[SESAR DEMOR SAFIR-MED Preliminary Report]

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SAFIR-Med

SAFE AND FLEXIBLE INTEGRATION OF ADVANCED U-SPACE SERVICES FOCUSING ON MEDICAL AIR MOBILITY

This Demonstration Report is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 101017701 under European Union's Horizon 2020 research and innovation programme.

Abstract

The Safe and Flexible Integration of Advanced U-space services Focusing on Medical Air Mobility (SAFIR-Med) is a demonstration project whose objective is to achieve a safe, sustainable, socially accepted and socially beneficial urban air mobility. It aims to prepare and de-risk a deployment of U-space initial services (U1 and U2) and prepare.

This document presents the results obtained during the demonstration exercises that have taken place during the SAFIR-Med project, including deviations from the initial plan to the final plan, recommendations for future projects, conclusions and the level of maturity that has been reached after the performance of this project.

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1 Executive summary

The SAFIR-MED project is one of the SESAR Joint Undertaking funded projects whose main objective is to demonstrate the safe integration of urban air mobility (UAM) as additional airspace users. For demonstrating this, within the SAFIR-Med Project, one de-risking activity and two exercises were carried out to evaluate whether the requirements imposed by the medical use cases could be met by making use of U-space services.

U-space services and capabilities are meant to support a viable and sustainable UAS business.
A viable and sustainable UAS business can only thrive when UAS operations are accepted by society.

Requirements were gathered from 3 types of stakeholders:

- The medical community that is in demand for medical transportation flights by UAS
- Helicus as operator of medical UAS transportation flights
- The city of Aachen with its inputs from MAHHL cities and the UIC2 (UAM Initiative Cities Community) and the city of Antwerp as representative of local authorities

SAFIR-MED demonstrations have been planned and executed to evaluate the fulfilment of a selected set of requirements by integrating several platforms into a C2C (Command and Control Centre) in order to demonstrate as to how this integration affects the optimal delivery of selected U-Space services.

The solution put forward by the SAFIR-MED project is the digitally integrated ad-hoc organisation and execution of prioritised medical drone flights, and how that can be enabled by U-Space services.

The project identified that by thoroughly practicing and digitally integrating the entire U-Space process flow, efficiencies could be gained. The efficiencies gained are not sufficient to fully meet the very strict requirements as put forward by the medical community. Further automation and integration are required.

2 Introduction

2.1 Purpose of the document

This document provides the Demonstration Report for SAFIR-Med. It describes the results obtained after the conduction of the exercises that were defined in the SAFIR-Med Demonstration Plan, the deviations that have taken place along the project and a set of conclusions and recommendations.

2.2 Scope

This is the DEMO Report for VLD SAFIR-Med project, which aims to demonstrate the safe integration of urban air mobility (UAM) as additional airspace user by combining different UAV platforms and technologies from all the partners.

Through a set of exercises whose mainly aim is the medical transport delivery by using the SAFIR-Med Architecture, where the main focus is the machine-to-machine C2C-UTM integration, the SAFIR-Med project will demonstrate several U-space services and how this can be integrated into the SESAR solutions.

2.3 Intended readership

The SAFIR-Med partners (the beneficiaries, linked-third-parties, subcontractors and the advisory board) and the SJU will use the Demonstration Report as a record of the achieved outcome of the SAFIR U-space demonstration project.

Other SESAR/Horizon 2020 projects addressing U-space may use the Demonstration Report as a tool to support collaboration on their project work related to U-space.

External associates of SESAR – notably EASA, DG-Move, EUROCAE, national CAA's and ANSP's– may use the Demonstration Report as a reference document to support collaboration on their activities related to U-space.

2.4 Background

The SAFIR-Med Demonstration plan takes into account the following previous work:

- SAFIR
- CORUS-XUAM
- U-space Blueprint
- GOF
- VUTURA

SAFIR-Med will use the federated architecture developed in SAFIR project, which will be further refined considering the lessons learned of each of the U-space demonstrator projects and the "State-of-the-Art report" issued by the SJU.

By using the same Federated U-space architecture as within SAFIR, the SAFIR-Med project will be demonstrated in live conditions and the information exchange between different modules of the architecture in an operational environment. Besides, BVLOS flights within a city and industrial environment will be executed in Belgium.

2.5 Structure of the document

The Demonstration Report is composed of different parts:

- Chapter 1 (Executive summary) aims to provide a high-level summary of the project.
- Chapter 2 (Introduction) aims to introduce this document to the readers.
- Chapter 3 (VLD scope) describes of the scope of the SAFIR-Med project and demonstrations. It describes the U-space services that will be demonstrated within the scope of the project and provides a brief summary of what was initially planned on the Demonstration Plan.
- Chapter 4 (Demonstration Results) describes the consolidation of the results of all the exercises performed on the SAFIR-Med project, including a detailed analysis of the demonstration results per demonstration objective and confidence in results.
- Chapter 5 (Conclusions and Recommendations) present conclusions and recommendations regarding the further industrialization, standardization and development of the U-space concept and services.
- Chapter 6 (Summary of Communication and Dissemination activities) describes the high-level messages, target audiences, and the means and evens for SAFIR-Med project.
- Chapter 7 (References) describes the references used.
- Appendixes A and B describe the detailed level of results for each of the exercises performed within the SAFIR-Med project.
- Appendix C describes the operating environment requirement (safety, human performance, etc.).
- Appendix D provides the different communication and dissemination activities performed for this project

2.6 Glossary of terms

Term	Definition	Source of the definition

AIR-REPORT	A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.	ICAO Annex
Beyond visual line of sight (BVLOS)	An operation where neither the drone pilot nor the observer maintains direct unaided visual contact with the RPA.	EASA NPA 2017-05
Command and Control (C2)	Ability of drones to communicate with their ground control station to manage the conduct of the flight, normally via a specific data link.	Manual on remotely piloted aircraft systems (ICAO Doc. 10019)
Geo-fence	A geographical fence or "geo-fence" is a two-dimensional virtual boundary defined by geographical coordinates that divides a real-world volume in two parts.	EASA/NAA Task Force Report: Study and Recommendations regarding Unmanned Aircraft System Geo-Limitations
Geo-fencing	Function to make a UAS comply automatically with one or more geo-limitations based on geo-fences. The function can be implemented only in the UAS or distributed between the UAS and an external system (e.g., UTM system).	EASA/NAA Task Force Report: Study and Recommendations regarding Unmanned Aircraft System Geo-Limitations
Small UA/ Drones	Generally weighing less than 25 kg, this subset of smaller UA is commonly referred to as drones.	ICAO Unmanned Aviation Bulletin 2018/1
UAS traffic management (UTM) system	The UTM system is a concrete technical implementation comprising software, the necessary infrastructure for running the software, and the drones themselves all contributing to the achievement of UTM.	UAS Traffic Management Architecture (GUTMA)

Table 1: Glossary of terms

2.7 List of Acronyms.

Acronym	Definition
ATM	Air Traffic Management
ADS-B	Automatic Dependant Surveillance – Broadcast
AED	Automated External Defibrillator
AIM	Aeronautical Information Management

AGL	Above Ground Level
AMC	Acceptable Means of Compliance
AMSL	Above Mean Sea Level
ANSP	Air Navigation System Providers
API	Application Programming Interface
ARC	Air Risk Class
ATAS	Air Traffic Awareness System
ATC	Air Traffic Control
ATM	Air Traffic Management
ATSP	Air Traffic Service Provide
AAV	Anomalous Aerial Vehicle
AVLL	Above Very Low Level
BCAA	Belgian Civil Aviation Authority
BIPT	Belgian Institute for Postal Service and Telecommunications
BVLOS	Beyond Visual Line of Sight
C2C	Command and Control
CAA	Civil Aviation Authority
CD&R	Conflict Detection & Resolution
CISP	Common Information System Provider
CONOPS	Concept of Operations
CORUS	Concept of Operations for European UTM Systems
CPR	Correlated Position Report
CR	Change Request
CTR	Control Zone
DAA	Detect & Avoid
DEMOP	Demonstration Plan
DEMOR	Demonstration Report
DSA	Drone Service Application
EASA	European Aviation Safety Agency
EATMA	European ATM Architecture
ED	Emergency Department
EU	Europe Union

eID	e-Identification
ERP	Emergency Response Plan
FLARM	Flight Alarm
FPL	Flight Plan
GM	Guidance Material
GNSS	Global Navigation Satellite System
GRC	Ground Risk Class
HMI	Human Machine Interface
HPAR	Human Performance Assessment Report
IFR	Instrument Flight Rules
iGRC	Intrinsic Ground Risk Class
INTEROP	Interoperability Requirements
ISIAR	Initial Safety Impact Assessment Report
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
KPA	Key Performance Area
LTE	Long-Term Evolution
LTE-Network	Mobile Telecommunication Network
MAHHL	Maastricht-Aachen-Heerlen-Hasselt-Liege region
MUG	Medical Staff Mug
NAA	National Aviation Authority
NDZ	No Drone Zone
NOTAM	Notice to Airmen
OI	Operational Improvement
OSED	Operational Service and Environment Definition
OSO	Operation Safety Objectives
PAR	Performance Assessment Report
QoS	Quality of Service
RPAS	Remotely Piloted Aircraft System
SAC	Safety Criteria
SAFIR	Safe and Flexible integration of Initial U-space services in real environment
SAFIR-Med	SAFE AND FLEXIBLE INTEGRATION OF ADVANCED U-SPACE SERVICES FOCUSING ON MEDICAL AIR MOBILITY
SAIL	Specific Assurance and Integrity Level

SAR	Safety Assessment Report
SCC	SAFIR Coordination Center
SDSP	Software Development Service Provider
SeAR	Security Assessment Report
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SORA	Specific Operations Risk Assessment
SPR	Safety and Performance Requirements
TS	Technical Specification
SMEs	Subject Matter Experts
SWIM	System Wide Information Model
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
USSP	U-space service provider
UTM	UAS Traffic Management
VFR	Visual Flight Rules
VLD	Very-Large Demonstration
VLL	Very Low Level
VLOS	Visual Line of Sight
ATM	Air Traffic Management
CNS	Communication, Navigation and Surveillance
CONOPS	Concept of Operations
CR	Change Request
DEMOP	Demonstration Plan
DEMOR	Demonstration Report
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
HPAR	Human Performance Assessment Report
INTEROP	Interoperability Requirements
KPA	Key Performance Area
OI	Operational Improvement

OPAR	Operational Performance Assessment Report
OSED	Operational Service and Environment Definition
PAR	Performance Assessment Report
PIRM	Programme Information Reference Model
QoS	Quality of Service
SAC	Safety Criteria
SAR	Safety Assessment Report
SecAR	Security Assessment Report
SESAR	Single European Sky ATM Research Programme
S3JU	SESAR3 Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
SWIM	System Wide Information Model
TS	Technical Specification
TSA	Temporarily Segregated Airspace

Table 2: List of acronyms

3 Very Large Demonstration (VLD) Scope

The following sections will define the scope of the SAFIR-Med project and will list the main deviations that happened between the Demonstration Plan and the Demonstration Report at project level.

3.1 Very Large Demonstration Purpose

The main purposes of this Demonstration are:

- Demonstrate the safe integration of UAM as additional airspace user.
- Prepare and demonstrate different U-space services (U1, U2 and initial U3) using a federated architecture, where several U-space service providers will be coordinate by an UAM ecosystem.
- Provide recommendations on future deployment and for regulations and standards.
- Consolidate requirements with the concept of smart cities.

The main objectives of this Demonstrations are:

- Help urban authorities realised their role and make their first steps in the UAS world.
- Improve infrastructure contributing to safer transport with a positive social impact.
- Ensure sustainable infrastructure that is beneficial for society and environmentally friendly.

- Demonstrate novel public UAM services and services models.
- Regulation, standards, business prospects and outputs dissemination: ensure sustainability and mid-term wide adoption of the proposed solution.

