



SESAR Solution 06-01 SPR/INTEROP-OSED for V3 - Part IV - Human Performance Assessment Report

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PJ06-01 — OPTIMIZED TRAFFIC MANAGEMENT TO ENABLE FREE ROUTING IN HIGH AND VERY HIGH COMPLEXITY ENVIRONMENTS

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Abstract

This document contains the Human Performance (HP) assessment report for the PJ06.01 which consists of the HP assessment plan, the results of the HP activities conducted according to the HP assessment process, newly identified issues and the HP recommendations & requirements. It corresponds to the completion of the four steps of the Human Performance assessment process, namely: Step 1 – Understand the concept: Baseline, Solution and Assumptions, Step 2 – Understand the Human Performance Implications, Step 3 – Improve and Validate the concept and Step4 – Collate findings & conclude on transition to next V-phase.



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1 Executive Summary

This document provides contains the Human Performance Assessment Report (HPAR) for Solution PJ06.01: Optimized traffic management to enable free routing in high and very high complexity environments.

The document contains the Human Performance (HP) assessment report for the Solution PJ06.01, which consists of the HP assessment plan, the results of the HP activities conducted according to the HP assessment process, newly identified issues and the HP recommendations & requirements. The report corresponds to the completion of the four steps of the Human Performance assessment process, namely: Step 1 – Understand the concept: Baseline, Solution and Assumptions, Step 2 – Understand the Human Performance Implications, Step 3 – Improve and Validate the concept and Step4 – Collate findings & conclude on transition to next V-phase.

The HP present assessment will report the results of the two main validation exercises (real time simulations) performed at V3 maturity level:

- Thread 1- Skyguide (EXE-06.01-V3-VALP-001): Very high complexity environment
- Thread 2 – ENAIRE (EXE-06.01-V3-VALP-002): High complexity environment

The complete list of identified benefits and issues and related objectives and success criteria as well as the derived Human Performance activities per partner are described in the attached HP Log

2 Introduction

2.1 Purpose of the document

The purpose of this document is to describe the result of the activities conducted according to the Human Performance (HP) assessment process **Erreur ! Source du renvoi introuvable.** in order to derive the HP assessment report for SESAR Solution PJ06.01 (V3) including the HP requirements and recommendations to inform the design and development of the concept explored in the validation activities and to ensure that it is mature enough to move on the next V-phase.

2.2 Intended readership

The intended audience of this document for Solution PJ.06-01 are:

- the key stakeholders targeted by the Solution, i.e.
 - Airspace Users who will benefit from the deployment of Free Routing operations in En-Route airspace including in high and very high complexity environment;
 - Air Traffic Controllers who will be directly impacted by the Solution to enable to Free Routing operations in Free Routing Airspace in En-route airspace of permanently or temporary high complexity;
- the SESAR Projects developing Solutions related to advanced ATM Capabilities planned to be deployed, or that can be impacted by the deployment, of Free Routing operations in En-Route airspace.

2.3 Scope of the document

The scope of this document is to report on HP activities undertaken in the framework of PJ06-01 SESAR Solution, by describing the objectives, the related indicators, the metrics, the analysis derived and the ways/methods to capture HP data.

PJ.06-01 Solution “Optimized traffic management to enable Free Routing in high and very high complexity environments” addresses the OI AOM-0505 where the initial e-OCVM maturity level is V2 and is targeted to be a V3 maturity OI at the end of SESAR2020 Wave 1.

In order to reach maturity [V3], two validation activities were carried out. In Thread 1 and in Thread 2, respectively, Skyguide and ENAIRE performed an RTS in their platforms in relevant operational environments.

2.4 Structure of the document

This document is composed of 5 main chapters:

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- Chapters 1 and 2 introduce the content of the document and its scope;
- Chapter 3 highlights the steps of the Human Performance Assessment process which are within the scope of this document;
- Chapter 4 details describes the four two steps of the Human Performance Assessment. In particular, it reports the main findings and the HP recommendations and requirements from the activities performed as part of the HP assessment process;
- Chapter 5 includes the list of reference documents;
- Appendix A provides the HP recommendations register which specifies the list of HP recommendations gathered in the project;
- Appendix B provides the HP requirements register which offers the list of HP requirements gathered in the project;
- Appendix C provides the HP Log in which all the data/information obtained from all HP activities conducted as part of the HP assessment (Step1 – Step 4) have been documented. It specifies the list of HP requirements gathered in the project

2.5 Acronyms and Terminology

2.5.1 Acronyms

Acronym	Meaning
ACC	Area Control Center
ANSP	Air Navigation Service Provider
AoM	Airspace Organisation and Management
AoI	Area of Interest
AoR	Area of Responsibility
ARES	Airspace Reservation
ARN	ATS Route Network
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATS	Air Traffic Service



Acronym	Meaning
ATSU	Air Traffic Services Unit
CDT	Conflicts Detection Tool
CD/R	Conflict Detection and Resolution
COP	Coordination Point
CPDLC	Controller Pilot Data Link Communications
CWP	Controller Working Position
DCB	Demand and Capacity Balancing
DS	Data Set
e-OCVM	European Concept Validation Methodology
EATMA	European ATM Architecture
EC	Executive ATCO
EFL	Entry Flight Level
EXE	Executive ATCO
FDPS	Flight Data Processing System
FRA	Free Route Airspace
HF	Human Factors
HMI	Human Machine Interface
HP	Human Performance
INAP	Integrated Network Management and Extended ATC Plan
INTEROP	INTEROPerability
NM	Network Manager
OI	Operational Improvement
OSED	Operational Service and Environment Description
PC	Planner ATCO
PLN	Planner ATCO
RBT	Reference Business Trajectory

Acronym	Meaning
R&D	Research and Development
RTS	Real Time Simulation
SPR	Safety and Performance Requirements
STCA	Short Term Conflict Alert
VALP	Validation Plan
VO	Validation Objective

Table 1: List of Acronyms

2.5.2 Terminology

Term	Description
Human Factors (HF)	HF is used to denote aspects that influence a human’s capability to accomplish tasks and meet job requirements. These can be external to the human (e.g. light & noise conditions at the work place) or internal (e.g. fatigue). In this way, “Human Factors” can be considered as <i>focussing on the variables that determine Human Performance</i> .
Human Performance (HP)	HP is used to denote the human capability to successfully accomplish tasks and meet job requirements. In this way, “Human Performance” can be considered as <i>focussing on the observable result of human activity in a work context</i> . Human Performance is a function of Human Factors (see above). It also depends on aspects related to Recruitment, Training, Competence, and Staffing (RTCS) as well as Social Factors and Change Management.
HP activity	An HP activity is an evidence-gathering activity carried out as part of Step 3 of the HP assessment process. An HP activity can relate to, among others, task analyses, cognitive walkthroughs, and experimental studies.
HP argument	An HP argument is an HP claim that needs to be proven through the HP Assessment Process.
HP assessment	An HP assessment is the documented result of applying the HP assessment process to the SESAR Solution-level. HP assessments provide the input for the HP case.

HP assessment process	The HP assessment process is the process by which HP aspects related to the proposed changes in SESAR are identified and addressed. It covers the conduct of HP assessments on the Solution-level as well as the HP case building over larger clusters of Solutions.
HP benefit	An HP benefit relates to those aspects of the proposed ATM concept that are likely to have a positive impact on human performance.
HP case	An HP case is the documented result of combining HP assessments from Solutions into larger clusters (SESAR Projects, deployment packages) in SESAR.
HP issue	An HP issue relates to those aspects in the ATM concept that need to be resolved before the proposed change can deliver the intended positive effects on Human Performance.
HP impact	An HP impact relates to the effect of the proposed solution on the human operator. Impacts can be positive (i.e. leading to an increase in Human Performance) or negative (leading to a decrease in Human Performance).
HP recommendations	HP recommendations propose means for mitigating HP issues related to a specific operational or technical change. HF recommendations are proposals that require additional analysis (i.e. refinement and validation). Once this additional analysis is performed, HF recommendations may be transformed into HF requirements.
HP requirements	HP requirements are statements that specify required characteristics of a solution from an HF point of view. HP requirements should be integrated into the DOD, OSED, SPR, or specifications. HF requirements can be seen as the stable result of the HF contribution to the Solution, leading to a redefinition of the operational concept or the specification of the technical solution.

Table 2: Terminology

3 The Human Performance Assessment Process: Objective and Approach

The HP assessment process is a four-step process. Figure 1 provides an overview of these four steps with the tasks to be carried out and the two main outputs (i.e. HP plan and HP assessment report). In addition, an HP Log is maintained throughout the lifecycle of the Solution in which all the data/information obtained from all HP activities conducted as part of the HP assessment is documented. This HP Log is a living document and is continuously updated and / or added to as the SESAR Solution progresses (see **Erreur ! Source du renvoi introuvable.**).

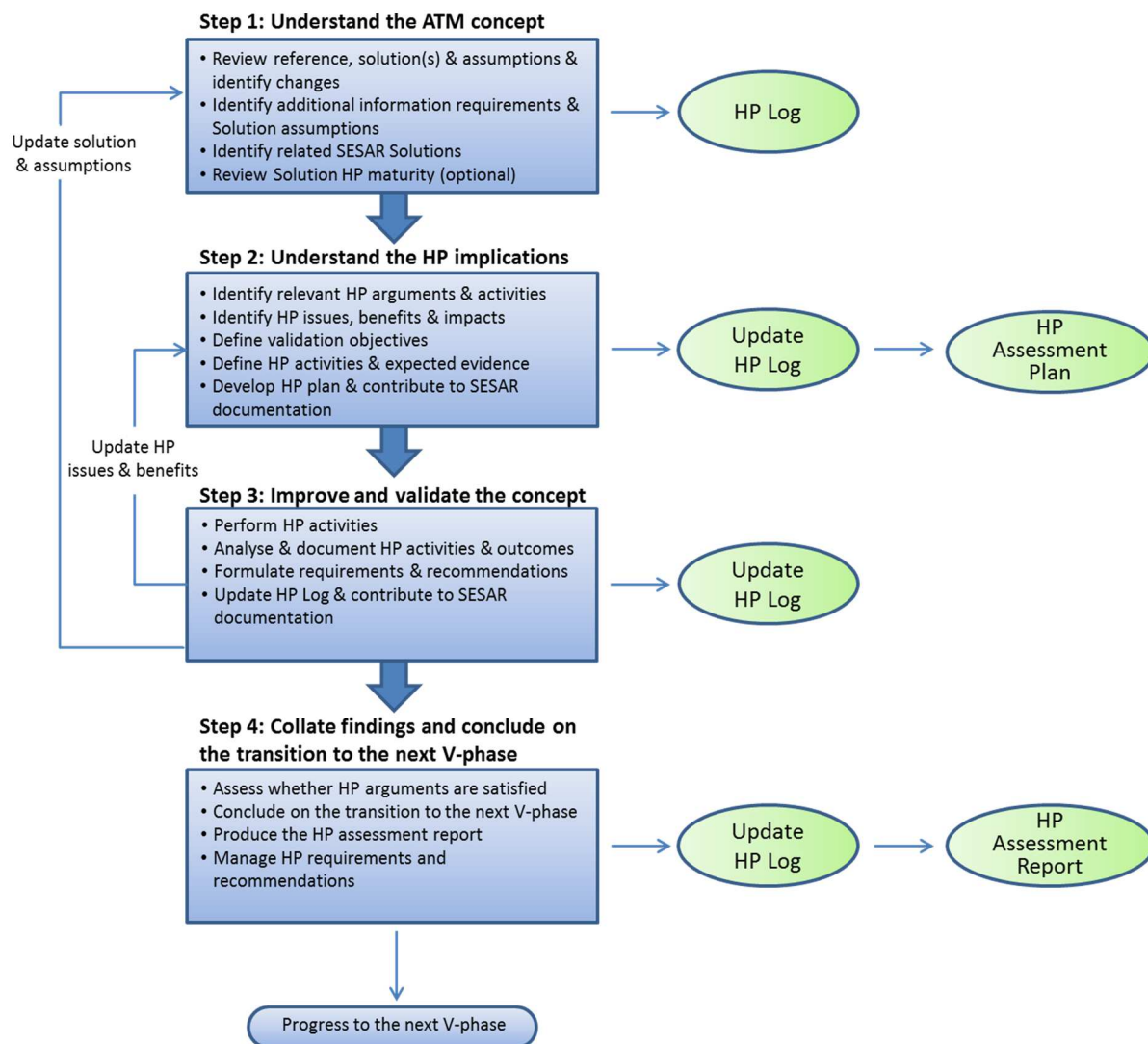


Figure 1: Steps of the HP assessment process

This document addresses HP activities up to the final step, step 4 of this process, the reporting of the findings.

