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SESAR Solution 53B SPR-INTEROP/OSED for V3 - Part IV - Human Performance Assessment Report

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PJ18W2 4DSkyways

SOLUTION 53B: IMPROVED PERFORMANCE OF CD/R TOOLS ENABLED BY REDUCED TRAJECTORY PREDICTION UNCERTAINTY

This human performance assessment report is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 872320 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document contains the Human Performance (HP) assessment report for the Solution 18-53B 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 V4 phase.

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1 Executive Summary

This document contains the Human Performance (HP) assessment report for the Solution 18-53b, 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 the transition to next V4 phase.

This solution was built on the work performed in wave 1 solutions PJ.10-02a2 and PJ.18-06a and addresses the improvement of conflict detection and resolution tools derived from the improvement of ground Trajectory Prediction (TP) with the use of advanced data from ATN B2 ADS-C reports messages as defined in the EUROCAE standards ED228A and ED75C and improved meteorological data.

This solution consists of four validation exercises but in terms of HP results only the following four were considered (since EXE-010 was an offline analysis):

- PJ18-W2-53B-V3-EXE-008 -TP improvement and CD&R tools enhancements through multiple data sources (ADS-C, Mode S).
- PJ18-W2-53B-V3-EXE-009 -TP improvement and CD&R tools enhancements through ADS-C data, improved weather information, and AWAs management.
- PJ18-W2-53B-V3-EXE-011 -TP improvement and CD&R tools enhancements through ADS-C data and improved tactical tools.
- PJ18-W2-53B-V3-EXE-012 -TP improvement and CD&R tools enhancements through ADS-C data (Skyguide).

The HP assessment aims to provide the necessary ‘evidence’ to show that the HP arguments impacted have been considered and satisfied by the HP assessment process. This includes identifying HP requirements and recommendations to support the design and development of the concept.

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. The results collected have been used to draft recommendations and requirements to mitigate the identified issues or to ensure the identified benefits.

The level of maturity of the concept at the start of the HP assessment was V2. Therefore, the argument structure for V3 (ongoing) was applied to the solution. Specific HP issues and benefits relating to the concept for each of the relevant arguments were identified based on which HP activities were recommended.

Recommendations and requirements validated at V2 level in previous phase have not been included in this HPAR, they are available at PJ18.53A HPAR.

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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 [1] to derive the HP assessment report for PJ18-53B including requirements and recommendations.

2.2 Intended readership

The intended audience for this document is the other team members of the Solution PJ.18-W2-53B under investigation:

- HP practitioners at the level of the transversal areas are also expected to have an interest in this document.
- Safety assessment expert(s) allocated to the Solution, to allow definition, planning and performance of the safety assessment activities, and to allow proper coordination of the HP assessment with the safety assessment activities, taking advantage of the existing synergy.
- Project Manager/Solution Leader, to allow definition of the way the human performance assessment activities will be embedded into the Design and Validation and how they will contribute to the Project deliverables and identification and planning of Project resources to support the safety assessment tasks.
- Actors responsible for the preparation and conduct of the Validation exercises and ultimately the integration of the collected safety evidence into the Validation Report.
- Actors involved in the design, responsible to produce the TS/IRS documents, to ensure alignment with the outcomes of the safety assessment (Safety Requirements)

Another intended readership for the document is to be found among:

- Other SESAR Solutions within PJ18 that might depend on Solution 53:
    - PJ.18-W2-53A: Increased Automation in Planning and Tactical Separation Management
    - PJ.18-W2-56: Air/Ground Trajectory Synchronisation via Lateral and Vertical Complex CPDLC Clearances to Support TBO
    - PJ.18-W2-57: RBT revision supported by datalink and increased automation
- Other SESAR Projects that might have a dependency on Separation and Monitoring Tools:
    - PJ.10: Controller Tools and Team Organisation for the Provision of Separation in Air Traffic Management
- Transverse and federating projects.
    - PJ. W2-19: Content Integration

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- Stakeholders
    - ANSPs: Management and ATCOs as guidance for the implementation of controller tools.
    - Ground Industry: Management and Engineers as a guidance for building ATM systems and controllers' tools.

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2.3 Structure of the document

This section describes the content of the different chapters:

Section 1 presents the Executive summary.

Section 2 outlines the scope and intended readership as well as the context of the HP work.

Section 3 describes the objective and approach of the HP assessment process.

Section 4 describes the HP assessment of the concept element under investigation including the nature of the change, the identification of argument and issues and the description of the performed HP activities.

Section 5 contains the list of references.

Appendix A contains the final list of HP recommendations to consider in the solution.

Appendix B contains the final list of HP requirements.

Appendix C encloses the HP log file.

2.4 Acronyms

Term	Definition
ACC	Area Control Centre
ADS-C	Automatic Dependent Surveillance – Contract
AIM-I	Assessing the Impact of Automation on Mental Workload
AN	Availability Note
AoI	Area of Interest
AoR	Area of Responsibility
ATM	Air Traffic Management
ATM MP	Air Traffic Management Master Plan
ATN B2	Aeronautical Telecommunications Network Baseline 2
AWA	Adverse Weather Area
CARS	Controller Acceptance Rating Scale
CD/R	Conflict Detection and Resolution
CM	Conflict Management

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Term	Definition
CMON	Conformance Monitoring
CTA	Controlled Time of Arrival
CWP	Controller Working Position
DSS	Decision Support System
DWR	Descent When Ready
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
EC	European Commission
EC	Executive Controller[1]
eFPL	extended Flight PLan
EPP	Extended Projected Profile
E-OCVM	European Operational Concept Validation Methodology
ER	En-Route
FMS	Flight Management System
HC	High Complexity
HMI	Human Machine Interface
HPAP	Human Performance Assessment Plan
INAP	Integrated Network management and extended ATC Planning
INTEROP	Interoperability Requirements
IOMP	Integrated Operational Management Function
IRS	Interface Requirements Specification
ISA	Instantaneous Self-Assessment
KPA	Key Performance Area

[1] Both wordings “Tactical Controller” and “Executive Controller” are used interchangeably within the document.

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Term	Definition
KPI	Key Performance Indicator
LC	Level constraint
LoA	Letter of Agreement
MC	Medium Complexity
ME	Mean Error
MET	Meteorological
MONA	Monitoring Aids
MTCD	Medium Term Conflict Detection
OI	Operational Improvement
OSED	Operational Service and Environment Definition
PC	Planner Controller
RTS	Real Time Simulation
SASHA	Situational Awareness for SHAPE
SATI	SHAPE Automation Trust Index
SESAR	Single European Sky ATM Research Programme
SHAPE	Solutions for Human Automation Partnerships in European ATM
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SMS	Session Manager Position
SPR	Safety and Performance Requirements
STCA	Short Term Conflict Alert
STQ-s	SHAPE Teamwork Questionnaire (short version)
SUT	System Under Test
SWIM	System Wide Information Model
PC	Planner Controller
TCT	Tactical Controller Tool
TESLA	Tactical Encounter SoLver Assistant

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Term	Definition
TMA	Terminal Manoeuvring Area
TP	Trajectory Prediction
TRL	Technology Readiness Level
UAC	Upper Area Control Centre
UC	Use Case
VADS	Very Advanced Display System
VALP	Validation Plan
VALR	Validation Report
VALS	Validation Strategy
VHC	Very High Complexity

Table 1: Acronyms and terminology

2.5 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 *focussing on the variables that determine Human Performance*.
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 focussing on the observable result of human activity in a work context*. 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.

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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. The development of this process constitutes the scope of Project 16.04.01. 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

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3 The Human Performance Assessment Process: Objective and Approach

The purpose of the HP assessment process described in detail in Human Performance Guidance (see latest version in Program Library) is to ensure that HP aspects related to SESAR technical and operational developments are systematically identified and managed.

The SESAR HP assessment process uses an 'argument' and 'evidence' approach. A HP argument is a 'HP claim that needs to be proven'. The aim of the HP assessment is to provide the necessary 'evidence' to show that the HP arguments impacted have been considered and satisfied by the HP assessment process. This includes the identification of HP requirements and recommendations to support the design and development of the concept.

The HP assessment process is a four-step process that 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, a 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 updated and / or added to as the Solution progresses.