The SAFIR-Med project activities will follow a two-phased approach:

- The first phase consisted of a de-risking activity. During this preparatory phase, all UAS, UTM systems, U-space interfaces, SDSP and ATAS providers were thoroughly tested and demonstrated within the segregated airspace of DronePort. SAFIR-Med prioritizes safety and considers successful completion of demonstrations at DronePort to be a necessary precondition for moving to the second phase. Complex scenarios were tested in segregated airspace, allowing to identify potentially unidentified risks in a real-life environment excluding the17ccompanyying risk of executing those scenarios in non-segregated airspace.
- The second phase consisted of a real urban demonstrations.
    - In Real Urban demos, demonstrating UAS operations with a viable integrated U-space solution, was the non-segregated airspace of Antwerp in Belgium and the MAHHL region in the Dutch, German, and Belgian border region.
    - In Simulated urban demos, the aim was dual: enhancing real demos and amplifying their effects at large-scale to test maximum capacity of a given airspace with a variety of U-space services and scenarios and transferring and testing our assumptions to different locations in Europe, thus validating further the results. This part of the second phase will contribute to the DEMOR[21] since the results of the simulated trials will be considered for further validations and tests.

The Real urban demonstrations took place in Antwerp, Belgium (overlapping controlled airspace of EBAW, the restricted zone above Port of Antwerp as well as heliports) and MAHHL-region (contains hospital heliport and required a Permit-To-Fly for cross-border operation BVLOS between the Netherlands and Germany or from hospital within the limits of Aachen).

The simulated demonstrations took place in Athens, Greece and Prague, Czech Republic, and, as mentioned, will contribute to the results of the DEMOR[21].

- Athens, Greece: Two main hospitals with a distance less than 20km by car.
- Prague, Czech Republic: Several hospitals spread around the city.

The technology and platforms to be used:

- An UAM ecosystem architecture centralizing all UAV/AAV platforms, which all must be centrally directed to the Helicus C2C.
- U-space Services Providers: Droniq and SkeyDrone
- UTM Technology Providers: Unifly, Involi, TU Delft
- Future looking operators: Helicus and NSX
- U-space integratable UAS platforms (flyXdrive, HyFly, SABCA, Ehang and TU Delft)

- Simulations (Athens, Prague)
- U-space and UAM knowledge centres as Hellenic U-space Institute, RWTH Aachen University and Future Needs
- Air Navigation Service Providers (ANSP): Skeyes
- UAM stakeholder: Stadt Aachen

3.2 SESAR Solution(s) addressed by VLD

On below table, the list of U-space services that were initially planned to be addressed can be found.

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SESAR Solution ID and Title			SESAR Solution Description	OI Steps ref. (coming from EATMA)	Enablers ref. (coming from EATMA)	Solution/service addressed or assumed?
US1-01	U1	Registration	Interaction with the registrar to enable the registrations of the drone, its owner, its operator, and its pilot. Different classes of user may query data, or maintain or cancel their own data, according to defined permissions.	N/A	N/A	Assumed
US1-02		e-Identification	e-identification enables information about the drone and other relevant information to be verified without physical access to the unmanned aircraft.	N/A	N/A	Assumed
US1-03		Geo-Awareness	This provides geo-fence and other flight restriction information to drone pilots and operators for their consultation up to the moment of take-off. It includes existing aeronautical information, such as: - restricted areas, danger areas, CTRs, etc.; - information extracted from NOTAMS, and legislation; - temporary restrictions from the national airspace authority; to produce an overall picture of where drones may operate.	N/A	N/A	Assumed
US1-04		Registration assistance	This provides assistance to people undertaking the registration process	N/A	N/A	Assumed
US2-01	U2	Geo-fence provision (incl. dynamic geo-fencing)	An enhancement of geo-awareness that allows geo-fence changes to be sent to drones immediately. The drone must have the ability to request, receive and use geo-fencing data.	N/A	N/A	Addressed

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US2-02		Emergency Management	Provides assistance to a drone pilot experiencing an emergency with their drone and communicates emerging information to interested parties.	N/A	N/A	N/A
US2-03		Strategic Conflict Resolution	Checks for possible conflicts in a specific operations plan, and proposes solutions, during operational plan processing.	N/A	N/A	Addressed
US2-04		Weather information	Collects and presents relevant weather information for the drone operation including hyperlocal weather information when available/required.	N/A	N/A	N/A
US2-05		Tracking and position reporting	Receives location reports, fuses multiple sources, and provides tracking information about drone movements	N/A	N/A	Addressed
US2-06		Operation plan preparation/optimization	Provides assistance to the operator in filing of a operation plan. This service functions as the interface between the drone operator and the operation plan processing service	N/A	N/A	Addressed
US2-07		Monitoring	Provides monitoring alerts (preferably audible) about the progress of a flight (i.e., conformance monitoring, weather compliance monitoring, ground risk compliance monitoring, electromagnetic monitoring)	N/A	N/A	Addressed
US2-08		Traffic Information	Provides the drone pilot or operator with information about other flights that may be of interest to the drone pilot; generally, where there could be some risk of collision with the pilot's own aircraft	N/A	N/A	Addressed
US2-09		Drone Aeronautical Information Management	The drone equivalent of the Aeronautical Information Management service. This service maintains the map of X, Y and Z airspaces, and	N/A	N/A	Assumed

			permanent and temporary changes to it. (i.e., a weekend festival will change an area from sparsely to densely populated). This service provides information to the geo-fencing services as well as operational planning preparation service.			
US2-10		Procedural Interface with ATC	A mechanism invoked by the operation plan processing service for coordinating the entry of a flight into controlled airspace before flight. Through this, ATC can either accept or refuse the flight and can describe the requirements and process to be followed by the flight.	N/A	N/A	Assumed
US2-11		Surveillance data exchange	Exchanges data between the tracking service and other sources or consumers of tracks – radar, other drone trackers, etc.	N/A	N/A	Assumed
US2-12		Operations plan processing	A safety-critical, access-controlled service that manages live operation plans sub-mitted via the operation plan preparation service and checks them against other services. The service manages authorisation workflows with relevant authorities, and dynamically takes airspace changes into account.	N/A	N/A	Assumed
US2-13		Risk analysis assistance	Provides a risk analysis, mainly for Specific operations, combining information from other services – drone AIM, environment, traffic information, etc. This can also be used by insurance services.	N/A	N/A	N/A
US2-14		Accident/Incident Reporting	A secure and access-restricted system that allows drone operators and others to report incidents and accidents, maintaining reports for their entire life cycle. A similar citizen-access service is possible.	N/A	N/A	N/A

US2-15		Navigation Infrastructure Monitoring	Provides status information about navigation infrastructure during operations. This service should give warnings about loss of navigation accuracy.	N/A	N/A	N/A
US2-16		Communication Infrastructure Monitoring	Provides status information about communication infrastructure during operations. The service should give warnings about degradation of communication infrastructure.	N/A	N/A	N/A
US2-17		Digital Logbook	Produces reports for a user based on their legal recording information.	N/A	N/A	Assumed
US2-18		Legal Recording	A restricted-access service to support accident and incident investigation by recording all input to U-space and giving the full state of the system at any moment. A source of information for research and training.	N/A	N/A	N/A
US2-19		Geospatial Information service	Collects and provides relevant terrain map, buildings, obstacles – with different levels of precision – for the drone operation.	N/A	N/A	N/A
US2-20		Population Density Map	Collects and presents a population density map for the drone operator to assess ground risk. This could be proxy data, i.e., mobile telephone density.	N/A	N/A	N/A
US2-21		Electromagnetic interference information	Collects and presents relevant electromagnetic interference information for the drone operation.	N/A	N/A	N/A
US2-22		Navigation Coverage Information	Provides information about navigation coverage for missions that will rely on it. This information can be specialised depending on the navigation infrastructure available (i.e., ground or satellite based).	N/A	N/A	N/A
US2-23		Communication coverage information	Provides information about communication coverage for missions that will rely on it. This	N/A	N/A	N/A

			information can be specialised depending on the communication infrastructure available (i.e., ground or satellite based).			
US2-24		Citizen Reporting Service	Similar to the Accident and Incident reporting service, this U-space service is to be used by the citizen to inform the law enforcement about not cooperative drone traffic or another suspicious event to be reported. The user interface should be designed to encourage the reporting of sufficient information to identify the flights concerned.	N/A	N/A	N/A
US3-02	U3	Tactical Conflict Resolution	Checks for possible conflicts in real time and issues instructions to aircraft to change their speed, level or heading as needed.	N/A	N/A	Assumed
US3-03		Collaborative Interface with ATC	Offers verbal or textual communication between the remote pilot and ATC when a drone is in a controlled area. This service replaces previous ad-hoc solutions and enables flights to receive instructions and clearances in a standard and efficient manner.	N/A	N/A	N/A
US4-04		Dynamic Capacity Management	Responsible for balancing traffic demand and capacity constraints during operational plan processing.	N/A	N/A	N/A

Table 3. SESAR Solution(s) under Demonstration

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3.2.1 Deviations with respect to the SESAR Solution(s) definition

Here below you will find description on the deviations with respect to the U-space services as described in the EU 2021/664 compared to how they were provided

U-space service	SESAR Solution ID and Title		Solution/service addressed or assumed?	Deviations
Network identification service	**US1-01**	Registration	Assumed	Network identification of the operation will include pre-defined priorities in a medical environment taking into account several aspects of the operation.
	US1-02	e-Identification	Assumed	
	US1-04	Registration assistance	Assumed	
	US2-17	Digital Logbook	Assumed	
Geo-awareness service	**US1-03**	Geo-Awareness	Assumed	Within the activities conducted, geo-awareness service did not take place within the project environment as you would have in a U-space eco-system.
	US2-01	Geo-fence provision (incl. dynamic geo-fencing)	Addressed	
UAS flight authorisation service	**US2-03**	Strategic Conflict Resolution	Addressed	Strategic deconfliction of the different operations within the SAFIR Med project was done on the basis of the pre-defined prioritisation criteria. These criteria were defined during the scenario elaborations for the de-risking activities at DronePort.
	US2-06	Operation plan preparation/optimization	Addressed	
	US2-10	Procedural Interface with ATC	Assumed	
	US2-12	Operations plan processing	Assumed	

	US3-02	Tactical Conflict Resolution	Assumed	
Traffic information service	**US2-05**	Tracking and position reporting	Addressed	Within the SAFIR Med eco-system surveillance data was not interchanged between the ANSP and the USSP
	US2-08	Traffic Information	Addressed	
	US2-11	Surveillance data exchange	Assumed	
Conformance monitoring service	**US2-07**	Monitoring	Addressed	During the hybrid activities and live demonstrations at Antwerp the remote ID and flight authorizations enabled the USSP to monitor the conformance of the conducted operations. There was no technical solution in place to advice the UAS if he would have been leaving its operational volume.

Table 4 Deviation respect SESAR Solution(s)

3.3 Summary of Demonstration Plan

3.3.1 Demonstration Plan Purpose

The purposes of the Demonstration plan of the SAFIR-Med project are the following:

- Describe the project set up, planned drone demonstrations, C2C integration and DAA services.
- Provide a baseline plan for the execution of the project.
- Map and explain the alignment of the U-space initiative and U-space services.

3.3.2 Operating method description

The table below summarizes the new operational method that was used during the demonstrations.