3.1 Human performance assessment within the Solution

This section highlights the main HP assessment activities steps undertaken as part of PJ06-01 HP assessment and reporting.

Activity		Date	Who
ENAIRES RTS Thread 2 - High complexity	RTS	14th to 29th November 2018	ENAIRES
	Results in VALR Appendix	12 June 2019	ENAIRES
Skyguide RTS Thread 1 – Very high complexity	RTS	January-February 2019 for two first simulation sessions (weeks 1 & 2) and end of May for a third one (week 3).	Skyguide
	Results in VALR Appendix	16 th July 2019	Skyguide
HP Results Integration (ENAV)	HPAR draft Thread 2	20th June 2019	DBL (on behalf of ENAV), ENAIRES
	Final HPAR Consolidation (including thread 1 results)	25th July 2019	ENAIRES, Skyguide, DBL (on behalf of ENAV)

Table 3: HP Assessment report task schedule

3.2 Deviations

3.2.1 Deviations with respect to the SJU Project Handbook

The High Level validation objectives allocated to PJ.06-01 are:

Id	OBJ-DS18A-PJ0601-VALS3.001
Title	Operational feasibility and acceptability of PJ06-01 Solution
Description	To confirm operational feasibility and acceptability from controllers and pilots perspectives of PJ06-01 Solution (workload, change of practices, versatility of procedures, situation awareness, vigilance, risk of deskilling, perceived safety) as a function of the design options (ex. enhanced ATC support tools, use of R/T and/or CPDLC) and the operational conditions (e.g. complexity of the airspace without routes structures, interaction with lower airspace, flows of trajectories required by the AUs, mixed equipage, non-nominal, degraded mode).
OIs concerned	AOM-0505
Success criteria 1	Positive feedback from controllers and pilots, complemented with evidence of feasibility: acceptable quality of service and acceptable level of safety (situation awareness) with acceptable level of workload especially for Air/Ground coordination and inter sector/ATSU coordination.
Success criteria 2	Evidence of complexity resolution, traffic synchronisation and separation provision performed across ATSU/sector boundaries, with maintained or increased capacity compared to current operations, even without reference to published directs or fixed route network.
Success criteria 3	Evidence of smooth entry and exit to/from Free Routing Airspace and adapted procedures for transition to/from conventional ATS route Network, in both vertical and horizontal plans.
Success criteria 4	Evidence that Airspace Capacity is at least maintained (ex. no increase of ATFCM delays).
Success criteria 5	Evidence of systematic fuel and/or flight time benefits, depending on Airspace Users target to plan more optimum tracks.
Success criteria 6	Assessment of predictability (only if integrated to other SESAR 2020 solutions displaying other Flight Planning and Network Management operations).

Id	OBJ-DS18A-PJ0601-VALS3.002
Title	ATM Benefits in accordance with Performance Validation Targets.
Description	To perform an assessment of the ATM benefits produced by PJ06-01 Solution in terms of Predictability and Environment/fuel efficiency.
OIs concerned	AOM-0505
Success criteria 1	For the Predictability KPA, benefits identified in terms of reduction of En-Route variability per flight, in line with Validation targets.
Success criteria 2	For the Fuel Efficiency KPA, benefits identified in terms of fuel burn per flight in line with Validation targets.

Due to some technical issues it is not possible to properly trace the coverage of these High level validation objectives by the PJ.06-01 Validation objectives. Nevertheless, the table below provides a traceability in a textual format:

SESAR validation ID	Solution Objective	SESAR Validation Title	Solution Objective	Covers High level Objective	SESAR High Validation Title	Covers High level Objective	SESAR High Validation Title
OBJ-06.01-V3-VALP-001		Increased fuel efficiency in FRA of high / very high complexity		OBJ-DS18A-PJ0601-VALS3.001		Operational feasibility and acceptability of PJ06-01 Solution	
OBJ-06.01-V3-VALP-001		Increased fuel efficiency in FRA of high / very high complexity					
OBJ-06.01-V3-VALP-011		Increase in predictability by implementing SUV in High/very high complexity environment		OBJ-DS18A-PJ0601-VALS3.001		Operational feasibility and acceptability of PJ06-01 Solution	
OBJ-06.01-V3-VALP-011		Increase in predictability by implementing SUV in High/very high complexity environment					

OBJ-06.01-V3-VALP-021	Impact on safety of SUV in High / Very High complexity environment	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution
OBJ-06.01-V3-VALP-031	Capacity in FRA of High / Very High complexity	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution
OBJ-06.01-V3-VALP-041	Impact of SUV in high / very high complexity FRA on ATCOs tasks	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution
OBJ-06.01-V3-VALP-042	Impact of SUV on Human Performance in high / very high complexity	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution
OBJ-06.01-V3-VALP-043	Usability of HMI in SUV	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution
OBJ-06.01-V3-VALP-044	ATCOs situation awareness in SUV in high / very high complexity environment	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution
OBJ-06.01-V3-VALP-045	ATCOs workload in SUV in high / very high complexity environment	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution
OBJ-06.01-V3-VALP-046	ATCOs team communication in SUV in high / very high complexity environment	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution
OBJ-06.01-V3-VALP-047	ATCOs operating methods in SUV in high / very high complexity environment	OBJ-DS18A-PJ0601-VALS3.001	Operational feasibility and acceptability of PJ06-01 Solution

It is to be noted that the high level validation objectives are covered in the limit of PJ.06-01 scope. More particularly the Solution focuses on the controller working position and does not address any complexity management aspects. (c.f. **Erreur ! Source du renvoi introuvable.**).

3.2.2 Deviations with respect to the Validation Plan

VALP deviation with reference to the Thread 1:

Validation platform configuration and Solutions under validation

This simulation was initially planned to be run using ENAV and Skyguide platforms connected, in order to assess cross-border FRA concept implementation impact in a wide operational environment of very High complexity. This was unfortunately not possible to achieve, neither in January/February, nor in May, due to various planning and technical reasons.

This situation has been mitigated by using Skyguide platform in isolation and implementing additional enablers in this platform. Details can be found in section **Erreur ! Source du renvoi introuvable.**

A Solution under validation based on Cross-border FRA management with ATC support tools corresponding to SESAR2020 baseline (SESAR I) was supposed to be part of the simulation, this SUV has not been covered. Skyguide platform benefits from advanced ATC support tools (e.g. What-if, advanced electronic screen-to-screen coordination) which are already in operations today. It would have been a non-sense to de-activate these tools which are already used by ATCOs in the OPS room today. In the frame of this validation, from ATC tool point of view, Skyguide intended to adapt the tools and associated functions to cross-border FRA environment and associated trajectories characteristics. This SUV was aiming to provide CBA team with outputs regarding the benefits of SESAR2020 advanced ATC support tools. Skyguide is providing benefits of the adapted advanced ATC support tools, for which the corresponding development costs have been estimated.

Military areas activity have finally not been simulated for two reasons:

- Given the impact of military areas in terms of Airspace occupancy, when analyzing this scenario with ATCOs, it was deemed out of interest, because too close to fixed route environment.
- Military areas activation or de-activation would have been of interest in terms of triggered coordination actions with ENAV ATCOs, but connection with ENAV platform did not take place.

Metrics

A risk was raised in the VALP concerning local assessment of fuel efficiency and predictability. It has been decided to use the Key Environment performance indicators (based on filed flight plans and actual trajectories) used at European level and defined by the PRU in order to mitigate this risk. Therefore SESAR metrics for HFE and Predictability, initially mentioned in the VALP have not been used.

As STCA was finally not available on Skyguide platform, the metric linked to STCA warnings has not been used. This issue has been mitigated (see section **Erreur ! Source du renvoi introuvable.**)

Abnormal conditions

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Some abnormal conditions were tested with the reduced performance of some tools during the first validation sessions. Nevertheless, bad weather conditions have not been simulated, ATCOs feedback being that in case of stormy weather and CBs, the situation will be similar in Cross-Border FRA environment and in fixed route network environment: all flights will not follow their initial flight plans and will be managed through radar vectoring.

Simulation sessions

Two simulation sessions were initially planned, finally 3 sessions have been organized to cover the needs. The third simulation session took place end of May 2019.

Traffic demand

It was initially planned to use traffic scenarios with 2017 and 2022 traffic loads. As mentioned to the SJU during the external review period of the VALP, a significant traffic increase has already been absorbed during year 2018 in the sectors planned to be measured sectors (in Switzerland and Italy), simulating a 2017 traffic would not have been realistic. It has been therefore decided to only simulate 2022 traffic demand.

VALP deviation with reference to the Thread 2:

Deviations from the planned activities that do not impact objectives or success criteria:

- Deviation -1. The traffic sample with an increment of a 30% was not used during the simulations due to the number of runs finally performed.
- Deviation – 2. Personal interviews with each controller were initially planned, but due to the high number of controllers and schedule limitations, finally no personal interviews took place.

Deviations from the planned activities impacting success criteria; Next Success Criteria were finally not covered:

- CRT-06.01-V3-VALP-001-004 The planning of minimum cost tracks in solution under validation of high/very high complexity lead to fuel consumption gains in execution phase.

Due to the configuration of the exercise with two ACCs belonging to the same country, there was no difference in the navigation taxes.

- CRT-06.01-V3-VALP-004-007 In solution under validation in High/very high complexity environment, the ratio number of STCA warning / number of aircraft is not increased.

Deviation – 3. Due to effort optimisation CRIDA and Indra agreed to not develop the STCA warnings in the platform. Minimum separation infringements have been analysed during the post-processing.

- CRT-06.01-V3-VALP-021-004 In solution under validation in high complexity environment, in a considered sector/AoR the ratio Number of CDTs alerts / number of aircraft is not increased.

The CDT alerts were not recorded by the platform and have not been analysed.



- CRT-06.01-V3-VALP-031-003 In solution under validation in high complexity environment the number of ATCOs tactical actions per flight is not increased (ATCOs initiatives or Flight crew requests)

The actions per ATCO were not recorded by the platform and have not been analysed.

Concerning the HPAR in particular all INAP related issues were removed.

4 Human Performance Assessment

4.1 Step 1 Understand the ATM concept

4.1.1 Description of reference scenario

The Reference scenario is described by current practices for En-Route operations in high complexity operational environments, with a special focus on those items subject to change in the solution scenario. Actually, today's operations for sensitive items are ensured through:

- Traffic Complexity Management (at local level): performed by the Local Traffic Manager (in coordination with the NM) using baseline DCB tools (e.g. STAM)
- Aircraft-to-Aircraft Separation Provision (airspace): Provision of planning and tactical separation in upper en-route airspace (with ARN or Direct Routings) using baseline ATC tools
- Coordination and Transfer: Standard coordination and transfer of flights in upper en-route airspace (with ARN or Direct Routings).

4.1.2 Description of solution scenario

To enable safe and efficient Free Routing operations in En-route airspace of high or very high complexity, the Solution PJ.06-01 relies on two main changes at local ATM level:

- Structurally limited FRA defined to allow AUs to plan flight without reference to a fixed ATS route network in cross-border environments;
- Air Traffic Control in En-Route airspace using ATC sector support tools (Conflict Detection Tools, Monitoring Aids, Inter-sector coordination support tool) adapted to Free Routing cross-border operations.

Considering the nature of the change brought by the Solution PJ.06-01, which impacts the activities of the local ATM actors in a new operating environment, additional R&D activities are required (beyond the ones already conducted in SESAR 1) to demonstrate the V3 maturity of the Solution and its added value in support to the implementation of FRA in high and very high complexity environments.

The table below succinctly highlights the main differences between the new and the previous operating methods highlighting what are the key aspects that will change in relation with the ATM Capabilities impacted by the Solution PJ.06-01.



