT for the flight is frozen, the RTA for this flight is active.

B. If a CTA is active, the Pilot, Upper Area or Lower Area Controller is not able to realize the CTA.

C. The aircraft is in upper area airspace. The flight is under control by the upper area ATCO.

2.5.2 Post Condition

A. The CTA is canceled. (A new CTA will not be issued.)

2.5.3 Operating Method

Step	*Aircraft*	*Upper area ATSU*	*Destination ATSU*	
			iCAS	*AMAN*
1A	The pilot informs the Current Upper Area Controller via R/T that the CTA is no longer achievable. (In this exercise the pilot is not able to initiate a CTA cancellation, see paragraph 4.4.)			
1B		The Controller decides that the CTA request or agreement must be cancelled.		
1C			The ACC Controller decides that the CTA request or	

			agreement must be cancelled and informs the current Upper Area Controller accordingly via Ground-Ground Voice Communication.	
1D				The APP planner decides that the CTA request or agreement must be cancelled and informs the current Upper Area Controller accordingly via Ground-Ground Voice Communication.
2		The controller makes an input to cancel the CTA and informs the Pilot via R/T if applicable.		
3	Pilot cancels CTA in FMS if applicable.			
In parallel after step 2.				
4		Update the Flight Object with CTA cancellation and share with Downstream ATSU.		
5			Provide AMAN with CTA cancellation.	
6				Recalculate the inbound planning using the AMAN TP for the CTA cancelled flights.
7				Provide iCAS-FDP with changed EATs..
8				Cancel CTA's from subsequent flights if applicable.

The table below contains the description of the operating method. Depending on the initiator only one of the steps 1A, 1B, 1C and 1D is performed.

The operating method is visualised in the figure below.

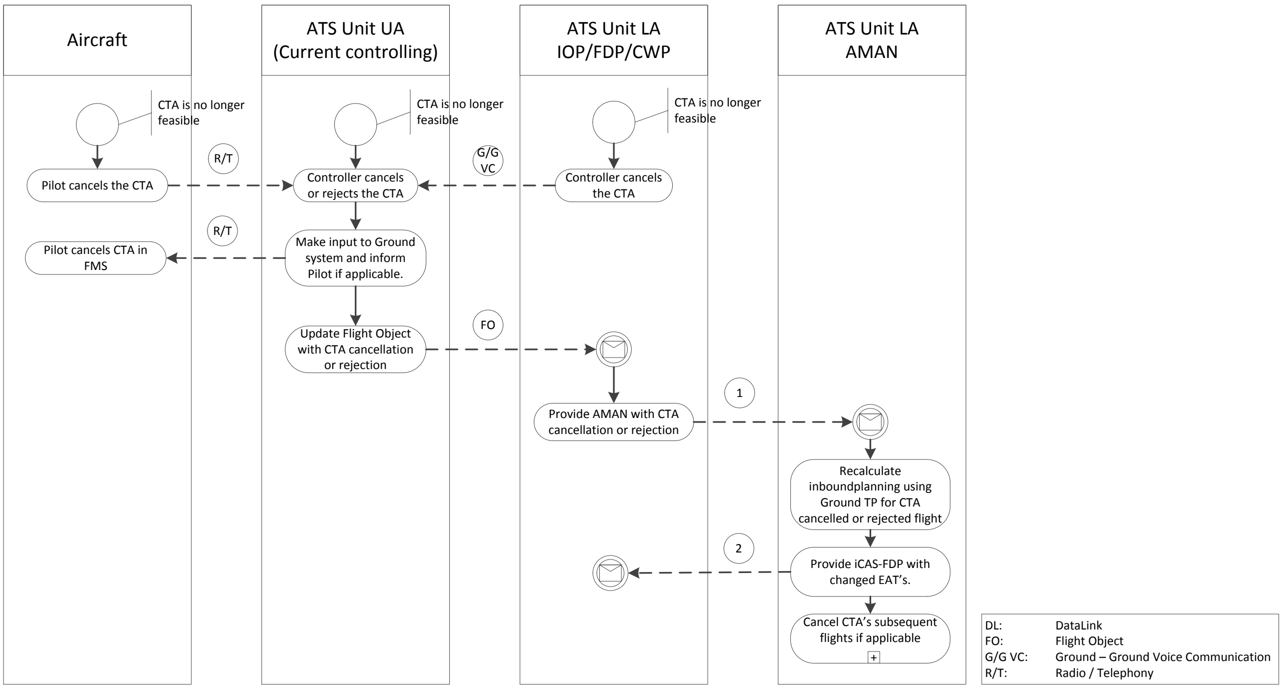


Figure 8: Cancel a CTA in Upper Area airspace

2.5.4 AMAN Interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	CTA cancellation	iCAS-FDP	AMAN	• Flight identification • CTA cancellation
2	Inbound planning info	AMAN	iCAS-FDP	For all a/c with changed inbound planning: • Flight identification • EAT

2.6 Use case: Cancel a CTA in Lower Area Airspace

This use case can have two initiators, the pilot and the lower area controller. It can also have different causes, for instance unforeseen conflicts with other traffic or changed weather conditions.

2.6.1 Pre-Conditions

A. The EAT for the flight is frozen, a CTA is requested or issued.

B. If a CTA is issued, the Pilot or Lower Area Controller is not able to realize the CTA. If a CTA is requested, the Upper or Lower Area Controller can no longer wait for the response.

C. The aircraft is in Lower Area airspace. The flight is under control by the lower area ATCO.

2.6.2 Post Condition

A. The CTA is canceled. (A new CTA will not be issued.)

2.6.3 Operating Method

The table below contains the description of the operating method:

Step	*Aircraft*	*Upper area ATSU*	*Destination ATSU*	
			iCAS	*AMAN*
1A	The pilot informs the Current Lower Area Controller via R/T that the CTA is no longer achievable.			
1B			The ACC Controller decides that the CTA agreement must be cancelled.	
1C				The APP planner decides that the CTA request or agreement must be cancelled and informs the current ACC Controller accordingly.
2			The controller makes an input to cancel the CTA and informs the Pilot via R/T if applicable.	
3	Pilot cancels the CTA in FMS.			
In parallel after step 2				
4			Provide AMAN with CTA cancellation.	
5				Recalculate the inbound planning using the AMAN TP for the CTA cancelled flights.
6				Provide iCAS-FDP with changed EATs..
7				Cancel CTA's from subsequent flights if applicable.

The operating method is visualised in the figure below.

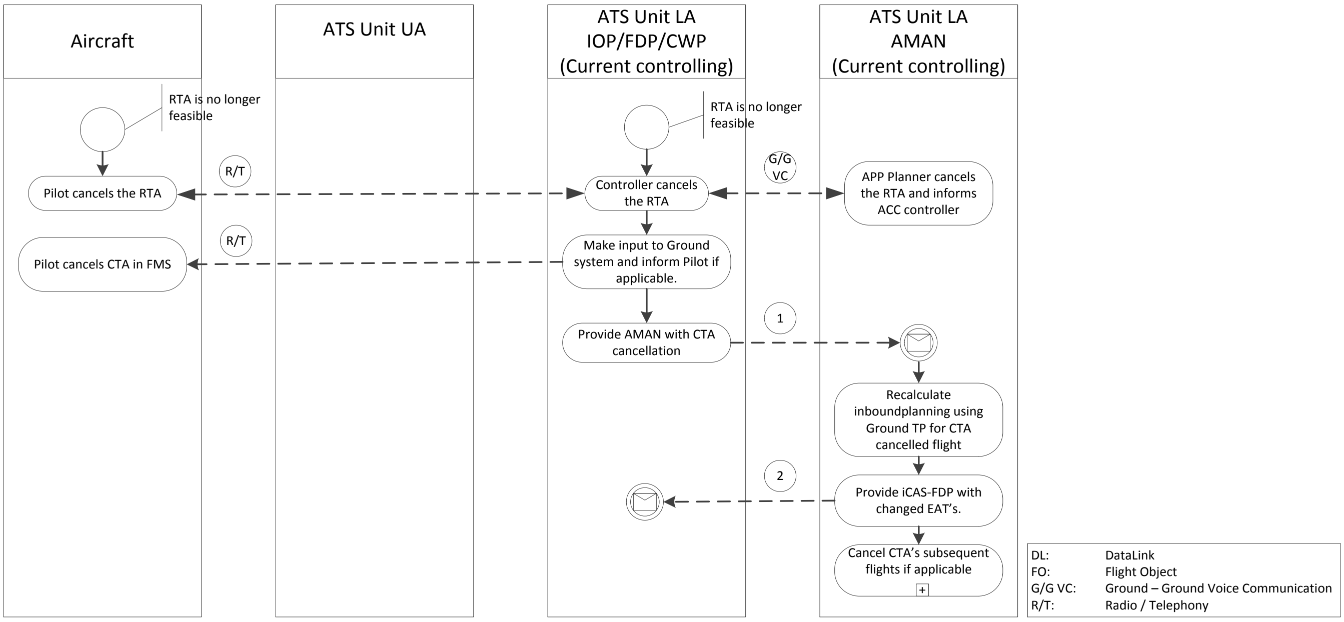


Figure 9: Cancel a CTA within Lower Area airspace

2.6.4 AMAN Interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	CTA cancellation	iCAS-FDP	AMAN	• Flight identification • CTA cancellation
2	Inbound planning info	AMAN	iCAS-FDP	For all a/c with changed inbound planning: • Flight identification • EAT

2.7 Use case: Change 4D trajectory initiated by Upper Area ATCO within freeze horizon

This use case is initiated by an instruction of the Upper Area controller, for instance to maintain separation or to decrease the number of track miles for this flight.