				Demo execution
1.				**Order step**
1.				A medical facility (Medical) orders Helicus (Medical UAS operator), through the Helicus C2C order intake interface, to transport medical cargo between two medical sites. The order is manually created in the C2C.
2.				**Flight execution**

2.	a.			Flight-plan generation: The Helicus (Medical UAS operator) C2C manually generates a flight plan, based upon pre-defined landing and take-off locations and taking into account airspace information (static and dynamic airspace configuration as well as live traffic) from the USSP as well as ground risk and weather information.
2.	b.			Flight-plan submission: The Helicus (Medical UAS operator) C2C submits a flight request to the USSP through an API, passing a priority identifier based upon the 'Time frame' and 'Priority' and using a UAS that is available at the departure location and that is capable of executing the requested mission.
2.	c.			Pre-flight checks: In parallel with b., Helicus (Medical UAS operator) executes the pre-flight check process
2.	d.			Flight-plan processing: The USSP evaluates, prioritises and deconflicts (checks for conflicts with other flight plans) the Helicus flight request from other flight requests in the same airspace during the same timeframe.
2.	e.			ANSP coordination: The USSP also coordinates with ANSP when if required
2.	f.			Flight-plan approval: The USSP sends an authorization for the flight to the Helicus C2C through an API.
2.	g.			Drone transport confirmation: The Helicus C2C sends a confirmation to the medical facility that transport by drone is possible within the required time-frame. Pre-flight checks, Flight-plan processing, ANSP coordination and Flight-plan approval need to be completed and confirmed to the C2C in under a minute, since this information is key to inform the medical facility that transport by drone is possible within the required time-frame. In case transport by drone is not possible, the medical facility needs to have the time to organise alternative transport. Also, those steps are on the critical path for loading the medical cargo onto the drone.
2.	h.			Cargo handling at departure location: The hospital brings the medical cargo to the UA take-off location
2.	i.			Cargo loading: The medical cargo is loaded onto the UA
2.	j.			Flight-plan upload: Following receipt of the USSP authorization and successful completion of the pre-flight checks, including loading the cargo, the Helicus C2C sends the automatically generated flight plan to the UAS
2.	k.			**Flight-plan execution:**
2.	k.	i.		Readiness confirmation: The Helicus C2C sends a flight readiness confirmation to the USSP
2.	k.	ii.		Position through Telemetry transmission: The Helicus C2C start sending UA telemetry information to the USSP to provide real-time UA position information

2.	k.	iii.		Position through Remote-ID: The on-board remote ID device sends position information to the USSP
2.	k.	iv.		Geo awareness: The USSP sends real-time geo-awareness information to the Helicus C2C
2.	k.	iv.	1.	Live traffic information
2.	k.	iv.	2.	Dynamic airspace configuration changes
2.	k.	v.		Take-off clearance: The USSP sends a take-off activation to the Helicus C2C
2.	k.	vi.		Take-off command: The Helicus C2C sends a 'take-off' command to the UA
2.	k.	vii.		Take-off: The UA takes off and automatically executes the uploaded flight plan
2.	k.	viii.		DAA: The C2C DAA algorithm permanently evaluates the live traffic information received from the USSP and compares trajectories of other live traffic with the Helicus UAS trajectory and executes an avoidance manoeuvre when a conflict is detected within the pre-defined conflict time threshold.
2.	k.	ix.		Airspace evaluation: The C2C permanently evaluates dynamic airspace reconfiguration. When (new) dynamic airspace constraints are received from the USSP, the C2C evaluates whether those constraints do impact the Helicus UAS mission. This evaluation is done based on:
2.	k.	ix.	1.	Location: Is a new dynamic geofence located on the UAS flightpath ahead or is the UAS inside such a geofenced area?
2.	k.	ix.	2.	Priority: Does the dynamic geofence apply to this medical UAS given its priority?
2.	k.	ix.	2.	When conflicting geofence areas are detected in pre-flight, the C2C calculates a new flight path from current location, uploads this to the UAS and executes it. During in-flight phase, the UAS will have to land and a new flight path will be generated so that it can be executed without any conflict with geozones.
2.	k.	x.		ATC commands: When GCS API ready, during the flight, the USSP is passing ATC commands from the ANSP to the C2C through the API. Those commands could be: "Return", "Hold" (360 or hover when possible), "Land as soon as practical". During the demonstration execution, there were no ATC commands passed.
2.	k.	xi.		Landing: Upon arrival and landing at the pre-defined landing location at the arrival hospital, the C2C sends a flight closure message to the USSP
3.				Flight closure
3.	a.			Drone arrival confirmation: The C2C informs the hospital that the medical delivery is present to be collected.
3.	b.			Cargo handling at arrival location: The hospital collects the medical cargo.

3.	c.			Post flight checks: Helicus carries out post flight checks
3.	d.			Flight plan closure: The C2C closes the flight plan.

Figure 1: A first figure

3.3.3 Summary of Demonstration Objectives and success criteria

The demonstration objectives and success criteria can be found in the SAFIR-Med DEMO Plan D2.1 edition 01.00.03 under the section 4.4 Demonstration Objectives.

3.3.4 Demonstration Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Assumption status report	Impact on Assessment
ASM-VLD-SAFIR-Med-001	Airspace users	Operational	Airspace users are fully involved to support demonstrations requiring cooperation between manned and unmanned flights. Pre-flight	Involvement of airspace users is required to minimize risks related to the execution of the demonstration flights.	Assumption conditions were met	High
ASM-VLD-SAFIR-Med-002	Pilot training	Operational	All Remote Pilots have the required training and/or licenses as per the applicable Operational Authorisation to operate the drones intended for the demonstration flights. Pre-flight	When Remote Pilot training levels and/or license requirements are not met, the pilot is not allowed to fly a drone for the BVLOS missions over populated area.	Assumption conditions were met	High
ASM-VLD-SAFIR-Med-003	Helicus C2C platform available and able to exchange information with other platforms	Technical	The integration of the UA platforms with the Helicus C2C platform should be available and able to exchange the required information between them. Pre-flight, In-flight	Without the availability of the required C2C platform and the other platforms and their ability to exchange the required information, the demonstration flights cannot be performed.	Not all platforms were fully integrated for the 2 interfaces in scope for SAFIR-MED (Telemetry, Flightplan upload): - Ehang: Telemetry only, no flightplan upload - flyXdrive: Telemetry OK,	High

					Flightplan upload OK - HyFly: Telemetry implemented but not used in urban area, no flightplan upload - SABCA: Telemetry OK, Flightplan upload available but not used in urban area - TUDelft: Full integration including in-flight flightplan change	
ASM-VLD-SAFIR-Med-004	Drone, pilot and operator availability	Operational	The intended drones, pilots and operators are ready and available during the demonstration flights. Pre-flight	Execution of scenario's depend on the readiness and availability of drones, pilots and operators.	Drones were not always ready / available but that did not impact project timelines given that authorisations were the key bottleneck	High
ASM-VLD-SAFIR-Med-005	Drone flight route design	Operational	The routes and procedures for the drone operations are appropriately designed and approved by all relevant authorities (overflight, distance	The flight routes are designed in such a manner to minimize the risks related to the demonstration flight.	All routes were appropriately designed. Not all routes were approved due to mitigations missing for some drones resulting in a too high SAIL risk level	Medium

			from building, etc.) Pre-flight			
ASM-VLD-SAFIR-Med-006	U-space regulation	Operational	The U-space regulation will not be into effect during the demonstrations. Therefore, all it needs to be assumed as if those U-space regulations are in place for the purpose of the SAFIR-MED project.	There will be limited services, areas of responsibilities, etc. We might expect some changes once the U-space regulation is established that may affect the content of this document.	U-space scenarios were executed in parallel with current regulation limitations. TSA were established in the absence of validated mitigating U-Space services	High
ASM-VLD-SAFIR-Med-007	Tracker compatibility with drones	Technical	Trackers are available, integrated on the drones and the tracking output is interfaced with UTM and the C2C INVOLI tracker to be used for the Belgium case. Droniq tracker to be used for the German case. Pre-flight	Real-time positions of the drones are needed, even as a backup information retrieved via GPS.	INVOLI trackers available, tested and operational for the Belgium case. Droniq HoD trackers available, tested and operational for the German case.	High
ASM-VLD-SAFIR-Med-008	Weather conditions	Operational	Weather conditions are suitable for the operations. Pre-flight, In-flight	Drone operations can only be performed in suitable weather conditions (e.g., no storm). For this project, a back-up week has been set up in case there is bad weather	Weather conditions were show-stopping pre-conditions for demonstrations. Weather conditions during the April 7th Droneport demo have	Medium

				during the demonstration's trials.	caused flight cancellation (storm wind and rain)	
ASM-VLD-SAFIR-Med-009	U-space regulation	Operational	U-space services are simulated for all SAFIR-MED Operational Environments	U space regulation will not yet be in effect and U-space areas will not all have been defined. For SAFIR-MED trials and demonstration it needs to be simulated that all operational environments are covered by U-space	Compliant for Belgium and German operational environments	High
ASM-VLD-SAFIR-Med-010	Integration readiness	Technical	All UTM, UA, C2C integrations are developed, tested and functional before the DronePort trials	UTM, UA, C2C integration is a cornerstone for properly demonstrating SAFIR-MED U-Space functionality	UTM integrations: not ready for Droneport trials UA: partially ready for Droneport trials	High
ASM-VLD-SAFIR-Med-011	Approval Radio license	Operational	Long-range, high-power data links require licenses to operate. Where required a license from the radio network authority is required.	Without approval of the to-be-used frequencies, no demo flights are allowed.	SABCA C-Band licence expired during the course of the project	High

Table 5. Demonstration Assumptions overview

3.3.5 Demonstration Exercises List

[EXE]

Identifier	EXE-VLD-SAFIR-Med-001
Title	Demonstration of U1 and U2 operational acceptability in Antwerp, and to prepare and de-risk the rapid deployment of these services to provide advance U-space services (U3 and U4)
Description	The main objective of this case is the transport of medical goods between medical facilities within drones' mission in an Urban environment, since it is happening on the CTR of Antwerp airport and the Port of Antwerp.
Demonstration Technique	Execution of real time drones' flights
KPA/TA Addressed	Areas covered are safety, security, operational feasibility, and acceptability
Number of flights	8 + 1 platform flight public event (4 flights days plus extra back-up week: test, technical, project execution and public demonstration)
Start Date	30/05/2022
End Date	27/06/2022
Demonstration Coordinator	SkeyDrone
Demonstration Platform	Dedicated SAFIR-Med platform
Demonstration Location	Antwerp
Status	in progress
Dependencies	None

[EXE Trace]

Linked Element Type	Identifier
<SESAR Solution>	Geo-fence provision; Strategic Conflict Resolution; Tracking and position reporting; Operation plan preparation/optimisation; Monitoring; Traffic Information;
<Demo Objective>	OBJ-VLD-SAFIR-Med-100; OBJ-VLD-SAFIR-Med-200; OBJ-VLD-SAFIR-Med-300; OBJ-VLD-SAFIR-Med-400; OBJ-VLD-SAFIR-Med-500

[EXE]

Identifier	EXE-VLD-SAFIR-Med-002
Title	Demonstration of U1 and U2 operational acceptability in Aachen

Description	The overarching goal of the exercises is to smoothly execute medical transport within drone missions in a rural, sub-urban or mix environment, each with their own specific challenges (e.g. cross-border flight, flight near the border) and embed them in a central operations centre. For the MAHHL region (Aachen & Maastricht), the cross-border cooperation and dense settlement in this area offers a unique testing ground for the cooperative use of medical services via a linkage of UAS transport routes. This should later ensure easy connection to logistics and order systems of medical stakeholders.
Demonstration Technique	Execution of real time drones' flights, cross borders
KPA/TA Addressed	Areas covered are safety and operational feasibility
Number of flights	5 + 1 platform flight public event (3 flights days plus extra back-up week: test, technical, project execution and public demonstration)
Start Date	29/08/2022
End Date	28/10/2022
Demonstration Coordinator	Droniq
Demonstration Platform	Dedicated SAFIR-Med platform
Demonstration Location	MAHHL-Region, especially cross-border zone between Aachen – Heerlen – Maastricht.
Status	in progress
Dependencies	None

[EXE Trace]

Linked Element Type	Identifier
<SESAR Solution>	Geo-fence provision; Strategic Conflict Resolution; Tracking and position reporting; Operation plan preparation/optimisation; Monitoring; Traffic Information
<Demo Objective>	OBJ-VLD-SAFIR-Med-100; OBJ-VLD-SAFIR-Med-200; OBJ-VLD-SAFIR-Med-300; OBJ-VLD-SAFIR-Med-400; OBJ-VLD-SAFIR-Med-500

3.4 Deviations

3.4.1 Deviations with respect to the SJU Project Handbook

N/A

3.4.2 Deviations with respect to the Demonstration Plan

During the preparation and execution of both Antwerp and Aachen Demonstrations, a common deviation for both exercises occurred from the described activities in the SAFIR-Med Demonstration Plan, which was a deviation at the level of Operation Authorization.

3.4.2.1 Deviations at the level of Operational Authorisations

3.4.2.1.1 Authorisation Preparations:

Within the SAFIR-MED project, it was decided from the beginning that new European drone law was going to be used in support of SAFIR-MED demonstration flights and that no use would be made of transition measures under old national law. Even when this would mean running into unplanned delays. This decision was strongly supported by SESAR Joint Undertaking and EASA as those activities would result in important learnings.

In support of the several SAFIR-MED demonstrations, the planning at the beginning of the project has been to submit 4 requests for operational authorisation for flights in Belgium to the BCAA in Belgium by Helicus as a Belgian operator for flights with flyXdrive (DE), HyFly (NL), SABCA (BE) and TUDelft (NL) drones and one request for operational authorisation to DGAC in France by Ehang as a French operator for flights with the Ehang 216 in Antwerp.

It was planned to submit an authorisation request for each combination of a UA platform with the required Operational scenarios as per the SORA methodology as per AMC1 Article 11 to EU regulation 2019/947.