ATM Capabilities (in EATMA) that are impacted by the SESAR Solution	Current Operating Method	New Operating Method
Free Route Airspace Design		Traffic Complexity Management through “structurally” limited FRA (at long and medium-term flight planning phase);
Aircraft-to-Aircraft Separation Provision (airspace)	Provision of planning and tactical separation in en-route airspace (with ARN or Direct Routings) using baseline ATC tools	Provision of planning and tactical separation in Free Routing high and very high complexity cross-border environments using: <ul style="list-style-type: none"> • Enhanced CDT (possibly within AOI) to assist ATCOs’ to determine planning problems and safe entry/exit conditions • Enhanced FDPS (without COP) to support conflict detection in FRA
Coordination and transfer	Standard coordination and transfer of flights in en-route airspace (with ARN or Direct Routings)	Coordination of flights between sectors/ATSUs in Free Routing high and very high complexity cross-border environments using: <ul style="list-style-type: none"> • Enhanced FDPS (without COP) to support coordination of flights in FRA • Enhanced Coordination support Tools to agree on safe entry/exit conditions (outside COP)

Aircraft-to-Aircraft Separation Provision

In Free Routing Airspace in high and very high complexity cross-border environments, the use of Conflict Detection support tools and What-if probing tools are considered to support Planning Separation Assurance (What-else tools are considered nice to have): detection of problems at Entry/Exit and along planned flight trajectory within AoR/AoI.

In order to assess tactical conflict resolution options ATCOs should be provided with What-if probing tools.

The implementation of automated ATC support tools allows a better anticipation of traffic situation and provide ATCOs with more accurate conflict data (e.g. conflict geometry display, minimum separation distances, extrapolation of aircraft positions at separation minima infringement), more

time to analyse problems and select the best solutions, taking into account Safety, ATM constraints and flight efficiency aspects. These advanced tools support the selection of solutions ensuring a minimum deviation from agreed RBT. Task sharing and coordination within ATC sector team as well as coordination with adjacent sectors are facilitated by advanced HMI functions (e.g. common TC/PC conflict list and display of conflict resolution allocation TC/PC, trajectory revision proposal display shared with adjacent sectors).

Even if sector shape should be adapted at best according to traffic flows, some specific rules should be defined in order to clearly allocate conflict resolution responsibility in case of converging flows managed by two contiguous ATC sectors or frequent conflict situations over/close to the sector boundaries.

Coordination and Transfer

Enhanced FDP and Coordination support Tools to agree on safe entry/exit conditions (outside COP) are needed to support Free Routing cross-border operations.

The Cross-Border context imposes to consider a larger Area of Interest (extension according to local needs) and an adaptation of ATC support tools, in particular for supporting coordination actions made more difficult due to the high variability of trajectories and the lack of mandatory coordination points on ACC/sector boundaries.

Advanced coordination associated to advanced HMI functions are highly recommended (e.g. :

- Support to unambiguous flight identification
- Graphic trajectory Edition/ Modifications tools, elastic vector, and other CWP graphic tools
- trajectory revision proposal display shared with adjacent sectors, taking into account all types of trajectory revision actions (Vertical, Lateral, Speed, time), in isolation or mixed, to improve coordination action efficiency (better anticipation, no identification mistake, improved visualization of proposals)
- Trajectory revision negotiation support (accept, reject, counter-proposal)
- Display of the latest agreed RBT/RMT in order to support the minimum deviation rule/principle

According to local operational environment/needs, some specific rules should be defined in case of regular conflicts to be solved over/close to the sector boundaries (conflict resolution responsibility and transfer conditions).

Traffic Expedition

Trajectory revisions during the execution phase to expedite traffic (in the frame of Air Traffic Control service) will still be part of ATC planning role tasks, but will be much fewer. Indeed, the RBT defined in planning phase, in particular the portion in Free Routing Airspace, represents the best compromise between known ATM constraints, aircraft performance and flight/company business needs. Therefore



this RBT must be facilitated as far as possible. However, in some specific situations, like the cancellation of an ATM constraint (e.g. early deactivation of an ARES) expedite traffic on ATCO initiative will still be possible.

4.1.3 Consolidated list of assumptions

The HP related transition factors to operations will be kept out of scope of PJ06-01 validation exercises and they will be addressed at local level by single ANSP experts, prior to starting of operations. However, any outcome concerning those aspects stemming from validation exercises will be captured and reported in the validation report, despite not specifically addressing HP arguments 4.1, 4.2 and 4.3.

4.1.4 List of related SESAR Solutions to be considered in the HP assessment

The SESAR Solution PJ.06-01 is defined in the applicable version of EATMA (Dataset 19) as follows:

Optimized traffic management to enable Free Routing in high and very high complexity environments sees airspace users being able to plan flight trajectories without reference to a fixed route network or published directs within high & very high-complexity environments so they can optimise their associated flights in line with their individual operator business needs or military requirements.

4.1.5 Identification of the nature of the change

This section highlights the HP elements which are likely to be impacted that will be part of the HP activities to be undertaken in the context of this solution.

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES	
1.1 ROLES & RESPONSIBILITIES	CONFLICTS RESOLUTION RESPONSIBILITY AT BORDERS (TASK SHARING BETWEEN ATCO TEAM MEMBERS OF ADJACENT SECTORS COULD NOT BE OBVIOUS) → EXE AND PLN

1.2 OPERATING METHODS	CONFLICTS RESOLUTION RESPONSIBILITY AT BORDERS COULD INTRODUCE SOME LACK OF CLARITY IN THE OPERATING METHODS BETWEEN ALL ACTORS.) → EXE AND PLN
1.3 TASKS	DEFINITION OF ADDITIONAL/UPDATE OF EXISTING TASKS TO MANAGE TRAFFIC COMPLEXITY AND ENSURE AIRCRAFT SEPARATION (DUE TO INCREASED INTERACTION WITH FLIGHTS AND CONFLICTS MANAGEMENT WITHOUT KNOWN HOT-SPOTS ALONG ATS ROUTES) → EXE, PLN
2. HUMAN & SYSTEM	
2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)	NOT APPLICABLE
2.2 PERFORMANCE OF TECHNICAL SYSTEM	NOT APPLICABLE
2.3 HUMAN – MACHINE INTERFACE	IMPACT ON ELECTRONIC COORDINATION TOOLS (COMMON TC/PC CONFLICT LISTS, WHAT IF HMI ELEMENTS) → EXE AND PLN
3. TEAMS & COMMUNICATION	
3.1 TEAM COMPOSITION	NOT APPLICABLE
3.2 ALLOCATION OF TASKS	NOT APPLICABLE
3.3 COMMUNICATION	INDIVIDUAL AND TEAM SITUATIONAL AWARENESS, PLUS SUPPORT FOR TIMELY EXCHANGE OF INFORMATION (DEFINITION OF A POINT TO INITIATE/AGREE COORDINATION)
4. HP RELATED TRANSITION FACTORS	
4.1 ACCEPTANCE & JOB SATISFACTION	Not YET ADDRESSED
4.2 COMPETENCE REQUIREMENTS	NOT YET ADDRESSED
4.3 STAFFING REQUIREMENTS & STAFFING LEVELS	NOT YET ADDRESSED



*“Not Applicable” indicated in the table above stands for HF Argument not relevant for PJ06.01 SESAR Solution, whereas “Not Yet Addressed” refers to HF Argument not yet analysed and/or work is still in progress.

4.2 Step 2 Understand the HP implications

4.2.1 Identification of relevant arguments, HP issues & benefits and HP activities

The HP arguments are “claims” that need to “proven” during HP assessment. Therefore, the aim of HP assessment is to provide “evidence” to show the HP arguments impacted have been considered and satisfied by the HP assessment process. The main arguments to be considered during the HP assessment process were:

1. Roles and Responsibilities

- Argument 1.1: Roles and responsibilities of human actors are clear and exhaustive
- Argument 1.2: The operating methods are clear, exhaustive and support human performance
- Argument 1.3: Human actors can achieve their tasks (in normal & abnormal conditions of the operational environment and degraded modes of operation).

2. Human and System

- Argument 2.3 The design of the HMI supports the human in carrying out their tasks

3. Teams and Communication

- Argument 3.3 The communication between team members supports human performance

The table below describes these HP arguments. It also lists the Solution-specific HP issues and benefits that have been identified related to an HP argument.



Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies	Success Criteria
1.1.1	ISS-PJ06-01-001	Description of Roles and associated responsibilities may not cover all affected human actors	OBJ-PJ06-01-HP001	Evaluate that Roles and Responsibilities are complete and unambiguous	Identify/update human actors likely to be impacted by the change (during OSED/SPR/INTEROP) & check against the description of roles and responsibilities. Assess them in RTS.	The description of roles and responsibilities likely to be impacted by the change contains all affected human actors. OSED/SPR/INTEROP release A successful Operational Acceptance Test is carried out
1.1.2	ISS-PJ06-01-002	Updated/New description of roles & responsibilities may not cover all tasks to be performed by the human actors	OBJ-PJ06-01-HP001	Evaluate that Roles and Responsibilities are complete and unambiguous	Identify/update tasks to be performed for ensuring complexity management using Task Analysis (during OSED/SPR/INTEROP) & check against the description of roles and responsibilities Assess them in RTS	The description of roles and responsibilities, and tasks is created OSED/SPR/INTEROP release A successful Operational Acceptance Test is carried out
1.1.3	ISS-PJ06-01-003	Roles and responsibilities could not be clear and consistent. In particular: The task sharing between ATCO team members of adjacent sectors could not be	OBJ-PJ06-01-HP001	Evaluate that Roles and Responsibilities are complete and unambiguous	Review roles and responsibilities with end users (to ensure they are clear and consistent) during OSED/SPR/INTEROP	OSED/SPR/INTEROP release A successful Operational



Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies	Success Criteria
		obvious, especially about the decision making of the conflict resolution (Who is in charge to execute the resolution?)			preparation and assess them in RTS	Acceptance Test is carried out
1.2.5	ISS-PJ06-01-004	Evaluate feasibility of the new/modified operating methods (procedures) for managing traffic complexity	OBJ-PJ06-01-HP002	Assess Feasibility of Operating Methods	Assess operating methods in a Real-Time Simulation: -subjective methods: questionnaires	Operating methods can be followed in an accurate, efficient and timely manner
1.3.2	ISS-PJ06-01-005	Evaluate feasibility of duty tasks in a timely manner. Potential additional workload may have a negative impact on this aspect	OBJ-PJ06-01-HP003	Assess the impact of Free Route Operations on ATCO tasks	Assess timeliness of actions in Real-Time -objective methods: observations, data recordings -subjective methods: interviews, debriefings	- Number of late actions are within acceptable limits, taking into account the consequences of a late action. - Tasks are effectively completed
1.3.3	ISS-PJ06-01-006	Controllers' workload may be negatively impacted by high and very high complexity free route operations	OBJ-PJ06-01-HP003	Assess the impact of Free Route Operations on ATCO tasks	Assess workload and underlying factors in a Real-Time Simulation:	Workload levels are within acceptable limits ('acceptable limits' to be defined)



Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies	Success Criteria
					-subjective methods: questionnaires -objective methods: data recordings	
1.3.4	ISS-PJ06-01-007	The new operating methods in FRA could be more complex compare to the ones in ATS route network	OBJ-PJ06-01-HP003	Assess the impact of Free Route Operations on ATCO tasks	Assess trust in a Real-Time Simulation: - objective methods: observations - subjective methods: questionnaires.	Level of trust in the new procedures is assessed as appropriate.
1.3.5	ISS-PJ06-01-008	How high-complexity/high density free route operations impact on controllers' situational awareness Potential increase of ATCO's Workload and reduction of ATCO's Situational Awareness <ul style="list-style-type: none"> • <u>ATCO's Flight Integration could be</u> more complex and demanding in terms of cognitive resources. It may be difficult to know what path the flight is following. The difficulty comes when the building traffic 	OBJ-PJ06-01-HP003	Assess the impact of Free Route Operations on ATCO tasks	- Assess situational awareness in Real-Time Simulation or operational trials: - subjective methods: questionnaires - objective methods: observations	- The Level of situational awareness is within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment). - The User is able to perceive and interpret



Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies	Success Criteria
		<p>picture composed of many different flight trajectories</p> <ul style="list-style-type: none"> ATCO's Conflict Management: <ul style="list-style-type: none"> Conflict detection: Controllers may no longer rely on their knowledge of the usual traffic patterns and have to monitor the whole airspace. Many conflicts may occur near sector boundaries and those ones seem to be harder to detect. The lack of traffic structure imposes to extend the geographical scope of ATCOs situation awareness, more attention has to be dedicated to traffic situations and operational configurations (<i>e.g. ARES activation and shape</i>) in adjacent sectors. The concept of the Area of interest (<i>extension of the Area Of Responsibility</i>) has been proved to fulfil this operational need in Free Routing airspace. Conflict Resolution: Every conflict is a "new conflict", probably a recurrent strategy cannot be applied. Some 				<p>task relevant information and to anticipate future events/actions. -Workload levels are within acceptable limits</p>



Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies	Success Criteria
		<p>conflicts come with small angles and are more difficult to solve. The biggest issue is nevertheless solving conflicts which occur on sector boundaries.</p> <ul style="list-style-type: none"> • Coordination: Coordination process may be longer and more difficult, as a new solution should be negotiated for every conflicting situation. 				
2.3.1	ISS-PJ06-01-009	Provided HMI information could not be fit for purpose and thus not supporting controllers in achieving their duty tasks	OBJ-PJ06-01-HP004	Assess Usability and Effectiveness of proposed HMI	<p>Assess Human Performance & Usability during Real-Time Simulation</p> <ul style="list-style-type: none"> - subjective methods: questionnaires, debriefings & interviews (feedback on system support) - objective methods: data recordings, observations (task performance). 	<p>The End user perceives usability as sufficient.</p> <p>The End user is able to perform the task in a timely and error free manner.</p>



Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies	Success Criteria
2.3.6	ISS-PJ06-01-010	Evaluate Usability of the proposed user interface (input devices, visual displays/output devices, alarms& alerts) for the new/updated items introduced due to free routing operations (if any)	OBJ-PJ06-01-HP004	Assess Usability and Effectiveness of proposed HMI	Assess usability with: - objective methods: observations - subjective methods: questionnaires, debriefings.	- The End user experiences the integrated interface, including any new system components, as sufficiently usable. - The End user is able to perform interaction without noticeable problems.
2.3.8	ISS-PJ06-01-011	Evaluate that individual situational awareness is not negatively affected by user interface design of the new/updated items introduced due to free routing operations (if any)	OBJ-PJ06-01-HP004	Assess Usability and Effectiveness of proposed HMI	Assess individual situational awareness in a Real-Time Simulation: - objective methods: observations - subjective methods: questionnaires, debriefings	- The Level of individual situational awareness is within acceptable limits - The End user is able to perceive and interpret task relevant information and to anticipate future events/actions



Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies	Success Criteria
3.3.1	ISS-PJ06-01-012	Evaluate if the need of specific information (requirements) to achieve new/updated tasks, by single team members, is satisfied through intra-team and inter-team communications	OBJ-PJ06-01-HP005	Assess the impact of Free Route Operations on intra-team and inter-team communications	<ul style="list-style-type: none"> - Analyse intra-team/ inter-team communications in a Real-Time Simulation or in operational trials: - objective methods: observation, data recordings (R/T, HMI interaction) - subjective methods: interviews, questionnaires & debriefings 	<ul style="list-style-type: none"> - There is Timely communication of task relevant information within the team/between teams. - Team communication is judged as being consistent with their information needs.
3.3.2	ISS-PJ06-01-013	Evaluate if phraseology supports intra-team and inter-team communication and there is no lack of its support to perform additional/modified duty tasks	OBJ-PJ06-01-HP005	Assess the impact of Free Route Operations on intra-team and inter-team communications	<ul style="list-style-type: none"> Assess the phraseology in a Real-Time Simulation: - subjective methods: interviews, questionnaires & debriefings. 	<ul style="list-style-type: none"> - Proposed phraseology does not lead to errors related to perception & interpretation of audio information/voice communication.



Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies	Success Criteria
						- Phraseology is judged as being appropriate for all encountered operational conditions
3.3.4	ISS-PJ06-01-014	The communications load may increase due to additional/modified tasks (e.g. ground-ground)	OBJ-PJ06-01-HP005	Assess the impact of Free Route Operations on intra-team and inter-team communications	Assess communication load in Real-Time: - subjective methods: questionnaires - objective methods: data recordings.	The communication load is considered adequate by the end user.
3.3.5	ISS-PJ06-01-015	Controllers situational awareness may be negatively impacted by high and very high complexity free route operations	OBJ-PJ06-01-HP005	Assess the impact of Free Route Operations on intra-team and inter-team communications	Assess team situational awareness in Real-Time Simulation: - subjective methods: questionnaires - objective methods: probe methods	The Level of team situational awareness is within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment).



Table 4: Summary of the PJ06.01 HP issues and arguments

Founding Members





4.3 Step 3 Improve and validate the concept

4.3.1 Description of HP activities conducted

The tables below summarize how the HP arguments were addressed during HP activities undertaken.

ACTIVITY 1.	REAL TIME SIMULATION AT ENAIRE
Description	Real Time Simulation
Related Arguments	Arguments List 1.1, 1.3, 2.3 and 3.3 and related HP issues (as per HP log – see Erreur ! Source du renvoi introuvable.)
HP objectives	<p>The following HP objectives are identified for the planned exercises:</p> <ul style="list-style-type: none"> • Demonstrate that Roles and Responsibilities are complete and unambiguous • Demonstrate Feasibility of Free Route Operating Methods • Assess the impact of Free Route Operations on ATCO tasks • Assess Usability and Effectiveness of proposed HMI • Assess the impact of Free Route Operations on intra-team and inter-team communications
Issues to be addressed / investigated from issues analysis	Refer to section 4.2.1.
Tools/Methods selected out of the hp repository	Over the shoulder observations, questionnaires, debriefings and system logged data analysis.
Summary of the HP Activity	<p>Twelve controllers participated in the execution of the exercise. The background of the controllers was diverse: some of the controllers had participated in previous simulations were familiar with platform and working method whereas for some of them it was the first time. Teams were composed with one controller with iTEC background and one controller without the background, to compensate this difference. Another background difference is that there were more controllers from Madrid ACC than from Barcelona ACC, which may impact the results from Barcelona measured sectors. Only one of the controllers had previous knowledge on Free Route.</p>

The following runs were performed by scenario:

- Reference- 4 runs
- FR Advanced Tools- 7 runs
- FR Basic Tools- 2 runs
- FR Military Area- 3 runs
- 2022 Traffic & advanced tools- 1 run

The collection methods that were used during the exercise were the following:

- Post run questionnaire that were filled in by each controller after each run.
- Directed debriefing after each run.
- Gaphas: eye blinking. Two devices were available, but due to some limitations (e.g. the controller cannot wear glasses) they were not always operative.
- Scope: is based in the standard method within ENAIRE to measure workload. In this exercise the measurement is performed in post-processing using video and audio recordings of the executive controllers workplace.
- ISA (self-assessment instantaneous) workload measurement. In each run, for each controller, a tablet were the controllers score their subjective workload. The tablet flashed every 2 minutes and there was a limited of one minute to input the information.
- Radar track and flight plan modification recording. In each run, for both platforms.
- CWP logs. In each run, for each CWP.
- Post exercise questionnaires were filled in the last day.
- Final debriefing that took place on the last day.

Table 5: Description of Activity 2 ENAIRE RTS (Thread2)



ACTIVITY 2.	REAL TIME SIMULATION AT SKYGUIDE
Description	Real Time Simulation
Related Arguments	Arguments List 1.1, 1.3, 2.3 and 3.3 and related HP issues (as per HP log – see Erreur ! Source du renvoi introuvable.)
HP objectives	OBJ-PJ06-01-HP001 OBJ-PJ06-01-HP002 OBJ-PJ06-01-HP003 OBJ-PJ06-01-HP004 OBJ-PJ06-01-HP005
Issues to be addressed / investigated from issues analysis	Refer to section 4.2.1.
Tools/Methods selected out of the hp repository	Over the shoulder observations, questionnaires, debriefings and system logged data analysis.
summary of the HP activity	Observations, debriefings and questionnaires after each run and at the end of the simulation. The questionnaires were agreed with exercise EXE-06.01-V3-VALP-002 and include, among other questions standard questionnaires such as CARS, NASA-TLX, or SHAPE. System data recording, including radar tracks, clearances, Conflict detection tools alerts, separation minima infringements, phone calls, RT communications, Instantaneous Self-assessment rating.

Table 6: Description of Activity 2 Skyguide RTS (Thread 1)



4.4 Step 4 Collate findings & conclude on transition to next V-phase

4.4.1 Summary of HP activities results & recommendations / requirements

The table below summarizes the main results and evidences collected on the HP issues/benefits and reports the associated recommendations and requirements coming from EXE-06.01-V3-VALP-002.

The HP recommendations are split in the following categories:

- Procedural
- Training
- System design and usability



Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	Activity conducted	Results / Evidence	Recommendations	Requirements
Arg. 1.1.1. The description of roles & responsibilities							
ISS-PJ06-01-001	Description of Roles and associated responsibilities may not cover all affected human actors.	Closed	OBJ-06.01-V3-VALP-042	Observations Debriefings	<p>High complexity (Thread 2):</p> <p>The roles and responsibilities covered all human actors.</p> <p>Very high complexity (Thread 1):</p> <p>Overall, Cross-Border FRA solutions in very high complexity environment did not generate any need to</p>		REQ-06.01-SPRINTEROP-HP01.0034. Civil ATS En-Route Service Provider shall define clear and complete role and responsibilities of human actors.





					change the existing Roles and Responsibility distribution in the Team.		
Arg. 1.1.2. The description of roles & responsibilities cover all tasks to be performed by a human actor.							
ISS-PJ06-01-002	Updated/New description of roles & responsibilities may not cover all tasks to be performed by the human actors	Closed	OBJ-06.01-V3-VALP-042	Observations Debriefings	<p>High complexity (Thread 2): The roles and responsibilities covered all tasks to be performed by actors.</p> <p>Very high complexity (Thread 1): The roles and responsibilities covered all tasks and were clear to ATCOs.</p>		REQ-06.01-SPRINTEROP-HP01.0034. Civil ATS En-Route Service Provider shall define clear and complete role and responsibilities of human actors.



Arg. 1.1.3. Roles and responsibilities are clear and consistent (in V1: non-contradictory).							
ISS-PJ06-01-003	Roles and responsibilities could not be clear and consistent. In particular: The task sharing between ATCO team members of adjacent sectors could not be obvious, especially about the decision making of the conflict resolution (Who is in charge to execute the resolution?)	Closed	OBJ-06.01-V3-VALP-042	Questionnaire Debriefings	<p>High complexity [Thread 2]:</p> <p>The roles and responsibilities between the team members were considered clear. Controllers preferred to perform an early release or if not possible coordinate between planning controllers the resolution of a conflict near the border.</p> <p>Very high complexity [Thread 1]:</p>		REQ-06.01-SPRINTEROP-HP01.0034. Civil ATS En-Route Service Provider shall define clear and complete role and responsibilities of human actors.



					Cross-Border FRA solutions in very high complexity environment did not generate any need to change the existing Roles and Responsibility distribution in the Team.		
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Arg. 1.2.5. Operating methods (procedures) can be followed in an accurate, efficient and timely manner.