Note 1: Depending on the instruction of the controller, a 4D TP recomputation is performed or not. See 4.2 for more information. If a recalculation of the 4D trajectory is not possible, this should result in a CTA cancellation (refer to uses cases 2.5, since aircraft is in upper area airspace).

2.7.1 Pre-Conditions

A. FMS trajectory and ground TP trajectories are 2D synchronized.

B. The flight is in upper area airspace.

C. The controller of the upper area ATSU has the flight under control.

D. The EAT for the flight is frozen, a CTA is accepted, rejected or cancelled.

E.

2.7.2 Post Condition

A. The CTA status remains unchanged (the CTA is robust for “limited” vectoring. If necessary, the instructions will induce use case 2.5)

B. The 4D trajectory for the flight is recalculated.

2.7.3 Operating Method

The table below contains the description of the operating method:

Step	*Aircraft*	*Upper area ATSU*	*Destination ATSU*	
			iCAS	*AMAN*
1		Instruction to aircraft.		
2		Recalculate 4D trajectory (by ground TP)		
In parallel after Step 1				
3	Pilot follows the instruction.			
4	Recalculate 4D trajectory (by FMS)			
5	Downlink updated EPP data.			
6		Resolve discrepancies between EPP and Ground trajectory in Upper and Lower Area airspace. (Refer to use case 2.10)		
7		Update EPP data in the Flight Object and share with downstream ATSU.		
8			Provide AMAN with EPP data.	
9				Recalculate Planning Delay (= difference between EAT and ETO IAF (estimated by AMAN TP with nominal speed))
10				Provide iCAS-FDP with ETO IAF.

The operating method is visualised in the figure below.

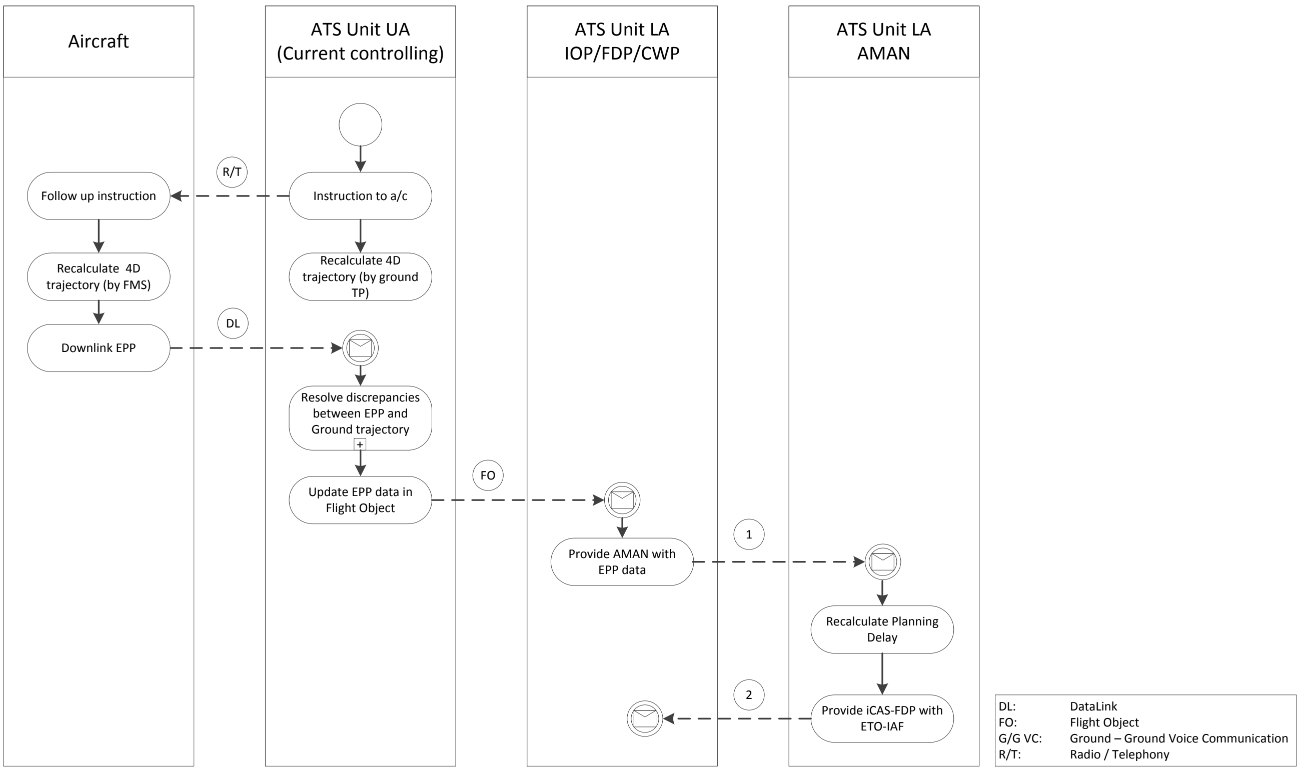


Figure 10: use case Change 4D trajectory by upper Area ATCO within freeze horizon

2.7.4 AMAN Interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	EPP data	iCAS-FDP	AMAN	• Flight identification • ETO-IAF (FMS) • Aircraft intent: : LastCruiseSpeedatTOD, MachDescentSpeed, CasDescentSpeed. (See remark in 2.1.4) • Timestamp
2	ETO IAF	AMAN	iCAS-FDP	• Flight identification • ETO IAF

2.8 Use case: Change 4D trajectory by Lower Area ATCO

This use case is initiated by an instruction of the Lower Area controller, for instance to maintain separation or to decrease the number of track miles for this flight.

2.8.1 Pre-Conditions

A. FMS trajectory and ground TP trajectories are 2D synchronized.

B. The flight is in lower area airspace.

C. The controller of the lower area ATSU has the flight under control.

D. The EAT for the flight is frozen, a CTA is accepted, rejected or cancelled.

2.8.2 Post Condition

A. The CTA status remains unchanged (the CTA is robust for “limited” vectoring. If necessary, the instructions will induce use case 2.5)

B. The 4D trajectory for the flight is recalculated.

2.8.3 Operating Method

The table below contains the description of the operating method:

Step	*Aircraft*	*Upper area ATSU*	*Downstream Center*	
			iCAS	*AMAN*
1			Instruction to aircraft via R/T.	
	Pilot follows the instruction.			
2			Provide AMAN with instruction info (speed, remaining routepoints)	
3				Recalculate Planning Delay (= difference between EAT and ETO IAF (estimated by AMAN TP with nominal speed)) (Re)calculate Delta T (= difference between EAT and ETO IAF (estimated by AMAN TP with instructed speed))
4				Provide iCAS-FDP with ETO IAF (based on instructed speed)

The operating method is visualised in the figure below.

