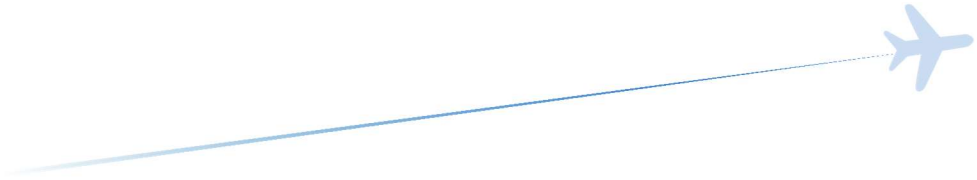

PODIUM Demonstration report for VLD - Part IV - Human Performance Assessment Report

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PODIUM

PROVING OPERATIONS OF DRONES WITH INITIAL UTM

This Human Performance Assessment Plan is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 783230 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document contains the Human Performance (HP) Assessment Report for the PODIUM demonstrations that consists of the HP issues identified at the level of the HP Plan, the results of the activities conducted in order to clarify the identified issues and the corresponding HP recommendation and requirements.

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1 Executive Summary

The Human Performance Assessment Report encompasses the results obtained in all five sites for the pre-flight services and flight execution services, through questionnaire data, debrief discussions and expert observations.

On the basis of the HP Assessment Plan, the HP objectives were embedded in the Validation Plan in order to ensure an appropriate evaluation of the potential issues and benefits identified.

The main HP Arguments addressed in the demonstrations were:

- **Arg.1:** The role of the human is consistent with human capabilities and limitations
- **Arg.2:** Technical systems support the human actors in performing their tasks
- **Arg.3:** Team structures and team communication support the human actors in performing their tasks
- **Arg. 4**: Human Performance related transition factors are considered.

With regard to human performance activities, the assessment focused on roles and responsibilities, situational awareness, trust in the HMI, acceptability/feasibility of the procedures and the system, usability and usefulness of the system and teamwork and communication.

Additionally, other HP aspects that were assessed or that emerged out of the demonstrations have been documented in the form of HP requirements and recommendations to be used for future evaluations and eventually for implementation.

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 HP reference material [1], in order to derive the HP Assessment Report for the U-Space concept and UTM system as demonstrated in PODIUM, including requirements and recommendation.

2.2 Intended readership

The Intended readership is the main PODIUM partners (i.e. the beneficiaries, linked-third-parties, and subcontractors) and the SJU that will use the Demonstration report to draw a conclusion on the project, while having the HP report available for more details with regard to HP related objectives and results.

Other SESAR/Horizon 2020 projects addressing U-space may use the HP report as a tool to support collaboration.

2.3 Scope of the document

This document describes the result of the activities conducted to date according to the Human Performance assessment process [1], concluding on aspects such as usability, acceptability, trust, situational awareness in the context of the U-Space concept and the UTM system. Separate analyses have been performed and described in the Demonstration Report [4], for the flight preparation and the flight execution phases, for both the supervisor and the flight crew. The derived Human Performance requirements and recommendations are to be used upon implementation and in further research.

2.4 Human performance work schedule within the Solution

The Human Performance activities executed according to the demonstration plan encompassed the HP objectives as identified in the HP Plan [5]. The HP data were collected during the demonstration activities and analysed thereafter. The results are presented partly in the body text of the demonstration report and more in detail in this document- The HP assessment report.

2.5 Structure of the document

This document contains 5 chapters.

- Chapter 1 contains an executive summary which gives information about the purpose and scope of the Human Performance Assessment, including a reference to results and conclusions, as well as requirements and recommendations.
- Chapter 2 describes the purpose and the scope of the document, introducing the intended readership and detailing the HP work schedule within the Solution. It entails a list of acronyms and terminology.
- Chapter 3 provides information with regard to the HP Assessment Process
- Chapter 4 in line with the HP reference material [1], it describes the 4 steps defined in the HP Assessment Process
    - Step 1: Understand the ATM Concept
    - Step 2: Understand the HP Implications
    - Step 3: Improve and validate the concept
    - Step 4: Collate findings & conclude on transition to the next V-phase.
- Chapter 5 is intended to include all relevant reference material as well as additional information in the Appendixes:
    - Appendix A: HP Recommendations Register
    - Appendix B: HP Requirements Register

2.6 Acronyms and 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.

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 1: Acronyms and terminology