ISS-PJ06-01-004	Evaluate feasibility of the new/modified operating methods (procedures) for managing traffic complexity	Closed	OBJ-06.01-V3-VALP-047	Questionnaire Debriefings	<p>High complexity [Thread 2]:</p> <p>The working methods were considered clear.</p> <p>Both PC an EC workload remains acceptable in solution under validation in high</p>	<ul style="list-style-type: none"> R-PROC-01- The Letter of Agreement (LoA) should clearly state the information on the transfer conditions (i.e. specifying the actor responsible of resolving a 	REQ-06.01-SPRINTEROP-HP01.0035. Civil ATS En-Route Service Provider shall have well defined operating methods and handover procedures for sector transitions in order to
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				<p>complexity environment.</p> <p>During the final debriefing controllers mentioned they would benefit from a more clear definition of handover procedures during transitions between sectors. This was related to the limited training ATCOs had on the platform.</p> <p>Very high complexity [Thread 1]:</p> <p>ATCOs were asked not to change their current working methods in order to identify any issue and/or required</p>	<p>conflict near the border of a sector) [T1,T2].</p> <ul style="list-style-type: none"> • R-TRAINING-01- The operating methods and procedures in FRA environment must be clear to all the actors. [T1, T2] • R-TRAINING-02- Handover procedures for sector transitions must be clear for all actors. [T1, T2] 	<p>support human performance.</p> <p>REQ-06.01-SPRINTEROP-PC01.0010. The Planning Controller shall be provided with procedures for ACC/sector coordination of flights not necessarily supported by published coordination points.</p> <p>REQ-06.01-SPRINTEROP-PC01.0030. Adjacent ACCs shall consistently apply ATC planning procedures for inter-</p>
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				<p>modification in solution scenarios.</p> <p>The working methods and procedures were considered acceptable in very high complexity environments.</p> <p>Globally, ATCOs considered that they were able to develop and apply appropriate working methods for all scenarios. There was no specific issue detected when managing solution scenarios.</p> <p>Structurally limited cross-border FRA implementation in very</p>		<p>sector coordination across ACCs.</p> <p>REQ-06.01-SPRINTEROP-TC01.0010. The ATCOs should be provided with procedures for tactical coordination of flights not necessarily supported by published coordination points.</p> <p>REQ-06.01-SPRINTEROP-TC01.0030. Adjacent ACCs shall consistently apply ATC procedures for inter-sector tactical coordination across ACCs.</p>
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				<p>high complexity environment does not significantly modify ATCOS working principles and operating methods have not been altered with the use of the adapted ATC support tools.</p> <p>However, it is highlighted that:</p> <ul style="list-style-type: none"> - automation supports takes more importance with the higher variability of trajectories and the more random geographical 		<p>REQ-06.01-SPRINTEROP-HP01.XX01. The Letter of Agreement (LoA) shall clearly state the information on the transfer conditions.</p>
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				<p>distribution of crossing points/ Conflicts.</p> <ul style="list-style-type: none"> - Some uncertainties between sectors conflict resolution occurring close to the boundary between Geneva and Zurich ACCs (after flights exit from one ACC to another one) were observed during the simulation sessions during SOL1 and SOL2 runs, which were also mentioned during the debriefing. - Appropriate training period / sessions are 	
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				<p>required as well as an adaptation period.</p> <p>The FRA structure took vertical and lateral transitions into account, but vertical transitions were addressed in a simplified way. This point is clearly identified as requiring a specific and detailed local study before any cross-border FRA implementation.</p> <p>However, when discussing transition aspects to/from non-FRA environment during the debriefing sessions, no specific</p>	
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					issue was reported for lateral transitions and no specific anticipated issue was expressed by ATCOs about vertical transitions but for ATCOs and OPS experts, it cannot be considered as validated.	
Arg. 1.3.2. Feasibility of tasks in a timely manner.						
ISS-PJ06-01-005	Evaluate feasibility of duty tasks in a timely manner. Potential additional workload may have a negative impact on this aspect.	Closed	OBJ-06.01-V3-VALP-041	Questionnaire Debriefings	High complexity [Thread 2]: The NASA-TLX cognitive workload results indicate that: temporal demand is higher for all roles when a Military	REQ-06.01-SPRINTEROP-HP01.0036. Civil ATS En-Route Service Provider shall provide the capability to human actors to achieve their tasks in a timely





				<p>Area is active. The temporal demand is lower for PC with Advanced Tools in FRA.</p> <p>Both PC an EC workload remains acceptable in solution under validation in high complexity environment.</p> <p>Very high complexity [Thread 1]:</p> <p>ATCOs considered having succeeded in accomplishing their tasks during all runs, no significant variation can be observed between</p>		<p>manner, with limited error rate and acceptable workload level.</p>
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				<p>the reference and solutions scenarios.</p> <p>Conflict detection and resolution have been considered acceptable by ATCOs during all runs.</p> <p>They reported that even if working principles and procedures are not strongly modified in cross-border FRA environment of very high complexity, given the higher variability of trajectories and the more random distribution of crossing points in the airspace (and consequently</p>	
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					conflicts to be solved), the good accomplishment of conflict detection and resolution tasks by ATCOs is more dependent on good ATC support tools support.		
Arg. 1.3.3. How high and very high complexity free route operations impact on controllers' workload.							
ISS-PJ06-01-006	Controllers' workload may be negatively impacted by high and very high complexity free route operations.	Closed	OBJ-06.01-V3-VALP-045	Questionnaire Debriefings	High complexity [Thread 2]: In Free Route environment workload was increased especially to solve conflicts, but the increase is within manageable limits if	<ul style="list-style-type: none"> R-SDU-01- False alerts of CD/R tools should be minimized in order not to increase ATCOs workload [T1, T2]. R-SDU-02- The CD/R tools detection horizon and exit-conflict 	REQ-06.01-SPRINTEROP-HP01.0036. Civil ATS En-Route Service Provider shall provide the capability to human actors to achieve their tasks in a timely manner, with limited error rate and





				<p>supported with the appropriate tools.</p> <p>During the debriefings controllers indicated that the workload distribution between planner and executive controllers is more distributed in FR environment than nowadays. The workload values obtained through the different runs are quite divergent. In some cases, the workload in Solution scenario decrease above 40% compared to Reference scenario. On the other hand, there are trials where the workload in</p>	<p>detection should be fine-tuned to better support ATCOs in FRA environment [T1,T2].</p>	<p>acceptable workload level.</p>
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					<p>Solution scenario increase around 6%-17% compared to the Reference scenario.</p> <p>According to the workload measurements with eyetracker the scenarios with higher workload are the Military and the 2022 scenarios. The use of basic tools require higher workload than the use of advanced tools.</p> <p>Very high complexity [Thread 1]:</p> <p>ATCOs considered having succeeded in</p>	
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					accomplishing their tasks during all runs, no significant variation can be observed between the reference and solutions scenarios.		
Arg. 1.3.4. Level of trust in the new procedures for managing traffic complexity.							
ISS-PJ06-01-007	The new operating methods in FRA could be more complex compare to the ones in ATS route network	Closed	OBJ-06.01-V3-VALP-047	Questionnaire Debriefings	High complexity [Thread 2]: ATCOs considered that the system allowed them to develop and apply the working methods but some features still need to be improved. The advanced tools supported the ATCO tasks, even better than		REQ-06.01-SPRINTEROP-HP01.0036. Civil ATS En-Route Service Provider shall provide the capability to human actors to achieve their tasks in a timely manner, with limited error rate and acceptable workload level.



				<p>in the reference scenario.</p> <p>Very high complexity [Thread 1]:</p> <p>They indicated that procedures were appropriate but can be improved with an adaptation to FRA environment (e.g. no more reference to mandatory Entry/Exit points and a clear definition of conflict resolution responsibilities between contiguous centres, avoiding coordination actions</p>	
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					<p>and contributing to Safety level keeping).</p> <p>Coordination with adjacent units was acceptable to the ATCOs in all three weeks and in all the runs and scenarios.</p> <p>Screen-to-screen electronic coordination tools (ATCOs<>ATCOs) between Geneva and Zurich sectors (similar to the ones available between sectors from the same ACC), have been intensively used and strongly appreciated by ATCOs.</p>	
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Arg. 1.3.5. How high and very high complexity free route operations impact on controllers' situational awareness

<p>ISS-PJ06-01-008</p>	<p>Potential increase of ATCO's Workload and reduction of ATCO's Situational Awareness:</p> <p>-ATCO's Flight Integration could be more complex and demanding in terms of cognitive resources. It may be difficult to know what path the flight is following. The difficulty comes when the building traffic picture composed of many</p>	<p>Closed</p>	<p>OBJ-06.01-V3-VALP-044</p>	<p>Questionnaire Debriefings</p>	<p>High complexity [Thread 2]:</p> <p>ATCOs (both EC and PC) average Situation Awareness was rated in the medium values of the scale. During the debriefings ATCOs mentioned that they felt that their situational awareness within the ATC sector team was enough to adequately perform their tasks.</p> <p>The situational awareness of the planning controller decreases when using</p>	<p>[Redacted]</p>	<p>REQ-06.01-SPRINTEROP-HP01.0036. Civil ATS En-Route Service Provider shall provide the capability to human actors to achieve their tasks in a timely manner, with limited error rate and acceptable workload level.</p>
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<p>different flight trajectories</p> <p>ATCO's Conflict Management:</p> <ul style="list-style-type: none"> -Conflict detection: Controllers may no longer rely on their knowledge of the usual traffic patterns and have to monitor the whole airspace. Many conflicts may occur near sector boundaries and those ones seem to be harder to detect. The lack of traffic structure imposes to extend 				<p>basic tools and when the military area is activated.</p> <p>Controllers indicated that in FR environment situational awareness has decreased a bit with regards to structured routes, due to the spread of possible conflict locations along the sectors. Nevertheless, some controllers pointed out that some sectors with a "STAR" route structure defined improved their situational awareness.</p>		
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<p>the geographical scope of ATCOs situation awareness, more attention has to be dedicated to traffic situations and operational configurations (e.g. ARES activation and shape) in adjacent sectors. The concept of the Area of interest (extension of the Area Of Responsibility) has been proved to fulfil this operational need in Free Routing airspace.</p>				<p>Very high complexity [Thread 1]:</p> <p>TC and PC workload remained acceptable during all runs, there was no observed degradation in solution scenarios compared to reference scenarios.</p> <p>Maintaining situation awareness was reported as more mentally demanding due to the increased variability of the trajectories, but thanks to the adapted ATC support tools, situation awareness has not been degraded in solution scenarios</p>	
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<p>Conflict Resolution: Every conflict is a “new conflict”, probably a recurrent strategy cannot be applied. Some conflicts come with small angles and are more difficult to solve. The biggest issue is nevertheless solving conflicts which occur on sector boundaries.</p> <p>Coordination: Coordination process may be longer and more difficult, as a new solution should be</p>					<p>compared to reference scenarios.</p>		
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	negotiated for every conflicting situation.						
Arg. 2.3.1. Provided information is fit for purpose and satisfies information requirements of the humans.							
ISS-PJ06-01-009	Provided HMI information could not be fit for purpose and thus not supporting controllers in achieving their duty tasks.	Closed	OBJ-06.01-V3-VALP-043	Questionnaire Debriefings	High complexity [Thread 2]: ATCOs (both EC and PC) average Situation Awareness was rated in the medium values of the scale. During the debriefings ATCOs mentioned that they felt that their situational awareness within the ATC sector team was enough to adequately perform their tasks.	<ul style="list-style-type: none"> R-SDU-03- ATCOs should have the possibility to acknowledge a MTCD conflict alert after analysis [T2]. R-SDU-04- MTCD and TCT lookahead time should be fine-tuned in FRA environment [T2]. R-SDU-05- The Crossing Tool, monitoring and display of the Minimum Horizontal 	REQ-06.01-SPRINTEROP-HP01.0037. Civil ATS En-Route Service Provider shall have adequate human machine interface in supporting the human in carrying out their tasks.