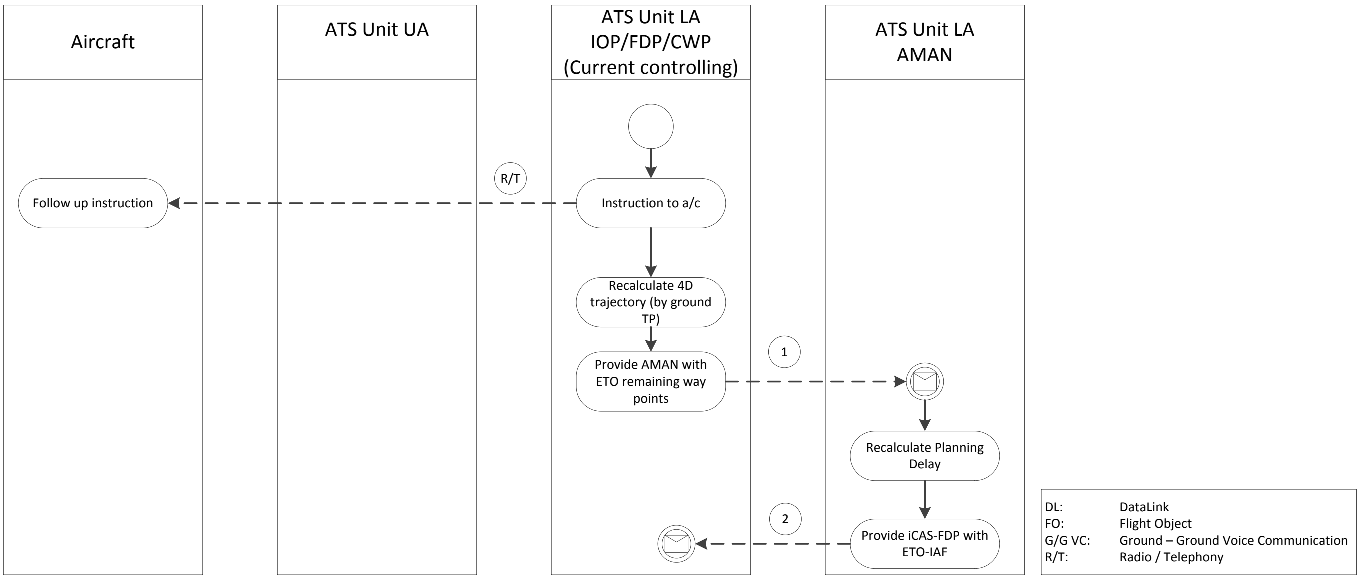


Figure 11: Use case Change 4D trajectory by Lower Area ATCO.

2.8.4 AMAN Interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	Instruction info	iCAS-FDP	AMAN	• Flight identification • Speed • Remaining routepoints
2	ETO IAF	AMAN	iCAS-FDP	• Flight identification • ETO IAF (instructed speed)

2.9 Change EAT

Having an overview of all inbounds the APP planner decides to change the EAT for a specific inbound. This does not necessarily mean that the CTA is cancelled. For instance, if the aircraft is still in Upper Area and the CTA is equal to ETA MAX and the planner decides to give the aircraft a later EAT, the agreed CTA can be maintained. That way, as much as possible delay can already be absorbed in Upper Area. The APP planner does, in this exercise, not have the possibility to request a new CTA.

2.9.1 Pre-conditions

No pre-conditions.

2.9.2 Post Condition

A. A new EAT is determined by the APP planner and shared with the ACC ATCOs.

2.9.3 Operating method

The table below contains the description of the operating method:

Step	*Aircraft*	*ATS Unit Upper Area (Current controlling)*	*ATS Unit Lower Area*	
			iCAS (IOP/FDP/CWP)	*AMAN*
1				APP planner decides to change the EAT and brings in the new value in AMAN.
2				AMAN provides iCAS-FDP with new EAT.

The operating method is visualised in the figure below.

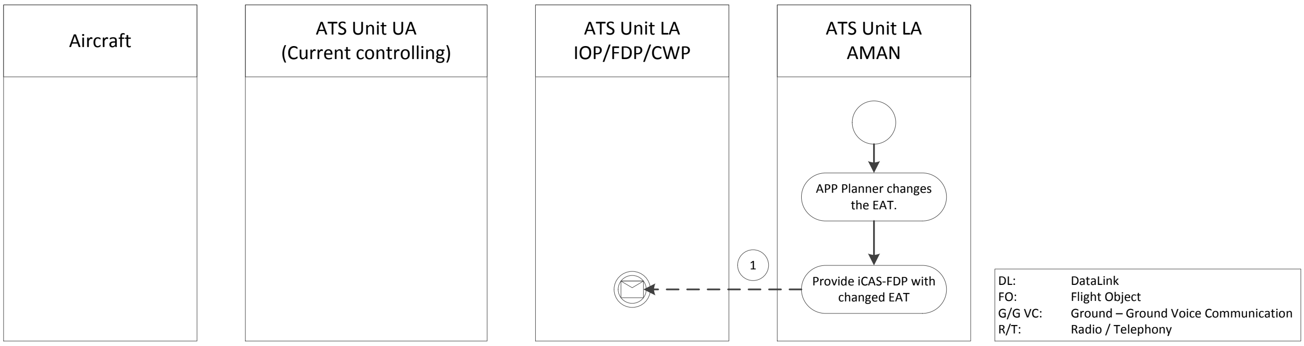


Figure 12: Use case Change EAT

2.9.4 AMAN interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	Changed EAT	AMAN	iCAS-FDP	• EAT

2.10 Resolve 2D discrepancies between EPP and Ground trajectory

This use case is triggered by a downlink of EPP data for a flight. In exercise VP 030 only one point is managed by the Simulator outside MUAC AOR. Therefore a 2D discrepancy check in lower area is not relevant. For the purpose of this exercise only a 2D check in upper area is performed.

2.10.1 Pre-Conditions

A. FMS trajectory and ground TP trajectories are not synchronized.

B. The flight is in upper area airspace. (In exercise VP 030 no data link will be used in the Lower Area airspace.)

2.10.2 Post Condition

B. 2D discrepancies both in Upper and Lower Area airspace are resolved.

2.10.3 Operating Method

The table below contains the description of the operating method:

Step	*Aircraft*	*ATS Unit Upper Area (Current controlling)*	*ATS Unit Lower Area*	
			iCAS (IOP/FDP/CWP)	*AMAN*
1		Perform 2D check of EPP trajectory against the ground TP trajectory, within Upper. Since in this exercise MUAC's SimK is used for both Upper and Lower area airspace there are some limitations to the simulation setup (see paragraph 4.8).		
If no discrepancies found.				
2		Ready. (This use case is included in other use cases. As part of those use cases the EPP data will be updated in the flight object.		
If discrepancies in Upper Area airspace.				
3		Present Upper Area		

		discrepancies to ATCO		
4		Resolve all discrepancies to be resolved ground based.		
In parallel with step 3.				
5		Share EPP data and Discrepancy status via Flight Object.		
6			Provide AMAN with Discrepancy status.	
If remaining discrepancies in Upper Area airspace (thus to be resolved in FMS)				
7		Instruction to aircraft to adapt trajectory via R/T or via datalink.		
8	Recalculate aircraft trajectory. Downlink updated EPP data.			
9		Resolve 2D discrepancies between EPP and Ground trajectory. (Recursive call to current use case.)		
In parallel with Step 7				
		Share EPP data and Discrepancy status via Flight Object.		
			Provide AMAN with Discrepancy status.	

The operating method is visualised in the figure below.

