AFUA (FOC) Step1 Technical Specification

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Abstract

This document has been written to describe the technical requirements applicable to the FOC-related systems that have to be implemented to support validation exercise EXE07.05.04-VP-710.

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Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

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Executive summary

This document has been written to describe the technical requirements applicable to the FOC-related systems that have to be implemented to support validation exercise EXE07.05.04-VP-710.

Exercise VP-710 aims at demonstrating the feasibility of updating the real time airspace status automatically into the NM systems, delivering a closed CDM process between ASM support systems, NM systems, ATC systems and FOC systems. The main objective is to validate the expected benefits from the exchange of real time airspace availability information for the Military, ATC, NM and AO stakeholders.

When an airspace reservation is released prior relevant scheduled time of de-activation or when it is activated in addition to the planned schedules communicated by the latest available AUPs/UUPs, RTSA information sharing offers to the airspace users opportunities for managing concerned trajectories to the benefit of mission economics. The potential stemming from the new scenario is tactically assessed by the airspace users with due regard to the overall operational situation based on individual procedures and priorities in place at each FOC. The aim is to make informed decisions on the actual use of released airspace, or to adapt the flight trajectories to the new allocated airspace volumes in the most efficient way.

Potential trajectories are first assessed in terms of safety (change in fuel requirements compared to fuel on-board, check of terrain clearances and of other safety-relevant elements). Then, they are assessed with regard to the direct operating cost changes prompted by the new operational scenario.

FOC-related systems shall support FOC's decision-making capabilities by collecting and structuring required information. This in fact occurs by adapting the FOC systems to manage the RTSA-related information.

1 Introduction

1.1 Purpose of the document

This document has been written to describe the technical requirements applicable to the FOC-related system that has to be implemented to support the validation exercise EXE07.05.04-VP-710.

Exercise VP-710 aims at demonstrating the feasibility of updating the real time airspace status automatically into the NM systems, delivering a closed CDM process between ASM support systems, NM systems, ATC systems and FOC systems. The main objective is to validate the expected benefits from the exchange of real time airspace availability information for the Military, ATC, NM and AO stakeholders.

With regard to the functional blocks description provided by WP11.01 TS document [8], this document delivers further information in regards to the functional decomposition of the FOC system and of its functional blocks. However the descriptions made in the WP11.01 TS document [8] are still valid.

Further updates of this document might be required as a result of validation exercise EXE07.05.04-VP-710. Those updates will be planned for the next regular update of this document.

1.2 Intended readership

The intended audience is:

- SWP 7.2.
- P7.5 and subordinated projects.
- P7.6 and subordinated projects.
- P16.6.x.
- WP7 NM system projects (previously WP13).
- SESAR JU.
- Airspace users.
- WP11.1/ WOC.
- AMC.
- ANSPs.

1.3 Inputs from other projects

The following inputs have been considered while writing this system specification:

- WP11.01 Step 1 Use Cases and System Requirements for FOC system 00.00.21 [8].
- For a correct writing of all requirements, this document has also taken into account the guidelines provided by the SJU [1][2][3][5][6].

1.4 Structure of the document

The general content of each chapter is hereinafter briefly described:

- **Chapter 1:** It provides a general idea of the entire document. It includes the purpose, readership, inputs from other projects, requirements structure, component purpose and high level overview and acronyms used in the document.
- **Chapter 2:** It provides a general description of the proposed functional blocks.
- **Chapter 3:** It reports all the system requirements divided into sub sections to specify the system requirements and characteristics of the system that are conditions for its verification.
- **Chapter 4:** It compiles all the assumptions that have been considered all along the document.
- **Chapter 5:** This section lists the number, title, revision, and date of all documents referenced in this specification.

1.5 Requirements Definitions – General Guidance

The system requirements in this technical specification are produced to describe functional and non-functional requirements at system level in accordance with the Requirements and V&V Guidelines 03.00.00 [2].

The purpose of component specification is to transform the functional and non-functional operational requirements, safety recommendations and other requirements that have been identified through the operational requirements analysis from P11.01.02 into a coherent description of subsystem capabilities and conditions that can be used to guide the system designers while developing the system. This Specification will not include a High Level Design which is analysing the Use Case specification and requirements and creates a Service Oriented Architecture model that fits the need of the Use Cases. This is part of P11.01.04 and is not considered within this document.

All “REQ Trace” tables of the requirement have been completed with information from affected Functional blocks and Enablers as well as Operational Focus Areas.

Requirements are numbered according to the template available at Section 1.5 of the “Step 1 Use Cases and System Requirements for FOC system” document [8].

1.6 Functional block Purpose

Refer to [8], Section 1.6.

1.7 Functional block Overview

1.7.1 Schedule Management

Refer to [8], Section 1.7.1.

1.7.2 Flight Data Support Management

Refer to [8], Section 1.7.2.

1.7.3 Flight Planning

Refer to [8], Section 1.7.3.

1.7.4 Flight Operations Management

Refer to [8], Section 1.7.4.

1.7.5 Information and Communication Management

Refer to [8], Section 1.7.5.