UA platforms: Ehang 216 ePassenger drone, flyXdrive TW-NEO eVTOL, HyFly 25 eVTOL, TU Delft AED Octocopter, SABCA X8 Octocopter

Initially intended SORA scenarios to fulfil the SAFIR-MED scenarios were, BVLOS populated area, BVLOS controlled ground (EVLOS), either in populated (urban) or sparsely populated (Droneport) areas.

With demo flights at Droneport planned for April 7th, 2022, in Antwerp on June 2nd 2022 and MAHHL (Aachen – Heerlen) on September 1st 2022, the preparation of the authorisation requests started right at the start of the SAFIR-MED project in December 2020, building upon documentation that had been prepared under Belgian UA legislation in the preceding year and was re-written to comply to EU regulations coming into effect December 31st 2020. Helicus submitted the first authorisation request under EU law to the BCAA on April 2nd, 2021.

This is more than a year before the Droneport de-risking flights that were planned for the week of April 4th, 2022.

As per the initial plan, upon receipt of the different Operational Authorisations from the BCAA, cross-border authorisation requests would be submitted to the NAA of Germany (LBA, Luftfahrtbundesmt) and the NAA of the Netherlands (ILT, Inspectie Leefmilieu en Transport / Inspection Environment and Transport) in support of the demonstrations in the MAHHL-region (3 country cross-border region around the cities of Maastricht, NL – Aachen, DE – Hasselt, BE – Heerlen, NL – Liège, BE) on September 1st, 2022.

In preparation for those cross-border submissions, contact with LBA and ILT was initiated through EASA in May 2021 already, right after the submission of the first operational authorisation case to the BCAA.

Feedback from the LBA was fairly quick with the first meeting between the LBA and the SAFIR-MED project being organised in July 2021.

First feedback from Ministry IenW (Infrastructure and Water management), the ministry to which ILT belongs, in the Netherlands only came through in September 2021 and the first feedback from ILT only came through in April 2022 with the first meeting in May 2022 only.

The last operational authorisation requests for SAFIR-MED were submitted to the BCAA in February 2022. Since those requests were all based upon the same core documentation (Operations Manual, Conops, SORA, ERP, …), as the initial request, the only difference between the first request submitted in April 2022 and the remaining ones were related to the technical specifications of the UA (drone) platforms used and trajectories flown. While all processes and procedures were shared with earlier authorisation requests submitted to the BCAA.

During 2021 it also became clear that authorisations would even be required for the de-risking flights at Droneport in the week of April 4th, 2022. In the EU drone legislation, there is no provision to facilitate flights at test locations such as DronePort. A test facility such as DronePort, does not have the possibility to obtain an authorisation that is covering all operators that intend to execute test flights at their facility since as per EU 2019/947, it is each individual operator who is required to obtain an authorisation.

3.4.2.1.2 De-risking:

Two types of de-risking activities were performed:

Operational de-risking: Following operational training of all crew, a number of hardware in the loop flights were executed with all flight crews, focussing on the knowledge of all operational procedures by all crew and practicing the simultaneous control and flight of multiple drones.

U-Space de-risking: Practice all U-Space process steps by drilling the U-Space process script that was developed during the project. Involving the different U-Space scenarios that were set-out for each drone and combination of drones ensuring that the committed U-Space services are being demonstrated.

Since the outcome of operational de-risking flights were a pre-condition for BCAA to issue authorisations to Helicus and to give BCAA sufficient time to process the outcome of the operational de-risking flights, operational de-risking flights were already started in December 2021, instead of during the demonstration week of April 4th 2022 as per the initial plan. Those operational de-risking flights were preceded by intensive training of each of the UA manufacturer flight crews (flyXdrive, HyFly, SABCA, TU Delft) on Helicus operator procedures, Crew Resource Management and multi-crew communication protocols.

The first operational de-risking exercises consisted of a number of individual hardware in the loop flights, for each UA platform separately, testing its integration with the Helicus C2C (Command and Control centre), since that C2C is the interface between each of the UA platforms and the UTM systems, and real-life practicing of Helicus operator procedures. Individual flights were carried out on the manufacturers local test sites under the OPEN A3 class while being commanded and controlled remotely from the C2C in Belgium. Those flights were held between December 2021 and February 2022

Also a combined full hardware in the loop operational de-risking flight day was organised at DronePort, testing seamless coordination of multiple UA being in the air simultaneously at the same physical location. During this test day, simultaneous flights were executed with each drone being assigned its own flight sector and its own cruise height.

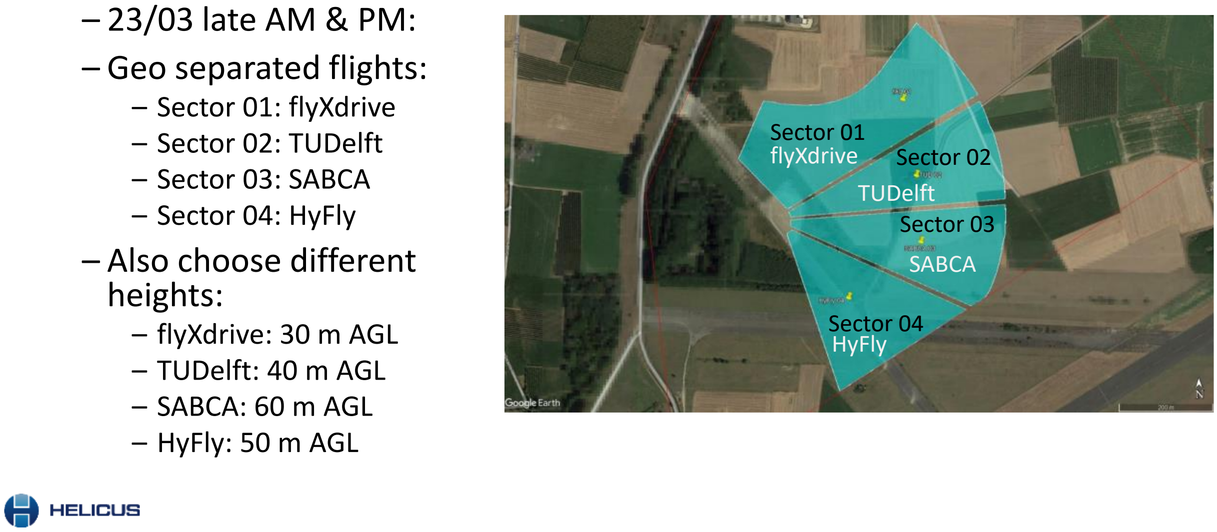

Figure 2 Droneport set-up for hardware in the loop operational de-risking

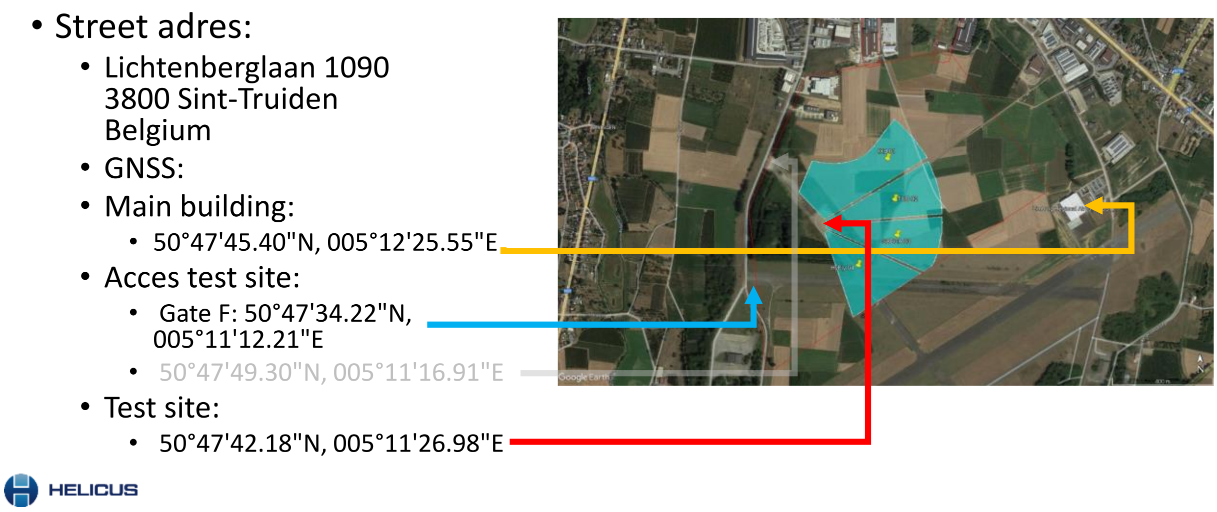

Figure 3 DronePort Operational de-risking situational context

These tests were executed with the Helicus C2C situated at the "Test site" in close proximity to the individual drone crews during morning flights and with the C2C located at the "Main building" / "Tower" location at DronePort for the afternoon flights.

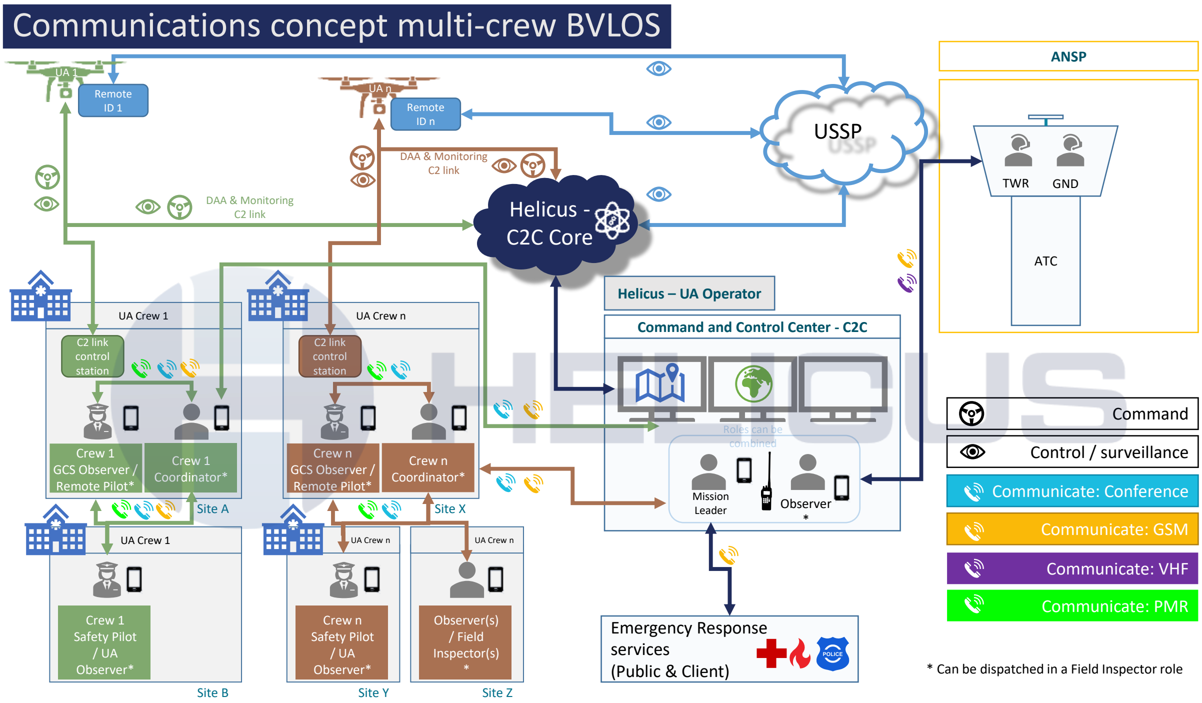

Figure 4 Multi-crew communication concept

This set-up allowed to stress-test robustness of communication architecture and protocols with multiple simultaneous drones involved and having C2C coordination at a remote location.

This hardware in the loop operational de-risking flight day at DronePort was held on March 23rd, 2022.

3.4.2.1.3 Alternate planning:

Initially it was foreseen to have these integrated Droneport operational de-risking flights, as well as the Droneport U-Space de-risking and demonstration flights to be operated under an authorisation in the Specific category.

However, due to the delays in getting the authorisations in the SPECIFIC category, the OPEN A3 class was used for the Droneport operational de-risking activities, including the limitations that this entails.