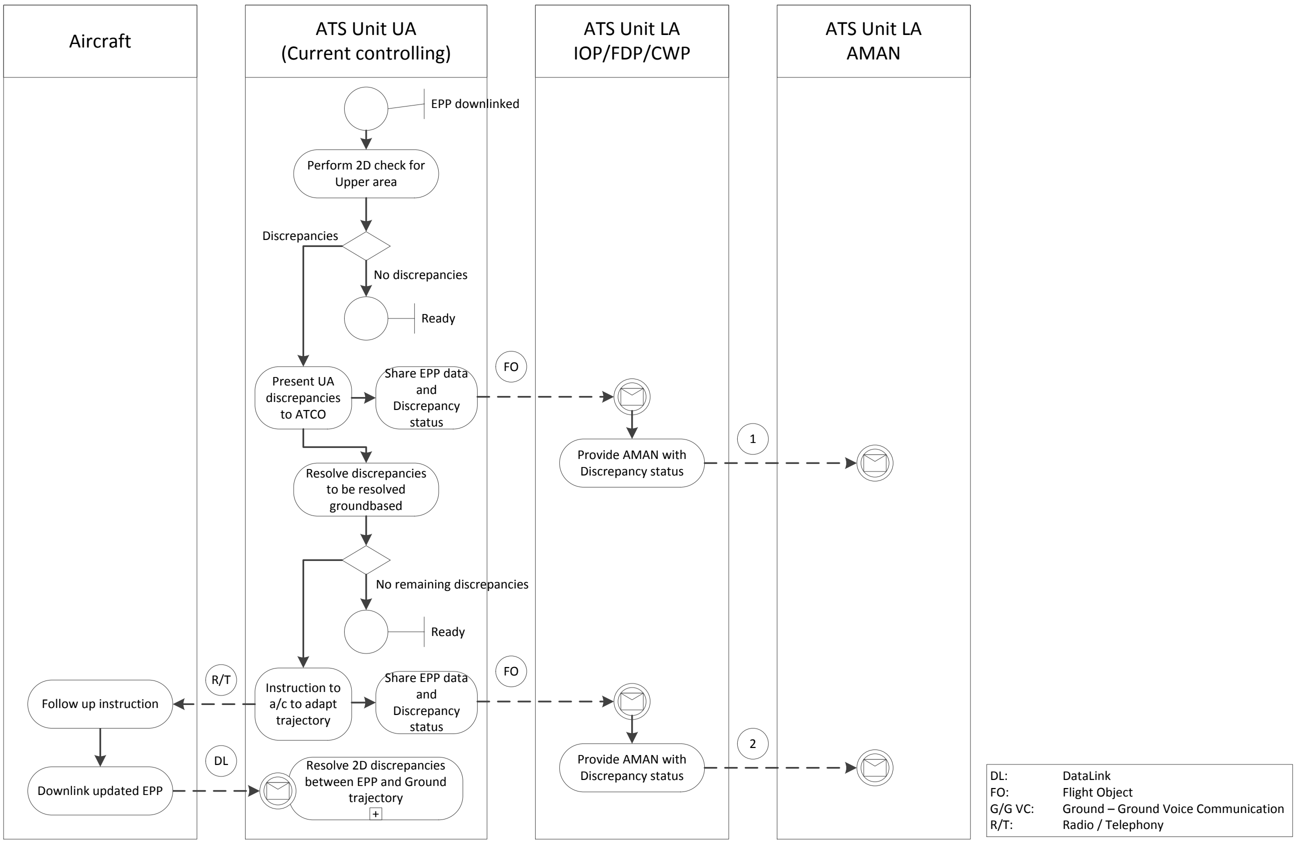


Figure 13: Use case Resolve 2D discrepancies between EPP and ground trajectory.

2.10.4 AMAN Interface

The table below identifies the information exchanges between iCAS (IOP, FDP, CWP) and AMAN within the Lower Area IBP.

No.	Information Exchange	Issuer	Addressees	Information Element(s)

	Name			
1	Discrepancy status	iCAS-FDP	AMAN	• Discrepancy status
2	Discrepancy status	iCAS-FDP	AMAN	• Discrepancy status

3 Presentation inbound planning

As part of the use cases described in the previous chapter, the ATCOs at all sites must be kept informed on the latest status of the inbound planning.

The table below shows the information elements to be presented to the several ATCOs at different stages of the flight.

	Upper Area ATCO	ACC ATCO	APP Planner
Outside freeze horizon	-	-	• EAT • EAT status (= 'Provisional') • ETO-IAF (EPP) • RTA Reliable interval •

Within freeze horizon with CTA agreement	• CTA
	• CTA status:
	  o No CTA request, no RTA in place;
	  o CTA Request Received;
	  o CTA Uplinked
	  o RTA Acknowledged
	  o RTA not achievable
	• EPP-data
		Show when surveillance data is available:
		• EAT
		• CTA
		• CTA status (= 'Requested', 'Accepted')
		• EPP data
		• IAF Delta-T: difference between EAT and ETO-IAF (ETO IAF calculated by the AMAN TP using instructed speed)
			• EAT
			• EAT status ('Frozen')
			• CTA
			• CTA status (= 'Requested', 'Accepted')
			• IAF Planning delay: difference between EAT and ETO-IAF (ETO IAF calculated by the AMAN TP using nominal speed)

Within freeze horizon without CTA agreement	• CTA status (= ' No CTA request and No RTA in place ', 'Rejected', 'Cancelled') • EPP data	Show when surveillance data is available: • EAT • CTA status (= 'Rejected', 'Cancelled') • EPP data • IAF Delta-T: difference between EAT and ETO-IAF (ETO IAF calculated by the AMAN TP using instructed speed)	• EAT • EAT status ('Frozen') • CTA status (= 'Rejected', 'Cancelled') • IAF Planning delay: difference between EAT and ETO-IAF (ETO IAF calculated by the AMAN TP using nominal speed)

4 Limitations of the simulation

4.1 On-going route modification

When a route update is performed (via voice or CPDLC), the ground route is changed immediately, which is reflected in the FO. However, the EPP contained in the FO is not immediately updated since the airborne side needs time to re-compute the trajectory, and network transition times also interfere.

2D Discrepancy might appear for a short time after a route update because of that. This is a limitation of this simulation.

In the future, a flag could be envisaged in the FO to tag an on-going route change.

4.2 Impact of a route modification on the RTA reliable interval

After a profile modification (2D route change, level clearance…), the RTA reliable interval will change but it is not communicated to the ground system unless a specific request is made by the AMAN.

So the RTA reliable interval part of the FO will be obsolete after a route change until the AMAN makes a request.

Note that this standard behaviour from the airborne side so it is not really a limitation, more a constraint of implementation for the AMAN.

Moreover, not all instructions from ATCO to aircraft will trigger an EPP downlink. For instance, the aircraft will not downlink an EPP after a heading instruction, since it can not predict its trajectory in this situation. The following events will trigger an EPP " downlink", as managed by MUAC SimKernel:

- Periodic EPP (10 minutes)
- 2D trajectory change (Point inserted or deleted)
- RTA activation (First time that the RTA constraint is inserted)
- RTA cancellation
- Level change: an EPP is sent when the target level is actually reached by the track (not when the input is made by the pilot)
- Speed change: an EPP is sent when the target speed is actually reached by the track (not when the input is made by the pilot)

Note that the speed can only be changed if no RTA is active (If a RTA is active, the speed cannot be manually managed by the pilots)

4.3 EAT outside of the RTA reliable interval

In the simulation if an EAT is outside of the RTA reliable interval computed by the airborne side when the RTA request is received by the airborne side, it will be accepted by the pilots and the simulator will manage the flight to reach the metering fix as close as possible to the RTA.

However, this is not consistent with what was defined with Airbus in i4D. Pilots will answer UNABLE to any RTA Requests that are outside of the RTA reliable interval. The behaviour of the simulations is a limitation due to the fact that the RTA reliable interval is not available to the pseudo pilots.

It has to be understood that in an operational environment, the AMAN shall set the EAT within the RTA reliable interval as much as possible, otherwise it will be rejected. Also, in an operational environment, some margins should be added because the RTA reliable interval used by the AMAN to compute the EAT will be obsolete when the RTA is received by the flight crew: by the time that the AMAN computes the EAT, proposes it to en-route, that the en-route uplinks it, and that the pilot compares it to the RTA reliable interval, a significant interval has elapsed and the flight has progressed, changing de facto the RTA reliable interval. If the CTA is set to ETAmax, it is most probable that the corresponding RTA will be refused by the flight crew since it will likely be out of range.

4.4 RTA not achievable trigger

In an operational environment, it is expected that the flight crew contacts the controlling ATSU on frequency to state that the RTA is not achievable. The downlink of the RTA not achievable status is for information only and not a trigger for the ATCO to cancel the RTA.

However, this information is not displayed to the pseudo-pilots in MUAC simulation environment, so they cannot call the ATCOs.

- ⇨ For VP030 the pilot confirmation via voice will not be performed. The RTA not achievable will be presented in white in the label to the controller and the controller will cancel the RTA even without the pilot voice communication.

This is not the expected operational procedure and is a limitation of this simulation.

4.5 First ADS-C contract establishment

In an operational environment, the first EPP downlink is performed when the aircraft logs on, when the ADS-C contracts are established. This is at pilot discretion and usually performed a short time before the AOR entry.

In the simulation environment, the following process applies:

- ⇨ The SimK tries to logon as soon as the flight is created. If this logon is rejected (usually because the flight plan is not activated), the SimK tries to logon regularly so the ADS-C contracts will be established before assume in the environment of VP030 (when the flight is activated).

4.6 Fine tuning for the periodic RTA reliable interval

Depending on the number of aircraft and the period chosen by the AMAN to request RTA reliable interval, a SimK/4D predictor overload is possible. The period will have to be tuned during the integration phase to reach an acceptable load for the SimK.
This effect will be increased by the fact that an EPP request is performed by the AMAN after each RTA reliable interval request.