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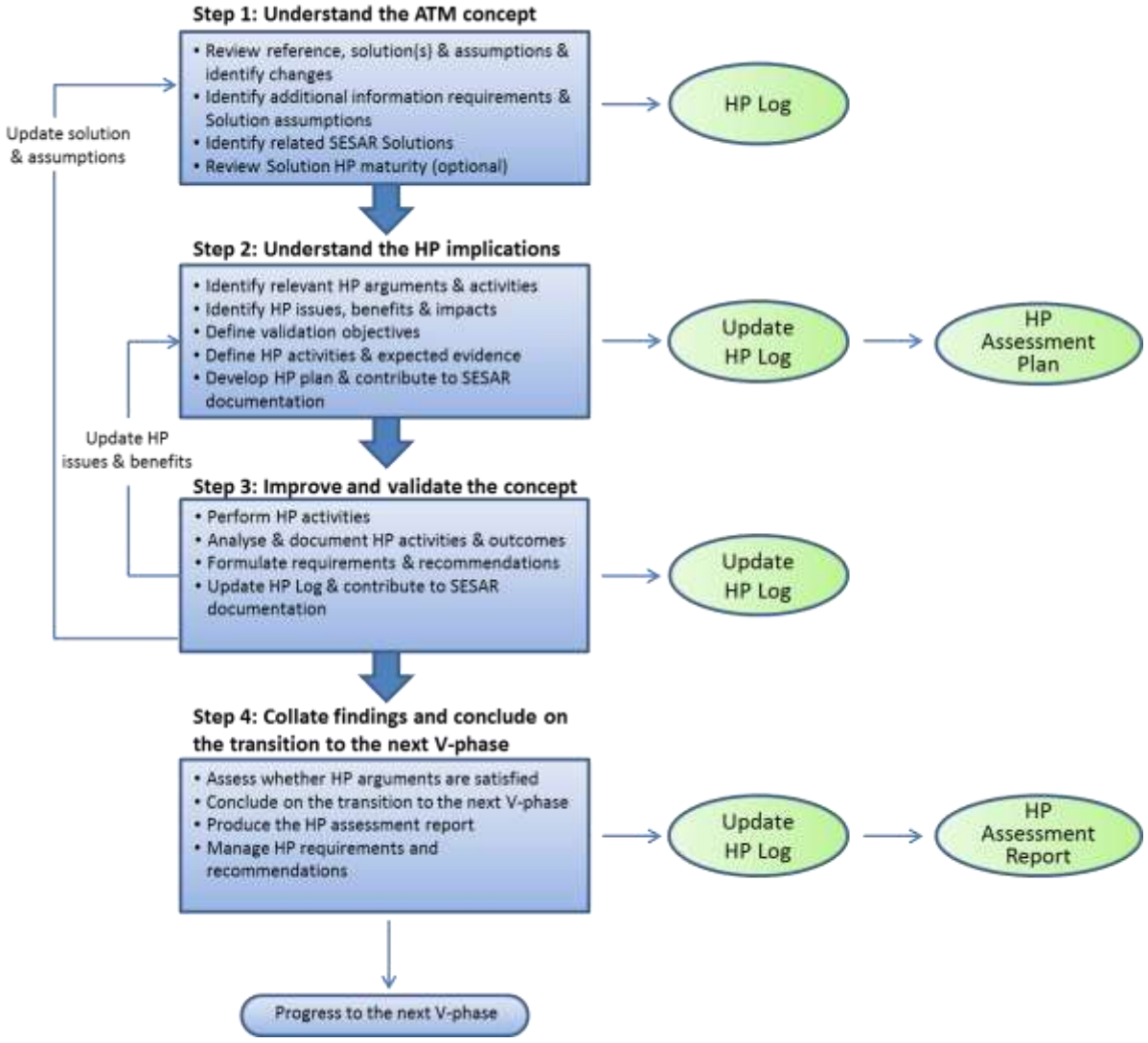

Figure 1: Steps of the HP assessment process

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4 Human Performance Assessment

4.1 Step 1 Understand the ATM concept

4.1.1 Description of reference scenario

Please refer to the VALP Part I section 3 SESAR Solution 18-53B [4] which describes the baseline of the Solution scope. For detailed description of the reference scenarios per validation exercise please refer to the VALP Part I section 5 [4] .

4.1.2 Description of solution scenario

Please refer to the VALP Part I section 3 SESAR Solution 18-53B [4] which describes the baseline of the Solution scope. For detailed description of the reference scenarios per validation exercise please refer to the VALP Part I section 5 [4].

4.1.3 Consolidated list of assumptions

The description of relevant HP assumption can be found in VALP Part I section 4.4 of Solution 18-53B. The assumptions on exercise level can be found in the VALP Part I sections 5.1-5.5.

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

The following solution should be considered for the HP assessment:

- Solution PJ18-W2-53A
- Solution PJ18-W2-56
- PJ10-W2-73

4.1.5 Identification of the nature of the change

The following table provides the nature of the change due to the introduction of the Separation Management and Monitoring Tools addressed by the Solution 18-W2-53B, in terms of the ATM actors impacted as well as the potential changes to their work.

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES	
1.1 ROLES & RESPONSIBILITIES	No change in roles and responsibilities has been identified.
1.2 OPERATING METHODS	Due to new functionality/ies of the CD/R tools (e.g., what next) some minor changes to the

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	operating methods are expected.
1.3 TASKS	Improvements in controller's tasks is expected due to advanced conflict detection and resolution tools. the accuracy and timeliness of ATCO task Performance is expected to improve due to availability of better strategies due to the more accurate information.
2. HUMAN & SYSTEM	
2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)	The allocation of tasks between controller and the machine is expected to improve thanks to the provision of resolution support to the ATCOs for some conflicts and therefore reducing related cognitive workload. Additionally, the support tools reduce to the minimum the need for the ATCOs to actively detect separation infringements and increasing situational awareness through highlighting relevant traffic.
2.2 PERFORMANCE OF TECHNICAL SYSTEM	The performance of technical system is expected to improve due to most accurate trajectory predictions available (including ADS-C), accurate aircraft position and additional advanced MET information. It is expected that the spurious detection of conflicts (nuisance alarms) is decreased to minimum.
2.3 HUMAN – MACHINE INTERFACE	Due to availability of the CD&R tools for both EC and PC at the same time, it is important that the user interface supports specific needs of each position and associated tasks (information accuracy, timeliness, and its presentation).
3. TEAMS & COMMUNICATION	
3.1 TEAM COMPOSITION	No changes in team composition were identified.
3.2 ALLOCATION OF TASKS	No changes in task allocation were identified
3.3 COMMUNICATION	The team situation awareness is expected to improve due to the availability of the same tool for Planner and executive controller.
4. HP RELATED TRANSITION FACTORS	
4.1 ACCEPTANCE & JOB SATISFACTION	Due to availability of more accurate data, and more efficient tools, job satisfaction is expected

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	to increase. The controllers that can solve conflicts in a more efficient manner, and therefore potentially decrease their workload, are likely to have higher job acceptance.
4.2 COMPETENCE REQUIREMENTS	No changes in competence requirements were identified.
4.3 STAFFING REQUIREMENTS & STAFFING LEVELS	Thanks to more efficient tools (more strategic) the complexity of work might decrease, therefore the duration of shifts could be adapted contributing to facilitation of rostering.
4.4. RECRUITMENT AND SELECTION	No changes in recruitment and selection were identified.
4.5. TRAINING NEEDS	No changes in training needed were identified.

Table 3: PJ18.53B description of the change

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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 be “proven” by the 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. From the changes that would result from the introduction of the operational concept it is identified that eight out of twelve the following V3 level HP arguments need to be considered by the HP assessment. Hence the arguments to be considered by the HP assessment process are:

- Argument 1.2: Operating methods (procedures) are 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)
- Argument 2.1: There is appropriate allocation of tasks between the human and the machine
- Argument 2.2: The performance of the technical system supports the human in carrying out their tasks
- Argument 2.3: The design of the HMI supports the human in carrying out their tasks
- Argument 3.3: The communication between team members supports human performance
- Argument 4.1: The proposed solution is acceptable to affected human actors.
- Argument 4.3: Staffing requirements & staffing levels

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. For each issue and / or benefit the impact on human performance as well as system performance (in terms of KPAs) is described. From this, the HP validation objectives can be defined. Based on the general guidance on the satisfaction of HP arguments as well as the HP issues and benefits identified for the PJ.18-53B, the proposed HP activity/ies are described. To provide a more detailed description of the recommended activities as well as the benefits/issues HP Log has been created and added as Annex.

Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Recommended activity/ies
Arg. 1.2.1.	HPI-Arg.1.2-18-W2-53B-001	The operating methods for normal operating conditions for new functionality/ies of the CD&R tool need to be clear and	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers’ tasks and	-Identify/update situations that constitute normal operating conditions in cooperation with the safety

		consistent. If not well defined, there might be a negative impact on human performance increasing the risk for human error. This in turn would have a negative impact on safety.		operating methods (HP argument 1).	and operational specialists & check against the scope of the operating methods. -Liaise the procedure team (operational experts) to define operating methods for normal operating conditions if necessary.
Arg. 1.2.2	HPI-Arg.1.2-18-W2-53B-002	The operating methods for abnormal operating conditions for new functionality/ies of the CD&R tool need to be clear and consistent. If not well defined, there might be a negative impact on human performance increasing the risk for human error. This in turn would have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	-Identify/update situations that constitute abnormal operating conditions in cooperation with the safety and operational specialists & check against the scope of the operating methods. -Liaise the procedure team (operational experts) to define operating methods for normal operating conditions if necessary.
Arg. 1.2.3	HPI-Arg.1.2-18-W2-53B-003	The operating methods for degraded operating conditions for new functionality/ies of the CD&R tool need to be clear and consistent. If not well defined, there might be a negative impact on human performance increasing the risk for human error. This in turn would have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	-Identify/update situations that constitute degraded operating conditions in cooperation with the safety and operational specialists & check against the scope of the operating methods. -Liaise the procedure team (operational experts) to define operating methods for

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					normal operating conditions if necessary.
Arg. 1.2.4.	HPI-Arg.1.2-18-W2-53B-004	The content of operating methods (procedures) for new functionality/ies of the CD&R tool need to be clear and consistent. If not well defined, there might be a negative impact on human performance increasing the risk for human error. This in turn would have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	Review operating methods to ensure they are clear and consistent. The review should be carried out with end users, if necessary, supported by native speakers/linguistic experts.
Arg. 1.2.5	HPI-Arg.1.2-18-W2-53B-005	The changes introduced to the operating methods for normal, abnormal operating conditions and degraded modes of operation for CD&R tools cannot be applied by the end users without causing significant errors and respecting the sequence and timing of actions. This in turn would have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	-Review errors and recovery mean in the solution ATM system (e.g., using fault trees of Accident/Incident Models) & compare with likely errors and recovery means in the reference ATM system.
Arg. 1.3.1	HPB-Arg.1.3-18-W2-53B-001	Availability of more accurate information and CD&R support tools is expected to reduce the potential for human error.	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	-Review errors and recovery mean in the solution ATM system (e.g., using fault trees of Accident/Incident Models) & compare with likely errors and recovery means in the reference ATM system.