				<p>Trust in automation of the executive and planning controllers is increased when using advanced tools.</p> <p>Controllers considered the conflict detection tools (TCT/TTM) as the most useful in the FRA environment. The main concern of ATCOs was on how they could get more familiar the range of the tool, sometimes they considered the range as long, but other times as short. As possible implementation improvements they indicated an improvement on the</p>	<p>Distance (MHD) between any two displayed tracks, should include a Route Mode (to consider actual cleared route) [T1].</p> <ul style="list-style-type: none"> R-SDU-06- ATCO should be able to visualize of planned and alternative trajectories with next or previous waypoint outside sector area of responsibility to improve their SA. [T1].
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				<p>detection precision/accurateness, and the possibility to withdraw an alert after analysis. Controllers indicated that due to the different time horizon MTCD and TCT should not be integrated in one panel, or if integrated it should be easy to distinguish between both.</p> <p>Very high complexity [Thread 1]:</p> <p>Globally, the system was deemed by ATCOs as usable, especially in week 3 (corresponding to the optimized</p>		
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					performance of the platform), which gave the highest ratings whatever the scenarios.		
Arg. 2.3.6. Usability of the user interface (input devices, visual displays/output devices, alarms& alerts)							
ISS-PJ06-01-010	Evaluate Usability of the proposed user interface (input devices, visual displays/output devices, alarms& alerts) for the new/updated items introduced due to free routing operations (if any).	Closed	OBJ-06.01-V3-VALP-043	Questionnaire Debriefings	<p>High complexity [Thread 2]:</p> <p>The overall system usability and information provided are enough but there is room for improvement.</p> <p>Very high complexity [Thread 1]:</p> <p>Globally, the system was deemed by ATCOs as usable, especially in</p>	<ul style="list-style-type: none"> R-SDU-07- The MTCD and TCT alert information should be easily distinguishable and should not be integrated in a single panel [T2]. 	REQ-06.01-SPRINTEROP-HP01.0037. Civil ATS En-Route Service Provider shall have adequate human machine interface in supporting the human in carrying out their tasks.



					week 3 (corresponding to the optimized performance of the platform), which gave the highest ratings whatever the scenarios.		
Arg. 2.3.8. User interface design supports a sufficient level of individual situational awareness.							
ISS-PJ06-01-011	Evaluate that individual situational awareness is not negatively affected by user interface design of the new/updated items introduced due to free routing operations (if any)	Closed	OBJ-06.01-V3-VALP-043	Questionnaire Debriefings	High complexity [Thread 2]: ATCOs (both EC and PC) average Situation Awareness was rated in the medium values of the scale. During the debriefings ATCOs mentioned that they felt that their situational awareness within the ATC sector	<ul style="list-style-type: none"> R-SDU-08- The HMI should provide the ATCOs with a prompt trajectory preview possibility when a flight is accepted [T2]. R-SDU-09- In cross border operations ATCOs should have the possibility to visualize the 	REQ-06.01-SPRINTEROP-HP01.0037. Civil ATS En-Route Service Provider shall have adequate human machine interface in supporting the human in carrying out their tasks.



				<p>team was enough to adequately perform their work.</p> <p>ATCOs recommended that the graphical route of a flight is displayed briefly and automatically when the flight is assumed thus improving situational awareness.</p> <p>Very high complexity [Thread 1]:</p> <p>Situational awareness was enough for TC and not degraded with 2022 amount of traffic in the solutions scenarios.</p>	<p>expected vertical evolution and entry/exit conditions in the Area of responsibility (EFL>XFL) [T1].</p>	
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					Maintaining situation awareness was reported as more mentally demanding due to the increased variability of the trajectories, but thanks to the adapted ATC support tools, situation awareness has not been degraded in solution scenarios compared to reference scenarios.		
Arg. 3.3.1. Intra-team and inter-team communications support the information requirements of team members.							
ISS-PJ06-01-012	Evaluate if the need of specific information (requirements) to achieve new/updated tasks,	Closed	OBJ-06.01-V3-VALP-046	Questionnaire Debriefings	High complexity [Thread 2]: ATCOs considered that communication within	<ul style="list-style-type: none"> R-SDU-10- The coordination information should be provided in a 	REQ-06.01-SPRINTEROP-HP01.0038. Civil ATS En-Route Service Provider shall ensure adequate team





<p>by single team members, is satisfied through intra-team and inter-team communications</p>				<p>the team was good in all the scenarios.</p> <p>Communication within the sector team is better in Free Route with advanced tools than in all the other scenarios including the reference scenario.</p> <p>Coordination with adjacent sectors is considered as good in all the scenarios.</p> <p>Coordination information in the coordination panel disappeared in the moment it was accepted.</p>	<p>timely manner [T2].</p> <ul style="list-style-type: none"> • R-SDU-11- There should be a possibility of having a quick 'undo' option on a proposed coordination should be mandatory [T2]. • R-SDU-12- The extension of the conflict detection horizon of the conflict manager and the exit-conflict detection tools settings beyond Area of Responsibility was 	<p>communication with regard to communication modalities, technical enablers and impact on situation awareness/workload.</p>
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					<p>Very high complexity [Thread 1]:</p> <p>Cross Border FRA solutions in very high complexity environment did not generate any negative impact on internal Team communication. Internal team communication was efficient and unambiguous.</p>	considered useful [T1].	
Arg. 3.3.2. Intra-team and inter-team communications support the information requirements of team members.							
ISS-PJ06-01-013	Evaluate if phraseology supports intra-team and inter-team communication and	Closed	OBJ-06.01-V3-VALP-046		<p>High complexity [Thread 2]:</p> <p>Communication within the sector team is better in Free Route</p>		REQ-06.01-SPRINTEROP-HP01.0038. Civil ATS En-Route Service Provider shall ensure adequate team





<p>there is no lack of support to perform additional/modified tasks</p>				<p>with advanced tools than in all the other scenarios including the reference scenario.</p> <p>During the military scenario there were some communication problems.</p> <p>External communication has also been intensively supported by the use of electronic coordination, which has been reported really good and efficient.</p> <p>Very high complexity [Thread 1]:</p>		<p>communication with regard to communication modalities, technical enablers and impact on situation awareness/workload.</p>
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					<p>Cross Border FRA solutions in very high complexity environment did not generate any negative impact on internal Team communication. Internal team communication was efficient and unambiguous.</p> <p>No specific comment or mention on the phraseology adequacy.</p>		
Arg. 3.3.4. Communications load							
ISS-PJ06-01-014	The communications load may increase due to additional/modified	Closed	OBJ-06.01-V3-VALP-046	Observations Debriefings	<p>High complexity [Thread 2]:</p> <p>No evidence that communication load</p>	<ul style="list-style-type: none"> R-SDU-13-Advanced CPDLC clearances and HMI improvements could bring 	REQ-06.01-SPRINTEROP-HP01.0038. Civil ATS En-Route Service Provider shall ensure





	<p>tasks (e.g. ground-ground)</p>			<p>was increased. The communication was considered efficient in all the scenarios.</p> <p>Very high complexity [Thread 1]:</p> <p>Cross Border FRA solutions in very high complexity environment did not generate any negative impact on internal Team communication. Internal team communication was efficient and unambiguous.</p> <p>Screen-to-screen electronic coordination tools (ATCOs<>ATCOs)</p>	<p>benefits in reducing ATCOs workload associated to air-ground communication [T1].</p>	<p>adequate team communication with regard to communication modalities, technical enablers and impact on situation awareness/workload.</p>
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				<p>between Geneva and Zurich sectors (similar to the ones available between sectors from the same ACC), have been intensively used and strongly appreciated by ATCOs.</p> <p>CPDLC functions were available and have been quite intensively used but mainly for change of frequencies. ATCOs having reported that due to the reduction of the number of available points along the trajectories and in the free route airspace structure, conflict resolution is much</p>		
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					more based on heading clearances instead of direct clearances. This generate additional clearances and workload, compared to direct clearances to intermediate waypoints.		
Arg. 3.3.5. How high-complexity/high density free route operations impact on controllers situational awareness.							
ISS-PJ06-01-015	Controllers situational awareness may be negatively impacted by high-complexity/high density free route operations.	Closed	OBJ-06.01-V3-VALP-044	Questionnaire Debriefings	High complexity [Thread 2]: ATCOs (both EC and PC) average Situation Awareness was rated in the medium values of the scale. During the debriefings ATCOs mentioned that they felt that their		REQ-06.01-SPRINTEROP-HP01.0038. Civil ATS En-Route Service Provider shall ensure adequate team communication with regard to communication modalities, technical enablers and impact on



				<p>situational awareness within the ATC sector team was enough to adequately perform their work.</p> <p>ATCOs recommendation was to display the flight route momentarily when the flight is assumed.</p> <p>Very high complexity [Thread 1]:</p> <p>Situation awareness has not been degraded in solution scenarios compared to reference scenarios and there was no reported specific issue related to</p>		<p>situation awareness/workload.</p>
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					sharing and coherency of situation awareness between Executive and Planner controller during de-briefing sessions.		
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Table 7: Summary of the PJ06.01 HP results and recommendations/ requirements for each identified issue & related argument



4.4.2 Maturity of the Solution

From the completion of the HP maturity criteria checklist for transition from V3 is based on the ‘evidence’ obtained from the HP related validation activities conducted within SESAR PJ06.01, Optimized traffic management to enable free routing in high and very high complexity environments, it can be concluded that the operational concept tested in the validation exercises has reached the V2 level of HP maturity.

The checklist was completed based on the activities conducted and the evidence collected to date, as described in section 4.4.1.

But for next phases, transitions between FRA and Non-FRA sectors should be addressed in more detail. Before a cross-border implementation a RTS with ATCOS in both FRA and Non-FRA sectors must be performed, instead of just using of feeder sectors.

PJ06.01 Maturity checklist for finalising the V3 assessment			
ID	Question	Answer	Comments
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	Y	The present report encloses the HP Assessment report. Relevant arguments, associated HP issues and HP VOs have been addressed in this document (section 4.4.2).
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e. on the level required for V3)?	Y	All benefits and issues have been addressed and the associated evidence provided (section 4.4.2).
3	Have all the parts of the solution/concept been considered?	Y	All parts of the solution scope were assessed. But for next phases, transitions between FRA and Non-FRA sectors should be addressed in more detail. Before a cross-border implementation a RTS with ATCOS in both FRA and Non-FRA sectors must be performed, instead of just using of feeder sectors.

4	Have potential interactions with related projects/concepts been considered and addressed?	Y	The list of projects the solution relates to is reported in OSED part I.
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Y	Refer to results provided in the table in section 4.4.1.
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	Y	Refer to results provided in the table in section 4.4.1.
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	Y	The proposed solution has been tested with end-users in 2 different RTS which covered high and very high complexity environment in scenarios, also they covered the use of advanced ATC tools and military areas.
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Y	Validation results related to the interaction between the human and the system confirm that the concept is operationally feasible but also highly dependent on advanced ATC support tools adequacy in free routing environment and the quality of the actual FRA structure.
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	Y	HP results have provided the input for the HP results in HPAR have been integrated in the OSED.

10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Y	The results do not show blocking point regarding human performance. The main improvements are related to Tools usability aspects a better definition of procedures in transitions between sectors. Human Performance aspects of the concept contribute to the expected KPA.
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Y	HP recommendations were taken into consideration in the HMI design, procedures and training. However, even if they no blocking point points were found some improvements should be carried out before an actual implementation of the concept.
12	Have the major factors that can influence the transition feasibility (e.g. changes in competence requirements, recruitment and selection, training needs, staffing requirements, and relocation of the workforce) been addressed? Are there any ideas on how to overcome any issues?	Y	Transition aspects have been considered in the V3 exercises and in the reporting
13	Have any impacts been identified that may require changes to regulation in the area of HP/ATM? This includes changes in roles & responsibilities, competence requirements, or the task allocation between human & machine.	N	No changes in roles and responsibilities and operating methods regarding the one currently implemented will require regulations changes.
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Y	Recommendations for future research concerning HP aspects have been identified.



Table 8: PJ06.01 HP Maturity checklist for the V3 assessment.