1.8 Glossary of terms

Term	Description
Airspace Restriction	A defined volume of airspace within which, variously, activities dangerous to the flight of aircraft may be conducted at specified times (a "danger area"); or such airspace situated above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions (a restricted area); or airspace situated above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited (a prohibited area).
Airspace Use Plan	The Airspace Use Plan is an ASM message of NOTAM status notifying the daily decision of an Airspace Management Cell on the temporary allocation of the airspace within its jurisdiction for a specific time period, by means of a standard message format. (Source: ernip-part3-asm-handbook/ECTRL)
Extended Flight Plan (EFPL)	Calculated 4D trajectory of the flight as part of the filed flight plan
Flight Operation Centre (FOC)	Flight Operation Centre is a part (department, employee) of an Airspace User or a system used by an Airspace User providing FOC services and support like operational control, flight planning, pre-flight briefing, in-flight support and post-flight analyses in accordance to AU's Operational Manual and Standard Operational Procedures.
Notice to airmen (NOTAM)	Notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations

1.9 Acronyms and Terminology

Term	Definition
ACK	Acknowledgement message
ARES	Airspace Reservation/Restriction
ATCO	Air Traffic Controller
ATC	Air Traffic Control

Term	Definition
ATM	Air Traffic Management
AUP	Airspace Use Plan
CHG	FPL Change message
DOC	Direct Operating Cost
EFPL	Extended Flight Plan
IFPS	Initial Flight Plan Processing System
NM	Network Manager
NMOC	Network Manager Operations Centre
OFA	Operational Focus Areas
OI	Operational Improvement
OSED	Operational Service and Environment Definition
REJ	Reject message
RTS	Real time Simulation
RTSA	Real Time Status of Airspace
SESAR	Single European Sky ATM Research Programme
SUUP	Special UUP
TS	Technical Specification
UUP	Updated Airspace Use Plan

2 General Functional block Description

2.1 Context

The present document describes the trajectory management in the context of AFUA from the airspace users' perspective. Specifically, the specifications herein described address the management of trajectories as airspace status changes and relevant information (RTSA information) is shared among the ATM stakeholders' community.
It is here assumed that the airspace user makes use of a FOC to control its flight operations, either directly or via a contracted third party. In this context, presented specifications are defined irrespective of the individual FOC's decision-making procedures, priorities and set up, to ensure they can fit any single operational control environment.

Main tasks of the FOC within the RTSA-related trajectory management are:

- Generation of the trajectories and preparation of relevant Operational Flight Plan and Briefing Package.
- Monitoring of the releasing of real time airspace availability information by NM.
- Monitoring of the evolvement of the trajectory and of related operational constraints throughout all phases of a flight.
- Assessment of the effect of RTSA-induced deviations from previous planning in terms of safety and mission costs.
- Updating and supporting the flight crews during all phases of a flight.
- Coordination and communication with concerned ATM stakeholders outside the user's organization.

In SESAR Step 1 the direct contribution of the FOC in the trajectory management processes between all ATM stakeholders is almost limited to the planning phase. Regardless of the fact that FOC systems are already capable to support the flight crews during all phases of a flight, the connectivity to other ATM stakeholders is still limited, especially in the execution phase. As a consequence of the currently undergoing paradigm change in flight operations that leads to a higher focus on flight execution support, the need for a direct contribution of the FOC in the flight execution phase is rising. A more holistic trajectory management system supported by collaborative decision making procedures among all concerned ATM stakeholders is considered to be a key enabler in this regard. Effectively exchanging airspace availability information goes into this direction.

Despite within the SESAR Step 1 framework the actual execution of a modified trajectory by flight crews and ATCOs is out of scope, this document specifies the requirements to make a FOC, through its processes and systems, contribute to this collaborative effort and benefit out of it.

2.2 Functional block Modes and States

Not applicable to FOC.

2.3 Major Functional block Capabilities

2.3.1 Schedule Management

Refer to [8], Section 2.3.1.

2.3.2 Flight Data Support Management

Refer to [8], Section 2.3.2.

In the context of AFUA's RTSA information sharing, this functional block gathers the additional functionalities needed to support the airspace user in:

- Identifying the trajectories concerned with an early release or with an unscheduled booking of any airspace.
- Detecting relevant flight attributes to enable FOC decision-making (i.e. supporting the <FB> Flight Operations Management).
- Facilitating the activities performed within the <FB> Information and Communication Management and the <FB> Flight Planning in the context of the overall RTSA information sharing process.

2.3.3 Flight Planning

Refer to [8], Section 2.3.3.

2.3.4 Flight Operations Management

Refer to [8], Section 2.3.2.

When an airspace reservation is released prior relevant scheduled time of de-activation or when it is activated in addition to the planned schedules communicated by the latest available AUPs/UUPs, RTSA information sharing offers opportunities for managing concerned trajectories to the benefit of mission economics. The potential stemming from the new scenario is tactically assessed by the airspace users with due regard to the overall operational situation based on individual procedures and priorities in place at each FOC. The aim is to make informed decisions on the actual use of released airspace, or to adapt the flight trajectories to the new allocated airspace volumes in the most efficient way. This typically occurs within the domain of the <FB> Flight Operations Management.

Potential trajectories are first assessed in terms of safety (change in fuel requirements compared to fuel on-board, check of terrain clearances and of other safety-relevant elements). Then, they are assessed with regard to the overall impact on AO's operations (mainly in terms of direct operating cost changes prompted by the new operational scenario and individual operational priorities).