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					Perform Cognitive Walkthrough on prototype with identification of likely errors. Assess errors and recovery means in Real-Time Simulation2 or operational trials 3 : -objective methods: observations, data recordings -subjective methods: interviews, debriefings. & Analyse operational impact of errors with safety specialists
Arg. 1.3.2	HPB-Arg.1.3-18-W2-53B-002	Availability of more accurate information and CD&R support tools is expected to reduce time needed for ATCO to perform tasks.	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	-Assess timeliness of actions in Real-Time Simulation or operational trials -objective methods: observations, data recordings -subjective methods: interviews, debriefings.

2 Whenever Real Time Simulations are listed as HP activity, it is assumed that they are to be carried out with representatives end users and under sufficient realistic operational condition

3 Whenever Operational trials are listed as HP activity in V2, it is assumed that they are passive shadow mode trials (i.e. active shadow mode trials are not conducted in V2) .

Arg. 1.3.3	HPB-Arg.1.3-18-W2-53B-003	Availability of more accurate information and CD&R support tools is expected to reduce the level of workload (induced by cognitive and/or physical task demands).	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	Assess workload and underlying factors in Real-Time Simulation and or operational trials: -subjective methods: questionnaires -objective methods: data recordings
Arg. 1.3.4	HPI-Arg.1.3-18-W2-53B-004	Controllers do not trust the benefits brought by the operational changes associated with the CD&R tools. This could have a detrimental impact on human performance, which in turn would have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	Assess trust in Real-Time Simulation or operational trials: - objective methods: observations, data recordings (tool usage) - subjective methods: questionnaires.
Arg. 1.3.5	HPB-Arg.1.3-18-W2-53B-005	Availability of more accurate information and CD&R support tools is expected to increase the level of ATCO's situation awareness.	OBJ-18-W2-53B-V3-HPAP-001	To assess the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods (HP argument 1).	-Assess situational awareness in Real-Time Simulation or operational trials: -subjective methods: questionnaires -objective methods: situational awareness probes
Arg. 2.1.1	HPB-Arg.2.1-18-W2-53B-001	The task allocation between the human and the machine brought by the introduction of CD&R tools is consistent with automation principles improving human	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human	-Identify or update task allocation with respect to consistency with deliverable of 16.5.1 'Guidance material for HP automation support

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		performance in terms of controllers' productivity (CEF2).		performance (HP argument 2).	'12 and/ or other automation guidelines
Arg. 2.1.2	HPB-Arg.2.1-18-W2-53B-002	The task allocation between the human and the machine brought by the introduction of CD&R tools is improving human performance in terms of controllers' productivity (CEF2).	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human performance (HP argument 2).	Identify or update task allocation with respect to consistency with deliverable of 16.5.2 (trade-off between planning and flexibility
Arg. 2.1.3	HPI-Arg.2.1-18-W2-53B-003	In case of transition from automatic to manual modes and vice versa, human-intended or failure induced, if the controller cannot perform tasks in an efficient manner and on time, it might increase the risk for human error. This would have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human performance (HP argument 2).	Assess timeliness and accuracy of transition actions in Real-Time Simulation or operational trials with: -objective methods: observations, data recordings -subjective methods: interviews, debriefings. & Analyse operational impact with safety specialists
Arg. 2.1.4	HPB-Arg.2.1-18-W2-53B-004	Availability of more accurate information and CD&R support tools is expected to reduce the level of workload (induced by cognitive and/or physical task demands).	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human performance (HP argument 2).	-Assess workload and underlying factors in Real-Time Simulation or operational trials with: -subjective methods: questionnaires -objective methods: data recordings

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Arg. 2.1.5	HPI-Arg.2.1-18-W2-53B-005	If the controllers cannot acquire an adequate mental model of the CD&R tool and its automated functions, their performance might be negatively impacted, which in turn would have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human performance (HP argument 2).	-Assess end users' understanding of the technical system's behaviour using think-aloud methods, questionnaires and debriefings in Real Time Simulations or operational trials
Arg. 2.1.6	HPI-Arg.2.1-18-W2-53B-006	Controllers do not trust the benefits brought by automated functions of the CD&R tools. This could have a detrimental impact on human performance, which in turn would have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human performance (HP argument 2).	-Assess trust in automated functions in Real-Time Simulation or operational trials using data recordings and observations
Arg. 2.2.1	HPB-Arg.2.2-18-W2-53B-001	Availability of more accurate information and CD&R support tools is expected to improve human performance by reducing the number of false [low probability] conflicts and allow the better identification of actual conflicts and reducing to the minimum the need for the ATCOs to actively detect separation infringements and increase situational awareness through highlighting relevant traffic.	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human performance (HP argument 2).	Assess information accuracy in prototyping sessions or Real-Time Simulation or operational trials with: -objective methods: observations -subjective methods: questionnaires, debriefings

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Arg. 2.2.2	HPB-Arg.2.2-18-W2-53B-002	Availability of more accurate and timely provided information by the CD&R support tools is expected to improve human performance by reducing the number of false [low probability] conflicts and allow the better identification of actual conflicts and reducing to the minimum the need for the ATCOs to actively detect separation infringements and increase situational awareness through highlighting relevant traffic.	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human performance (HP argument 2).	Assess timeliness of information in prototyping sessions or Real-Time Simulation or operational trials with: -objective methods: observations -subjective methods: questionnaires, debriefings
Arg. 2.3.8	HPI-Arg.2.3-18-W2-53B-008	It is important that the user interface supports specific needs of controllers' tasks. If the level of situational awareness is reduced due to inferior user interface, it might have a negative impact on safety.	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human performance (HP argument 2).	Assess individual situational awareness in Real-Time Simulation or operational trials: - objective methods: observations -subjective methods: questionnaires, debriefings
Arg. 2.3.9	HPI-Arg.2.3-18-W2-53B-009	Due to the availability of the CD&R tools for both EC and PC at the same time, it is important that the user interface supports specific needs of each position and associated tasks. If the level of team situational awareness is	OBJ-18-W2-53B-V3-HPAP-002	To assess the impact of the changes to the technical systems related to the introduction of enhanced CD&R support tools using aircraft data on human	Assess team situational awareness in Real-Time Simulation or operational trials: - objective methods: observations

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		reduced due to inferior user interface, it might have a negative impact on safety.		performance (HP argument 2).	- subjective methods: questionnaires, debriefings
Arg. 3.3.5	HPB-Arg.3.3-18-W2-53B-005	Due to availability of the CD&R tools for both EC and PC, it is expected that team situational awareness will increase.	OBJ-18-W2-53B-V3-HPAP-003	To assess the changes to the team tasks sharing and communication related to the introduction of enhanced CD&R support tools using aircraft data and their impact on human performance (HP argument 3).	Assess team situational awareness in Real-Time Simulation or operational trials: -subjective methods: questionnaires -objective methods: probe methods
Arg. 4.1.2	HPB-Arg.4.1-18-W2-53B-002	It is expected that the benefits brought by the usage of the CD&R support tool will have a positive affective response of the controllers contributing to the overall job satisfaction.	OBJ-18-W2-53B-V3-HPAP-004	To assess the changes to transition factors related to the introduction of CD&R support tools using aircraft data and their impact on human performance (HP argument 4).	Assess acceptability of the proposed changes in Real-Time Simulation or operational trials: -subjective methods: questionnaires and debriefings. Discuss proposed solutions with end users & get feedback on potential impact on job satisfaction.
Arg. 4.3.2	HPB-Arg.4.3-18-W2-53B-002	Thanks to more efficient tools (more strategic) the complexity of work might decrease, therefore the duration of shifts could be adapted contributing to facilitation of rostering.	OBJ-18-W2-53B-V3-HPAP-004	To assess the changes to transition factors related to the introduction of CD&R support tools using aircraft data and their impact on human performance (HP argument 4).	Discuss proposed solutions with controllers & get feedback on potential impact on shift duration and rostering.