3 The Human Performance Assessment Process: Objective and Approach

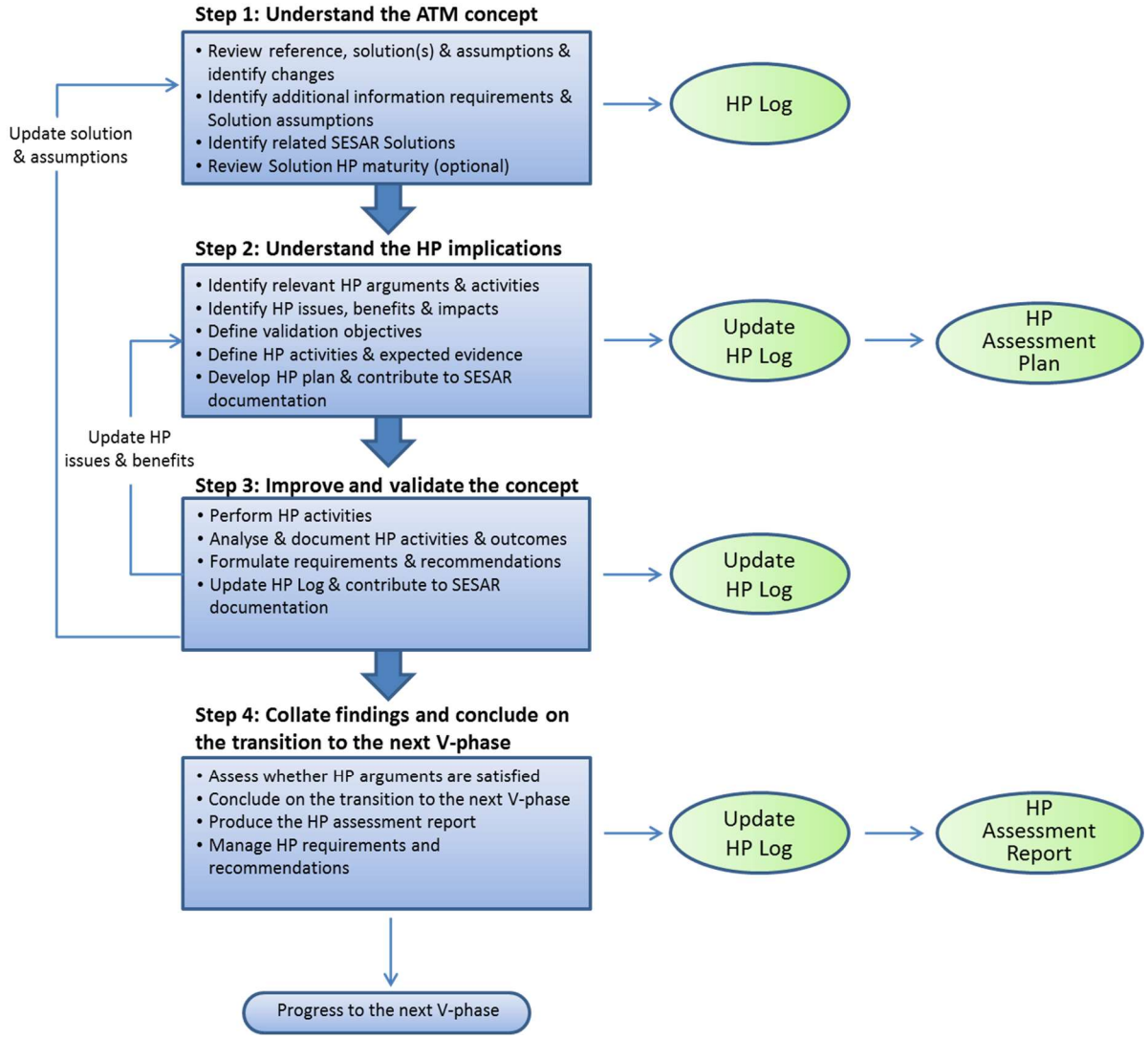

Figure 1: Steps of the HP assessment process

4 Human Performance Assessment

4.1 Step 1 Understand the ATM concept

4.1.1 Description of exercises

Please refer to the PODIUM Demonstration Plan [2] for a detailed description of the exercises.

4.1.2 PODIUM list of assumptions

A common set of generic assumptions and principles were defined in the CONOPS [3]:

- Safety of all airspace users is a key priority.
- PODIUM UTM system will represent specific design/technical solution; this CONOPS will not represent a generic UTM architectures or Concept.
- PODIUM UTM system will be used in the very low-level airspace (VLL).
- PODIUM UTM will provide its services in Class G uncontrolled airspace and classes C and D controlled airspace.
- There will be no overlap between ATM and UTM areas of responsibilities.
- There will be a single PODIUM UTM system providing services and management.
- Airspace where UTM will provide its services will have an interface with ATM, where relevant (for example in CTRs).
- PODIUM solution should meet the PODIUM Demonstrations Plan demand and should fit planned operations.
- PODIUM Solution will not provide active “air traffic control “of every UAS.

4.1.3 Identification of the nature of the change

The following table captures the nature of change identified following the implementation of U-space services and technologies and captures the new roles and responsibilities identified, as well as the new operating methods and team composition.