FOC systems shall support FOC's decision-making capabilities by collecting and structuring required information. This occurs by adapting the FOC systems to manage the RTSA-related information. However, since decision-making set ups of each individual FOC broadly differ within the airspace users' community (e.g. some rely more on automation than others while making decisions), this document does not address any system requirement in the <FB> Flight Operations Management domain. As a consequence, although the use cases presented in this document mention that the individual AO assesses the new scenario (safety-wise and operations-wise) such steps are not reflected as system's requirements in Section 3.

2.3.5 Information and Communication Management

Refer to [8], Section 2.3.5.

In the context of AFUA's RTSA information sharing, this functional block gathers the additional capability to handle the RTSA-related information (SUUPs and RTSA UUPs) and to exchange

amended trajectories with concerned ATM stakeholders. To the purpose, in addition to managing usual communication channels (AFTN, SITA Ground/Ground and Air/Ground communication), this functional block includes the web based B2B services as provided by NM since some years.

2.4 User Characteristics

Refer to [8], Section 2.4.

2.5 Operational Scenarios

This chapter describes main FOC scenarios related to trajectory management in the context of AFUA's related RTSA information sharing. It focuses on the content of the validation exercise EXE07.05.04-VP-710-AFUA Step1.

The idea behind is to perform the communication with all other ATM stakeholders using the <FB> Information and Communication Management. Airspace information will be received using functions within this <FB>. Within the <FB> Flight Data Support Management the incoming information will be transformed into data that can be used for the trajectory generation. Then, trajectories are generated by the <FB> Flight Planning. Generated trajectories will form the setting of reference for the feasibility assessment (safety and direct operating costs) performed by the individual user's FOC to appreciate whether a released airspace can be actually used or to evaluate how to minimize the impact on mission cost prompted by a last-minute airspace booking. Trajectories will be afterwards returned (via <FB> Information and Communication Management) to the NM and distributed to all concerned stakeholders.

2.5.1 Scenario 1 – Early Release of an Activated ARES

2.5.1.1 General Description of the Scenario

Starting point of this scenario is the sharing of RTSA information among the ATM stakeholders' community at local and network level via a B2B connection. RTSA message in the form of a SUUP conveys information on the changing status of an airspace (activated, de-activated, modified) on a tactical level, to update concerned ATM stakeholders of any modification with regard to what has been previously communicated via relevant AUPs/UUPs. It may include information on a single ARES, on part of it or on a set of changes related to several airspace reservations.

When an ARES is released prior relevant scheduled time of de-activation, RTSA information sharing offers opportunities for improving concerned trajectories to the benefit of mission economics. The potential stemming from the new scenario is tactically assessed by the airspace users with due regard to the overall operational situation based on individual procedures and priorities in place at each FOC. The aim is to make informed decisions on the actual use of released airspace.

Regardless of the individual FOC's decision-making set up, the performing of the assessment encompasses the ability to receive the RTSA information, to process it, to recognize the flights impacted and to re-calculate relevant trajectories. The baseline is the previously planned operational scenario for each flight.

Upon reception and storing of the RTSA information (i.e. the FOC checks the real time status of a planned ARES to identify de-activations), flights possibly concerned are recognized, be them off-blocks (including airborne aircraft) or still at the departure gate. Then respective trajectories are re-calculated according to the new airspace status. Since weather is a principal determinant of proper flight planning, the actual weather data are used for trajectory generation.

Generated trajectories are first assessed in terms of safety (change in fuel requirements compared to fuel on-board, check of terrain clearances and of other safety-relevant elements). Then, the new

trajectories are assessed to check whether they are beneficial to concerned AO's operations (in terms of direct operating cost changes prompted by the new operational scenario and individual operational priorities).

Here, major determinants of the decision-making are fuel cost and flight time cost. The calculation of fuel cost is a relatively simple concept, and its implementation in the assessment straightforwardly follows the amount of trip fuel as re-calculated (the lower the trip fuel – that is, the lower the air distance – the lower the fuel cost). The same might not be true for flight time-related cost. In general, flight time reductions are associated to lower time-related DOCs. However shortcuts (evaluated in terms of air distance) influence previously calculated time profiles (in terms of TTAs/TTOs) and might even lead to additional operating costs (e.g. holding at destination). Therefore, FOC's proper assessment of the new operational scenario is a major pre-requisite for deciding whether to actually make use or not of the released ARES. It is worth emphasizing that such an assessment is enabled by the data processing capabilities of relevant FOC systems but might require officers' evaluation and decision-making (depending on the individual FOC set up and procedures).

In case of positive results (i.e. when the airline positively values the offered opportunities) the AO informs involved ATM stakeholders with the trajectories to be amended by actually filing updated flight plans (CHGs) to be validated by IFPS. Upon reception of relevant acknowledgment, the airline sends the updated package to involved crews, with due regard to the flight phase the aircraft is in. This ends the scenario from a FOC perspective. In case of a flight plan rejection, the airline adjusts the concerned trajectory and re-files relevant EFPL for validation by IFPS. Upon reception of relevant acknowledgment, the airline sends the updated package to involved crews, with due regard to the flight phase.

2.5.1.2 Use Case Description

Scope

This Use Case describes the process of handling an early release of an activated ARES. The release can be either related to all modules of the ARES or can be also limited to de-activation of single modules.

Level

This System Use Case is at a sub-function level enabling the FOC system to provide trajectories to other ATM stakeholders that are matching the business needs of the user itself, including related safety requirements.