Table 4: PJ18.53B HP Arguments, related HP issues and benefits, and proposed HP activity

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4.3 Step 3 Improve and validate the concept

4.3.1 Description of HP activities conducted

This section provides a summary of activities conducted at currently V phase

Activity ID	HP activity	By when
Activity 1	HP & SAF scope and change assessment workshop	December 2020
Activity 2	HP & SAF metrics and indicators workshop	February 2021
Activity 3	EXE-008 /AIRBUS-BULATSA-ENAV	Q3 2022
Activity 4	EXE-009 / DFS-INDRA	Q3 2022
Activity 5	EXE-011 / PANSA-INDRA	Q3 2022
Activity 6	EXE-012 / Skyguide	Q2 2022
Activity 7	HP results and requirements consolidation workshop	12 February 2023

Table 5: Summary of the HP activities

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Activity 1. HP & SAF scope and change assessment workshop	
Description	The aim of the workshop is to discuss with partners the differences between the reference and the Solution's solution scenario, i.e. the changes introduced by the concept and the ATM actors impacted, plus assumptions and constraints and to examine the list of relevant HP arguments (identified earlier through solution documents review).*The aim of the workshop is to discuss with partners the differences between the reference and the Solution's solution scenario, i.e. the changes introduced by the concept and the ATM actors impacted, plus assumptions and constraints and to examine the list of relevant HP arguments (identified earlier through solution documents review).*
Arguments & related issues addressed	Refer to Table 3. HP Arguments, related HP issues and benefits, and proposed HP activity *OBJ-18-W2-53B-V3-HPAP-004*
HP objectives	OBJ-18-W2-53B-V3-HPAP-001 OBJ-18-W2-53B-V3-HPAP-002 OBJ-18-W2-53B-V3-HPAP-003 OBJ-18-W2-53B-V3-HPAP-004
Tools / Methods selected out of the HP repository	Online workshop with SMEs and exercises' partners Structured Walkthrough
Summary of the HP activity	Identification of relevant arguments, HP issues and benefits, preparation of supporting material in coordination with Safety experts

Table 6: Description of Activity 1: HP & SAF scope and change assessment workshop.

ACTIVITY 2. HP & SAF metrics and indicators workshop	
Description	Based on the defined HP validation objectives and their coverage by different solution exercises, identification of appropriate metrics and indicators to obtain necessary evidence
Related Arguments & related issues addressed	Refer to Table 3. HP Arguments, related HP issues and benefits, and proposed HP activity.
HP objectives	OBJ-18-W2-53B-V3-HPAP-001 OBJ-18-W2-53B-V3-HPAP-002 OBJ-18-W2-53B-V3-HPAP-003 OBJ-18-W2-53B-V3-HPAP-004

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Tools/Methods selected out of the HP repository	Online workshop with SMEs and exercise partners Focus group discussion
Summary of the HP activity	Review of the exercise validation plans, mapping of the validation objectives and success criteria, preparation of the portfolio of the appropriate HP tools.

Table 7: Description of Activity 2: HP & SAF metrics and indicators workshop.

ACTIVITY 3. EXE-008 / AIRBUS-BULATSA-ENAV REAL TIME SIMULATIONS	
Description	TP improvement and CD&R tools enhancements through multiple data sources (ADS-C, Mode S)
Related Arguments & related issues addressed	Refer to Table 3. HP Arguments, related HP issues and benefits, and proposed HP activity
HP objectives	OBJ-18-W2-53B-V3-HPAP-001 OBJ-18-W2-53B-V3-HPAP-002 OBJ-18-W2-53B-V3-HPAP-003 OBJ-18-W2-53B-V3-HPAP-004
Tools/Methods selected out of the HP repository	Objective data collection using RTS platform and team speak communication logs. Subjective data collection through questionnaires, structure debriefings, observations. The following KPIs were addressed in the questionnaire: • Workload: Bedford Workload Scale, Instantaneous self-assessment (ISA) and Impact of Automation on Mental Workload (AIM-I). • Situational awareness (SA): China Lake and SASHA (Situational Awareness for SHAPE) questionnaires.
summary of the HP activity	Trajectory based operations are in the focus of the development of Tactical Encounter Solver Assistant (TESLA) tool. Combining data from various sources such EPP and MET reports (downlinked from the aircraft via ADS-C), Mode-S, planned trajectory, ATCOs system inputs, etc. into complex algorithm. The exercise comprised of further V3 development of TESLA processes and functionalities, such as: - Increased level of CD&R aid automation – building on top of "What-If" and "What-Else" functionalities developed and

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	validated in Wave 1, EXE-008 incorporated "What-next" system recommendation element and ranking of resolutions; - Weather avoidance applicability of geo-fencing function used in the CD&R aid logic; - TP improvements thanks to ADS-C Meteo reports and implementation of catch-up manoeuvres. RTS exercise which addressed the EC (Executive Controller) and PC (Planner Controller) aids within TMA and En-route sectors, based on realistic operational constraints. The exercise is based on Sofia TMA, which is Medium Density/ Medium Complexity (MD/MC) and Sofia En-route sector which is classified as High Density/ High Complexity (HD/HC). The en-route sector has both fixed (up to FL175) and FRA operations. 9 licenced and active ATCOs participated in the validation of the tool. The simulated traffic is based on real-traffic recordings from the busiest day in 2019 (pre- COVID 19) increased with 10%. Both nominal, and emergency/abnormal situations were simulated in all the reference and solutions scenarios and military operations and activation of SUAs. The scenarios were distributed accordingly: Ref scenarios 1 and 2 (Traffic +10%), solution scenarios 1 (Traffic +10%, TESLA services, no EPP), 2 (Traffic +10%, TESLA services, 30 % EPP) and 3 (Traffic +10%, TESLA services, 50% EPP). To further simulate the real airspace environment Prohibited, Restricted, Dangerous and Anti-hail volumes of airspace were dynamically incorporated in both reference and solution runs.

Table 8: Description of Activity 3. AIRBUS-BULATSA-ENAV RTS

ACTIVITY 4. EXE-009 / DFS-INDRA REAL TIME SIMULATIONS	
Description	TP improvement and CD&R tools enhancements through ADS-C data, improved weather information, and AWAs management
Related Arguments & related issues addressed	Refer to Table 3. HP Arguments, related HP issues and benefits, and proposed HP activity.
HP objectives	OBJ-18-W2-53B-V3-HPAP-001 OBJ-18-W2-53B-V3-HPAP-002 OBJ-18-W2-53B-V3-HPAP-003 OBJ-18-W2-53B-V3-HPAP-004

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Tools/Methods selected out of the HP repository	Objective data collection using RTS platform Subjective data collection through questionnaires, briefings, interviews, observations.
summary of the HP activity	DFS and Indra (supported by Airbus, PAS@ATM simulator) developed and validated additional TP improvements using further elements of ADS-C EPP to what was done in PJ.18-06a and more recent weather information. The impact on conflict tools and separation management was assessed in a Real time simulation. The following activities were performed in the validation exercise: • Validate planned trajectories TP improvements using ADS-C EPP; • Validate TP improvements by the use of improved Met data processing; • Validate ATCO tools enhancements enabled by TP improvements and the resulting benefits on the level of CD&R. Each activity required separate simulation scenario, in order to assess the single influence factors and also the overall result. The exercise thread scenarios belonged to three according categories: • Exercise thread scenario 1 – TP improvement with EPP; • Exercise thread scenario 2 – TP improvement with weather and adverse weather zone; • Exercise thread scenario 3 – impact on CD&R.

Table 9: Description of Activity 3. EXE009 DFS-INDRA RTS

ACTIVITY 5. EXE-011 / PANSA-INDRA REAL TIME SIMULATIONS	
Description	TP improvement and CD&R tools enhancements through ADS-C data, weather nowcasting, and improved tactical tools
Related Arguments & related issues addressed	Refer to Table 3. HP Arguments, related HP issues and benefits, and proposed HP activity.
HP objectives	OBJ-18-W2-53B-V3-HPAP-001 OBJ-18-W2-53B-V3-HPAP-002 OBJ-18-W2-53B-V3-HPAP-003 OBJ-18-W2-53B-V3-HPAP-004
Tools/Methods selected out of the HP repository	Objective data collection using RTS platform. Subjective data collection through questionnaires, debriefings and observations. The following KPIs were addressed in the questionnaire:

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	• Workload: Bedford scale and Instantaneous self-assessment (ISA); • Situational awareness (SA): SASHA (Situational Awareness for SHAPE) questionnaires.
Summary of the HP activity	Real Time Simulation (RTS) with a traffic generator providing an aircraft (Indra ATM Simulator), addressing the use of the Aircraft Derived Data in particular the use of ADS-C EPP data in ground system (iTEC ATM System). Scenarios were based on real traffic flows in FIR EPWW. To validate new functionalities in real, up to date environment, the scenarios were based on 2022 data. The exercise scenarios were adapted to represent as much as possible the complexity and density of traffic in measured sectors and to be able to validate new functionalities in wide range of traffic configurations. Reference scenario: During the reference scenario, sector team was asked to follow current operational method. The system wasn't fed with simulated EPP data. Samples that were used to carry out exercise were taken from the times of medium traffic. Solution scenario: During the solution scenario, sector team was asked to follow current operational method. The system worked on trajectories calculated with the use of simulated EPP data.