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES	
1.1 ROLES & RESPONSIBILITIES	Identified actors are drone pilots & observers (demonstration exercise specific), supervisors, ATC personnel. The U-space concept has an impact on the responsibilities of all the roles.

1.2 OPERATING METHODS	The operating method for flying a drone does not change for the drone pilot. However, changes in the operating methods with regard to the flight preparation phase as well as with the communication between different actors with and via the system are foreseen. The operating methods can be systematised with the use of one common system.
1.3 TASKS	With the operating methods the tasks change –as the identification, registration, granting permission etc. is processed via one common system. The usage of the system itself implies already a new task.
2. HUMAN & SYSTEM	
2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)	The identification of changes occurring following the transition from a paper based information to the U-space services. Certain tasks that were manually done via phone and/or email by the drone pilot can now be handled by the system with a quicker responds time and more complete information available.
2.2 PERFORMANCE OF TECHNICAL SYSTEM	The technical system needs to facilitate a quick responds of the different actors
2.3 HUMAN – MACHINE INTERFACE	No system was available so far. The HMI impacts all actors that use the system. E-identification and e-registration (pilot and supervisor). System generation/ management of “no-fly zone” (related alarms and alerts) (supervisor) Automatic flight plan validation and permission (supervisor) Monitoring of compliance of the drone operations with the relevant rules and regulation (Supervisor, ATC) In flight updates of “no fly zones” (supervisor, pilots) Surveillance and tracking (alerts and alarms) (pilots, supervisor, ATC)
3. TEAMS & COMMUNICATION	

3.1 TEAM COMPOSITION	The team does not change only the mean of communication and information exchange between different team members (pilot, supervisor, ATC) changes.
3.2 ALLOCATION OF TASKS	Identification of the sharing of tasks (intra-team and inter-team)
3.3 COMMUNICATION	The communication means change with the use of the system for all involved actors. A standardised phraseology will be required.
4. HP RELATED TRANSITION FACTORS	
4.1 ACCEPTANCE & JOB SATISFACTION	N/A
4.2 COMPETENCE REQUIREMENTS	all actors will have to be trained on the tool
4.3 STAFFING REQUIREMENTS & STAFFING LEVELS	N/A
4.4 RECRUITMENT AND SELECTION	N/A
4.5. TRAINING NEEDS	N/A

Table 2: Description of the change

4.2 Step 2 Understand the HP implications

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

Two HP activities were proposed in order to clarify the HP issues: workshops and demonstration activities. The demonstration activities encompassed lengthy debrief discussions that have covered the proposed material for workshops from an HP perspective.

4.3 Step 3 Improve and validate the concept

4.3.1 Description of HP activities conducted

The HP issues have been addressed during the demonstration activities, either through debrief discussions, questionnaires or expert observations. As a result, the information from all participants (drone operators, drone manufacturers, pilots, supervisors etc.) was used in order to close the HP issues and formulate requirements and recommendations.

Activity 1.	**VLD**
Description	The VLD is used to demonstrate the new concept and technical solutions.

	HP measurements that are defined in line with the HPAP beforehand have been collected during the VLDs. Debrief discussions and questionnaires have been developed to cover HP issues that cannot be simulated, addressing the end-users (drone pilots, drone operators, regulators etc.).
Arguments & related issues addressed	All four high level arguments have been addressed.
HP objectives	All HP objectives have been addressed.
Tools / Methods selected out of the hp repository	Tailored questionnaires Debrief discussions HP expert observations
Summary of the hp activity	All findings can be found in Chapter 4.4.1

Table 3: Description of Activity 1

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

4.4.1 Summary of HP activities results & recommendations / requirements

N.B. The HP issues below have been identified in the beginning of the project and were used to phrase HP objectives and support the data collection. This means that the issues/ benefits column does not describe the findings of the HP Assessment. The main output of the HP Assessment consists therefore of the list of HP recommendations and requirements (Appendix A and B) that were formulated based on the demonstration findings (the "evidence" column), in order to ensure that in future research and eventually in the implementation phase, they will be implemented in order to ensure such potential issues would be avoided.

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
Arg. 1.1.1: The description of roles & responsibilities cover all affected human actors.							
1.1.1-1	The description of roles and responsibilities do not cover all affected human actors	Closed	OBJ-VLD-PODIUM-HP1.1.1-001	VLD Debrief	The roles and responsibilities proposed for the demonstration activities covered all the actors that have participated.		HP_REQ_PODIUM 1
Arg. 1.1.2: The description of roles & responsibilities cover all tasks to be performed by a human actor.							
1.1.2-1	The description of roles and responsibilities do not cover all tasks to be performed by the human actors	Closed	OBJ-VLD-PODIUM-HP1.1.2-001	VLD Debrief	The tasks corresponding to all actors involved in the demonstration have been defined prior to the demonstration activities.		HP_REQ_PODIUM 2

Arg. 1.1.3: Roles and responsibilities are clear and consistent (in V1: non-contradictory).