This is a simulation limitation.

4.7 Datalink Window messages on the ATCO display

The datalink window used at MUAC is part of the existing HMI and was not adapted to meet the needs of the exercise. This was an acceptable limitation given that the exchange of messages could still be followed as demonstrated in previous exercises conducted at MUAC under the P04.03 i4D exercises.

4.8 Route management outside of MUAC AOR

The SimK manages only one point outside of MUAC AOR (this should be the IAF in our scenarios).

There are some limitations in the possible cases of discrepancy in the lower area airspace, due to the simulation setup.

- ⇨ The only case of discrepancy in the lower airspace is if one point is inserted before the IAF.

This case should be avoided as much as possible since the IAF would not appear in the EPP anymore, making it impossible to request reliable intervals or uplink/change/cancel the RTA.

Appendix D MUAC HMI Description

The HMI changes are based on the changes used in other CTA+i4D exercises, which were performed before VP-030.

RTA field in the track label

Functionality description

The RTA to be set over the point is provided by the TMA simulated position via a simulated OLDI AMA message and is integrated into the controller's HMI. This information will be displayed in the track label but also in the EPP viewer.

In the track label, a field has been added to display the RTA (provided by the TMA or manually input by the controller) or the RTA accepted by the aircraft. This field is colour-coded to represent the possible states of this data:

State	Description	Label Field Example	Visible To
1	No RTA Request, No RTA in place.	No @ symbol 	All sectors and roles
2	RTA Request Received	Orange @ symbol 	All sectors and roles
3	RTA Uplinked	Light green @ symbol 	All sectors and roles

4	RTA uplinked, WILCO received, No EPP received	No @ symbol 	All sectors and roles
5	RTA uplinked, EPP received	Dark green @ symbol 	All sectors and roles
6	RTA rejected or cancelled	No @ symbol 	All sectors and roles

Figure 1: Label RTA Statuses

Notes:

- The representation is the same for both controllers of the same sector.
- When a WILCO is received for an RTA uplink, the green @ symbol is removed from display until the corresponding EPP is received. The ATCO has no information that there is an active RTA on the flight during this period. This is a simulation limitation, the final concept should maintain the RTA information in the track label.

EPP viewer

Functionality description

The EPP viewer enables the display of EPP-related information and can be used to uplink constraints to the aircraft.

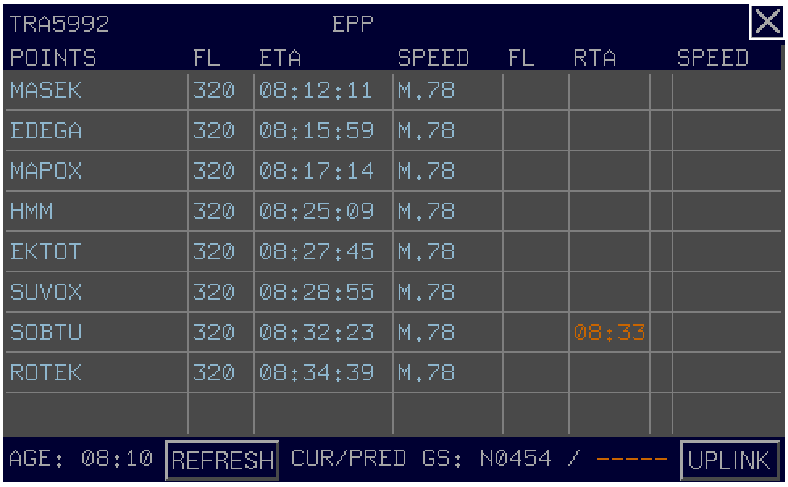


Figure 2: EPP viewer

The first four columns represent the data received in the last EPP (Airborne data). This information is also available in the FIM under the EPP tab. Without the menu bar

- A left click on a waypoint (in the “POINTS” column) enables to uplink a reliable RTA interval request for this point

The FL, RTA and speed columns are used by the ATCO to input constraints for the flight. These columns content is available to downstream sectors in a read-only mode.

At the bottom of the window, the following facilities can be found:

- The AGE field displays the time of sending of the EPP by the aircraft
- REFRESH is a button enabling to uplink an EPP request for 10 waypoints for this flight
- The CUR/PRED GS field displays the current ground speed of the aircraft and the predicted ground speed if the RTA were to be activated.
- UPLINK is a button enabling to uplink the constraints set in the EPP viewer

Notes:

- *This button is not available to downstream sectors*
- *The Speed constraint column cannot be used.*

The RTA field is colour-coded in a slightly different way than the RTA field in the track label to indicate the RTA status:

- RTA Request Received or RTA manual input: the RTA is displayed in orange

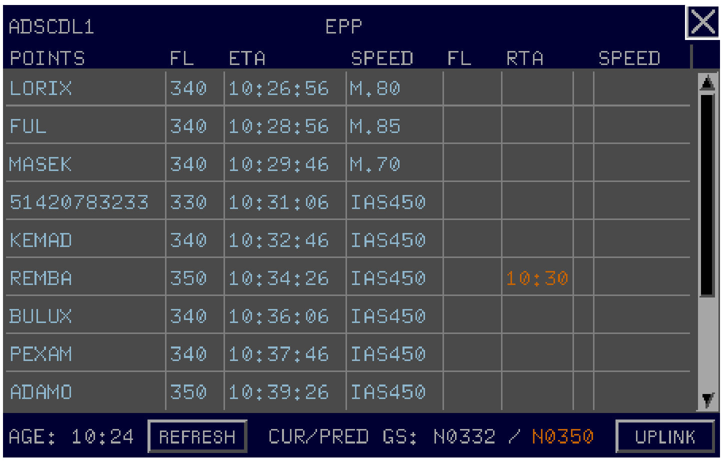
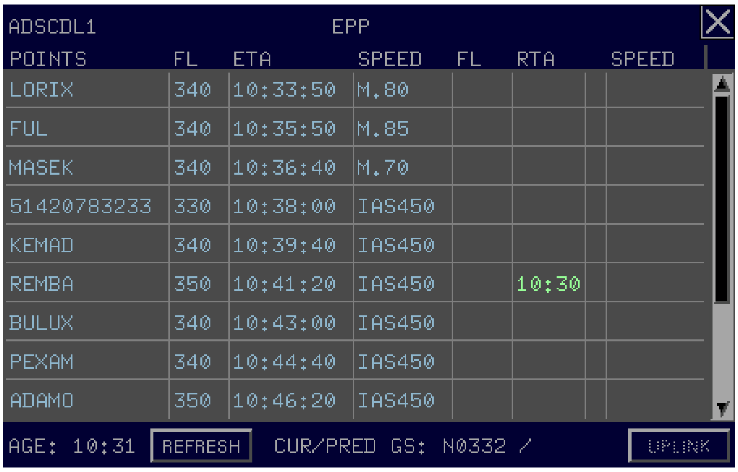


Figure 3: EPP viewer with RTA request received

- RTA uplinked: the RTA is displayed in light green



ADSCDL1 EPP

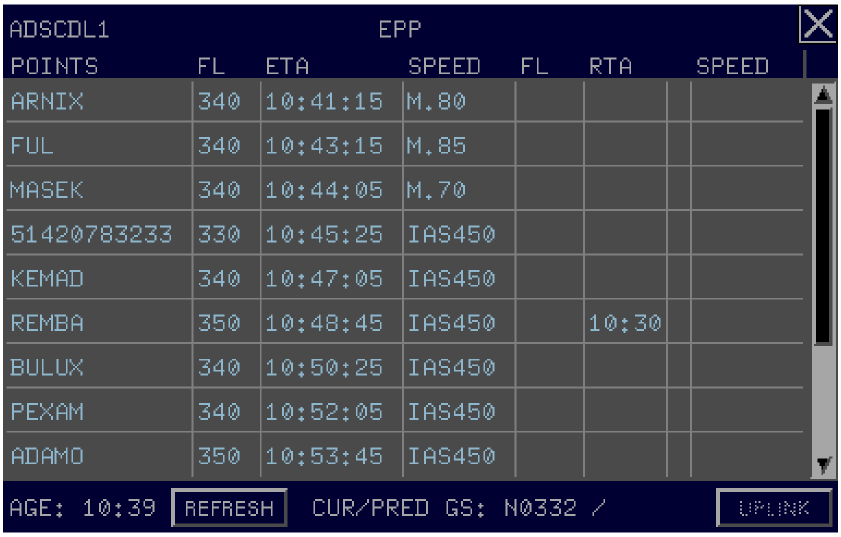
POINTS	FL	ETA	SPEED	FL	RTA	SPEED
LORIX	340	10:33:50	M.80			
FUL	340	10:35:50	M.85			
MASEK	340	10:36:40	M.70			
51420783233	330	10:38:00	IAS450			
KEMAD	340	10:39:40	IAS450			
REMBA	350	10:41:20	IAS450		10:30	
BULUX	340	10:43:00	IAS450			
PEXAM	340	10:44:40	IAS450			
ADAMO	350	10:46:20	IAS450			