Table 10: Description of Activity 5. EXE-011 / PANSA-INDRA RTS

ACTIVITY 6. EXE-012 / Skyguide REAL TIME SIMULATIONS	
Description	TP improvement and CD&R tools enhancements through ADS-C data
Related Arguments & related issues addressed	Refer to Table 3. HP Arguments, related HP issues and benefits, and proposed HP activity.
HP objectives	OBJ-18-W2-53B-V3-HPAP-001 OBJ-18-W2-53B-V3-HPAP-002 OBJ-18-W2-53B-V3-HPAP-003 OBJ-18-W2-53B-V3-HPAP-004
Tools/Methods selected out of the HP repository	Objective data collection using RTS platform. Subjective data collection through questionnaires, debriefings and observations. The following KPIs were addressed in the questionnaire:

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	• Operational Acceptability: CARS; • Usability: Customised questionnaire; • Situation Awareness: Customised questionnaire; • Team situation awareness: Customised questionnaire; • Workload: Bedford scale and Instantaneous self-assessment (ISA); Time spent on tasks (R/T communication and phone coordination versus CPDLC clearances + e-coordinations); and taskload customised questionnaire; • Technical performance (customised questionnaire)
Summary of the HP activity	Skyguide performed a V3 Real Time Simulation (RTS), based on Wave 1 validation exercises (PJ.10-02a1 and PJ.18-02a) in order to address the use of the Aircraft Derived Data in particular the use of ADS-C data (EPP, Speed schedule). Skyguide performed a V3 Real Time Simulation (RTS), based on Wave 1 validation exercises (PJ.10-02a1 and PJ.18-02a) in order to address the use of the Aircraft Derived Data in particular the use of ADS-C data (EPP, Speed schedule). Assessment mainly focused on: • Measuring the improvement in the Trajectory Prediction tool thanks to more aircraft data; ○ *TP precision improvements will be validated by offline analysis of recorded exercises data.* • Measuring the improvement in Conflict Detection & Resolution thanks to more accurate aircraft downlinked data and enhanced Trajectory Prediction. • ATCO interaction and acceptability of the improved Conflict Detection tools and HMI (*Through Trajectory display (horizontally and vertically); Conflicts display; What-if HMI and display)* Reference scenarios was based on traffic from 2019 summer period (June-July), corresponding to highest traffic volumes in the year. The solution scenarios were based on single Free Routing Airspace cells, two variants of the scenario addressing 2019 and 2035 traffic demand have been played. The real time simulations (RTS) were performed in May 2022. A total of 13 runs were conducted (2 training and 11 measured) over the 5 days of RTS.

Table 11: Description of Activity 6. EXE-012 / Skyguide E-011 / PANSA-INDRA RTS

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ACTIVITY 7. HP results and requirements consolidation workshop	
Description	Online workshop with SMEs, OSED/INTEROP/SPR lead and exercises' partners: • to consolidate at the solution level the HP results; • to discuss identified HP recommendations and requirements; • to discuss the HP maturity aspects of the solution.
Related Arguments & related issues addressed	Refer to Table 3. HP Arguments, related HP issues and benefits, and proposed HP activity.
HP objectives	OBJ-18-W2-53B-V3-HPAP-001 OBJ-18-W2-53B-V3-HPAP-002 OBJ-18-W2-53B-V3-HPAP-003 OBJ-18-W2-53B-V3-HPAP-004
Tools/Methods selected out of the HP repository	Focus group/ Workshop
summary of the HP activity	Analysis of the HP evidence obtained in the exercises and their consolidation to feed into HP validation objectives and associated success criteria and identification of HP requirement.

Table 12: Description of Activity 7. HP results and requirements consolidation workshop

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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 with the relevant arguments, HP issues & benefits and HP activities, in Section 4.2.1, provides a summary of the HP argument and related issues / benefits along with the HP activity (ies) conducted. It reports on the outcomes of HP issues that were included into the HP assessment plan. For each argument and issue / benefit the results/evidence obtained from the activities conducted were briefly described along with the recommendations and / or requirements generated.

The status of each HP issue was also given. The status of an issue / benefit can either be 'closed', 'open', 'cancelled': an issue is considered 'closed' when the issue had been sufficiently answered or no additional activities relating to that issue are foreseen as necessary; an issue is considered as being 'open' when the issue has been either: partially addressed and more studies are needed or; the issue had been addressed by certain activities but as a result other related issues had arisen or; when no activity has been performed to date to address a specific issue. An issue is considered as being 'cancelled' when the activities conducted have shown the issue to be not relevant to the given concept under investigation.

The HP recommendations and requirements fall into one of several categories:

- System design
- OPS (operating methods / procedures)
- New objective
- Training
- Other

In addition, HP recommendations can relate to test and validation activities that need to be conducted in later V phases to investigate issues/benefits and potential mitigation in more detail.

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Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.							
HPI-Arg.1.2-18-W2-53B-001	The operating methods for normal operating conditions for new functionality/ies of the CD&R tool need to be clear and consistent. If not well defined, there might be a negative impact on human performance increasing the risk for human error. This in turn would have a negative	Closed	OBJ-18-W2-53B-V3-HPAP-001	RTS	The operating methods in normal operations were considered clear and exhaustive. The results show good level of acceptability and suitability of the new tools and operating method. Having aircraft with different capabilities can bring different level and accuracy of information. This requires dynamic adaptation of conflict detection processes which could have an impact on ATCO's working methods, therefore, it is	R-PJ18-W2-53B-SDU-02. The information about the conflict detection quality assessment (figure of merit) should be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary. R-PJ18-W2-53B-OTHER-02. Ground-air communication aspects, namely phraseology and CPDLC wording should be further investigated for the Descent When Ready (DWR) function.	REQ-PJ18-W2-53B-TRAINING-01. Appropriate training (theoretical and on-the-job training) shall be developed to familiarise ATCOs with the new functionalities, capabilities and enhancements (CD&R tools).

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	impact on safety.				recommended to inform ATCOs about the conflicts accuracy.		
Arg. 1.2.2: Operating methods cover operations in abnormal operating conditions.							
HPI-Arg.1.2-18-W2-53B-002	The operating methods for abnormal operating conditions for new functionality/ies of the CD&R tool need to be clear and consistent. If not well defined, there might be a negative impact on human performance increasing the risk for human error. This in turn would have a negative	Closed	OBJ-18-W2-53B-V3-HPAP-001	Stakeholder workshop	The operating methods covered abnormal operating scenarios the enhanced CD&R tools and were considered clear and consistent. EXE011 implementation of the enhanced tools was not considered mature enough to conclude on this point.	R-PJ18-W2-53B-SDU-02. The information about the conflict detection quality assessment (figure of merit) should be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary.	REQ-PJ18-W2-53B-TRAINING-01. Appropriate training (theoretical and on-the-job training) shall be developed to familiarise ATCOs with the new functionalities, capabilities and enhancements (CD&R tools).

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	impact on safety.						
Arg. 1.2.3: Operating methods cover degraded modes of the ATM system.							
HPI-Arg.1.2-18-W2-53B-003	The operating methods for degraded operating conditions for new functionality/ies of the CD&R tool need to be clear and consistent. If not well defined, there might be a negative impact on human performance increasing the risk for human error. This in turn would have a negative	Open	OBJ-18-W2-53B-V3-HPAP-001	Stakeholder workshop	Degraded scenarios were not considered as part of the exercise. However, in some runs of EXE01 there was loss of EPP, CD&R tools are designed to dynamically revert to "classical" functioning mode (flight data treating without EPP) and ATCOs were informed with the appropriate warning (reverting to reference scenario CD&R tools performance). ATCOs managed the loss of EPP without problems. Operating methods are clear, exhaustive and support ATCO's		REQ-PJ18-W2-53B-TRAINING-01. Appropriate training (theoretical and on-the-job training) shall be developed to familiarise ATCOs with the new functionalities, capabilities and enhancements (CD&R tools).

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	impact on safety.				performance even with EPP loss.		
Arg. 1.2.4: The content of operating methods is clear and consistent (in V1: non-contradictory).							
HPI-Arg.1.2-18-W2-53B-004	The content of operating methods (procedures) for new functionality/ies of the CD&R tool need to be clear and consistent. If not well defined, there might be a negative impact on human performance increasing the risk for human error. This in turn would have a negative impact on safety.	Closed	OBJ-18-W2-53B-V3-HPAP-001	Stakeholder workshop.	The operating methods were considered clear and consistent in all exercises. In EXE009 the background of the improvement by ADS-C EPP and higher granularity for weather data was understood. In EXE012 the level of task performance appears to have increased and the level of workload to be reduced.		

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Arg. 1.2.5: Operating methods can be followed in an accurate, efficient, and timely manner.							
HPI-Arg.1.2-18-W2-53B-005	The changes introduced to the operating methods for normal, abnormal operating conditions and degraded modes of operation for CD&R tools cannot be applied by the end users without causing significant errors and respecting the sequence and timing of actions. This in turn would have a negative impact on safety.	Closed	OBJ-18-W2-53B-V3-HPAP-001	RTS	Operating methods were considered clear, exhaustive and support ATCO's performance for normal and abnormal scenarios. However, in few rare occasions during EXE008 the presentation of conflict trajectories when multiple aircraft were involved was considered to be overwhelming. Degraded scenarios should be further investigated in future steps.	R-PJ18-W2-53B-OPS-02. In TMA, ATCOs may need additional advanced sequencing support in order to improve CD&R tool use.	