1.1.3-1	The description of responsibilities is not clear and consistent under nominal, non-nominal and degraded modes of operations	Closed	OBJ-VLD-PODIUM-HP1.1.3-001	VLD Debrief	The proposed roles and responsibilities in the demonstration activities were clear to all actors. On the other hand, the results indicate lower acceptability levels for the roles and responsibilities. The results can be attributed to the fact that the flight crew and drone supervisors were not fully trained and familiar with the new responsibilities and associated tasks, relying on their previous experience in the drone industry, which might have influenced their performance and perception. Moreover, the fact that the flight crew was not able to see the flight view in the flight execution phase, made their responsibilities rather limited as they were not able to see their drone, the other operating drones or the “no fly” zones.		HP_REQ_PODIUM 1

Arg. 1.2.1: Operating methods cover operations in normal operating conditions.

1.2.1-1	Operating methods (procedures) are not appropriate for normal operating conditions	Closed	OBJ-VLD-PODIUM-HP1.2.1-001	VLD Debrief	Further developments are required (e.g. phraseology, communication etc.) for the national and local implementation phase. This issue has been closed, while relevant requirements and recommendations have been extrapolated in the upcoming arguments.		
Arg. 1.2.2: Operating methods cover operations in abnormal operating conditions.							
1.2.2-1	Operating methods do not cover abnormal operating conditions	Open	OBJ-VLD-PODIUM-HP1.2.2-001	out of scope	Abnormal and degraded modes of operations have not been covered in the demonstration activities. The AED delivery flight taking priority over other flights was successfully simulated in The Netherlands demonstration. However additional research is required.		HP_REQ_PODIUM 3:
Arg. 1.2.3: Operating methods cover degraded modes of the ATM system.							
1.2.3-1	Operating methods do not cover degraded modes of operations	Open	OBJ-VLD-PODIUM-HP1.2.3-001	out of scope			See HP_REQ_PODIUM 3:
Arg. 1.2.4: The content of operating methods is clear and consistent (in V1: non-contradictory).							

1.2.4-1	Procedures are not clear and consistent	Closed	OBJ-VLD-PODIUM-HP1.2.4-001	VLD Debrief	See arg. 1.2.1-1 Further developments are required (e.g. phraseology, communication etc.) for the national and local implementation phase. This issue has been closed, while relevant requirements and recommendations have been extrapolated in the upcoming arguments.		
Arg. 1.2.5: Operating methods (procedures) can be followed in an accurate, efficient and timely manner.							
1.2.5-1	Operating methods (procedures) can be followed in an accurate, efficient and timely manner	Closed	OBJ-VLD-PODIUM-HP1.2.5-001	VLD Debrief	The applicability of procedures was highly influenced by the HMI features, which will be extensively covered in Arg.2 Additionally see Arg. 1.2.1-1		
1.3.1-1	The potential for human error is reduced as far as possible.	Closed	OBJ-VLD-PODIUM-HP1.3.1-001	VLD Debrief	No potential increase in human error risks as compared to today`s operations. The participants confirm the benefit of the UTM system, concluding that with an enhanced UTM system (enhanced HMI functionalities) their		

					workload would be reduced, having a more efficient mode of operation, with an enhanced situational awareness resulting in a potential decrease of human error.		
1.3.2-1	Tasks cannot be achieved in an accurate and timely manner	Closed	OBJ-VLD-PODIUM-HP1.3.2-001	VLD Debrief	The applicability of procedures was highly influenced by the HMI features, which will be extensively covered in Arg.2 Additionally see Arg. 1.2.1-1		
1.3.3-1	The level of workload is unacceptable under the new working practices and related tasks	Closed	OBJ-VLD-PODIUM-HP1.3.3-001	VLD Debrief	With the U-Space/ UTM solutions the workload can be decreased. The professional drone operators strongly confirm the need and potential benefits for the U-Space/ UTM solutions.		
1.3.3-2	BENEFIT: The technical systems proposed offer an adequate support for the drone pilots whom maintain	Closed	OBJ-VLD-PODIUM-HP1.3.3-002	VLD Debrief	With an enhanced UTM system (requirements to follow in Arg. 2) the participants confirmed enhanced effectiveness, reduced workload and improved situational awareness.		