5 References

Human Performance

- [1] 16.06 Strawman Paper on Case Building in SESAR SWP 16.6.
- [2] 16.04.01 Evolution from the ATM HF case to a HP Case Methodology for SESAR, HP assessment process for projects in V1, V2 or V3. D10-001, 00.01.00.
- [3] 06.09.03 D05.1 Single Remote Tower Validation Plan – Appendix Human Performance Assessment Plan.
- [4] 16.06.05 D 27 HP Reference Material D27
- [5] 16.04.02 D04 e-HP Repository - Release note



Appendix A – HP Recommendations Register

HP Recommendations Register									
Reference	Type of recommendation	Recommendation	Rationale	Assessment source + Reference report	Scope (Air, Air/Ground, Ground)	Concept/solution Involved	Recommendation status	Rationale in case of rejection	Comments
R-PROC-01	Procedural	The Letter of Agreement (LoA) should clearly state the information on the transfer conditions (i.e. specifying the actor responsible of resolving a conflict near the border of a sector).	ATCOs reported that procedures are applicable, however the adaptation of LoAs and internal procedures to XFRA environment would contribute to safety level and workload reduction (e.g. some cases of uncertainties about resolution of conflicts	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		



			<p>around Geneva-Zurich ACC border (after flight exit from one ACC to the following one) generated additional coordination actions. [T1]</p> <p>The LoA must be adapted to the new sector configuration and be clear for controllers in both borders and between sectors of the same ACC. There is no need to refer to coordination waypoints in the</p>					
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			border, but reference to flows flying via a waypoint could be needed. [T2]						
R-TRAINING-01	Training	The operating methods and procedures in FRA environment must be clear to all the actors.	ATCOs recommend that procedures and operating methods in FRA environment must be addressed in training to make sure that they are clear to all actors.	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		
R-TRAINING-02	Training	Handover procedures for sector transitions must be clear for all actors.	In the debriefings ATCOs mentioned that in transitions would be	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		



			efficient if the handover procedures between sectors are clear.						
R-SDU-01	System design and usability	The CD/R tools detection horizon and exit-conflict detection should be fine-tuned to better support ATCOs in FRA environment.	Alerts not being reliable: the enhanced MTCD (RKM) was not fully adapted to the FR environment (A/D waypoints, LoA) and caused false alerts.	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		
R-SDU-02	System design and usability	False alerts of CD/R tools should be minimized in order not to increase ATCOs workload.	Alerts not being reliable: the enhanced MTCD (RKM) was not fully adapted to the FR environment	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		



			(A/D waypoints, LoA) and caused false alerts.						
R-SDU-03	System design and usability	ATCOs should have the possibility to acknowledge a MTCD conflict alert after analysis.	ATCOs mentioned as an improvement to improve their workload the possibility to withdraw an alert after it has been analysed. [T2]	Thread 2 RTS	Ground	PJ06.01	Accepted		
R-SDU-04	System design and usability	MTCD and TCT lookahead time should be fine-tuned in FRA environment [T2].	ATCOs found the lookahead was considered the range as long or short according to their experienced workload.	Thread 2 RTS	Ground	PJ06.01	Accepted		



R-SDU-05	System design and usability	The Crossing Tool, monitoring and display of the Minimum Horizontal Distance (MHD) between any two displayed tracks, should include a Route Mode (to consider actual cleared route) [T1].	This recommendation was mentioned by ATCOs as an improvement to the crossing tool functionalities.	Thread 1 RTS	Ground	PJ06.01	Accepted		
R-SDU-06	System design and usability	ATCO should be able to visualize of planned and alternative trajectories with next or previous waypoint outside sector area of responsibility to improve their SA.	The trajectory editor, enabling the visualisation of planned and alternative trajectories, including cross-border trajectories with next or previous waypoint outside sector/ATSU area	Thread 1 RTS	Ground	PJ06.01	Accepted		



			of responsibility, has been considered really efficient by ATCOs.						
R-SDU-07	System design and usability	The MTCD and TCT alert information should be easily distinguishable and should not be integrated in a single panel.	Controllers indicated that due to the different time horizon MTCD and TCT should not be integrated in one panel, or if integrated it should be easy to distinguish between both.	Thread 2 RTS	Ground	PJ06.01	Accepted		
R-SDU-08	System design and usability	The HMI should provide the ATCOs with a prompt trajectory preview	To improve their situation awareness ATCOS suggested upon accepting a	Thread 2 RTS	Ground	PJ06.01	Accepted		



		possibility when a flight is accepted.	flight that they would like to see a trajectory explosion.						
R-SDU-09	System design and usability	In cross border operations ATCOs should have the possibility to visualize the expected vertical evolution and entry/exit conditions in the Area of responsibility (EFL>XFL).	To improve ATCOs SA on entry and exit points are visualized in the flight label and in entry/exit information and to have a better idea of the vertical evolution to be achieved.	Thread 1 RTS	Ground	PJ06.01	Accepted		
R-SDU-10	System design and usability	The coordination information should be provided in a timely manner.	Need to improve the HMI of some functions to more quickly and effectively support ATCOs in	Thread 2 RTS	Ground	PJ06.01	Accepted		



			real time. Functions appointed are coordination panels, CCR request (MTCD) and labels [T2].						
R-SDU-11	System design and usability	There should be a possibility of having a quick 'undo' option on a proposed coordination should be mandatory.	The flight was blocked while the coordination was under negotiation. In some cases the flight had to be modified during this period, so a prompt override/cancel function is considered important.[T2]	Thread 2 RTS	Ground	PJ06.01	Accepted		



R-SDU-12	System design and usability	The extension of the conflict detection horizon of the conflict manager and the exit-conflict detection tools settings beyond Area of Responsibility was considered useful.	In order to support the detection, visualisation and resolution of conflicts, the detection horizon of the conflict manager and the exit-conflict detection tools have been extended to an Area of Interest going slightly beyond the Area of Responsibility.	Thread 1 RTS	Ground	PJ06.01	Accepted		
R-SDU-13	System design and usability	Advanced CPDLC clearances and HMI improvements could bring benefits in reducing ATCOs workload associated	ATCOs reported that due to the reduction of the number of available points along the	Thread 1 RTS	Ground	PJ06.01	Accepted		

Founding Members





		to air-ground communication.	trajectories and in the FRA structure, conflict resolution is much more based on heading clearances instead of direct clearances. This generate additional clearances and workload, compared to direct clearances to intermediate waypoints.						
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Table 9: PJ06.01 HP recommendations (High and very high complexity environment)

Founding Members





Appendix B – HP Requirements Register

HP Requirements Register									
Reference	Type of requirement	Requirement	Rationale	Assessment source + Reference report if available	Scope (Air, Air/Ground, Ground)	Concept / solution Involved	Requirement status	Rationale in case of rejection	Comments
REQ-06.01-SPRINTEROP-HP01.0034	Human Performance	Civil ATS En-Route Service Provider shall define clear and complete role and responsibilities of human actors.	Requirement takes reference in PJ06-01 D2.1.430 HP Plan, where impacts on the following arguments have been identified: • Arg. 1.1.1- Roles & responsibilities	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		



		<p>cover all affected human actors</p> <ul style="list-style-type: none">• Arg. 1.1.2- Descriptions of roles & responsibilities cover all tasks to be performed by the human actors• Arg. 1.1.3- Roles and responsibilities are clear and consistent <p>PJ06.01 HPAR Evidences:</p> <p>Arg. 1.1.1 [Closed]</p> <p>HC/VHC Overall, Cross-Border FRA solutions in high/very high complexity</p>					
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environment did not generate any need to change the existing roles and responsibilities distribution in the Team.

Arg. 1.1.2 [Closed]

HC/VHC The roles and responsibilities covered all tasks and were clear to ATCOs.

Arg 1.1.3 [Closed]

The roles and responsibilities between the team members were considered clear. Controllers preferred to



perform an early release or if not possible coordinate between planning controllers the resolution of a conflict near the border. Controllers raised issues regarding the legal responsibility in case of accident and some related real incidents due to different solving strategies between the upstream and downstream controllers.

Cross-Border FRA solutions in very high complexity (VHC) environment



did not generate any need to change the existing Roles and Responsibility distribution in the Team.

However, some uncertainties between sectors regarding the responsibilities of solving traffic conflicts occurring close to the boundary between Geneva and Zurich ACCs (after flights exit from one ACC to another one) were observed during the simulation sessions during SOL1 and



			SOL2 runs, which were also mentioned during the debriefing.						
REQ-06.01-SPRINTEROP-HP01.0035	Human Performance	Civil ATS En-Route Service Provider shall have well defined operating methods and handover procedures for sector transitions in order to support human performance.	Requirement takes reference in PJ06-01 D2.1.430 HP Plan, where impact on the following argument has been identified: Arg. 1.2.5- Feasibility of new procedures for managing traffic complexity PJ06-01 D2.1.020 Appendix A BIM also identifies for ANSP the impact on	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		



		<p>HP1.2 performance indicator.</p> <p>PJ06.01 HPAR Evidences:</p> <p>Arg. 1.2.5 [Closed]</p> <p>The working methods and procedures were considered acceptable both in high and very high complexity environments.</p> <p>Globally, ATCOs considered that they were able to develop and apply appropriate working methods for all scenarios.</p>					
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In the high complexity environment RTS during the final debriefing controllers mentioned they would benefit from a more clear definition of handover procedures during transitions between sectors. This was related to the limited training ATCOs had on the platform.

The FRA structure took vertical and lateral transitions into account, but vertical transitions



			<p>were addressed in a simplified way. This point is clearly identified as requiring a specific and detailed local study before any cross-border FRA implementation.</p>						
REQ-06.01-SPRINTEROP-HP01.0036	Human Performance	Civil ATS En-Route Service Provider shall provide the capability to human actors to achieve their tasks in a timely manner, with limited error rate and acceptable workload level.	<p>Requirement takes reference in PJ06-01 D2.1.430 HP Plan, where impact on the following arguments has been identified:</p> <ul style="list-style-type: none"> • Arg. 1.3.2- Feasibility of controllers' duty tasks in a timely manner 	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		



- Arg. 1.3.3- How high-complexity/high density free route operations impact on controllers' workload
 - Arg. 1.3.4- Level of trust in the new procedures for managing traffic complexity
 - Arg. 1.3.5- How high-complexity/high density free route operations impact on controllers' situational awareness
- PJ06-01 D2.1.020
Appendix A BIM for



ANSP also identifies the impact on HP1.3 performance indicator at ATC level.

PJ06.01 HPAR Evidences:

Arg. 1.3.2 [Closed]

In High Complexity Environment the NASA-TLX cognitive workload results indicate that: temporal demand is higher for all roles when a Military Area is active. The temporal demand is lower for PC with Advanced Tools in FRA.



		<p>Both PC an EC workload remains acceptable in solution under validation in high complexity environment.</p> <p>In very high complexity environment ATCOs considered having succeeded in accomplishing their tasks during all runs, no significant variation can be observed between the reference and solutions scenarios.</p> <p>Conflict detection and resolution have been considered acceptable by</p>					
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ATCOs during all runs.

They reported that even if working principles and procedures are not strongly modified in cross-border FRA environment of very high complexity, given the higher variability of trajectories and the more random distribution of crossing points in the airspace (and consequently conflicts to be solved), the good accomplishment of conflict detection and resolution tasks



		<p>by ATCOs is more dependent on good ATC support tools support.</p> <p>Arg. 1.3.3 [Closed]</p> <p>HC</p> <p>In Free Route environment workload was increased especially to solve conflicts, but the increase is within manageable limits if supported with the appropriate tools.</p> <p>During the debriefings controllers indicated that the workload</p>					
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distribution between planner and executive controllers is more distributed in FR environment than nowadays. The workload values obtained through the different runs are quite divergent. In some cases, the workload in Solution scenario decrease above 40% compared to Reference scenario. On the other hand, there are trials where the workload in Solution scenario increase around 6%-17% compared to



		<p>the Reference scenario.</p> <p>According to the workload measurements with eyetracker the scenarios with higher workload are the Military and the 2022 scenarios. The use of basic tools require higher workload than the use of advanced tools.</p> <p>VHC</p> <p>ATCOs considered having succeeded in accomplishing their tasks during all runs, no significant variation can be</p>				
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observed between the reference and solutions scenarios.

Arg. 1.3.4 [Closed]

HC

ATCOs considered that the system allowed them to develop and apply the working methods but some features still need to be improved. The advanced tools supported the ATCO tasks, even better than in the reference scenario.

VHC



They indicated that procedures were appropriate but can be improved with an adaptation to FRA environment (e.g. no more reference to mandatory Entry/Exit points and a clear definition of conflict resolution responsibilities between contiguous centres, avoiding coordination actions and contributing to Safety level keeping).