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Arg. 1.3.1: The potential for human error is reduced as far as possible.							
HPB-Arg.1.3-18-W2-53B-001	Availability of more accurate information and CD&R support tools is expected to reduce the potential for human error.	Closed	OBJ-18-W2-53B-V3-HPAP-001	RTS	Operating methods are clear, exhaustive and support ATCO's performance. The results show good level of acceptability and suitability of the new tools and operating method although the compatibility was assessed less satisfactory. However, in few rare occasions during EXE008 the presentation of conflict trajectories when multiple aircraft were involved was considered to be overwhelming.	R-PJ18-W2-53B-OTHER-02. Ground-air communication aspects, namely phraseology and CPDLC wording should be further investigated for the Descent When Ready (DWR) function. R-PJ18-W2-53B-OPS-02. In TMA, ATCOs may need additional advanced sequencing support in order to improve CD&R tool use.	
Arg. 1.3.2: Tasks can be achieved in a timely manner							
HPB-Arg.1.3-	Availability of more accurate	Closed	OBJ-18-W2-53B-	RTS	ATCOs mentioned that tasks could be		

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18-W2-53B-002	information and CD&R support tools is expected to reduce time needed for ATCO to perform tasks.		V3-HPAP-001		achieved on a timely manner. The level of ATCOs workload was reduced in the solutions scenarios. Less time lost on spurious conflicts analysis and less calculation thanks to advanced visualization of aircraft intent and performance.		
Arg. 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable.							
HPB-Arg.1.3-18-W2-53B-003	Availability of more accurate information and CD&R support tools is expected to reduce the level of workload (induced by cognitive and/or physical task demands).	Closed	OBJ-18-W2-53B-V3-HPAP-001	RTS	The level of workload in EXE008 and EXE012 was reduced in the solution scenarios.		
Arg. 1.3.4: The level of trust in the new concept/the new procedures is appropriate.							

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HPI-Arg.1.3-18-W2-53B-004	Controllers do not trust the benefits brought by the operational changes associated with the CD&R tools. This could have a detrimental impact on human performance, which in turn would have a negative impact on safety.	Open	OBJ-18-W2-53B-V3-HPAP-001	RTS	The level of trust and reliability were rated between medium to high by controllers on average and remained at an acceptable level.	R-PJ18-W2-53B-OPS-01. Concerning the Advanced Descent When Ready (DWR) function ATCOs may need to be supported by a new monitoring function on the descent profile of flights. R-PJ18-W2-53B-SDU-02. The information about the conflict detection quality assessment (figure of merit) should be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary. R-PJ18-W2-53B-SDU-04. Advanced visualization and EPP report features should clearly inform and display the flight phase considered by FMS.	REQ-PJ18-W2-53B-TRAINING-01. Appropriate training (theoretical and on-the-job training) shall be developed to familiarise ATCOs with the new functionalities, capabilities and enhancements (CD&R tools).

Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.

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HPB-Arg.1.3-18-W2-53B-005	Availability of more accurate information and CD&R support tools is expected to increase the level of ATCO's situation awareness.	Closed	OBJ-18-W2-53B-V3-HPAP-001	RTS	In EXE012 the ATCOs managed to maintain an acceptable situational awareness level. In EXE008 the ATCOs' SA was improved due to more accurate information and CD&R support.	R-PJ18-W2-53B-SDU-01. The colour coding and visibility of the information of enhanced tactical CD&R tool should support the ATCO in having a clear understanding of multiple conflicting trajectories. R-PJ18-W2-53B-SDU-02. The information about the conflict detection quality assessment (figure of merit) should be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary. R-PJ18-W2-53B-SDU-03. Advanced visualization of flight trajectory should clearly inform and distinguish between cleared and predicted trajectory parts.	

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						R-PJ18-W2-53B-SDU-04. Advanced visualization and EPP report features should clearly inform and display the flight phase considered by FMS.	
Arg. 2.1.1: The task allocation between the human and the machine is consistent with automation principles.							
HPB-Arg.2.1-18-W2-53B-001	The task allocation between the human and the machine brought by the introduction of CD&R tools is consistent with automation principles improving human performance in terms of controllers' productivity (CEF2).	Open	OBJ-18-W2-53B-V3-HPAP-002	RTS	ATCO feedback on CD&R impact of improved TP revealed that a resulting higher accuracy of conflict detection will support the ATCOs in carrying out their tasks (easily detect and resolve conflicts). This indicate an acceptable task allocation between the human and machine, consistent with automation principles and supporting ATCOs' performance.	R-PJ18-W2-53B-OPS-02. In TMA, ATCOs may need additional advanced sequencing support in order to improve CD&R tool use. R-PJ18-W2-53B-OTHER-01. Next steps should further explore how to improve the relevance and behaviour of the Advanced Descent When Ready (DWR) function according to different FMS capabilities.	

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					In EXE008 the ATCOs were able to easily detect and resolve conflicts. However, the TMA ATCOs' didn't consider the provided resolutions as useful as the ENR ATCOs. Even if ATCOs considered the resolutions were correct they did not always correspond to ATCOs' plan. Advanced sequencing support is needed for landing aircraft.		
Arg. 2.1.2 Changes to the task allocation between human and machine support human performance.							
HPB-Arg.2.1-18-W2-53B-002	The task allocation between the human and the machine brought by the introduction of CD&R tools is improving	Open	OBJ-18-W2-53B-V3-HPAP-002	RTS	ATCO feedback on CD&R impact of improved TP revealed that a resulting higher accuracy of conflict detection will support the ATCOs in carrying out their tasks (easily	R-PJ18-W2-53B-OTHER-01. Next steps should further explore how to improve the relevance and behaviour of the Advanced Descent When Ready (DWR) function	

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	human performance in terms of controllers' productivity (CEF2).				detect and resolve conflicts). In EXE012 DWR tool conflict detection must be reliable as well as aircraft evolution monitoring tool. Any deviation from predicted evolution envelope could generate unexpected conflicts.	according to different FMS capabilities.	
Arg. 2.1.3: Transition from automatic to manual modes and vice versa, human-intended or failure induced, can be performed by the human actors in a timely, efficient, and accurate manner.							
HPI-Arg.2.1-18-W2-53B-003	In case of transition from automatic to manual modes and vice versa, human-intended or failure induced, if the controller cannot perform tasks in an efficient	Open	OBJ-18-W2-53B-V3-HPAP-002	RTS	The transition between automatic to manual modes was not directly addressed in scenarios. However, in EXE008, based on observations during the validation we can say the ATCOs didn't rely solely on the tool to detect and provide resolutions for		

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	manner and on time, it might increase the risk for human error. This would have a negative impact on safety.				conflicts. They executed their tasks as like in operational environment, constantly scanning for potential conflicts and considered different resolutions for identified conflicts.		
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.							
HPB-Arg.2.1-18-W2-53B-004	Availability of more accurate information and CD&R support tools is expected to reduce the level of workload (induced by cognitive and/or physical task demands).	Open	OBJ-18-W2-53B-V3-HPAP-002	RTS	In EXE008 and EXE012 the level of ATCOs workload was reduced in the solution scenarios.		
Arg. 2.1.5: Human actors can acquire an adequate mental model of the machine and its automated functions.							
HPI-Arg.2.1-18-W2-	If the controllers cannot acquire	Open	OBJ-18-W2-53B-	RTS	Based on general feedback the visualization of	R-PJ18-W2-53B-SDU-01. The colour coding and visibility of the	REQ-PJ18-W2-53B-TRAINING-01. Appropriate training (theoretical and

53B-005	an adequate mental model of the CD&R tool and its automated functions, their performance might be negatively impacted, which in turn would have a negative impact on safety.		V3-HPAP-002		detected conflicts and proposed resolutions is intuitive and easy to understand. ATCOs were able to acquire an adequate mental model of the tools. In EXE012 concerning the Descent When Ready (DWR) function, ATCOs you need to be sure that the a/c is targeting the planned optimal descent and does not deviate beyond margins exceeding conflict detection envelope. DWR conflict detection tool must be reliable as well as aircraft evolution monitoring tool. For Level constraint (LC), the what-if needs to be improved.	information of enhanced tactical CD&R tool should support the ATCO in having a clear understanding of multiple conflicting trajectories. R-PJ18-W2-53B-SDU-02. The information about the conflict detection quality assessment (figure of merit) should be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary. R-PJ18-W2-53B-SDU-03. Advanced visualization of flight trajectory should clearly inform and distinguish between cleared and predicted trajectory parts. R-PJ18-W2-53B-SDU-04. Advanced visualization and EPP report features	on-the-job training) shall be developed to familiarise ATCOs with the new functionalities, capabilities and enhancements (CD&R tools).

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						should clearly inform and display the flight phase considered by FMS.	
Arg. 2.1.6: The level of trust in automated functions is appropriate.							
HPI-Arg.2.1-18-W2-53B-006	Controllers do not trust the benefits brought by automated functions of the CD&R tools. This could have a detrimental impact on human performance, which in turn would have a negative impact on safety.	Open	OBJ-18-W2-53B-V3-HPAP-002	RTS	CD&R tools with improved performance worked in a reliable way and supported ATCOs trust. Concerning trust in the new functions tested by EXE012 ATCOs reported some reservations: • DWR with pilots may be misunderstood by pilots as that they can descend at any time. • IF LC is exceeding the cost index limitation, the FMS may accept it	R-PJ18-W2-53B-OPS-01. Concerning the Advanced Descent When Ready (DWR) function ATCOs may need to be supported by a new monitoring function on the descent profile of flights. R-PJ18-W2-53B-SDU-02. The information about the conflict detection quality assessment (figure of merit) should be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary. R-PJ18-W2-53B-SDU-04. Advanced visualization and EPP report features	REQ-PJ18-W2-53B-TRAINING-01. Appropriate training (theoretical and on-the-job training) shall be developed to familiarise ATCOs with the new functionalities, capabilities and enhancements (CD&R tools).