	acceptable levels of workload.						
1.3.4-1	The level of trust in the U-space related systems and procedures is not appropriate	Closed	OBJ-VLD-PODIUM-HP1.3.4-001	VLD Debrief	Based on the questionnaire data, the level of trust in the system was rather low for the flight crew and it was high and moderate for the supervisors. The trust results were influenced by the fact that a prototype was used during the demonstrations that requires additional improvements. The need of further refinements to the current UTM system was communicated by both the flight crew and the supervisors.		
1.3.4-2	The level of trust in the data provided by UTM system is not appropriate	Closed	OBJ-VLD-PODIUM-HP1.3.4-001	VLD Debrief	The participants have mentioned the need of having accurate data in the system, which would enhance their effectiveness, lower workload and increase situational awareness. (e.g. national flight rules, “no fly zones”, “reserved” fly zones, weather forecast, NOTAMs-for a dynamic		HP_REQ_PODIUM 5:

					cycle, AIRAC-for a static cycle, aerial views etc.)		
1.3.5-1	The level of situational awareness is unacceptable under the new working practices and tasks	Closed	OBJ-VLD-PODIUM-HP1.3.5-001	VLD Debrief	Overall, the participants agree that with an enhanced UTM system, situation awareness will be positively impacted in both the preparation phase and the execution phase.		
1.3.6-1	Safety requirements on human performance are not satisfied	Closed	OBJ-VLD-PODIUM-HP1.3.6-001	VLD Debrief	Addressed by SAF “Reduced air risk, with a good implementation of warnings for operations over populated areas or close to buildings, roads, etc. also a potential reduction in ground risk.”- supervisor input		
1.3.6-2	Security requirements on human performance are not satisfied	Closed	OBJ-VLD-PODIUM-HP1.3.6-002	VLD Debrief	Addressed by security Potential concerns expressed by the participants with regard to security are: Malignant purposes/abuse- if all drone activities are registered, easier		HP_REQ_PODIUM 4:

					to track. Tracking of other drones/traffic to purposely hinder their operation. Using knowledge of the UTM system to enable drone flights outside the system (undetected, uncontrolled).		
2.1.1-1	The task allocation between the human and the machine is not consistent with automation principles	Closed	OBJ-VLD-PODIUM-HP2.1.1-001	VLD Debrief	No inconsistencies have been identified from an HP perspective. Future evaluations are recommended upon local implementation.		HP_REQ_PODIUM 14
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.							
2.1.4-1	The level of workload induced by the allocation of tasks between the human and the machine is not acceptable	Closed	OBJ-VLD-PODIUM-HP2.1.4-001	VLD Debrief	See Arg. 1.3.1-1		
Arg. 2.1.6: The level of trust in automated functions is appropriate							

2.1.6-1	The level of trust in automated functions is not appropriate	Closed	OBJ-VLD-PODIUM-HP2.1.6-001		See Arg. 1.3.4-1		
Arg. 2.2.1: The accuracy of information provided by the system is adequate for carrying out the task							
2.2.1-1	The accuracy of information provided by the system is not adequate for carrying out the task for all actors involved	Closed	OBJ-VLD-PODIUM-HP2.2.1-001	VLD Debrief	The current version of the UTM system lacked some information/ features that according to the flight crew/ supervisor would have enhanced their effectiveness. See Arg. 2.3.1		
Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task							
2.2.2-1	The timeliness of information provided by the system is not adequate for carrying out the task	Closed	OBJ-VLD-PODIUM-HP2.2.2-001	VLD Debrief	The current version of the UTM system lacked some information/ features that according to the flight crew/ supervisor would have enhanced their effectiveness. See Arg. 2.3.1	HP_REC_PODIUM2	
Arg. 2.3.1: The type of information provided satisfies the information requirements of the human							
2.3.1-1	The type of information provided does not satisfy the information requirements of	Closed	OBJ-VLD-PODIUM-HP2.2.3-001	VLD Debrief	The current version of the UTM system lacked some information/ features that according to the flight	HP_REC_PODIUM1	HP_REQ_PODIUM5

	the human (pilots, operators, regulators etc.)				crew/ supervisor would have enhanced their effectiveness.		HP_REQ_PODIUM 6 HP_REQ_PODIUM 7
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch, screen) correspond to HF principles							
2.3.2-1	Input devices (e.g. keyboard, mouse, touch screens etc.) do not correspond to HF principles	Closed	OBJ-VLD-PODIUM-HP2.3.2-001	VLD Debrief	See Arg. 2.3.5-1		
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles							
2.3.3-1	Visual displays and other type of output devices do not adhere to HF principles	Closed	OBJ-VLD-PODIUM-HP2.3.3-001	VLD Debrief	The visual display was still under development and the actors noted improvements for further development.		HP_REQ_PODIUM 8: HP_REQ_PODIUM 9 HP_REQ_PODIUM 7 HP_REQ_PODIUM 21