AGE: 10:31 REFRESH CUR/PRED GS: N0332 / UPLINK

Figure 4: EPP viewer with RTA uplinked

WILCO received from the aircraft: the RTA is removed from the EPP viewer display

- An EPP including the RTA is received: the RTA is displayed in light blue



ADSCDL1 EPP

POINTS	FL	ETA	SPEED	FL	RTA	SPEED
ARNIX	340	10:41:15	M.80			
FUL	340	10:43:15	M.85			
MASEK	340	10:44:05	M.70			
51420783233	330	10:45:25	IAS450			
KEMAD	340	10:47:05	IAS450			
REMBA	350	10:48:45	IAS450		10:30	
BULUX	340	10:50:25	IAS450			
PEXAM	340	10:52:05	IAS450			
ADAMO	350	10:53:45	IAS450			

AGE: 10:39 REFRESH CUR/PRED GS: N0332 / UPLINK

Figure 5: EPP viewer with active RTA

Discrepancy indicator

Functionality description

The discrepancy indicator indicates to the controller if the airborne 2D-trajectory differs from the ground one:

This automatic detection of a discrepancy between the airborne and the ground route is not fully mature However, the system still enables to compare the EPP route to the ground route at the controller need and provides a warning in case of a difference. This can be used to check if the airborne route has been updated after a direct for instance.

- The discrepancy indicator appears in the following format:

Figure 6: Discrepancy indicator

Mouse over the diamond displays the airborne route in purple, along with ToC and ToD markers.

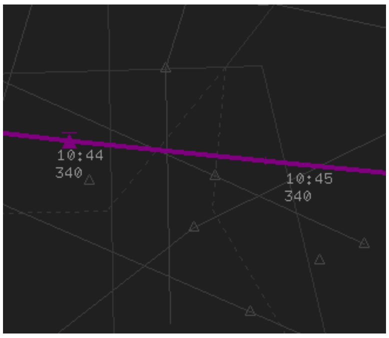


Figure 7: TOC

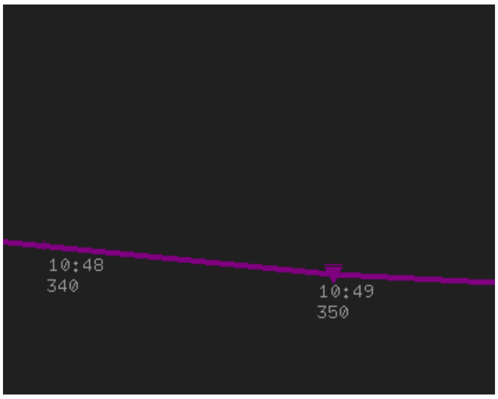


Figure 9: TOD

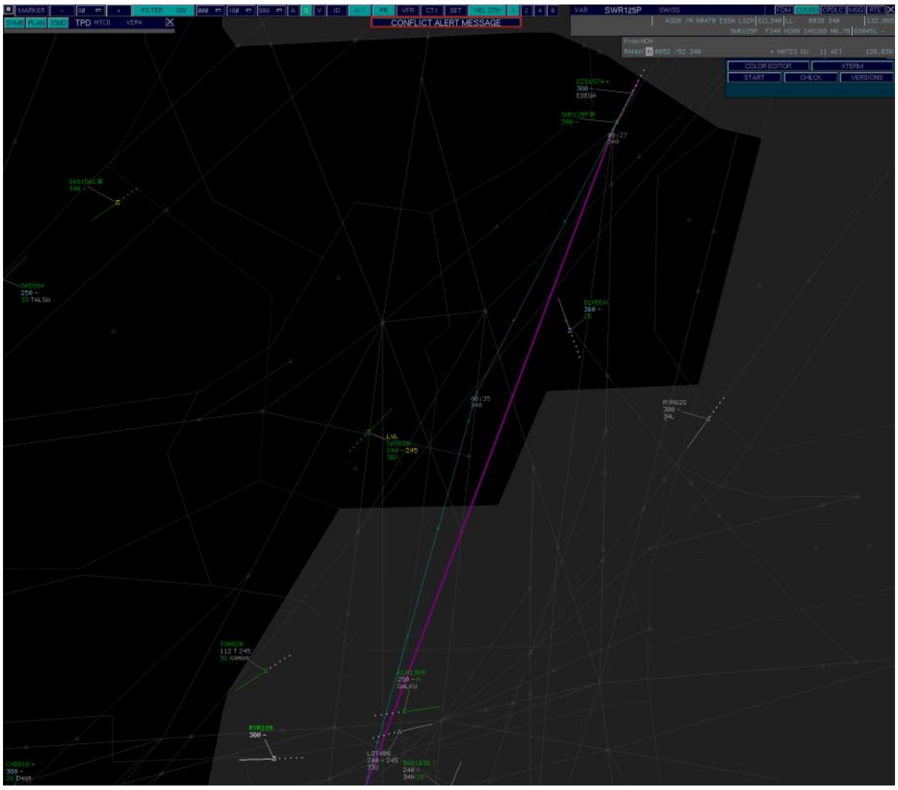


Figure 9: Route discrepancy

Menus

Route menus

The route is edited by selecting the SIGNIFICANT POINT (label line 3) and selecting either the sequence of points from the menu or graphically via the radar window.

The new route must always re-join the original route.

Once the route is completed select EXECUTE to enter it in to the FDP.

The controller will not be able to enter a new route and at the same time give constraints on points that are in this new route but are not in the current air route (EPP). During the simulation the controller will have to enter the new route and then wait for a new EPP before entering the constraints.

CALLSIGN menu ⇨ CPDLC REP ⇨ EP PROFILE ⇨ number of points ⇨ UPLINK

Figure 10: CPDLC REP menu

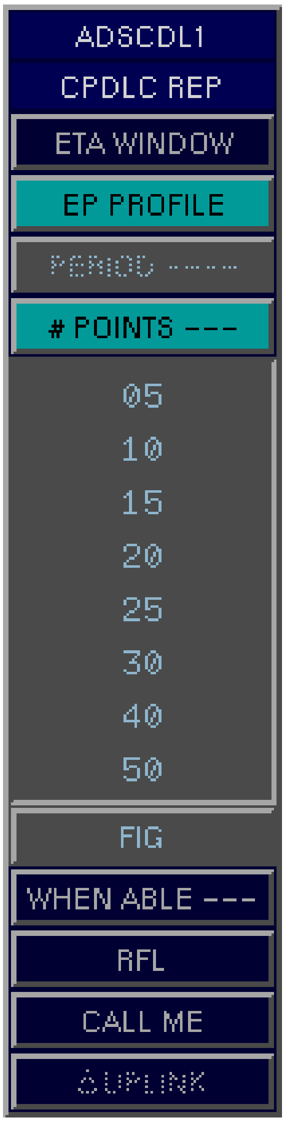


Figure 11: EP profile menu

The response is displayed in the EPP viewer.

Reliable RTA interval Request menu

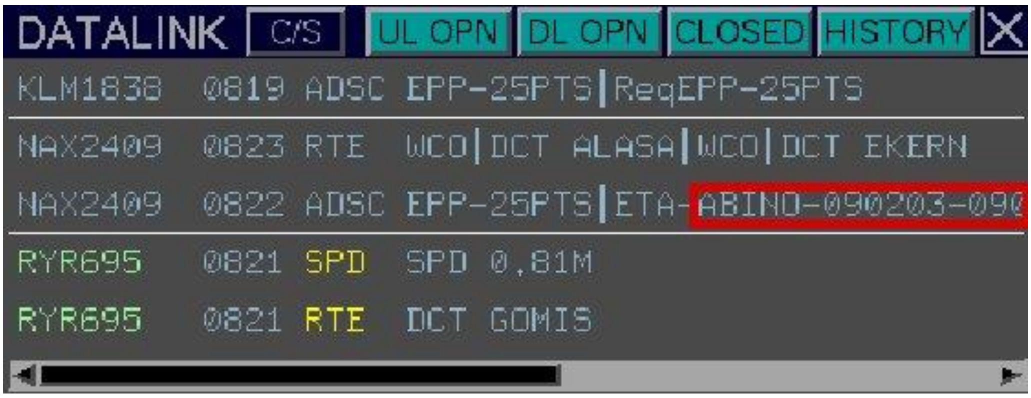
Left clicking on a waypoint in the EPP Viewer opens the menu to request a reliable RTA interval for that waypoint.