Summary

The Use Case starts as soon as a SUUP conveying the information of an early release of an ARES (or of part of it or of more than one ARES) is recognized by an airspace user. This occurrence triggers a scenario assessment on the new operational setting at the users' level.

As the SUUP data are stored in the relevant FOC system, the collected information is used to update the Operational Scenario of each flight whose previously filed trajectory could be considered for updates. Flights possibly concerned are recognized and listed. Each listed flight is associated to following operational attributes:

- Flight number.
- Phase of flight (already off-blocks or still at the gate).
- Final fuel (aircraft at the gate) or fuel on-board (aircraft off-blocks).

- Time to released ARES (aircraft off-blocks).
- Availability of any datalink.

Then, relevant trajectories are re-calculated according to the new airspace status. Since weather is a principal determinant of proper flight planning, the actual weather data are used for trajectory generation.

Generated trajectories are first assessed in terms of safety. Following items are considered:

- Trip fuel.
- Final fuel or fuel on-board.
- Obstacle clearance altitudes with regard to possible engine failures.
- Oxygen diversion routes in case of decompression.
- NOTAMs.
- Non-scheduled weather messages (e.g. SIGMETs).
- Airline-specific safety items.

As safety criteria are fully met, the new trajectories are assessed to check whether they actually benefit the operations of the involved AO (mainly with regard to the direct operating cost changes prompted by the new operational scenario and individual operational priorities). Following items are considered:

- Trip fuel.
- Flight time.
- ATS charges
- TTAs/TTOs.
- AO-specific operational priorities.

As the AO positively values the offered opportunities, it informs involved ATM stakeholders with the trajectories to be amended by actually filing updated flight plans (CHGs) to be validated by IFPS. As relevant ACK is received, the airline sends the updated package to involved crews with due regard to the flight phase (aircraft off-blocks or still at the gate), to inform the pilots about the new operational scenario and enable Captain's decision-making[1]. The Use Case finishes when the involved crews have accepted the proposal. In case of a refusal, the FOC shall amend the operational environment accordingly (back to originally accepted plan). Updated information is sent to all airborne crews that have still time to make their own assessment of the proposal for final decision. Therefore, the FOC shall identify the flights that are too close to the released airspace to have the time for assessing the information. In this case the actual usage of the airspace is left to the decisions directly taken by the crew in touch with the ATCO.

[1] In most regulatory environments – specifically, in all European regulatory environments – the authority for operational control is delegated to the Captain. This means that any change to the intended trajectory must be assessed and approved by the Captain of the flight concerned.

In case of a refusal of proposed trajectory by IFPS (REJ), the airline adjusts the concerned trajectory and re-files relevant EFPL for validation by IFPS. Upon reception of relevant ACK, the airline sends the updated package to involved crews, with due regard to the flight phase for Captain's decision-making.

Actors

Direct actors:

- Flight Dispatcher; Inflight Monitor Officer, Flight Crew

Indirect actors:

- NMOC, IFPS systems, ATC systems, ATCO.

Preconditions

- A flight plan as already been filed and the RBT is already available and distributed between all ATM stakeholders.
- An ARES is de-activated.

Post conditions

The FOC has proposed a new trajectory to NM that has been accepted as the new RBT.

Success end state

The trajectory has been adapted, submitted to NMOC, accepted and distributed.

Failed end state

The ad hoc de-activated or cancelled ARES is not used.

Notes

N/A

Trigger

The Use Case starts as soon as a RTSA message conveying the information of an early release of an ARES (or of part of it or of more than one ARES) is recognized by an airspace user.

Main Flow

1. The FOC receives a RTSA information and stores it.
2. The FOC identifies impacted flights and displays them together with relevant operational attributes.
3. The FOC generates an amended trajectory consistent with available RTSA information.
4. The FOC assesses the new trajectory against safety items.
5. The FOC assesses if the new trajectory is beneficial (in terms of mission costs and airline-specific operational requirements).

6. The trajectory exchange process is initiated (refer to [8], section 3.3.2).
7. The FOC receives the ACK from the IFPS.
8. The FOC distributes the amended trajectory to the concerned crew.
9. The Captain accepts the amended trajectory.
10. The scenario is deactivated.

Alternative Flow 1 (from point 10 of Main Flow)

11. The Captain refuses the amended trajectory.
12. The FOC re-stores previously filed trajectory.
13. The trajectory exchange process is initiated (refer to [8], section 3.3.2)..
14. The FOC receives the ACK from the IFPS.
15. The FOC distributes the amended trajectory to the concerned crew.
16. The scenario is deactivated.

Alternative Flow 2 (from point 8 of Main Flow)

9. The FOC receives a REJ from the IFPS.
10. The FOC generates an amended trajectory.
11. The FOC assesses the new trajectory against safety items.
12. The FOC assesses if the new trajectory is beneficial (in terms of mission costs and airline-specific operational requirements).
13. The trajectory exchange process is initiated (refer to [8], section 3.3.2).The FOC receives the ACK from the IFPS.
14. The FOC distributes the amended trajectory to the concerned crew.
15. The Captain accepts the amended trajectory.
16. The scenario is deactivated.