In parallel, Pre-defined Risk Assessment (PDRA) authorisation requests in the Specific category covering all the SAFIR-MED drone platforms, except for the passenger drone, were submitted for use during Antwerp demonstrations. The PDRA authorisation request was limited to VLOS flights only. The first PDRA authorisation request for use with the SABCA drone was submitted December 1st 2021 and approved March 3rd 2022. A PDRA authorisation request for all SAFIR-MED drones excluding the passenger drone was submitted May 16th 2022 and approved June 26th 2022.

The Ehang 216 passenger drone does not meet the requirements of neither the OPEN A3 class nor the limitations imposed by the PDRA. Intense discussions were held involving DGAC in France, BCAA in Belgium and local authorities in Antwerp in support of the flight with the Ehang 216 passenger drone. In spite of these efforts, authorisations were not granted on time for the Droneport nor the Antwerp demonstrations. Authorisations are expected to come through in 2023 only.

3.4.2.1.4 DronePort demonstration

Droneport U-Space de-risking was carried out as table-top exercises due to platform readiness and adverse weather conditions from April 1st to April 7th 2022. A live Droneport demonstration was cancelled due to severe weather on the demonstration day of April 7th, 2022.

Thanks to the table-top approach for the U-Space de-risking exercises, a high number of end-to-end runs of the U-Space scenario script could be carried out. During the Droneport U-Space de-risking alone, 6 full script runs involving all SAFIR-MED drones and scenarios were carried out.

During the DronePort table-top exercises, integration between the drones and the C2C and the drone platforms was in place at different levels of maturity, while UTM requests were still entered manually into the Helicus C2C and into the UTM system versus being interfaced automatically from the Helicus C2C to the UTM system. This allows for an excellent comparison of efficiency gained with C2C to UTM interface integration being in place during the Antwerp demonstrations.

3.4.2.1.5 Antwerp demonstration

Further de-risking flights were held throughout April and May 2022 in preparation of the Antwerp demonstrations.

During Antwerp demonstrations from May 30th to June 2nd 2022, interface integration was in place between the C2C and the UTM system on top of the integration between drone and UTM system.

Since only the PDRA authorisation for a SABCA drone got approved on time for the Antwerp demonstrations, an alternative approach was chosen for Antwerp demonstrations where TUDelft, HyFly and flyXdrive executed integrated flights remotely at their local home test sites, SABCA at the Antwerp Porthouse, fully linked with the Helicus C2C and coordinated using the communication architecture and protocols.

During the Antwerp demonstration week, three table-top exercises were executed and two fully integrated hardware in the loop U-Space scenario exercises were executed with each of the drones flying at different physical locations across Europe. flyXdrive executed simulated flights in Germany, HyFly and TUDelft executed flights at two different locations in The Netherlands and SABCA executed its flight in Antwerp, Belgium.

A video was recorded to document these exercises and shown to the audience of the Antwerp SAFIR-MED conference on June 2nd, 2022.

During the Antwerp SAFIR-MED conference, a live U-Space demonstration was executed using the SABCA drone.

Also during this demonstration, the full U-Space integrated processes were executed and live-streamed to the audience, with the drone departing from a remote site in the port and physically landing in front of the conference audience at the Antwerp Porthouse.

After the Antwerp demonstration week, the authorisation for BVLOS flights over populated area with the SABCA drone and the PDRA authorisation for all SAFIR-MED drones excluding the passenger drone were approved.

BVLOS populated for flights with the SABCA drone was approved June 17th, 2022, and the PDRA for flights with 4 drones on June 23rd, 2022.

The authorisation for a BVLOS flight with observers with the TU Delft drone, was about to be granted on-time for a back-up demonstration flight on June 28th 2022 but didn't get approved following BCAA experts leaving the drone section and the hand-over to other experts slowing the process down.

3.4.2.1.6 Cross border request

Upon receipt of the Belgian operational authorisations, the requests for the cross-border authorisations in Germany and The Netherlands, in preparation for the September 1st demonstrations in Aachen, were prepared and submitted.

The PDRA cross border request was submitted in Germany on June 29th 2022, in The Netherlands on July 14th 2022. The BVLOS populated cross border requests were submitted in Germany on July 19th 2022 and in The Netherlands on Augusts 8th 2022.

To increase the chances to be able to execute flights in the MAHHL demonstration, it was at this time also decided that flyXdrive as a German operator would use their running German authorisation request for BVLOS flights in sparsely populated environment in support of the SAFIR-MED MAHHL demonstrations. flyXdrive would also include the flight with the TUDelft drone in their request.

flyXdrive did not obtained the authorisation for the flyXdrive drone as well as the TU Delft drone in time for the demonstration on September 1st. The authorisation was obtained on-time for a back-up demonstration on October 24th 2022. Unfortunately, the flights could then not be executed due to bad weather. flyXdrive was able to execute a flight on the back-up day of October 26th 2022.

Based upon the German authorisation, flyXdrive also submitted a cross border request in the Netherlands which didn't get granted yet.

3.4.2.1.7 Back-up Antwerp demonstrations

With the authorisations available in Belgium, the SAFIR-MED consortium decided to immediately execute a BVLOS flight over populated area between two hospitals in Antwerp, Belgium on June 21st 2022 in preparation of more integrated U-Space flights on August 23rd, 24th and 25th 2022.

On August 23rd, BVLOS populated test flights were executed between the Middelheim and Sint-Augustinus hospitals using the SABCA drone.

On August 24th, VLOS test flights were executed at the Sint-Augustinus hospital with the HyFly drone.

On August 25th, full U-Space scenarios were executed using the SABCA drone flying BVLOS populated flights between the Middelheim and UZA hospitals and the HyFly drone executing its part of the scenario's as VLOS flights at the Sint-Augustinus hospital.

3.4.2.1.8 MAHHL demonstrations

None of the authorisations (Helicus cross border nor flyXdrive German authorisation) were available on-time to execute demonstration flights during the MAHHL demonstration day in Aachen on September 1st.

The PDRA cross border authorisation for The Netherlands was granted on November 10th 2022.

At this time (25/11/2022) the SAFIR-MED consortium is making preparations to still execute MAHHL demonstration flights second half of January 2023. The timing for these demonstrations is being planned, pending the remaining authorisations to be granted.

3.4.2.1.9 Issues encountered during Operational Authorisations and cross border requests:

During the process of requesting Operational Authorisations (SORA and PDRA) and applying for cross border authorisations using those authorisations, a very high number of hurdles were encountered.

3.4.2.1.9.1 Operational Authorisation BCAA:

Upon the implementation of EU regulation 2019/947 and 2019/945 on 31/12/2020, the BCAA were very quick in making a portal available to drone operators.

This portal was even available before 31/12/2020 for operators to pre-register as an operator under the new legislation.

As from January 1st 2021, Belgian drone pilots had an on-line possibility to convert pilot licenses under the former Belgian legislation into European A1/A3, A2 including training and examination material.

Having been an operator under former Belgian law already, Helicus pre-registered as an Operator under EU law on 15 December 2020 and converted pilot licenses first half of January 2021.

In December 2020, meetings were held with EASA and BCAA to agree on the material to be prepared for SAFIR-MED Operational Authorisations.

At that time, the assumption was that each drone manufacturer would apply for Restricted Type certificate. A requirement that later would turn-out to be a too lengthy process.

Therefore, it was decided that the SORA risk level would be limited to SAIL II. Meeting SAIL II requirements for BVLOS flights in populated area for a drone up to 25kg does require an extensive set of risk mitigations to be in place. It was understood that the Helicus operational authorisations would need to score well on all 3 ground risk mitigations (M1, M2 and M3).

A very high number of meetings were held between Helicus, BCAA, EASA and the drone manufacturers over several months to get clarity of the acceptable means to fulfil mitigation levels.

Helicus worked on ensuring sufficient mitigation scores on the M1 and M3 mitigations, while the drone manufacturers needed to ensure a sufficient score on M2 in order to achieve SAIL II for BVLOS in populated area.

Also air risk needed to be brought down significantly to achieve SAIL II, knowing that the flights were going to be executed in controlled airspace and in the vicinity of an airport.

The first Operational Authorisation request under those conditions was submitted to the BCAA on April 2nd 2021.

Before that time, existing Helicus documentation was completely re-written to comply with EU regulations and acceptable mitigation measures were discussed.

A large number of comments were exchange with BCAA leading to increased knowledge at all levels: EASA, BCAA, Helicus as an operator and the manufacturers:

- EASA confirms that we are exploring "new types of operations for which the EU UAS community was lacking knowledge"
- Given that Helicus authorisation requests were submitted right after the roll-out of the EU legislation 2019/947, back and forth exchange of comments helped to mutually clarifying interpretation of this new legislation.
- Elements like, "which standards had to be applied to meet mitigation levels" had to be clarified for all stakeholders.
- The fact that, from the beginning, those authorisation requests were meant to be brought cross border through Article 13 added to the volume of comments.
- Taking the authorisation requests cross border was also taken into account when selecting mitigation means that are available in each country. As a result, a promising service to measure population density in Belgium, was not further explored since this service does not exist in Germany nor in The Netherlands and thus could not be used there.
- The Helicus operator set-up with the multiple UA-service provider-crews, the contracts and innovative insurance model, this complex set-up also resulted in a lot of communication back and forth. Also this element was EASA validated and approved.
- The structure of the BCAA drone portal has changed a number of times in the course of the process, adding to the number of comments. For example, the conops document could be uploaded in an older version of the BCAA drone portal but not anymore in a later version. As a result, the old and outdated conops which were once uploaded by Helicus, could still be seen by BCAA, but were no longer visible and could no longer be updated by Helicus. This has led to misunderstandings.
- When submitting a request for authorisation to the BCAA through the BCAA portal, no unique identification of the request is being provided. This makes it difficult to share accompanying documentation by e-mail and uniquely link it to an existing authorisation request.
- The AMC and GM to EU 2019/947 have been updated during the evaluation process and are still in evolution. Also adding to the comments. Helicus has been at the source of modifications to those AMC and GM
- EASA was involved, increasing the number of comments back and forth.
- EASA provided formal positive feedback about the value they obtain from our interaction towards the development of EU legislation on these points.
- BCAA drone cell management changed in September 2021 resulting in:
    - Authorisation processes being frozen until the new management had been able to settle-in

  - The need to re-introduce the ongoing authorisation requests and their importance to the new management
  - Procedure changes and the introduction of a 4 eyes principle by the new management resulting in a slow down as additional staff needed to become knowledgeable of the requests

- BCAA drone cell is seriously under-staffed.

It turned out that the SAIL for some manufacturers could not be brought below SAIL III due to lack of sufficient mitigations at M2.

As a follow-up, EASA developed a methodology with Helicus containing “mitigations for the demonstration of UAS operations, as part of research activities” to enable demonstrations at the higher SAIL III for project research purposes. This methodology was circulated for consultation to EASA member states.

Since this methodology was not going to be beneficial for SAFIR-MED demonstrations at relatively short notice, this methodology was not pursued further from a SAFIR-MED project point of view. This methodology needs to be picked-up again for future projects.

As a result, no authorisation for BVLOS flights in populated area could be obtained for the flyXdrive and HyFly drones.

3.4.2.1.9.2 Cross border authorisations (Article 13):

EU drone legislation provides a method for EU drone operators to take an authorisation in the Specific category cross-border to another EASA member state.

The operator needs to prove to the NAA of the other member state that mitigations are adapted to the local conditions.

During the request for cross border operations in Germany and The Netherlands, in preparation for MAHHL demonstrations, the following observations were noted and hurdles encountered:

- Support from local authorities:
  - As part of the process to have BVLOS demonstration flights in populated area approved by Germany National Aviation Authority, LBA (Luftfahrt Bundesamt), a review of the planned trajectory through local authorities is required as per Criterion #2 (Evaluation of people at risk) of mitigation M1 to achieve medium level of assurance. The administrative structure of the City of Aachen did not foresee urban UAS missions at the beginning of the project even though this was part of the project proposal and the demonstration plan. As a workaround, the project partner the Department of Economics of City of Aachen involved the district offices, which neither have the necessary expertise nor the necessary resources to handle the kind of requests put forward by the LBA for flights by Helicus. The request overextended their limited capacity, therefore no solution was reached and LBA could not deliver the cross-border authorisation for Helicus flights. The request by flyXdrive to check for

possible events in the general area of the flights took only some weeks to be processed.