The menu can also be opened using the sequence:

CALLSIGN menu ⇨ CPDLC REP ⇨ ETA WINDOW

Figure 12: reliable RTA interval menu

The response is displayed in the datalink dialogue window and the FIM (scrolling may be necessary).



RTA menu

An RTA can be manually added to a point by using the EPP viewer window. Selecting the field to the right of the point under the RTA column opens the RTA menu, enter the time followed by "AT" enters the value locally in to the EPP viewer window – UPLINK can then be selected to send the time.

Similarly flight levels and speed changes can be entered in to the EPP viewer window.

Should changes need to be made, it is first needed to cancel the existing values.

Figure 13: manual RTA menu

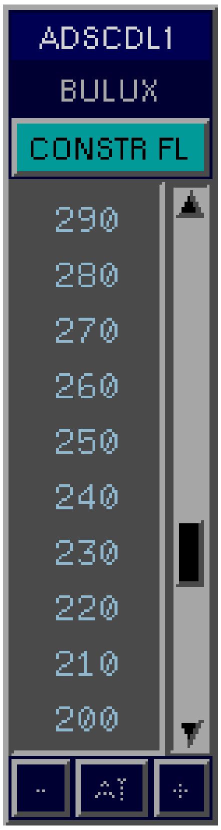


Figure 14: FL constraint menu

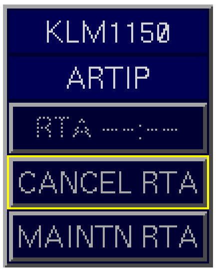


Figure 15: Cancel RTA menu

Datalink dialogue window

- ADS-C request for which an acknowledgement has been received will be displayed in the Datalink dialogue window even if the CLOSED messages are filtered.

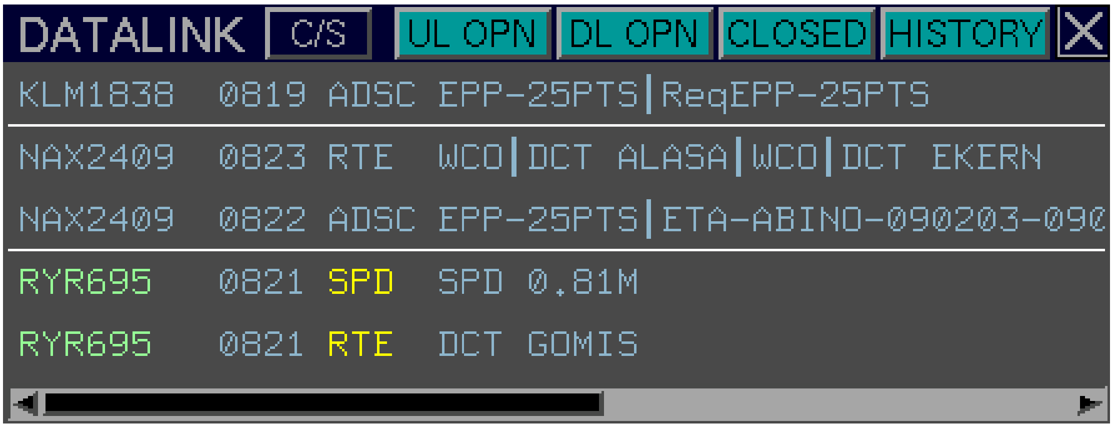


Figure 16: Datalink window: sorted by Call sign

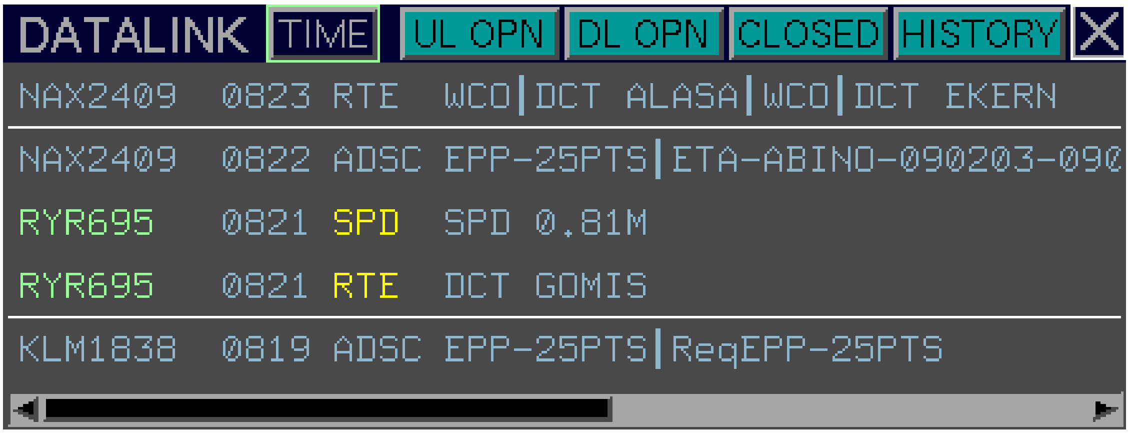


Figure 17: Datalink window: sorted by Time

Appendix E LVNL HMI Description

Short Introduction

The objective of this document is to present the HMI design to display AMAN information, with and without i4D information, integrated in the iCWP-IBP.

HMI Thinspec

iCWP Subsystem is already handling Basic AMAN information (not including IOP/i4D data). The following AMAN fields are necessary to be displayed in the iCWP to have the complete scene of the air traffic situation:

- Metering Fix information
  - Metering Fix (MFX)
  - Time Over Metering Fix (EAT) [hhmmss]
  - Speed Assigned to the Metering Fix (MFIXSPEED)
  - Time to Lose (TTL) / Time to Gain (TTG) [(+,-)mmss]
    - TTL if [mmss] is negative
    - TTG if [mmss] is positive
- Target Landing Time (TLDT) [hhmmss]
- AMAN Assigned Runway (RWYARR)
- Target Landing Time Status (TLDTSTAT) [UNP, PRE, PLN, MAN]
- Delta-T (difference between EAT and ETO to IAF, EAT – IAF_ETO) [(+,-)mmss]

Moreover, the iCWP Subsystem is also able to receive i4D information and, therefore, to present it to the user in several display objects explained in the following chapters.

All this information will be presented for all kind of iCWP users and flight plan status (access rights to the information is not restricted).

The proposed HMI objects where to display AMAN and i4D information are:

1. Track Data Label presentation:

At a first sight, iCWP user can check for AMAN and i4D information in the Track Data Label, where:

- A new field for EAT information is added to the label
- A new specific (configurable) symbol will indicate the existence of CTA information [@]
- A new specific (configurable) symbol will indicate the existence of EPP downlinked by the aircraft for that flight plan. [⇩]

The flights displaying EAT and CTA in the track data label are the ones in "FROZEN" status[2].

EAT information field will be coloured depending on the DELTA-T information:

- Display value in BLACK colour if DELTA-T is unknown
- Display value in GREEN colour if the absolute value of the DELTA-T field is less than 2 minutes

[2] "FROZEN" status corresponds with the PLN and MAN values of the Target Landing Time Status.

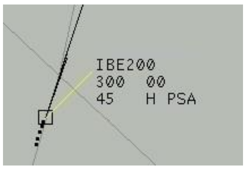
- Display value in BLUE colour if the absolute value of the DELTA-T field is bigger or equal to 2 minutes

CTA symbol [@] field will be coloured depending on the CTA status:

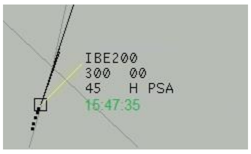
- @ for CTA Requested
- @ for CTA Rejected
- @ for CTA Cancelled
- @ for CTA Accepted

EPP symbol [⇩] field will be coloured depending on its 2D conformity with the ground trajectory (checked by MUAC):

- ⇩ when the EPP is in conformance with the MUAC ground trajectory
- ⇩ when the EPP is not in conformance with the MUAC ground trajectory



Picture 1: Track Data Label without i4D information and EAT



Picture 2: Track Data Label with EAT and without i4D information

Picture 3: Track Data Label with EAT and CTA, but without i4D information

Picture 4: Track Data Label with i4D information without EAT and CTA

Picture 5: Track Data Label with i4D information with EAT and CTA

1.1. <u>Interactions with Track Data Label:</u>

- Selecting the EPP symbol [⇩] with SC_IB the i4D-DFL will appear.