Failure Flows (from point 5 of Main Flow)

6. The FOC assessment is negative (trajectories are not amended).
7. The scenario is deactivated.

2.5.2 Scenario 2 – Unplanned Activation of Airspace Volumes

2.5.2.1 General Description of the Scenario

Starting point of this scenario is the sharing of RTSA information among the ATM stakeholders' community at local and network level via a B2B connection.

When an ARES is activated in addition to the planned schedules communicated by the latest available AUPs/UUPs, RTSA information sharing offers the airspace users the opportunity to limit the impact on involved trajectories to the benefit of mission economics. As a matter of fact, the airlines' goal is to adapt the flight trajectories to the new allocated airspace volumes in the most efficient way, considering flight safety and the impact on mission costs. The new scenario – that includes re-route proposals from NM – is tactically assessed with due regard to the overall operational situation, based on individual procedures and priorities in place at each airline's FOC. The aim is to make informed decisions on how to re-route concerned traffic.

Regardless of the individual FOC's decision-making procedures and priorities, the performing of the tactical assessment encompasses the ability to receive the RTSA information and related re-route proposals, to process them, to recognize the flights impacted and to re-calculate relevant trajectories. The baseline is the previously planned operational scenario for each flight, assumed to be the best possible outcome at the time of initial planning (i.e. – trajectory-wise – the trajectory generated considering the constraints known at the time of planning, including latest AUPs/UUPs).

Upon reception and storing of the RTSA information (i.e. the FOC checks the real time status of a planned ARES to identify new activations) and of re-route proposals, the flights concerned are recognized, be them already off-blocks (including airborne) or still at the departure gate. Then, respective trajectories are re-calculated according to the new airspace status. Since weather is a principal determinant of proper flight planning, the actual weather data are used for trajectory generation.

Generated trajectories are first assessed in terms of safety (change in fuel requirements compared to fuel on-board, check of terrain clearances and of other safety-relevant items). Then, the new trajectories are assessed with regard to the direct operating cost changes prompted by the new operational scenario.

Here, major determinants of the decision-making are additional fuel cost and additional flight time cost. The calculation of additional fuel cost is a relatively simple concept, and its implementation in the assessment straightforwardly follows the amount of trip fuel as re-calculated (the higher the trip fuel – that is, the higher the air distance – the higher the fuel cost). The same is true for time-related cost items associated to the additional flight-time. Additional flight time is associated to higher time-related DOCs. Furthermore, longer routes (evaluated in terms of air distance) influence previously calculated time profiles (in terms of TTAs/TTOs) and might even lead to additional operating costs (e.g. holding at destination). Therefore, FOC's proper assessment of the new operational scenario is a major pre-requisite for deciding how to react to unforeseen ARES activations. It is worth emphasizing that such an assessment is enabled by the data processing capabilities of relevant FOC systems but might require officers' evaluation and decision-making.

The outcome (regardless it sticks to proposed re-routes or not) is shared with NM by actually filing updated trajectories to be validated by IFPS. Upon reception of relevant acknowledgment, the airline sends the updated package to involved crews, with due regard to the flight phase the aircraft is in. This ends the scenario from a FOC perspective. In case of a flight plan rejection, the airline adjusts the concerned trajectory and re-files relevant flight plan for validation by IFPS. Upon reception of relevant acknowledgment, the airline sends the updated package to involved crews, with due regard to the flight phase.

2.5.2.2 Use Case Description

Scope

This use case describes the process of reacting to new information about an unplanned activation of additional airspace volumes from a civil airspace user perspective.

Level

This System Use Case is at a sub-function level enabling the FOC system to provide trajectories to other ATM stakeholders that are matching the business needs of the user itself, including related safety requirements.

Summary

The Use Case starts as soon as a SUUP conveying the information of the activation of an additional ARES (or of part of it or of more than one ARES) is recognized by an airspace user. This occurrence triggers a scenario assessment on the new operational setting at the users' level.

As the SUUP message is stored in the relevant FOC system, the collected information is used to update the operational scenario of each impacted flight. Flights concerned are recognized and listed. Each listed flight is associated to following operational attributes:

- Flight number.
- Phase of flight (already off-blocks or still at the gate).
- Final fuel (aircraft at the gate) or fuel on-board (aircraft off-blocks).
- Time to newly activated ARES (aircraft off-blocks).
- Availability of any datalink.

Then, relevant trajectories are re-calculated according to the new airspace status. Since weather is a principal determinant of proper flight planning, the actual weather data are used for trajectory generation. The optimizer of the FOC system proofs all segments in a defined area between departure and destination and calculates the amended trajectory considering minimum costs requirements. Since the optimum trajectory would lead through the airspace volumes as allocated to the airspace requestor and which is planned to be active during planned flight time, the optimizer chooses a trajectory which leads around the previously planned area.

Generated trajectories are first assessed in terms of safety. Following items are considered:

- Fuel required by the new trajectory.
- Final fuel or fuel on-board.
- Obstacle clearance altitudes with regard to possible engine failures.
- Oxygen diversion routes in case of decompression.
- NOTAMs.
- Non-scheduled weather messages (e.g. SIGMETs).
- Airline-specific safety items.

As safety criteria are fully met, the new trajectories are assessed with regard to the direct operating cost changes prompted by the new operational scenario. Following items are considered:

- Trip fuel.
- Flight time.
- ATS charges
- TTAs/TTOs.
- AO-specific operational priorities.

As the AO positively values the re-calculated trajectories, updated trajectories are forwarded to IFPS for validation (CHGs).