- Support from University hospital (the flight locations):
    - The University Hospital Aachen (Public law institution; dt.: Universitätsklinikum Aachen, AöR) management decided that the SAFIR-MED flights at the University Hospital are supported in close proximity to their facilities and within the geographical zone of their helipad. The flights from the Franziskus facility of the University Hospital to the main campus were not executed as the hospital declined to support the request towards LBA. All other flights are not impacted as there is a solution in place with a starting and landing spot close to the premises of University Hospital Aachen's main campus.
- Availability of staff at the NAA:
    - NL: After initial difficulty to get hold of staff, the subsequent collaboration was good
    - DE: Good ongoing collaboration
- Finding the correct process to submitting the cross border request:
    - NL:
        - The wrong e-mail address for publishing cross border requests was published on ILnT website
        - No ILnT cross border request template available. Helicus created its own template as per AMC1 Article 13(1)
        - ILnT is working on a portal in support of cross-border submissions. That portal is not available yet.
    - DE:
        - LBA provides an LBA version of the cross-border application form as per AMC1 Article 13(1). Given that the fields have a fixed size, not all text is readable/visible when printing this document.
- Submission and analysis of the request:
    - Both LBA as well as ILnt are demanding that the PDRA-S01 is being made specific (only valid for a specific pre-defined location), while the original PDRA-S01 authorisation obtained from the Belgian CAA is generic as long as the PDRA-S01 conditions are being complied with.
    - DE: LBA requests a localisation of the ERP
    - Geozones:

    - Flight operations management (Geozone manager) of the University Hospital Aachen heliport are requiring compliance with their rules within a radius of 3330 m around the AD reference point, while German drone legislation implementing the EU legislation is limiting that radius to 1,5 km.
    - Initially LBA requested an approval from the University Hospital Aachen heliport Geozone manager as a condition to issue the authorisation (in this case to reduce ARC-c to ARC-b), while the University Hospital Aachen heliport Geozone manager requested proof of an existing cross border approval.
    - University Hospital Aachen heliport Geozone manager sought advice from local state aviation authorities. In that process, reference was made to German law that requires all inquiries to be done in German and that relevant documentation had to be presented in German. Resulting in delays translating documents.

- General process:
  - BVLOS populated:
    - NL: Dutch CAA, ILT, has got a country wide rule not to accept BVLOS populated requests as a basis. Such BVLOS populated requests are not even being evaluated.
  - Unique identification of cross border applications:
    - NL: ILnT provides a unique identification of the request that is sent in the automatic confirmation of receipt mail.
    - DE: No unique identification of the cross-border request is available.
  - Language: Some content of the original Belgian authorisations obtained by Helicus is written in Dutch only. LBA had to refer back to BCAA to understand the correct interpretation of that Dutch text. This while all Helicus documentation is presented in English
  - To achieve SAIL II in areas with an ARC higher than ARC-b, additional mitigating measures are required. The Belgian authorisation was obtained for flights in an ARC-d situation that could only be mitigated to an ARC of below ARC-c by creating atypical airspace. A TSA (Temporary Segregated Airspace) was created to create this atypical airspace which resulted in an ARC-a.
    - NL: A TGB (Tijdelijk Gebied met Beperkingen: Temporary Restricted Area) is required for BVLOS operations but the process to obtain one is very lengthy.
    - DE: Does not allow creation of TSA.

The above has led to authorisations that were delivered very late or not at all and has also led to demonstration flights that were executed late, partial or not at all.

In support of EASA and the BCAA, the above observations have been shared frequently as feedback throughout the project to allow them to fine-tune processes.

The above observations have also led to some recommendations (see 5.2.3.1).

4 Demonstration Results

4.1 Summary of Demonstration Results

Demonstration Objective ID	Demonstration Objective Title	Success Criterion ID	Success Criterion	Demonstration Results	Demonstration Objective Status
OBJ-VLD-SAFIR-Med-100	Operational acceptability of U-space services	CRT-VLD-SAFIR-Med-100-100	The roles and responsibilities of the involved actors (individual and at the level of the team) are clear and acceptable under U-space services (U1 and U2) in nominal situations	The execution of the scripted scenarios in the form of tabletop exercises during the demonstrations created a clear framework setting out the roles and responsibilities of the involved actors. These learnings facilitated further demonstration executions at Antwerp and Aachen.	OK
		CRT-VLD-SAFIR-Med-200-100	The tasks and procedures of the involved actors (individual and at the level of the team) are clear and acceptable under U-space services (U1 and U2) in nominal situations.	A framework was created for both Aachen and Antwerp including the tasks accompanying the responsibilities of the U-space eco-system participants.	OK

		CRT-VLD-SAFIR-Med-300-100	The UTM systems proposed are usable and acceptable to the Medical UAS operator, the Medical organization, local authorities and the USSPs for testing U-space services (U1 and U2) in nominal situations.	The UTM system was acceptable but was not enough to meet the expectation. The project made some improvements to increase the usability and the efficiency of the entire U-space process, but still more integrations and automations are required. No interactions by the Medical organizations nor the local authorities were evaluated.	Partially OK
		CRT-VLD-SAFIR-Med-400-100	The UTM systems proposed support the Medical UAS operator, the Medical organization, local authorities and the USSPs performance in order to achieve their tasks in an efficient, accurate and timely manner for tested U-space services (U1 and U2) in nominal situations	The UTM system was acceptable but was not enough to meet the expectation. The project made some improvements to increase the usability and the efficiency of the entire U-space process, but still more integrations and automations are required. No interactions by the Medical organizations nor the local authorities were evaluated.	Partially OK
		CRT-VLD-SAFIR-Med-500-100	The communication load and phraseology associated to U-space services (U1 and U2) are	Communication and phraseology were not on the level of aviation standards, complexifying the operation. There are a lot of improvements to be done so that the communication and	Partially OK

			acceptable in nominal situations	phraseology are verbally minimized to optimize the impact on the training.	
		CRT-VLD-SAFIR-Med-600-100	The training and transition needs associated to U-space services (U1 and U2) are identified and documented for all future users in nominal situations.	Training and transition material were identified and documented for all the future users, which were associated to the addressed U-space services demonstrated in this project and that they will be able to be used in the future.	OK
OBJ-VLD-SAFIR-Med-200	U-space services safety	CRT-VLD-SAFIR-Med-200-100	The U-space services (U1, U2) will ensure the safe integration of drones from pre-flight to post flights	Visualisation of the operation and tracking by the USSP makes it possible to in a later stage communicate (conformity- non conformity) to the ANSP and other airspace users. This communication was out of scope with regard to the project technical development objectives.	Partially OK
		CRT-VLD-SAFIR-Med-200-200	The U-space services (U1 and U2) contribute to the limitation of air risk in VLL airspace	As the risk for a UAS-to-UAS mid-air encounter is drastically reduced due to the strategic deconfliction, you can state that the ground risk is reduced as well. The same way of thinking is valid regarding the segregation between manned and unmanned due to the use of dynamic airspace reconfiguration. Operational Authorisations were granted by the BCAA based upon Ground Risk mitigation	OK

				measures (amongst others). Routes were designed based upon BCAA approved ground risk mitigation rules. As this route design was done through a very time-consuming manual process, automatic route creation is required for a viable automated service. This criterion needs to be re-evaluated following additional MAHHL demonstration flights.	
		CRT-VLD-SAFIR-Med-200-300	The U-space services and (U1 and U2) contribute to the limitation of ground risk	During the actual flights, ground risk mitigation measures were conducted during the planning phase of the flights.	OK
		CRT-VLD-SAFIR-Med-200-400	The U-space services (U1 and U2) contribute to the limitation excursion into no-drone zones nearby to the VLL airspace	For every drone operation a no drone zone was created at the level of the UTM. This way it was possible to make sure no other drone could plan an operation in the same airspace volume. The NO drone zone included a buffer keeping an operation with its conflict free portion of airspace. Planning of flight characteristics outside the limit of this allocated airspace is not possible.	OK

				This criterion needs to be re-evaluated following additional MAHHL demonstration flights.	
OBJ-VLD-SAFIR-Med-300	U-space system performance assessment	CRT-VLD-SAFIR-Med-300-100	The UTM system provides the information required for U-space services (U1 and U2) as it is needed and when it is needed	US1-01/US1-02: registration information and identification are made available through data provided by the UTM platform. US2-03: the strategic deconfliction worked in an automated way in the UTM system for same-priority flight authorisation requests on a first -come-first-served basis. For strategic deconfliction between a low-priority flight entered first and a high-priority flight entered later, manual assessment and intervention was required. US2-05/US2-08: Tracking of the manned and unmanned traffic was supported by the deployment of different tracking systems. During some of the flights tracking was rather limited and data on the UAS position was not available due to mobile network connectivity issues. Some technical issues caused the data stream to	Partially OK

				interrupt or not start-up without an extra technical, human, intervention. US2-11: surveillance data, relevant operational data on manned traffic was not part of a data stream set up between ANSP and USSP.	
		CRT-VLD-SAFIR-Med-300-200	For all U-space services (U1 and U2), the UTM system performs as expected even when used to supervise simultaneously multiple drones (by a single or by multiple drone pilots)	At the moment multiple drones were operated simultaneously the amount of data exchanged via the UTM system was rather limited.	OK
		CRT-VLD-SAFIR-Med-300-300	The various systems (e.g., trackers, data recorders, aeronautical data, displays) are interoperable enough for the end users to benefit from all U-space services (U1 and U2)	The data provided by different trackers can be shared within the U-space eco-system, increasing situational awareness and flight safety.	OK
OBJ-VLD-SAFIR-Med-400	U-space standard and regulation	CRT-VLD-SAFIR-Med-400-100	The impact of all U-space services (U1 and U2) on operational or technical standards (creation or	Within this document section 3.2.1 findings on the impact with regard to operational and technical standards are elaborated.	OK

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			changes of existing ones) is documented		
		CRT-VLD-SAFIR-Med-400-200	The impact of all U-space services (U1 and U2) on regulations (compatibility with or need for change) is documented	Within this document section 3.2.1 findings on the impact with regard to operational and technical standards are elaborated.	OK
OBJ-VLD-SAFIR-Med-500OBJ-VLD-SAFIR-Med-500	Performance assessment of U-space services	CRT-VLD-SAFIR-Med-500-100	The U-space services (U1 and U2) improve the cost effectiveness of flight preparation in reducing the associated time/effort/cost	Time effort and cost will highly depend on the level of automation. Every human interaction to the system requires training, will limit the capacity and therefore impact the cost-effectiveness of the U-space eco-system. At this moment the integration of the UAS platforms is not at the required level to enable multiple tasks to be automated. Currently the drone needs to be specifically prepared before each and every flight. This means besides the Command-and-Control operator a person needs to be physically near the drone to enable the preparation for departure. Integration of the package to be transported is a manual intervention as well.	OK

		CRT-VLD-SAFIR-Med-500-200	The U-space services (U1 and U2) improve the flight efficiency, e.g., as the integration of aeronautical data and flight preparation in a same system reduces the potential margins / deviation from the most optimal trajectory that drones can fly	As this was not developed and thus demonstrated this shall be added to the items of deviation.	NOT OK
		CRT-VLD-SAFIR-Med-500-300	The U-space services (U1 and U2) contribute to increase the capacity in drones' airspace through enabling more simultaneous flights (e.g., through strategic deconfliction before and during flight time, through the possibility to visualise flights in real time and avoid obstacles if any)	U-space services enable the coordination of conflicting flight requests. The flight authorization service deconflicts the UAS enabling both operations to take place in a safe and secure manner.	OK

Table 6: Summary of Demonstration Exercises Results

4.2 Detailed analysis of Demonstration Results per Demonstration objective

4.2.1 OBJ-VLD-SAFIR-Med-100, Operational acceptability of U-space services

4.2.1.1 U1 services

In general, the U1 services were aligned with the study objective. Efficiency is the key element when flying in a complex environment as the Antwerp CTR and MAHHL region. This is why, the U1 services were built in an efficient way.

From the operator point of view, the main task is to input the necessary registration information that allow the identification.

From the authority point of view, the purpose was to be able to track, identify and have a view of the geofences. It was also possible to see the drones live tracks and drone operation areas. By clicking on the drone track or the drone operation area, a window pops-up with detailed information on the drone, the drone operator and the drone operation area. The level of information provided and exchanged between DTMs was acceptable by the authorities.

4.2.1.2 U2 services

In general, the addressed U2 services were aligned with the study objective. Nevertheless, at this stage of technical development evaluating the operations volume is a human intervention. This leads to the need for coordination and predefined coordination procedures. During the exercises this was performed via voice communication leading to the need for a basic phraseology knowledge.