Coordination with adjacent units was acceptable to the



		<p>ATCOs in all three weeks and in all the runs and scenarios.</p> <p>Screen-to-screen electronic coordination tools (ATCOs<>ATCOs) between Geneva and Zurich sectors (similar to the ones available between sectors from the same ACC), have been intensively used and strongly appreciated by ATCOs.</p> <p>Arg. 1.3.5 [Closed]</p> <p>HC</p> <p>ATCOs (both EC and PC) average</p>					
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Situation Awareness was rated in the medium values of the scale. During the debriefings ATCOs mentioned that they felt that their situational awareness within the ATC sector team was enough to adequately perform their tasks.

The situational awareness of the planning controller decreases when using basic tools and when the military area is activated.

Controllers indicated that in FR





environment
situational
awareness has
decreased a bit with
regards to
structured routes,
due to the spread of
possible conflict
locations along the
sectors.
Nevertheless, some
controllers pointed
out that some
sectors with a
“STAR” route
structure defined
improved their
situational
awareness.

VHC

TC and PC workload
remained
acceptable during



all runs, there was no observed degradation in solution scenarios compared to reference scenarios.

Maintaining situation awareness was reported as more mentally demanding due to the increased variability of the trajectories, but thanks to the adapted ATC support tools, situation awareness has not been degraded in solution scenarios compared to reference scenarios.



REQ-06.01-SPRINTEROP-HP01.0037	Human Performance	Civil ATS En-Route Service Provider shall have adequate human machine interface in supporting the human in carrying out their tasks.	<p>Requirement takes reference in PJ06-01 D2.1.430 HP Plan, where impact on the following arguments has been identified:</p> <ul style="list-style-type: none"> • Arg. 2.3.1- Provided information is fit for purpose and satisfies information requirements of the humans • Arg. 2.3.6- Usability of the user interface (input devices, visual displays/output devices, alarms& alerts) 	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		
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• Arg. 2.3.8- User interface design supports a sufficient level of individual situational awareness

PJ06-01 D2.1.020 Appendix A BIM for ANSP also identifies the impact on HP2 performance indicator at ATC level.

Arg. 2.3.1 [Closed]

HC

ATCOs (both EC and PC) average Situation Awareness was rated in the medium values of the scale. During



the debriefings ATCOs mentioned that they felt that their situational awareness within the ATC sector team was enough to adequately perform their tasks.

Trust in automation of the executive and planning controllers is increased when using advanced tools.

Controllers considered the conflict detection tools (TCT/TTM) as the most useful in the FRA environment. The main concern of



ATCOs was on how they could get more familiar the range of the tool, sometimes they considered the range as long, but other times as short. As possible implementation improvements they indicated an improvement on the detection precision/accuracy, and the possibility to withdraw an alert after analysis. Controllers indicated that due to the different time horizon MTCD and TCT should not be integrated in one



panel, or if integrated it should be easy to distinguish between both.

VHC

Globally, the system was deemed by ATCOs as usable, especially in week 3 (corresponding to the optimized performance of the platform), which gave the highest ratings whatever the scenarios.

Arg. 2.3.6 [Closed]

HC/VHC



The overall system usability and information provided are enough but there is room for improvement.

Arg. 2.3.8 [Closed]

HC

ATCOs (both EC and PC) average Situation Awareness was rated in the medium values of the scale. During the debriefings ATCOs mentioned that they felt that their situational awareness within the ATC sector team was enough to



		<p>adequately perform their work.</p> <p>ATCOs recommended that the graphical route of a flight is displayed briefly and automatically when the flight is assumed thus improving situational awareness.</p> <p>VHC</p> <p>Situational awareness was enough for TC and not degraded with 2022 amount of traffic in the solutions scenarios.</p>					
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			Maintaining situation awareness was reported as more mentally demanding due to the increased variability of the trajectories, but thanks to the adapted ATC support tools, situation awareness has not been degraded in solution scenarios compared to reference scenarios.					
REQ-06.01-SPRINTEROP-HP01.0038	Human Performance	Civil ATS En-Route Service Provider shall ensure adequate team communication with regard to	Requirement takes reference in PJ06-01 D2.1.430 HP Plan, where impact on the following	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted	



	<p>communication modalities, technical enablers and impact on situation awareness/workload.</p>	<p>arguments has been identified:</p> <p>Arg. 3.3.1- Intra-team and inter-team communications support the information requirements of team members.</p> <p>Arg. 3.3.2- Phraseology supports for intra-team and inter-team communication</p> <p>Arg. 3.3.4- Communications load</p> <p>Arg. 3.3.5- How high-</p>						
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complexity/high density free route operations impact on controllers situational awareness

Arg. 3.3.1 [Closed]

HC

ATCOs considered that communication within the team was good in all the scenarios.

Communication within the sector team is better in Free Route with advance tools than in all the other scenarios including



		<p>the reference scenario.</p> <p>Coordination with adjacent sectors is considered as good in all the scenarios.</p> <p>Coordination information in the coordination panel disappeared in the moment it was accepted.</p> <p>VHC</p> <p>Cross Border FRA solutions in very high complexity environment did not generate any negative impact on internal Team communication.</p>					
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Internal team communication was efficient and unambiguous

Arg. 3.3.2 [Closed]

HC

Communication within the sector team is better in Free Route with advance tools than in all the other scenarios including the reference scenario.

During the military scenario there were some communication problems.



External communication has also been intensively supported by the use of electronic coordination, which has been reported really good and efficient.

VHC

Cross Border FRA solutions in very high complexity environment did not generate any negative impact on internal Team communication. Internal team communication was



			<p>efficient and unambiguous.</p> <p>No specific comment or mention on the phraseology adequacy.</p> <p>Arg. 3.3.4 [Closed]</p> <p>HC</p> <p>No evidence that communication load was increased. The communication was considered efficient in all the scenarios.</p> <p>VHC</p> <p>Cross Border FRA solutions in very high complexity environment did</p>						
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not generate any negative impact on internal Team communication. Internal team communication was efficient and unambiguous.

Screen-to-screen electronic coordination tools (ATCOs<->ATCOs) between Geneva and Zurich sectors (similar to the ones available between sectors from the same ACC), have been intensively used and strongly appreciated by ATCOs.



		<p>CPDLC functions were available and have been quite intensively used but mainly for change of frequencies. ATCOs having reported that due to the reduction of the number of available points along the trajectories and in the free route airspace structure, conflict resolution is much more based on heading clearances instead of direct clearances. This generate additional clearances and workload, compared to direct</p>					
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clearances to intermediate waypoints.

Arg. 3.3.5 [Closed]

HC

ATCOs (both EC and PC) average Situation Awareness was rated in the medium values of the scale. During the debriefings ATCOs mentioned that they felt that their situational awareness within the ATC sector team was enough to adequately perform their work.



		<p>ATCOs recommendation was to display the flight route momentarily when the flight is assumed.</p> <p>VHC</p> <p>Situation awareness has not been degraded in solution scenarios compared to reference scenarios and there was no reported specific issue related to sharing and coherency of situation awareness between Executive and Planner</p>					
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			controller during de-briefing sessions.					
REQ-06.01-SPRINTEROP-PC01.0010	Human Performance	The Planning Controller shall be provided with procedures for ACC/sector coordination of flights not necessarily supported by published coordination points.	In Free Routing cross-border environment, the need is to cope with the lack of published Coordination Points for user-defined routes across ATSU/sector AoRs (including at the border between neighbouring FRA volumes or within cross-border FRA) to support seamless Free Routing operations. Requirement takes reference in Arg. 1.2.5- Feasibility of	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted	



new procedures for managing traffic complexity

Arg. 1.2.5 [Closed]

The working methods and procedures were considered acceptable both in high and very high complexity environments.

Globally, ATCOs considered that they were able to develop and apply appropriate working methods for all scenarios.

In the high complexity





environment RTS during the final debriefing controllers mentioned they would benefit from a more clear definition of handover procedures during transitions between sectors. This was related to the limited training ATCOs had on the platform.

The present requirement has been agreed and validated with Expert Group during the final requirement SPR



			INTEROP workshop in Madrid.						
REQ-06.01-SPRINTEROP-PC01.0030	Human Performance	Adjacent ACCs shall consistently apply ATC planning procedures for inter-sector coordination across ACCs	<p>Consistent ATC coordination procedures permit seamless Free Routing operations and cross ACC/FIR boundary processing.</p> <p>Requirement takes reference in Arg. 1.2.5- Feasibility of new procedures for managing traffic complexity</p> <p>Arg. 1.2.5 [Closed]</p> <p>The working methods and procedures were considered</p>	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted		



acceptable both in high and very high complexity environments.

Globally, ATCOs considered that they were able to develop and apply appropriate working methods for all scenarios.

In the high complexity environment RTS during the final debriefing controllers mentioned they would benefit from a more clear definition of handover procedures during



			<p>transitions between sectors. This was related to the limited training ATCOs had on the platform.</p> <p>The present requirement has been agreed and validated with Expert Group during the final requirement SPR INTEROP workshop in Madrid.</p>						
REQ-06.01-SPRINTEROP-TC01.0010	Human Performance	The ATCOs should be provided with procedures for tactical coordination of flights not necessarily supported by	In Free Routing environment, some specific rules might need to be defined in order to clearly allocate conflict resolution responsibility in	Thread 1 and 2 RTS	Ground	PJ06.01	Accepted		



	<p>published coordination points.</p>	<p>case of converging flows managed by two contiguous ATC sectors or frequent conflict situations over/close to the ACC/sector boundaries.</p> <p>Requirement takes reference in Arg. 1.2.5- Feasibility of new procedures for managing traffic complexity</p> <p>Arg. 1.2.5 [Closed]</p> <p>The working methods and procedures were considered acceptable both in high and very high</p>						
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complexity environments.

Globally, ATCOs considered that they were able to develop and apply appropriate working methods for all scenarios.

In the high complexity environment RTS during the final debriefing controllers mentioned they would benefit from a more clear definition of handover procedures during transitions between sectors. This was



			<p>related to the limited training ATCOs had on the platform.</p> <p>The present requirement has been agreed and validated with Expert Group during the final requirement SPR INTEROP workshop in Madrid.</p>					
REQ-06.01-SPRINTEROP-TC01.0030	Human Performance	Adjacent ACCs shall consistently apply ATC procedures for inter-sector tactical coordination across ACCs.	Consistent ATC coordination procedures permit seamless Free Routing operations and cross ACC boundary processing.	Thread 1 and 2 RTS	Ground	PJ06.01	Accepted	



Requirement takes reference in Arg. 1.2.5- Feasibility of new procedures for managing traffic complexity.

Arg. 1.2.5 [Closed]

The working methods and procedures were considered acceptable both in high and very high complexity environments.

Globally, ATCOs considered that they were able to develop and apply appropriate working



		<p>methods for all scenarios.</p> <p>In the high complexity environment RTS during the final debriefing controllers mentioned they would benefit from a more clear definition of handover procedures during transitions between sectors. This was related to the limited training ATCOs had on the platform.</p> <p>The present requirement has been agreed and</p>					
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			validated with Expert Group during the final requirement SPR INTEROP workshop in Madrid.					
REQ-06.01-SPRINTEROP-HP01.XX01	Human Performance	The Letter of Agreement (LoA) shall clearly state the information on the transfer conditions.	The adaptation of LoAs and internal procedures to XFRA environment would contribute to safety level and workload reduction (e.g. some cases of uncertainties about resolution of conflicts generated additional coordination actions. Arg. 1.2.5 [Closed]	Thread 1 and Thread 2 RTS	Ground	PJ06.01	Accepted	



The working methods and procedures were considered acceptable both in high and very high complexity environments.

Globally, ATCOs considered that they were able to develop and apply appropriate working methods for all scenarios.

In the high complexity environment RTS during the final debriefing controllers mentioned they would benefit from



a more clear definition of handover procedures during transitions between sectors. This was related to the limited training ATCOs had on the platform.

The FRA structure took vertical and lateral transitions into account, but vertical transitions were addressed in a simplified way. This point is clearly identified as requiring a specific and detailed local study before any



		<p>cross-border FRA implementation.</p> <p>The present requirement has been agreed and validated with Expert Group during the final requirement SPR INTEROP workshop in Madrid.</p>						
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Table 10: PJ06.01 HP Requirements



Appendix C – HP Log



PJ06_01 HP Log_
(2_0).xlsx

Founding Members





END OF DOCUMENT-



Founding Members