Upon reception of relevant ACK the airline sends the updated package to involved crews with due regard to the flight phase (aircraft off-blocks or still at the gate), to inform the pilots about the new operational scenario and enable Captain's decision-making[2]. The Use Case finishes when the involved crews have accepted the proposal. In case of a refusal, the FOC shall amend the operational environment accordingly. Updated information is sent to all airborne crews that have still time to make their own assessment of the proposal for final decision. Therefore, the FOC shall identify the flights that are too close to the released airspace to have the time for assessing the information. In this case the actual usage of the airspace is left to the decisions directly taken by the crew in touch with the ATCO.

In case of a refusal of proposed trajectory by IFPS (REJ), the airline adjusts the concerned trajectory and re-files relevant EFPL for validation by IFPS. Upon reception of relevant ACK, the airline sends the updated package to involved crews, with due regard to the flight phase for Captain's decision-making.

Actors

Direct actors:

- Flight Dispatcher; In-flight Monitor Officer, Flight Crew

Indirect actors:

- NMOC, IFPS systems, ATC systems, ATCO.

Preconditions

- A flight plan as already been filed/ and the RBT is already available and distributed between all ATM stakeholders.
- An additional ARES is activated.

Post conditions

The FOC has proposed a new trajectory to NM that has been accepted as the new RBT.

Success end state

[2] See note 1 above.

The trajectory has been adapted, submitted to NMOC, accepted and distributed.

Failed end state

The trajectory has not been adapted and submitted to NMOC.

Notes

N/A

Trigger

The Use Case starts as soon as a SUUP conveying the information of the activation of an additional ARES (or of part of it or of more than one ARES) is recognized by an airspace user.

Main Flow

1. The FOC receives the RTSA information and stores it.
2. The FOC receives re-route proposals from NM.
3. The FOC identifies impacted flights and displays them together with relevant operational attributes.
4. The FOC assesses re-route proposals on minimum cost requirements.
5. The FOC generates an amended trajectory on minimum cost requirements.
6. The FOC assesses the new trajectory against safety items.
7. The trajectory exchange process is initiated (refer to [8], section 3.3.2).
8. The FOC receives the ACK from the IFPS.
9. The FOC distributes the amended trajectory to the concerned crew.
10. The Captain accepts the amended trajectory.
11. The scenario is deactivated.

Alternative Flow 1 (from point 9 of Main Flow)

10. The Captain refuses the amended trajectory.
11. The FOC re-calculates and assess the trajectory according to the information exchanged with the Captain.
12. The trajectory exchange process is initiated (refer to [8], section 3.3.2).
13. The FOC receives the ACK from the IFPS.
14. The FOC distributes the amended trajectory to the concerned crew.
15. The scenario is deactivated.

Alternative Flow 2 (from point 8 of Main Flow)

9. The FOC receives a REJ from the IFPS.
10. The FOC generates an amended trajectory.
11. The FOC assesses the new trajectory against safety items.
12. The FOC assesses the new trajectory in terms of impact on mission costs.
13. The trajectory exchange process is initiated (refer to [8], section 3.3.2).
14. The FOC receives the ACK from the IFPS.
15. The FOC distributes the amended trajectory to the concerned crew.
16. The Captain accepts the amended trajectory.
17. The scenario is deactivated.

Failure Flows (from point 2 of Main Flow)

3. The FOC is unable to amend and communicate to the crew the trajectory.
4. The RBT is changed tactically between the ATCO and the crew.
5. The scenario is de-activated.

2.6 Functional

2.6.1 Functional decomposition

Refer to [8], Section 2.6.1.

2.6.2 Functional analysis

Refer to [8], Section 2.6.2.

2.7 Service View

N/A

3 Functional block Functional and non-Functional Requirements

This Section only addresses the technical requirements that have to be implemented to support validation exercise EXE07.05.04-VP-710 in addition to the technical requirements already identified in the "Step 1 Use Cases and System Requirements for FOC system" document [8].

3.1 Capabilities

3.1.1 Schedule management

Not applicable.

3.1.2 Flight Data Support Management

[REQ]

Identifier	REQ-11.01.03-TS-0225.0005
Requirement	The FOC system shall link received RTSA information (SUUP and RTSA UUP) with flights whose trajectories are affected by the RTSA information.
Title	Flight Identification.
Status	<In Progress>
Rationale	SUUPs /RTSA UUPs inform about the changing status of airspaces (release or booking) that may have been previously planned for usage by a certain amount of trajectories in the time interval of interest. The identification of concerned trajectories and of related flight numbers is crucial for creating the list of flights to be re-calculated within the <FB> Flight Planning, and – therefore – to trigger the individual AO's safety and impact assessment.
Category	<Functional>
Validation Method	<Real Time Simulation>
Verification Method	<Test>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Func ional block>	Flight Data Support Management	N/A
<APPLIES_TO>	<Operational Focus Area>	ENB03.01.01 TMF	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0070	<Par ial>

[REQ]

Identifier	REQ-11.01.03-TS-0225.0010
Requirement	The FOC system shall display all flights linked to the RTSA information (SUUP and RTSA UUP) with relevant operational attributes.
Title	Flight Listing
Status	<In Progress>
Rationale	Based on the outcome of the flight identification step, the FOC system shall list all flights linked to SUUPs/RTSA UUPs with relevant operational attributes (flight number, phase of flight, final fuel/fuel on-board, time to released ARES, availability of any datalink). Individual trajectories will be then re-calculated within the <FB> Flight Planning.
Category	<Functional>
Validation Method	<Real Time Simulation>
Verification Method	<Test>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance

<ALLOCATED_TO>	<Func ional block>	Flight Data Support Management	N/A
<APPLIES_TO>	<Operational Focus Area>	ENB03.01.01 TMF	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0070	<Par ial>

[REQ]

Identifier	REQ-11.01.03-TS-0225.0015
Requirement	The FOC system shall identify all flights linked to the SUUP/RTSA UUP that are too close to the released airspace based on individual airspace user's parameters and highlight them.
Title	Flight Listing/2
Status	<In Progress>
Rationale	The FOC system shall identify and highlight all flights linked to SUUPs/RTSA UUPs that are too closed to the released airspaces in a way the airspace user can decide whether to re-calculate relevant trajectories within the <FB> Flight Planning or skip this step.
Category	<Functional>
Validation Method	<Real Time Simulation>
Verification Method	<Test>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Func ional block>	Flight Data Support Management	N/A
<APPLIES_TO>	<Operational Focus Area>	ENB03.01.01 TMF	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0070	<Par ial>

3.1.3 Flight Planning

[REQ]

Identifier	REQ-11.01.03-TS-0305.0035
Requirement	The FOC system shall re-calculate - consistently with the information brought about by the RTSA information - the trajectory of all flights that have been identified as affected by the RTSA information itself.
Title	Trajectory Re-calculation.
Status	<In Progress>
Rationale	To assess the impact of an airspace release or booking, concerned trajectories shall be re-calculated to collect the information required by the FOC to make decisions. For flights too close to the released airspace (according to the parameters set by the individual airspace user) the trajectory revision might not apply. Therefore such condition must be recognized to avoid unintended workload on AU side.
Category	<Functional>
Validation Method	<Real Time Simulation>
Verification Method	<Test>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Func ional block>	Flight Planning	N/A
<APPLIES_TO>	<Operational Focus Area>	ENB03.01.01 TMF	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0040	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0045	<Full>

3.1.4 Flight Operations Management

Not applicable. See Paragraph 2.3.4 above.

3.1.5 Information and Communication Management

[REQ]

Identifier	REQ-11.01.03-TS-0505.0010
Requirement	The FOC system shall receive the RTSA information (SUUP/RTSA UUP) sent by the NM system, validate and store it.
Title	SUUP/RTSA UUP Reception
Status	<In Progress>
Rationale	Getting SUUPs and RTSA UUPs (i.e. checking whether an ARES has been released or booked)) is the main trigger for the whole RTSA-related process of each individual FOC.
Category	<Functional>
Validation Method	<Real Time Simulation>
Verification Method	<Test>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<Enabler>	AOC-ATM-13	<Full>
<SATISFIES>	<Enabler>	SWIM.INFR-05a	<Full>
<ALLOCATED_TO>	<Func ional block>	Information and Communication Management	N/A
<APPLIES_TO>	<Operational Focus Area>	OFA 05.03 01	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-INTEROP-D001 0003	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-INTEROP-D001 0003	<Full>

3.2 Adaptability

3.2.1 Schedule Management

Not applicable.

3.2.2 Flight Data Support Management

Not applicable.

3.2.3 Flight Planning

Not applicable.

3.2.4 Flight Operations Management

Not applicable.

3.2.5 Information and Communication Management

Not applicable.

3.3 Performance Characteristics

3.3.1 Schedule Management

Not applicable.

3.3.2 Flight Data Support Management

[REQ]

Identifier	REQ-11.01.03-TS-0225.0020
Requirement	The FOC system shall initiate the RTSA impact assessment process in the shortest time possible
Title	Performance of RTSA Information Processing.
Status	<In Progress>
Rationale	As the time window especially for the in-flight trajectory revision is very short, the reaction time for the generation of a new trajectory must be as short as possible.
Category	<Performance>
Validation Method	<Real Time Simulation>
Verification Method	<Analysis>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Func ional block>	Flight Data Support Management	N/A
<APPLIES_TO>	<Operational Focus Area>	ENB03.01.01 TMF	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-SPR-D001.0001	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-SPR-D001.0004	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-SPR-D001.0005	<Full>

3.3.3 Flight Planning

[REQ]

Identifier	REQ-11.01.03-TS-0305.0040
Requirement	The FOC system shall initiate a trajectory revision in the shortest time possible.
Title	Performance of Trajectory Re-calculation.
Status	<In Progress>
Rationale	As the time window especially for the in-flight trajectory revision is very short, the reaction time for the generation of a new trajectory must be as short as possible.
Category	<Performance>
Validation Method	<Real Time Simulation>
Verification Method	<Analysis>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Func ional block>	Flight Planning	N/A
<APPLIES_TO>	<Operational Focus Area>	ENB03.01.01 TMF	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-SPR-D001.0001	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-SPR-D001.0002	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-SPR-D001.0003	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-SPR-D001.0004	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-SPR-D001.0005	<Full>

3.3.4 Flight Operations Management

Not applicable.

3.3.5 Information and Communication Management

Not applicable.

3.4 Safety & Security

3.4.1 Schedule Management

Not applicable.

3.4.2 Flight Data Support Management

Not applicable.