The direct electronic data connection between drone operator and the UTM enabled both parties to monitor the flight status of the UAS, as long as mobile cellular network was available. The traffic information service of the UTM system further provided an overview of the prevailing manned and unmanned air traffic situation.

Some U2 services were tested during the demonstration. During pre-flight, the strategic deconfliction was used to deconflict different operations that have different level of priority, giving priority to the emergency flights. This was due to a good preparation of the operation plan preparation and optimization. The Helicus C2C was supposed to receive all the flight plans as well as seeing the traffic information of the drone.

4.2.1.3 U3 services

There were no addressed U3 services on this project. Nevertheless, the tactical conflict handling could not be demonstrated due to the lack of permits (as designated by AMC1 Article 13). Therefore, only one German project partner was involved in the demonstration flights, flying with their own operational authorization and skipping the planned route sections over Dutch territory.

4.2.2 OBJ-VLD-SAFIR-Med-200, U-space services safety

4.2.2.1 U1/U2/U3 services

The addressed U1 and U2 services were aligned with the study objective. The services tested within the demonstration focus on the pre-tactical and tactical mitigation layer. As from the moment flight authorisations are submitted, until the flight has been terminated in the UTM platform, the details of the operations are available for the involved U-space actors.

The available air picture, including manned and unmanned traffic increases situational awareness toward the airspace users, reducing the air risk. By obtaining a flight authorization request as described in the EU 2021/664 the drone operator ensure itself to be presented a conflict free trajectory. Continuous conformance monitoring, which in this case is comparing the actual location of the drone to the authorised operational volume enables the USSP to advise the drone operator of unintended possible excursion of the flight

4.2.3 OBJ-VLD-SAFIR-Med-300, U-space system performance assessment

4.2.3.1 U1/U2/U3 services

The addressed U1 and U2 services were aligned with the study objective. During the exercises, it could be seen that supervising multiple drones meant an increase of the workload on all actors required to perform manipulations in the different platforms. Further automation will make it possible to mitigate these difficulties.

The UTM system worked as assumed during the flights, the manufacturers could register within the UTM system, the identification was visible during the flight and displayed to all involved stakeholder within the UTM display.

Further improvements on the UTM and Command-and-Control platform integration made it possible to make available different types of data regarding the intended operations available to all stakeholders in a user-friendly way, limiting the number of required inputs.

4.2.4 OBJ-VLD-SAFIR-Med-400, U-space standard and Regulations

4.2.4.1 U1/U2/U3 services

The addressed U1 and U2 services were aligned with the study objective. The preparation, optimization of all the operations followed the U-space standards and regulations.

The identification and registration of the UAS on the UTM system was visible during the preparation and execution of the flights. The tracking position and traffic information was displayed to the end users and the C2C could see the flight on the system.

4.2.5 OBJ-VLD-SAFIR-Med-500, Performance assessment of U-space services

4.2.5.1 U1/U2/U3 services

Tabletop de-risking activities enabled the drone operators to test the interaction with regard to the dynamic reconfiguration of airspace. This flexible segregation of airspace enables the drone operator to continue the mission taking into account new airspace characteristics instead of having to abord the operation completely, irrefutably improving drone efficiency.

Not to be taken into account is the amount of preparation and coordination between local ATC and the project participants. This coordination is related to the current way of working when conducting large scale operations within controlled airspace.

Using the UTM platform as a single point of contact for the drone operator enables the necessary coordination to be conducted in a more efficient way. Reducing the amount of pre-flight preparation and coordination.

The cost effectiveness by using the U-space services was shown in the preparing of the flight but due to a lack of automation between different UAS could not be really shown during the flight. At this moment the integration of the UAS platforms are not at the required level to enable multiple tasks to be automated. This means besides the Command-and-Control operator a person needs to be physically near the drone to enable the preparation for departure.

4.3 Confidence in Results of Demonstration Exercises

4.3.1 Limitations and impact on the level of Significance

The integration of the different UTM platforms with the Helicus C2C did not have any limitation and impact in order to perform the flights. Nevertheless, the limitations that we found during the demonstration preparation and executions were:

- The weather limitations
- The lack of CAA authorizations to perform the flights and the scenarios defined on this project
- The Mobile connectivity issues

These three limitations had a huge impact on the development of the exercises because what was initially planned could not be carried out at the end.

4.3.1.1 Quality of Demonstration Exercises Results

Seen the number of experienced practitioners in all different domains of the demonstrations (ANSP, experienced operators, drone manufacturers, future USSP), different elements of what makes up safe and secure drone operations were evaluated from different point of views. This ensured that valuable feedback could be gathered for the evaluation of results and reporting.

After each and every demonstration a dedicated feedback session ensured initial lessons learned from the demonstration could be identified.

4.3.1.2 It is important to state that the demonstration exercises required a lot of human intervention to time each of U-space process step, which in most cases it is not very accurate. Significance of Demonstration Exercises Results

The live demonstrations at DronePort and in Antwerp were conducted within atypical airspace. This creates an environment where the drone is to be able to conduct its operations with the risk of other, non-participating traffic. This creates an environment which is fundamentally different from how the future U-space will work. The flight in the MAHHL-region was not conducted within an atypical airspace but with additional safety procedures in place reduce the risk of conflicts with manned aviation. As the area of operation was confined to a rather small portion of reserved airspace, the amount of infrastructure required to be able to pick up remoteID signal and provide U-space services was limited as well. This made it easier to ensure ourselves of the tracking coverage provided. Nevertheless, at some instances the tracking of the drone was lost even after positive establishment of the remoteID contact in the UTM platform. The tracking coverage validation is an element that should not be forgotten when scaling up operations, it is a necessary part in order to build up the confidence in the system and services.

5 Conclusions and recommendations

The SAFIR-Med project demonstrated safe and secure integration of drone operations into shared airspace through the application of federated U-space services provided by multiple industry and air navigation service provider entities. It also demonstrated the integration with the different platforms with the Helicus C2C enabling priority management.

The SAFIR-Med project has performed until now:

- 5 operation scenarios in the real and complex environment of the Antwerp area in Belgium, which were first developed, tested, de-risked and demonstrated in the Drone test are of DronePort Sint-Truiden.
- One operation scenario from five scenarios in the real and complex environment of the MAHHL region. Of the other four scenarios two more are expected to take place in January 2023. The remaining two cannot be completed within the scope of SAFIR Med as they a flight permit for these cannot be issued in time as their technical and administrative complexity is too high.

As SAFIR-Med is one of the U-space demonstrations projects, that belong to the SESAR portfolio regarding U-space. This portfolio is based upon the assumption that Europe can deploy U1 and U2 services/capabilities by using existing commercial solutions and that U3 and U4 services/capabilities still require Research & Development activities before actual deployment.

This section captures the conclusion regarding:

- The achieved maturity of the demonstrated U-space services
- The concept clarification and operation feasibility of the services
- The Technical feasibility and architecture
- Aspects related to human performance and safety

5.1.1 Conclusions on maturity of the SESAR Solution(s) and addressed services/capabilities

As illustrated in Section 4.1, the SAFIR-Med Demonstration results, we consider that the SAFIR-Med Project is not mature enough to have reached TRL7. The maturity of the U-space services and capabilities that have been demonstrated in SAFIR-Med is assessed towards a set of criteria to determine their respective maturity provided by the SESAR Joint Undertaking.

Some reasons why the SAFIR-Med project is not mature enough is due to the lack of permits from CAA in order to perform the different scenarios and flights that were initially planned as part of this project

Not all maturity criteria were assessed within SAFIR-Med. SAFIR-Med concerted on following criteria:

- Operational criteria
- System criteria
- Performance criteria (focused on human performance and safety performance; security performance was not particularly assessed, but no negative occurrences were noticed during the demonstrations; no Environmental Impact Assessment or Cost Benefit Analysis were performed)
- Standards and regulations criteria
- Validation criteria: the SAFIR-Med demonstrations can be seen as a Validation Exercise in a real environment

Concerning the U1 services, it is concluded that these services and capabilities have almost reached TRL7 maturity and are mainly ready for deployment.

Regarding the operational level of maturity, the U1 services are well aligned with CORUS Concept of Operation. The SORA methodology supports an effective approach to deploy these services even in urban or complex environments as demonstrated by SAFIR-Med. The noticed shortcomings on during the SAFIR demonstrations related to the U1 services are supposed not to impact the maturity level of these services but are the result of temporary issues or missing features that exist on the market but were not part of SAFIR-Med. Further integration of the pilot Ground Control Station will improve the pilots Human Performance, even during pre-flight process.

Concerning the U2 services, it is concluded that these services have not reached TRL7. Several shortcomings for multiple services/capabilities were noticed during the SAFIR-Med demonstrations. It has been demonstrated that the U-space services that were used worked well and ensure a safe flight an intensified awareness for the operator. Nevertheless, the flights showed that the envisaged level of automation and maturity is not yet reached between the different systems, besides that, a lot of human intervention was needed in order to perform the flights.

At the level of Operational and System criteria, we noticed that the DTM systems within the SAFIR-Med contained a solution but was not enough to fulfil the system requirements, which were:

- Time: U-space processing and approval times need to be completed in under a minute
- Airspace: Free routing is required to allow fast delivery at non-predefined locations
- Priority: An AED drone needs to get priority over other air traffic
- Reliable: The U-space service needs to be always-up so that medical transport can be performed at any time of the day or night, every day of the week.
- Cost effective: U-space services should not cause a financial burden.

At the level of human performance, the services that require pilot interaction or attention while the drone is in the air result in a negative impact on its human performance in case no effective integration of these services into the pilots Ground Control System has been achieved. The human performance of ATCOs related to the effective handling of drone operations inside controlled airspace is key to further support the development the drone sector. Certainly, in the case of the SAFIR-Med scenarios which consisted of complex drone operations (BVLOS, VLL) were impacting conventional traffic. This demonstrates the urgent need for implementing a collaborative interface with ATC and USSP. It was opted for this project not to use DSA because the demonstrations were conducted in a TSA, otherwise the collaborative interface with ATC would have been addressed in this project.

No negative impact on safety was noticed, because a very high level of safety was required to receive the authorisations to execute the SAFIR-Med project.

It has been seen that a solution is needed:

- To minimize the human involvement during the demonstration execution
- To have pre-defined agreements between all the stakeholders for automatic approval of every flight within clearly defined parameters
- To automate the Machine-to-machine communication for the entire flight authorization process
- To reduce the learning curve for the crews involved

Figure 5. Execution timing and interaction

At the level of standards and regulations, the U2 services are not yet mature. For instance, the U-space 664 and the AMC & GMs regulation is still in a draft status. The Regulation (EU) 923/2012 (rules of the air) requires to be amended for clarifying the regulatory framework. At the level of Standards, it is clear that multiple standards still need to be developed on one hand, but at the level of interoperability the Helicus C2C was successfully used to exchange information between different U-space service providers.

Concerning the U3 services, there was no maturity assessment since these services were not addressed on this project. The end-to-end use of these services and the extended services of the U3 and U4 levels were missing, so that work is needed to being done at this point for rapid and comprehensive further development in the direction of a fully comprehensive solution extending deep into the service range of the U4 services. The area-wide availability and seamless integration of the U-Space services across different flight systems leads to increased safety and efficiency in planning and finally especially in operations The MAHHL demos showed that U-Space Services is on the right path, but it also has a long way to go.

[keywords: different levels of maturity regarding the level of automation]

5.1.2 Conclusions on concept clarification

Both demonstrations showed that the concept itself was sufficient for the targeted project scope. But acquiring Operational Authorisations for each individual platform and the implementation of the different system interfaces proved to be challenging and left us with little time for adequate testing. A deeper dive into the concept by means of extensive continued testing would allow us to collect more viable data to justify a higher TRL.

5.1.3 Conclusions on technical feasibility and architecture

The demonstrated architecture between the C2C, operators' systems and USSP did not fulfil the approach of an integrated ecosystem. The capabilities of the assumed system connection could not fully be exploited. A further development of the in the beginning of the project defined system architecture is recommend to exploit these potential synergies between a unified C2C in particular in the exchange with different operators and USSPs across borders. Also, the use of a unified C2C as a single point of contact between USSP and operators should be reconsidered.

We considered that the integration between the different platforms and the C2C must be improved and fully automated to reduce the burden of having a lot of human intervention and streamline the flight authorization processes.