Arg. 2.3.4: Alarms and alerts have been developed according to HF principles							
2.3.4-1	See Arg. 2.2.1 and 2.3.1 Alarms and alerts are not consistent with HF principles	Closed	OBJ-VLD-PODIUM-HP2.3.4-001	VLD Debrief	The UTM system was still under development and the actors noted improvements for further development.		HP_REQ_PODIUM 10 HP_REQ_PODIUM 11 HP_REQ_PODIUM 12 HP_REQ_PODIUM 13 HP_REQ_PODIUM 22:
Arg. 2.3.5: Workstations adhere to ergonomic principles							
2.3.5-1	Workstations do not adhere to ergonomic principles	Closed	OBJ-VLD-PODIUM-HP2.3.5-001	VLD Debrief	The use of a laptop on the field was found not practical, therefore a mobile display (handheld- integrated device) would accommodate one-person missions, allowing the manipulation of the two systems simultaneously.		HP_REQ_PODIUM 7
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarms & alerts) is acceptable							

2.3.6-1	The usability of the user interface (input devices, visual displays/ output devices and alarms and alerts) is not acceptable	Closed	OBJ-VLD-PODIUM-HP2.3.6-001	VLD Debrief	The UTM system was still under development and the actors noted improvements for further development.		
Arg. 2.3.7: The user interface design reduces human error as far as possible							
2.3.7-1	BENEFIT: The user interface design reduces human errors as far as possible	Closed	OBJ-VLD-PODIUM-HP2.3.7-001	VLD Debrief	See Arg. 2.3.1-1 to 2.3.5-1		
Arg. 3.1.1: Intra-team and inter-team communication supports the information requirements of team members							
3.1.1-1	Changes to existing roles in the team are identified	Closed	OBJ-VLD-PODIUM-HP3.1.1-001	VLD Debrief	During the demonstrations the flight crew was composed out of a pilot and an observer. The pilot`s role was to control the drone while the observer was in charge of the R/T via mobile phone. Ideally with the introduction of the in-flight connection to the UTM system on the pilot`s side, the observer will no longer be required. The supervisor role does not change but the mean of communication with the flight crew changes with the implementation of the UTM system.		HP_REQ_PODIUM 1

					The Authorities and ATC roles and responsibilities do not change but the mean of communication and information processing changes with the UTM system		
Arg. 3.2.1: Changes to the task allocation between human actors do not lead to adverse effects on human tasks							
3.2.1-1	Changes to tasks allocation between human actors might lead to adverse effects on human tasks	Closed	OBJ-VLD-PODIUM-HP3.2.1-001	VLD Debrief	See Arg. 3.1.1-1		
3.2.1-2	The division of responsibilities between all actors involved is not clear and/ or acceptable	Closed	OBJ-VLD-PODIUM-HP3.2.1-002	VLD Debrief	See Arg. 1.1.1-1 and Arg. 3.1.1-1		
Arg. 3.2.2: The proposed task allocation between human actors is supported by technical systems/ the HMI							
3.2.2-1	The proposed tasks allocation between the human actors is supported by the technical systems/ HMI	Closed	OBJ-VLD-PODIUM-HP3.2.2-001	VLD Debrief	In the demonstration exercise the communication between the flight crew and the supervisor was done via the mobile phone, while the communication between the flight crew and the ATCO was done via radio. In future more “automated” communication via the system is foreseen		HP_REQ_PODIUM 15 HP_REQ_PODIUM 16 HP_REQ_PODIUM 23

					The flight crew-supervisor communication was found to be inefficient, as while on the field, the flight crew either did not hear the phone call from the supervisor or did not pick up as they did not recognize the phone number and assumed the call was coming from someone else. The phone numbers were not part of the details inserted in the UTM system and although exchanged in advance, the numbers were not saved in advance. The task allocation related to the authorisation process is appropriately supported by the HMI.		
Arg. 3.2.3: The potential for human error in team tasks is reduced as far as possible							
3.2.3-1	The potential of human error in team tasks is reduced as far as possible	Closed	OBJ-VLD-PODIUM-HP3.2.3-001	VLD Debrief	See Arg. 3.2.3-1 and Arg. 3.2.2-1		
Arg. 3.3.1: Intra-team and inter-team communication supports the information requirements of team members							
3.3.1-1	Intra-team and inter-team communication does not support the information	Closed	OBJ-VLD-PODIUM-HP3.3.1-001	VLD Debrief	During the Eelde demonstrations, Tower ATCOs have recommended the flight crewmember that will be	HP_REC_PODIUM3:	

	requirements of team members (drone pilots-supervisors/ drone-pilots and operators, drone-pilots/ ANPS and drone operators/regulators)				communicating with ATC should have an R/T license for operations taking place in CTR. They considered this is particularly relevant for the shared situation awareness with the aircraft pilots on frequency that would hear the exchange of communication between the drone flight crew and the ATCO on the frequency.		
Arg. 3.3.2: The phraseology supports communication in all operating conditions							
3.3.2-1	The phraseology does not support the communication in all operating conditions	Closed	OBJ-VLD-PODIUM-HP3.3.2-001	Debrief VLD	At the moment no phraseology was defined and demonstrated but requirements for improvements have been formulated		HP_REQ_PODIUM 17 HP_REQ_PODIUM 18
Arg. 3.3.3: Changes in communication means and modalities are identified and acceptable							
3.3.3-1	Changes in communication means and modalities are not acceptable	Closed	OBJ-VLD-PODIUM-HP3.3.3-001	Debrief VLD	See Arg. 3.3.1 and 3.3.2		
Arg. 4.1.1: Changes in roles and responsibilities are acceptable to the affected human actors							
4.1.1-1	Changes in roles and responsibilities are	Closed	OBJ-VLD-PODIUM-HP4.1.1-001	VLD Debrief	See Arg. 1.1.1-1		