3.4.3 Flight Planning

[REQ]

Identifier	REQ-11.01.03-TS-0305.0045
Requirement	The FOC system shall generate a trajectory under consideration of all legal requirements that are essential for a safe execution of a flight.
Title	Safety of Trajectories.
Status	<In Progress>
Rationale	It must be ensured that the trajectory is generated under consideration of all safety relevant aspects. Only if all these parameters are considered a safe and orderly execution of trajectories can be ensured.
Category	<Safety>
Validation Method	<Real Time Simulation>
Verification Method	<Analysis>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<APPLIES_TO>	<Operational Focus Area>	ENB03.01.01 TMF	N/A
<ALLOCATED_TO>	<Func ional block>	Flight Planning	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0030	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0035	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0040	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0045	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0065	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0110	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0125	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0150	<Full>

3.4.4 Flight Operations Management

Not applicable.

3.4.5 Information and Communication Management

3.5 Maintainability

3.5.1 Schedule Management

Not applicable.

3.5.2 Flight Data Support Management

Not applicable.

3.5.3 Flight Planning

Not applicable.

3.5.4 Flight Operations Management

Not applicable.

3.5.5 Information and Communication Management

Not applicable.

3.6 Reliability

3.6.1 Schedule Management

Not applicable.

3.6.2 Flight Data Support Management

Not applicable.

3.6.3 Flight Planning

Not applicable.

3.6.4 Flight Operations Management

Not applicable.

3.6.5 Information and Communication Management

Not applicable.

3.7 Functional block Internal Data Requirements

3.7.1 Schedule Management

Not applicable.

3.7.2 Flight Data Support Management

Not applicable.

3.7.3 Flight Planning

Not applicable.

3.7.4 Flight Operations Management

Not applicable.

3.7.5 Information and Communication Management

Not applicable.

3.8 Design and Construction Constraints

3.8.1 Schedule Management

Not applicable.

3.8.2 Flight Data Support Management

Not applicable.

3.8.3 Flight Planning

Not applicable.

3.8.4 Flight Operations Management

Not applicable.

3.8.5 Information and Communication Management

Not applicable.

3.9 Functional block Interface Requirements

3.9.1 Schedule Management

Not applicable.

3.9.2 Flight Data Support Management

Not applicable.

3.9.3 Flight Planning

Not applicable.

3.9.4 Flight Operations Management

Not applicable.

3.9.5 Information and Communication Management

[REQ]

Identifier	REQ-11.01.03-TS-0505.0015
Requirement	The FOC system shall receive relevant ACK or REJ messages from IFPS.
Title	EFPL Acknowledgment or Rejection
Status	<In Progress>
Rationale	
Category	<Functional>
Validation Method	<Real Time Simulation>
Verification Method	<Test>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<Enabler>	AOC-ATM-13	<Full>
<SATISFIES>	<Enabler>	AOC-ATM-20	<Full>
<ALLOCATED_TO>	<Func ional block>	Information and Communication Management	N/A
<APPLIES_TO>	<Operational Focus Area>	OFA 05.03 01	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0020	<Full>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-D001.0025	<Full>

[REQ]

Identifier	REQ-11.01.03-TS-0510.0020
Requirement	The FOC system shall send updated flight plans and related briefing information to concerned crews.
Title	Flight Plan to Crews
Status	<In Progress>
Rationale	To inform the pilots about the new operational scenario and enable Captain's decision-making.
Category	<Functional>
Validation Method	<Real Time Simulation>
Verification Method	<Test>

[REQ Trace]

Rela ionship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<Enabler>	AOC-ATM-20	<Full>
<ALLOCATED_TO>	<Func ional block>	Information and Communication Management	N/A
<APPLIES_TO>	<Operational Focus Area>	ENB03.01.01 TMF	N/A
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-INTEROP-D001 0004	<Par ial>

4 Assumptions

The development is done as a bottom-up approach. That means a prototype is developed to support a validation exercise – in this case validation exercise EXE07.05.04-VP-710 – to define proper operational processes and technical descriptions. The experiences made during the validation exercise shall be used to detail and review the requirements and to update the superordinate documents.

5 References

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

[5] SESAR Definition Phase – Task 2.4.x Milestone 3 – System Architecture (DLT-0612-244-00-10), September 2007

[6] IEEE / MIL Standards

[7] European ATM Master Plan, Data set 12 version 003.12from the 13 of May 2014

[8] WP11.01 Step 1 Use Cases and System Requirements for FOC system 00.00.21
https://extranet.sesarju.eu/WP_11FW/Project_11.01.03/Project%20Plan/Deliverables/D11%2001%2003-1-20130321.doc

[9] Contribution to EXE-07.05.04-VP-710-AFUA Step 1 V3 Validation Plan
https://extranet.sesarju.eu/WP_11FW/Project_11.01.05/Project%20Plan/D11.1.5-1ca-AFUA%20-Contribution%20to%20EXE-07.05.04-VP-710-AFUA%20Step%201%20V3%20Validation%20Plan.doc

[10]SESAR_07_05_04_D48_S1_FAM_VALP
https://extranet.sesarju.eu/WP_07/Project_07.05.04/Project%20Plan/STEP%201/VALP/07.05_04-D48%20S1%20FAM%20VALP.docx

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5.1 Use of copyright / patent material /classified material

5.1.1 Classified Material

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