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					initially (with profile evolving to meet the LC) but ultimately the LC cannot be met, generating an alert. In this case, the ATCO may think that the LC is met, but in the end if may not be met.	should clearly inform and display the flight phase considered by FMS.	
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.							
HPB-Arg.2.2-18-W2-53B-001	Availability of more accurate information and CD&R support tools is expected to improve human performance by reducing the number of false [low probability] conflicts and allow the better	Closed	OBJ-18-W2-53B-V3-HPAP-002	RTS	ATCO feedback on CD&R impact of improved TP revealed that a resulting higher accuracy of conflict detection will support the ATCOs in carrying out their tasks (easily detect and resolve conflicts). In EXE008 the ATCOs were able to easily detect and resolve		

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	identification of actual conflicts and reducing to the minimum the need for the ATCOs to actively detect separation infringements and increase situational awareness through highlighting relevant traffic.				conflicts. However, the TMA ATCOs' didn't consider the provided resolutions as useful as the ENR ATCOs. Even if ATCOs considered the resolutions were correct they did not always correspond to ATCOs' plan. Advanced sequencing support is needed for landing aircraft.		
Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.							
HPB-Arg.2.2-18-W2-53B-002	Availability of more accurate and timely provided information by the CD&R support tools is expected to improve human performance by reducing the	Closed	OBJ-18-W2-53B-V3-HPAP-002	RTS	ATCO feedback on CD&R impact of improved TP revealed that a resulting higher accuracy of conflict detection will support the ATCOs in carrying out their tasks (easily detect and resolve conflicts). Overall, the timeliness of the		

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	number of false [low probability] conflicts and allow the better identification of actual conflicts and reducing to the minimum the need for the ATCOs to actively detect separation infringements and increase situational awareness through highlighting relevant traffic.				information was considered acceptable.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]							
HPI-Arg.2.3-18-W2-53B-008	It is important that the user interface supports specific needs of controllers'	Closed	OBJ-18-W2-53B-V3-HPAP-002	RTS	In EXE012 the ATCOs managed to maintain an acceptable situational awareness level.	R-PJ18-W2-53B-SDU-01. The colour coding and visibility of the information of enhanced tactical CD&R tool should support the ATCO	

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	tasks. If the level of situational awareness is reduced due to inferior user interface, it might have a negative impact on safety.				In EXE008 the ATCOs' SA was improved due to more accurate information and CD&R support.	in having a clear understanding of multiple conflicting trajectories. R-PJ18-W2-53B-SDU-02. The information about the conflict detection quality assessment (figure of merit) should be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary. R-PJ18-W2-53B-SDU-03. Advanced visualization of flight trajectory should clearly inform and distinguish between cleared and predicted trajectory parts. R-PJ18-W2-53B-SDU-04. Advanced visualization and EPP report features should clearly inform and	

						display the flight phase considered by FMS.	
Arg. 2.3.9: The user Interface design supports a sufficient level of team situational awareness. [V1: AIR only]							
HPI-Arg.2.3-18-W2-53B-009	Due to the availability of the CD&R tools for both EC and PC at the same time, it is important that the user interface supports specific needs of each position and associated tasks. If the level of team situational awareness is reduced due to inferior user interface, it might have a negative impact on safety.	Closed	OBJ-18-W2-53B-V3-HPAP-002	RTS	Results show that team situational awareness has been maintained. New visualization of aircraft performance (EPP content) was considered adequate and supported a common situation awareness.	R-PJ18-W2-53B-SDU-01. The colour coding and visibility of the information of enhanced tactical CD&R tool should support the ATCO in having a clear understanding of multiple conflicting trajectories. R-PJ18-W2-53B-SDU-02. The information about the conflict detection quality assessment (figure of merit) should be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary. R-PJ18-W2-53B-SDU-03. Advanced visualization of flight trajectory should	

						clearly inform and distinguish between cleared and predicted trajectory parts. R-PJ18-W2-53B-SDU-04. Advanced visualization and EPP report features should clearly inform and display the flight phase considered by FMS.	
Arg. 3.3.5: Team members can maintain a sufficient level of shared situation awareness.							
HPB-Arg.3.3-18-W2-53B-005	Due to availability of the CD&R tools for both EC and PC, it is expected that team situational awareness will increase.	Open	OBJ-18-W2-53B-V3-HPAP-003	RTS	Results show that team situational awareness has been maintained. New visualization of aircraft performance (EPP content) was considered adequate and supported a common situation awareness. In EXE011 the results on team situational awareness (SASHA)	R-PJ18-W2-53B-OTHER-02. Ground-air communication aspects, namely phraseology and CPDLC wording should be further investigated for the Descent When Ready (DWR) function.	

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					were contrasting because ATCOs reported that the situational awareness was decreased. The use of a new system during the validation and the lack of stability of the platform could partly explain the results.		
Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.							
HPB-Arg.4.1-18-W2-53B-002	It is expected that the benefits brought by the usage of the CD&R support tool will have a positive affective response of the controllers contributing to	Open	OBJ-18-W2-53B-V3-HPAP-004	RTS	The level of job satisfaction was maintained with the enhanced tools. For some ATCOs it could even be improved. Reflection of future implementation of similar tool on ATCOs' job satisfaction in EXE008 was the following:	R-PJ18-W2-53B-OTHER-01. Next steps should further explore how to improve the relevance and behaviour of the Advanced Descent When Ready (DWR) function according to different FMS capabilities.	REQ-PJ18-W2-53B-TRAINING-01. Appropriate training (theoretical and on-the-job training) shall be developed to familiarise ATCOs with the new functionalities, capabilities and enhancements (CD&R tools).

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	the overall job satisfaction.				• TMA - “Slightly positive” 17% and “Positive” 83% of the replies; • ENR - “Slightly positive” 83% and “Positive” 17% of the replies.		
Arg. 4.3.2: The impact on shift organisation is identified.							
HPB-Arg.4.3-18-W2-53B-002	Thanks to more efficient tools (more strategic) the complexity of work might decrease, therefore the duration of shifts could be adapted contributing to facilitation of rostering.	Closed	OBJ-18-W2-53B-V3-HPAP-004	RTS	The replies from ATCOs don't indicate a clear trend regarding the impact on shift organization. The impact on shift might be associated to how much the ATCOs workload is improved and the capacity to support tasks that the tools provide. In EXE012 the impact the on shift organization was not assessed and it does		

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					not seem that new tools could impact shift duration. EXE008 assessed the likelihood for an impact on shift organization as following: TMA - "Unlikely" 25%, "Neutral" 8%, "Likely" 50% and "Extremely likely" 17% of the replies; ENR - "Extremely unlikely" 8%,"Unlikely" 25%, "Neutral" 33%, "Likely" 33% of the replies.		

Table 13: PJ18.53B Summary of the HP results and recommendations/ requirements for each identified issue & related argument

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4.4.2 Maturity of the Solution

This section contains the HP maturity review at the end of the validation activity to give advice on the evidence has been produced to support the HP arguments at V3 level.

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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?	Yes	The present document encloses the HP outcomes and assessment report. All the identified relevant arguments, associated HP issues/benefits evidence have been addressed in this document (section 4.4.1). All the Arg. defined in the validation plan have been addressed.
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)?	Yes	All benefits and issues have been addressed and the associated evidence provided (section 4.4.1). However, Argument 1.2.3: Operating methods cover degraded modes have not been fully addressed in the exercise runs (e.g. corrupted data). EXE0012 (Skyguide) has gather some results only considering full loss of ADS-C EPP data.
3	Have all the parts of the solution/concept been considered?	Yes	This solution builds on the work performed in wave 1 solutions PJ.10-02a2 and PJ.18-06a and addresses the improvement of conflict detection and resolution tools that are derived from the improvement of ground Trajectory Prediction (TP) with the use of advanced data from ATN B2 ADS-C reports messages as defined in the EUROCAE standards ED228A and ED75C and improved meteorological data. Higher variability of cost indexes and meteo integration between air and ground systems (wind, temperature) were not part of the simulation. HP evidence regarding degraded modes were not fully addressed.

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4	Have potential interactions with related projects/concepts been considered and addressed?	Yes	The list of projects the PJ18.53B solution relates to is reported in OSED part I, the interactions with these projects have been considered in the solution and in the HP assessment.
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Yes	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?	Yes	Refer to results provided in the table in section 4.4.1.