	acceptable to all affected human actors						
Arg. 4.2.1: Knowledge, skill and experience requirements for human actors have been identified							
4.2.1	Knowledge, skills and experience requirements for the human actors have not been identified	Closed	OBJ-VLD-PODIUM-HP4.2.1-001	VLD Debrief	They will have to be locally defined.		HP_REQ_PODIUM 19
Arg. 4.5.2: The duration of training for each actor group is identified							
4.5.2-1	The duration of training for each actor group is identified	Out of scope	OBJ-VLD-PODIUM-HP4.5.2-001	VLD Debrief			HP_REQ_PODIUM 20

Table 4: Summary of the HP results and recommendations/ requirements for each identified issue & related argument

5 References

Human Performance

[1] PODIUM Demonstration report for VLD - Part IV - Human Performance Assessment Report

[2] PODIUM Demonstration Plan

[3] PODIUM Concept and Architecture

[4] PODIUM Demonstration Report

[5] PODIUM Human Performance Assessment Plan

Appendix A – HP Recommendations Register

HP Recommendations Register			
Reference	Type of recommendation	Recommendation	Rationale
HP_REC_PODIUM1:	Technical	The system should indicate what documentation is required (e.g. in the form of a checklist) in order to submit a flight plan.	This would help offer the flight crew clear visibility on what information is needed, reducing the time to submit a flight plan and ensuring the flight crew is correctly filling in the information. This would in turn reduced the risk for potential errors.
HP_REC_PODIUM2:	Technical	It should be possible to identify pre-planned flights even if the scheduled take-off time has passed before the drone actually took off.	At the moment the planned flight disappears from the list as soon as the take-off time is passed and the flight was not activated in the list, this results in the fact that the entire flight has to be planned again.
HP_REC_PODIUM3:	Operational	The flight crewmember communicating with ATC should have an R/T license.	During the Eelde demonstrations, Tower ATCOs have recommended the flight crewmember that will be communicating with ATC should have an R/T license for operations taking place in CTR. They considered this is particularly relevant for the shared situation awareness with the aircraft pilots on frequency that would hear the exchange of communication between the drone flight crew and the ATCO on the frequency.

Table 5: HP recommendations

Appendix B HP Requirements Register

HP Requirements Register			
Reference	Type of requirement	Requirement	Rationale
HP_REQ_PODIUM1	Operational	Roles and responsibilities shall be locally defined.	To ensure they appropriately fit the context of operations.
HP_REQ_PODIUM2	Operational	Local implementation shall ensure representatives of all actors involved participate in the description of tasks for the roles identified.	To ensure appropriate levels of acceptance and understanding of the tasks for each actor group.
HP_REQ_PODIUM3:	Operational	Abnormal and degraded modes of operations related procedures shall be locally defined (e.g.areas for stacking or emergency landings, equipment failure etc.).	To ensure they appropriately fit in the context of operations and accepted by the users.
HP_REQ_PODIUM4	Operational	Standards for equipment, software and data shall ensure the tracking of drones does not increase the risk for malignant purposes.	The potential concern expressed by the participants with regard to security is: malignant purposes/abuse- if all drone activities are registered, easier to track. Tracking of other drones/traffic to purposely hinder their operation. Using knowledge of the UTM system to enable drone flights outside the system (undetected, uncontrolled).
HP_REQ_PODIUM5:	Technical	For the mission preparation phase, the UTM system shall allow the flight crew to have access to all relevant information displayed into one interface. (e.g. national flight rules, “no fly zones”, “reserved” fly zones, weather forecast, NOTAMs-	This would enhance the effectiveness of the process, as well as ensure the flight crew have access to correct, up to date data, which would in turn enhance their situational awareness and decrease workload.