- Selecting the CTA symbol [@] with SC_AB a pop-up menu will display a “CANCEL CTA” button.

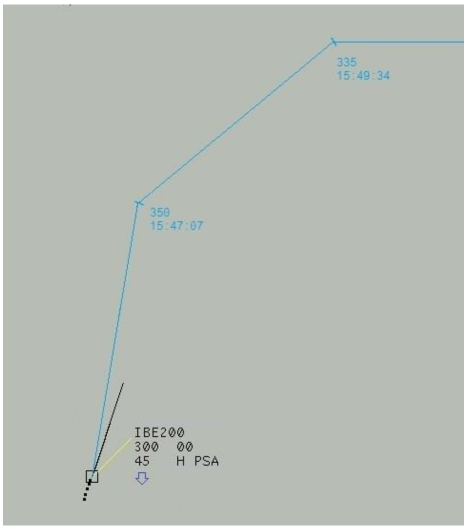
2. EPP (Extended Projected Profile) graphical presentation:

i4D-DFL visualization:

This object shows the EPP information in a graphical way, in order to allow to ATCO to compare it with the planned route simultaneously. i4D-DFL is displayed interacting with track data label EPP field [⇩].

This object displays the following information:

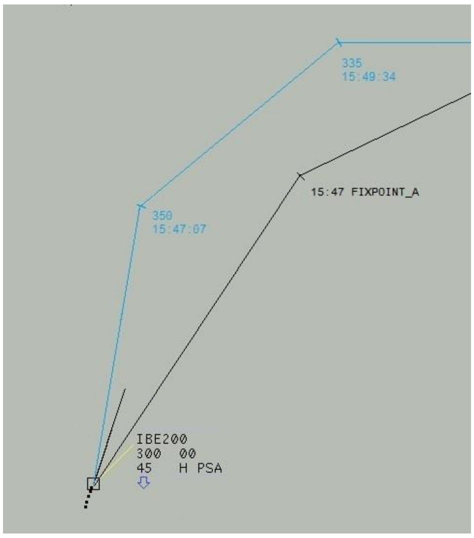
- Route segments of the flight plan in blue color
- FIXPOINT:
  - FLIGHT LEVEL
  - ETO



Picture 6: i4D-DFL object

Both DFL (display flight plan planned route) and i4D-DFL can coexist at the same time, being activated/hided from the respective objects:

- DFL -> SC_IB on the track symbol
- i4D-DFL -> SC_AB on the i4D symbol



Picture 7: DFL and i4D-DFL simultaneously displayed

3. **Arrival List Window:**

A new tabular window is used to present information related to the incoming traffic (all flights arriving in EHAM), showing all available information related to AMAN.

The flights displayed in the Arrival List Window are the ones in "FROZEN" status[3].

The flights will be removed from the Arrival List Window when the segment state transits to LEFT, or the flight state transits to TERMINATED.

The sorting criteria is the EAT, in ascending order (new flight on top of the list).

The colour coding for EAT and D-T (DELTA-T) is:

- Display value in BLACK colour if DELTA-T is unknown
- Display value in GREEN colour if the absolute value of the DELTA-T field is less than 2 minutes
  Display value in BLUE colour if the absolute value of the DELTA-T field is bigger or equal to 2 minutes

The colour coding for CTA is the same as for the CTA symbol [@] in the Track Data Label.

Callsign	METFIX	EAT	CTA	D-T	SPEED	TTL-TTG	RWY	TLDT	TLDT-STAT
IBE004	ARTIP	15:54:36	15:54:00	+02:10	145		36R	15:59:00	PLN
IBE012	SUGOL	15:50:00	15:50:00	- 00:10	121		36R	15:55:00	MAN
IBE001	RIVER	15:48:37			140	+00:00	36L	15:53:37	PLN
IBE007	SUGOL	15:47:34			140	- 00:30	36L	15:52:34	PLN
IBE045	ARTIP	15:47:07	15:45:00	+00:50	134		36R	15:52:07	PLN

Picture 8: Arrival List Window example

3.1. Interaction with Arrival List Window:

- Selecting the CTA value with SC_AB a pop-up menu will display a "CANCEL CTA" button.

[3] "FROZEN" status corresponds with the PLN and MAN values of the Target Landing Time Status.

4. “CANCEL CTA” action:

In order to be able to perform this action and enable the “CANCEL CTA” button, the following requirements have to be fulfilled (otherwise disabled):

- Flight must be Under-Control of the iCWP
- CTA must be in ACCEPTED or REQUESTED status

In order to perform a “CTA Cancelation” action, the ATCO has two options:

a. Over the CTA symbol [@] of the Track Data Label, selecting the CTA symbol with a SC_AB a pop-up menu will display a “CANCEL CTA” button. A SC_AB on the button will perform the command.

b. Over the CTA value of the Arrival List Window, selecting the CTA value with a SC_AB a pop-up menu will display a “CANCEL CTA” button. A SC_AB on the button will perform the command.

Callsign	METFIX	EAT	CTA	D-T	SPEED	TTL-TTG	RWY	TLDT	TLDT-STAT
IBE004	ARTIP	15:54:36	15:54:00	+02:10	145		36R	15:59:00	PLN
IBE012	SUGOL	15:50:00	15:50:00	- 00:10	121		36R	15:55:00	MAN
IBE001	RIVER	15:48:37	CANCEL CTA		140	+00:00	36L	15:53:37	PLN
IBE007	SUGOL	15:47:34			140	- 00:30	36L	15:52:34	PLN
IBE045	ARTIP	15:47:07	15:45:00	+00:50	134		36R	15:52:07	PLN

Picture 9: Arrival List Window with “CANCEL CTA” pop-up menu displayed for IBE012

Picture 10: “CANCEL CTA” action from Track Data Label

5. Acronyms:

SC_AB: Single Click Action Button – left mouse button click
SC_SB: Single Click Special Button – middle mouse button click
SC_IB: Single Click Information Button – right mouse button click

Appendix F VP-030 operational test cases

Some use cases has different options described in the column UC option.

Test case	UC id	UC description	UC option
1	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies fond
2	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	Discrepancies resolved by UA EC
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
3	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	Discrepancies resolved by pilot (FMS)
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
4	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA rejected by ATCO
5	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
6	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA not accepted by pilot
7	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found

	2.3	Change 4D trajectory outside freeze horizon (by UA controller)	
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
8	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.5	Cancel a CTA in Upper Area Airspace (by UA controller)	
9	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.5	Cancel a CTA in Upper Area Airspace (by LA controller)	
10	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.5	Cancel a CTA in Upper Area Airspace (Pilot)	
11	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.5	Cancel a CTA in Upper Area Airspace (by LA controller)	
12	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground	No discrepancies found

		trajectory	
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.6	Cancel a CTA in Lower Area Airspace (by pilot)	
13	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.7	Change 4D trajectory initiated by Upper Area ATCO within freeze horizon	
14	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.7	Change 4D trajectory initiated by Upper Area ATCO within freeze horizon	
	2.5	Cancel a CTA in Upper Area Airspace (Pilot)	
15	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.8	Change 4D trajectory by Lower Area ATCO within freeze horizon	
16	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot

	2.8	Change 4D trajectory by Lower Area ATCO within freeze horizon	
	2.6	Cancel a CTA in Lower Area Airspace (by pilot)	
17	2.1	Distribute EPP data via Flight Object	
	2.10	Resolve 2D discrepancies between EPP and Ground trajectory	No discrepancies found
	2.4	Freezing a flight	CTA accepted by ATCO
	2.4	Freezing a flight	CTA accepted by pilot
	2.9	Change EAT (by APP planner)	

Appendix G Flights used in scenario

Call sign	A/c type	Wake Turbulence Cat.
KLM856	A330-200	High
CSN345	A330-200	High
KLM88J	A330-200	High
KLM1762	A320	Medium
KLM28K	A320	Medium
BTI6RV	A320	Medium
KLM417	A330-200	High
KLM1764	A320	Medium
FIN4QA	A320	Medium
KLM1822	A320	Medium
KZR903	A320	Medium
KLM872	A330-200	High
KLM22T	A320	Medium

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