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7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	Yes	Overall, the solution was tested with end users under realistic conditions despite some limitations. • Clear procedure for recoding data logs, questionnaires and debriefings/interviews with ATCOs and observations. • The confidence in the validation results is satisfying, since the data come from various sources. • Qualitative data and number of quantitative data were sufficient to draw realistic conclusions. In the instances in which there was not enough quantitative data to reach a conclusion, this has been clearly specified in the results. • Experienced controllers with appropriate ratings participated in the simulation runs. Experienced controllers or simulator pilots participated in the role of pseudo-pilots. Their operational knowledge and the phraseology contributed to the quality of the results. • Training materials, demos and training runs were provided in advance. EXE008 HP feedback was considered a solid base for statistical significance. In addition, the different scenarios were comparable with each other with comparable traffic in all runs. The emergency/abnormal situations differed slightly from run to run. For EXE009 the setup of the exercise was enough to get significative results. EXE011 reports that the RTS represented real-life conditions and the traffic samples were tested to support highly realistic environment, but that a limited number of simulation runs and technical platform issues limited the operational significance of the analysed results. ATCOs indicated that the platform was not enough stable, thus, we could consider that the assessment

			of the impact of enhanced CD&R support tools using aircraft data on controllers' tasks and operating methods has not been fully performed. The traffic was considered too high to perform their tasks in an efficient way and be able to assess/analyse EPP information at the same time. The training on the platform and tools was also considered insufficient for an adequate assessment from ATCO side. ATCOs would need further training to identify in which cases EPPs are not relevant (heading clearances, specific FMS modes, etc.), this was a limitation during the assessment. In EXE012 some technical limitations on airborne side were identified during the validation which could impact the assessment. These limitations need to be further studied in the frame of SESAR 3 activities in order to identify possible mitigation actions from airborne or ground side. Nonetheless, the realism was considered high during the RTS assessment. HP argument regarding degraded modes were only partially addressed in EXE012 (Skyguide).
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Yes	Overall, the exercises report a positive effect on their performance when using the functionalities under validation, with improvements in ATCO's situational awareness and workload. The acceptability and suitability of enhanced CD&R tools and operating methods was rated as good level. The operating methods were considered clear and exhaustive. Refer to results provided in the table in section 4.4.1.
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	Yes	HP results have provided the input for the HP results in HPAR have been integrated in the OSED.

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10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Yes	The results do not show blocking point regarding human performance. The main recommendations for improvements were related to ATCO HMI and usability of provided information. See Appendix B.
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Yes	HP recommendations and have been drawn from the different exercises and integrated and at solution level.
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?	Yes	The major transition aspects have been considered in the V3 exercises and in the reporting. Refer to results provided in the table in section 4.4.1.
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.	No	No changes in roles and responsibilities and competence requirements were identified in the present solution. No changes in regulations were identified concerning the CD&R tools enhancements.
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Yes	Recommendations for future research concerning HP aspects have been identified and reported in the present document and in the VALR. • Next steps should further explore how to improve the relevance and behaviour of the Advanced Descent When Ready (DWR) function according to different FMS capabilities. • Ground-air communication aspects, namely phraseology and CPDLC wording should be further investigated for the Advanced Descent When Ready (DWR) function.

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5 References

Human Performance

[1] 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.

[2] 16.06.05 D 27 HP Reference Material D27.

Solution PJ18-53B Documents

[3] PJ18W2-D2.2.101-SESAR Solution 53B SPR_INTEROP_OSED_V3_Part-I.

[4] PJ18W2- D2.2.004 - SESAR Solution 53B VALP_Part-I

[5] PJ18W2-D2.2.004- SESAR Solution 53B VALP_Part-IV

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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-PJ18-W2-53B-OPS-01	OPS (operating methods / procedures)	Concerning the Advanced Descent When Ready (DWR) function ATCOs may need to be supported by a new monitoring function on the descent profile of flights.	ATCOs considered the DWR function as disturbing compared to today's traffic management and they do not feel comfortable with giving a DWR clearance when there is traffic below (even knowing that the planned profile will be respected, ensuring a safe separation). Concerning DWR function it was considered	RTS	Ground	PJ18.53B	Accepted		

			necessary to develop a new monitoring function on the descent profile permanently checking that initial Descent conditions considered for conflict detection are still valid and warn the controller if not.						
R-PJ18-W2-53B-OPS-02	OPS (operating methods / procedures)	In TMA, ATCOs may need additional advanced sequencing support in order to improve CD&R tool use.	The TMA ATCOs consider the resolutions provided by the CD&R tool correct. However, they are not always considered usable because they don't correspond to the plan for the sequence of landing aircraft. Advanced sequencing functionality should be considered to unlock the full potential of the CD&R tools for the	RTS	Ground	PJ18.53B	Accepted		

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			TMA sector, by improving ATCO's trust and acceptance.						
R-PJ18-W2-53B-SDU-01	System Design and Usability (SDU)	The colour coding and visibility of the information of enhanced tactical CD&R tool should support the ATCO in having a clear understanding of multiple conflicting trajectories.	ATCOs suggested that having a colour coding could support them in having an improved understand of multiple aircraft conflict trajectories. Improved colour coding/ intensity can help the ATCOs in having clear understanding of the conflict (better situation awareness and reduced workload in assessing the conflict information).	RTS	Ground	PJ18.53B	Accepted		
R-PJ18-W2-53B-SDU-02	System Design and Usability (SDU)	The information about the conflict detection quality assessment (figure of merit) should	Having aircraft with different capabilities (ATN-B1, ADS-C and ATS-B2) brings different level and	RTS	Ground	PJ18.53B	Accepted		

		be available to ATCOs, allowing them to adapt their strategies and approach according to it, if deemed necessary.	accuracy of information. This requires dynamic adaptation of conflict detection processes which could have an impact on ATCO's working methods, therefore, it is recommended to inform ATCOs about the conflicts accuracy. The accuracy of EPP data also varies according to the FMS modes (for speed, vertical, horizontal modes) and, therefore, the tools using EPP data must take it into account and this shall be known by the ATCO (figure of merit). ATCOs mentioned they could adapt the margin / buffer for						

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			separation in their way of controlling (analysis of the conflict and resolution as well). If ATCOs have access to the information on the figure of merit (associated to the assessment of conflict detection quality) associated with conflicts (conflicts between ATN-B1 flights, ATN-B1/ATS-B2 flights and ATS-B2/ATS-B2 flights) they will have an increased awareness and be able to, if they deem necessary, adapt their working method according to it.						
R-PJ18-W2-53B-SDU-03	System Design and	Advanced visualization of flight trajectory should clearly	When implementing advanced visualization of flight trajectory and EPP	RTS	Ground	PJ18.53B	Accepted		

	Usability (SDU)	inform and distinguish between cleared and predicted trajectory parts.	report (type of turns, TOC/TOD and vertical profile), to efficiently support ATCOs actions, a particular attention must be paid on displaying data in due time and without ambiguity in the distinction between cleared and predicted trajectory parts (possibly using colour coding). This will improve ATCOs situation awareness and possibly reducing the time spent (workload) in processing the information.						
R-PJ18-W2-53B-SDU-04	System Design and Usability (SDU)	Advanced visualization and EPP report features should clearly inform and display the flight	When implementing advanced visualization of flight trajectory and EPP report (type of turns, TOC/TOD and vertical profile), to	RTS	Ground	PJ18.53B	Accepted		

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		phase considered by FMS.	efficiently support ATCOs actions, a particular attention must be paid on displaying data in due time and without ambiguity concerning the flight phase considered by FMS (e.g. TOC/D display - more restrictive speeds in climb, cruise and descent) and adapted units (e.g. speed in MACH / CAS / IAS). This will improve ATCOs situation awareness and possibly reducing the time spent (workload) in processing the information.						
R-PJ18-W2-53B-OTHER-01	OTHER	Next steps should further explore how to improve the relevance and behaviour of the Advanced Descent	The Descent When Ready (DWR) function is really disturbing compared to today's traffic management,	RTS	Ground	PJ18.53B	Accepted		

		When Ready (DWR) function according to different FMS capabilities.	ATCOs are not really comfortable with giving a DWR clearance when there is another traffic below (even knowing that the planned profile will be respected, ensuring a safe separation).						
R-PJ18-W2-53B-OTHER-02	OTHER	Ground-air communication aspects, namely phraseology and CPDLC wording should be further investigated for the Advanced Descent When Ready (DWR) function.	"When Ready" name and phraseology are not fully appropriate as what is expected is in fact a descent according to the flight plan or last EPP, not a full freedom given to the flight crew to descent when ready. The phraseology might need to be further detailed to make sure the pilots understand the time frame in which they	RTS	Ground	PJ18.53B	Accepted		

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			should comply with an instruction. For instance ATCOs could use "Descent as FMS plan" instead of "Descent When Ready". An improvement opportunity for LC (Level constraint) what-if tool e.g to issue adequate clearances and constraints, ATCOs must benefit from a more advanced dedicated What-If tool, but this must be further investigated.						

Table 14: PJ18.53B HP recommendations

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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-PJ18-W2-53B-TRAINING-01	TRAINING	Appropriate training (theoretical and on-the-job training) shall be developed to familiarise ATCOs with the new functionalities, capabilities and enhanceme	During the debriefings ATCOs mentioned that the enhancements on conflict detection tools, procedures and operating methods must be addressed during training to make sure that they are clear to all actors before they start using the tools. ATCOs need to	RTS	Ground	PJ18.53B	Accepted		

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		nts (CD&R tools).	fully understand the system to rely on its functionalities. Trust is built up by appropriate training and exposure to the tool over time.						

Table 15: PJ18.53B HP Requirements

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Appendix C – HP Log

PJ18_53b HP LOG_1 (1_3).xlsx

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