		for a dynamic cycle, AIRAC-for a static cycle, aerial views etc.)	
HP_REQ_PODIUM6:	Technical	For the mission execution phase, the UTM system shall allow the flight crew to have access to an aerial map that would indicate “no fly” zone and other drones, as well as weather information, altitude of the drone etc.	This would increase the situational awareness of the flight crew, reducing the risk of human error.
HP_REQ_PODIUM7:	Technical	An in-flight view application (i.e. an in-flight UTM system) shall be available.	The use of a laptop on the field was found not practical, therefore a mobile display (handheld-integrated device) would accommodate one-person missions, allowing the manipulation of the two systems simultaneously. This would also ensure that in case a mission requires an in-flight “re-planning” (e.g. BVLOS flights) the pilot would not be required to take hands off controls.
HP_REQ_PODIUM21:	Technical	The in-flight view application shall allow the flight crew to simultaneously operate the drone and access, if needed, the UTM system.	The use of a laptop on the field was found not practical, therefore a mobile display (handheld-integrated device) would accommodate one-person missions, allowing the manipulation of the two systems simultaneously. This would also ensure that in case a mission requires an in-flight “re-planning” (e.g. BVLOS flights) the pilot would not be required to take hands off controls.
HP_REQ_PODIUM8:	Technical	Overlapping and easily distinguishable flight areas shall be visible for both the supervisor and the flight crew.	In order to ensure an appropriate level of situation awareness of the supervisor.

HP_REQ_PODIUM9:	Technical	The supervisor shall have all relevant information available at one glance, without having the need to switch between different “windows”.	Such information could comprise: the brand/ model of the drone, the contact details of the flight crew, the status of the drone, etc.
HP_REQ_PODIUM10:	Technical	Notifications shall allow the supervisor a manual check if required for flight mission requests.	This feature would ensure the supervisor timely acts upon requests.
HP_REQ_PODIUM11:	Technical	An alert shall be available on both the supervisor and flight crew interface, indicating the restricted area was not respected.	To reduce potential collisions or unexpected crossing of the “no-fly” zones.
HP_REQ_PODIUM12:	Technical	The system shall notify the flight crew in case a flight permission was cancelled by the Supervisor.	To ensure a swift communication between the flight crew and the supervisor.
HP_REQ_PODIUM22:	Technical	The system shall allow the “acknowledgement” of messages for both the flight crew and the supervisor.	This would allow - in the exchange of communication between the supervisor and the flight crew- a seamless exchange of information whereby the actors can confirm the receipt/ applicability of a message.
HP_REQ_PODIUM13:	Technical	The collision alert shall only be active when in fly mode (not in “landed” mode).	To avoid nuisance alerts.
HP_REQ_PODIUM14:	Technical	A rule-based and automated supervisor function shall be available as part of the UTM system.	To ensure an effective authorization process, whereby the supervisor would only intervene in case of emergency.
HP_REQ_PODIUM15:	Operational	The possibility to communicate via the “in-flight” UTM system shall be available for the flight crew and the supervisor.	This would ensure the flight crew receives and timely acts on the supervisor`s instructions. (see HP_REC_PODIUM3).

HP_REQ_PODIUM16:	Operational	The "in-flight" UTM system shall be further investigated, in connection with emergency services.	To ensure an adequate response time and exchange of information between all actors involved.
HP_REQ_PODIUM17:	Operational	In case of a drone operations involving multiple pilots (e.g. VLOS and BVLOS flights) the development of a protocol and phraseology is required for the transfer of responsibility to ensure the accurate and complete exchange of information between pilots.	No prior protocol was established during the demonstrations therefore an informal exchange of communication took place that did not include at times all the required details.
HP_REQ_PODIUM18:	Operational	Phraseology shall be defined for exchanges between all actors (pilot-pilot; pilot- supervisor; pilot-ATC).	Following the demonstrations the following have been noted: Flight crew- Supervisor communication: the flight crew concluded they have received more details than required from the supervisor Flight Crew- Flight Crew (VLOS/BVLOS flight): the exchange of communication was successful due to the familiarity between the pilots, although some details were missed in the conversation. Flight Crew- ATC: ATC concluded that they have received too much information from the flight crew. Once a slot is blocked, the ATCOs do not consider it relevant to be contacted for each take-off and landing if they take place during the assigned slot.
HP_REQ_PODIUM23:	Operational	The exchange of communication between the flight crew and the supervisor shall be improved.	Currently the communication between the flight crew and the supervisor was done via the mobile phone, while the communication between the flight crew and the Supervisor was done via radio. The flight crew-supervisor communication was found to be inefficient, as while on the field, the flight crew either did not

			hear the phone call from the supervisor or did not pick up as they did not recognize the phone number and assumed the call was coming from someone else. The phone numbers were not part of the details inserted in the UTM system and although exchanged in advance, the numbers were not saved in advance. As much information as possible shall be communicated via the system. Time critical information etc. might still require a phone call.
HP_REQ_PODIUM19:	Operational	The knowledge, skills and experience required from professional drone pilots that will be accessing the UTM system shall be locally/ nationally defined.	To ensure a harmonized way of operation and an appropriate level of knowledge for all drone pilots.
HP_REQ_PODIUM20:	Training	Training needs and a training curricula (if applicable) shall be local defined for all actors accessing the UTM system	To ensure a harmonized way of operation and an appropriate level of knowledge for all drone pilots.

Table 6: HP Requirements

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