5.1.4 Conclusions on performance assessments

Conclusions on performance assessments from the DronePort and Antwerp activities will highly focus on the impact of the human intervention. This element was identified as the factor having the largest impact on the performance and scalability of operations.

Given the lack of automation the execution of operations highly depended on human interventions and verbal coordination. This resulted in a high need for training as well regarding system manipulations and standard phraseology.

The effort done during the table top exercises at DronePort resulted in a high enough confidence of all parties involved to be able to continue live demonstrations in urban environment. No exact data was shared on the connectivity and traffic detection coverage. Keeping in mind the limited knowledge on this subject we are unable to provide a conclusive answer on safety and security within the SAFIR-MED framework. [For the German exercise, due to the highly limited demonstration, which included only one UAS in the air, only limited conclusions could be drawn from the performance data as well.

However, it can be said that during the flight a partially insufficiently available mobile network, probably due to the proximity to the international border, limited the continuous visibility of the aircraft via telemetry link to the C2C Operating under the flyXdrive backup flight permit for specific operations BVLOS in Germany, the ground equipment in place by flyXdrive and RWTH Aachen performed as expected and also implemented additional automatization steps towards flight plan upload and authorization by the USSP. Thus, the delay caused by uploading the flight plan to the UTM system and waiting for an take-off authorization was reduced to about one minute.

5.2 Recommendations

5.2.1 Recommendations for industrialization and deployment

In order to be able to turn this type of demonstrations into a real-world deployable solution further improvement on the synchronisation between all ecosystem participants is required.

The strong technical integration of service demanders (e.g. logistics partners from the medical sector) via C2C together with the close linking of the operators and their UAS with the respective USSPs has proven to be a target-oriented concept, which is also considered to be a reasonable value chain for the subsequent industrial exploitation of the project results. Here the recommendation is to foster the exchange between these stakeholders to understand the actual demand and carve the overall system architecture in that way as well as further integrate the UAS through the already planned U-Space Services.

5.2.2 Recommendations and requirements for updating the master documents

5.2.3 Recommendations on regulation and standardisation initiatives

5.2.3.1 Recommendations on regulation

Consideration should be given to how cross-border flights are exchanged between different USSPs in the future and how the flow of information here can be managed. Even though no direct cross-border demonstration took place in SAFIR-Med and an exchange with a second USSP across a border was not planned, this seems to be a still underdeveloped topic, which accordingly offers itself as a field of development for a future project.

Very practical recommendations based upon the SAFIR-MED authorization requests process:

- Accept a common language, (aviation) English for all communication, both inside the member state of the operator as well as cross border at all communication levels
- A unique identification of each request to the NAA to be available (both initial authorisation requests in the member state of registration as for cross border requests) to allow unique referencing

- Operational Emergency Management procedures were established as a legal and operational requirement for the BVLOS demonstration flights over populated area. Those procedures were not involving U-Space services. In future projects, U-Space services should be supporting Emergency Management communication

- Proper training of Geozone managers to be up-to-speed with regulations for unmanned aviation
- Legal provisions should be made to simplify legal requirements for flights at drone test-facilities
- The Means of Compliance “mitigations for the demonstration of UAS operations, as part of research activities” in support of SAIL III missions needs to be further rolled out and expanded
- EASA member states need to harmonize their acceptance of all SORA scenario’s for evaluation. A policy like the one ILT is maintaining in the Netherlands to not evaluate BVLOS populated requests should not exist
- An accepted generic ERP should be accepted cross border without change other than the telephone numbers to be contacted.
- PDRA that are derived from STS that can be simply declared, should be treated for generic locations. At this point the NAA of The Netherlands and Germany are not treating the PDRA-S01 like that when evaluating a cross border requests.
- Authorisations and cross border authorisations should be granted for a longer period of time
- The local authorities on city or regional level need to prepare infrastructure as staff positions and contact points to allow qualified and swift responses to UAS operator requests.
- Geozone access conditions should be made easily accessible in all countries including contact details to interact with geozone management

5.2.3.2 Recommendations on standardisation

The standardization of information exchange between UAS operators and USSPs has already progressed in the form of U-Space Services. However, the exchange between different USSPs, the flow of information from customers (e.g. in the form of a C2C and the UAS operators) is still completely without any standard. There is a need to catch up here, so that at best a uniform European standard for inter-company communication can be created for commercial drone transport and later quite generally for communication about drone flights between different stakeholders and authorization levels in one unified architecture. That has the potential to enable cross-border as well as large integrated UAS-operations across member states and different companies in the value chain of drone operations.

Operational Emergency Management procedures were established as a legal and operational requirement for the BVLOS demonstration flights over populated area. Those procedures were not involving U-Space services. In future projects, and as part of the U-Space CONOPs, U-Space services should be supporting Emergency Management communication.

5.2.4 Recommendations for updating ATM Master Plan Level 2

N/A

6 Summary of Communications and Dissemination activities

6.1 Summary of communications and dissemination activities

All project partners performed dissemination activities, but the content and the type differed according to the nature of the partner and the targeted audience. The industrial partners approached relevant standardization and regulatory bodies, industry sectors, as well as their distributors and client networks, while the academic and research partners mainly focused on disseminating the project results towards research institutes and universities. Such activities prepared the ground for the adoption of the SAFIR-Med results, mainly in the standardization body's documentation, and their final uptake by industry, verticals, and SMEs. The content was adapted accordingly, but the main focus remained on the SAFIR-Med activities, achievements, and results of use cases trials. The main goal of the SAFIR-Med dissemination strategy was to create and spread awareness of the project and its results to the broadest possible audience within the scientific and research community. To reach this goal, SAFIR-Med differentiated between two major strands of communication and dissemination: The general promotion/communication activities, which were focused on mainly in the first months of the project, targeting the wide public audience (mainly through the communication channels of the project), and a set of more specific activities, dissemination activities, dedicated to the presentation of SAFIR-Med advances and outcomes to the scientific communities, academia, and industries (through dissemination means and showcasing events). These dissemination activities became more important as the project evolved and concrete results became the focus of the dissemination plan/activities.

6.2 Target Audience Identification

SAFIR-Med communication, dissemination, showcasing, exploitation and standardization plans and strategies are executed by all the partners and differ in regard to the nature of the partner as well as the means, content and target audience used. The industrial partners approach industry sectors and their distributors as well as client networks, whereas the academic and research partners targeted relevant research institutes and universities. Furthermore, an additional number of activities are targeted to organizations, communities, industry, academia and research institutions, as well as the general public. Overall, the target audience of SAFIR-Med is the following:

- The broadest possible technical and non-technical audience: This category covers the potential end users of drones' products and services as well as the general public who is interested in these technological fields and advancements.

- All SAFIR-Med partners, collaborators and stakeholders: This document is addressed to the entire SAFIR-Med consortium and serves as initial documentation of the plans/strategies to be applied for efficiently performing communication and dissemination activities, demonstrations, partner specific exploitation and standardization activities and relevant collaborations in which SAFIR-Med partners, and stakeholders are involved and/or affected.

6.3 Project High Level Messages

Dissemination and showcasing activities are of crucial importance for the project's successful diffusion of knowledge, for raising awareness and for attracting potential supporters, industries and verticals as well as scientific interest. The main objectives that are fulfilled by the SAFIR-Med dissemination and showcasing actions are:

- To disseminate project outcomes to the scientific community.
- To disseminate and raise awareness of the project to relevant industries.
- To raise awareness of the project towards the most important stakeholders.
- To foster inter-communication with other research projects and communities.
- To disseminate and communicate project innovations to the broader public and society.

The dissemination and communications activities that were undertaken in order to promote the project's aims and actual results include up to now the publication of 3 Press Releases, 7 Newsletters, a full-fledged website with all the announcements, the demonstration, open days and simulations days' details, and last but not least a social media plan with numerous posts at Linkedin and Twitter accounts, 2 social media campaigns (#UAM explained & #SafirMedDemos that is still ongoing). It is remarkable that the SAFIR-Med LinkedIn account has attracted nearly 2.000 followers, showcasing this productive collaborative work that has been done by all partners and at the same time being a successful example among the Horizon projects community. You can see in detail all the above-mentioned activities record in the Appendix D.

7 References

7.1 Applicable Documents

Content Integration

[1] EUROCONTROL, *U-space Concept of Operations*, v03.00.02, 25th September 2019, SESAR UTM Concept Definition, 2016 SESAR 2020 RPAS Exploratory Research Call (H2020-SESAR-2016-1)

Content Development

[2] SESAR2020 CORUS CONOPS Ed.3, Concept of Operations for U-space – 01.01.03 [September 2019]

[3] U-space Requirements baseline #4 [March-April 2021] available in the STELLAR U-space coordination group > DOCUMENTS > U-space requirements baseline > Baseline4

[4] Consolidated report on SESAR U-space research and innovation results [November 2020]

Performance Management

[5] EUROCONTROL, *PJ19.04: Performance Framework (2019)*, v01.00.01, 30th November 2019, Content Integration, H2020-SESAR-2015-2

Validation

[6] SESAR 2020 Requirements and Validation Guidelines, v00.02.02, May 1st 2021.

System Engineering

[7] SESAR 2020 Requirements and Validation Guideline Wave 2

Safety

[8] AIRBUS, Safety – Guidance to Execute Proof of Concept – VLD, Develop "proof of concept" for aircraft certification when introducing a new concept of operations, v00.04.00, August 2015

Human Performance

[9] EUROCONTROL, SESAR Human Performance Assessment Process V1 to V3 – including VLD, v00.03.01, January 2020

Environment Assessment

[10] EUROCONTROL, SESAR Environment Assessment Process, v04.00.00, 23rd September 2019

Communication and dissemination

[11]SESAR, Communication Guidelines SESAR 2020 Projects, edition 07.00.00, 14th January 2019

Programme management

For what concerns the general collaboration between all the members of the programme:

[12]SESAR3 Membership Agreement

[13]SESAR3 Programme Management Plan

For what concerns the definition of the solutions being addressed by the project, their initial maturity levels and the target maturity dates aimed for:

[14]ATM Master Plan

[15]SESAR Maturity Report

[16]SESAR Release Strategy

For what concerns the specific scope of work covered by this project and the general way of working expected from all projects in the SESAR3 programme:

[17][101017701] [SAFIR-Med] Grant Agreement, [16/12/2020]

[18]SESAR3 Project Handbook

7.2 Reference Documents

[19]ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.

[20]CORUS CONOPS Ed3 [01.01.03 dated 04/09/2019]

[21]D4.3 - Airspace capacity assessment

[22]D1.1 – User requirements

Appendix A EXE#1 Antwerp plan

A.1 Demonstration Exercise Description and Scope

The SAFIR-Med project focusses on the U-space Initial services (U1 and U2) to prepare and de-risk the rapid deployment of these services to provide advance U-space services (U3 and U4) to ensure safe and simultaneous operations.

The project will demonstrate several U-services and address the corresponding technical requirements. The Consortium aims to accomplish this through the integration of UAS into shared airspace by deploying an effective, usable, modular, and scalable UAM ecosystem architecture, where different U-space services providers and drone platforms will be involved.

The project will follow a two-phased approach. The first phase will see demonstration trials conducted in the segregated airspace of DronePort and the second phase will see the Consortium conduct a full demonstration in the non-segregated airspace of the City of Antwerp A detailed demonstration test plan for both phases will be produced prior the beginning of the trials. The Specific Operations Risk Assessment (SORA) methodology will be applied for all SAFIR-Med demonstration operations at DronePort and the final demonstrations in Antwerp.

The experience and data gained through the execution of specific test scenarios during the demonstration trials at DronePort, will provide the required evidence to comply with the more robust operational safety objectives the demonstrations in the urban and non-segregated environment of Antwerp.

The Study will also ensure that all the required approvals from the appropriate regulatory bodies are in place for all demonstration activities.

A.2 Summary of Demonstration Exercise #1 Objectives and success criteria

The demonstration objectives and success criteria can be found in the SAFIR-Med DEMO Plan D2.1 edition 01.00.03 under the section 5.1.3 Demonstration Objectives.

A.3 Summary of Demonstration Exercise #1 Scenarios

During the different testing demonstration activities, initial scenarios as described in the SAFIR-Med DEMO Plan D2.1 edition 01.00.03 served as a basis for creating useful testcases. Due to the limitation on the operational authorizations not all individual scenarios could be retained for the live execution of the demonstrations. The individual scenarios where combined into more meaningful demonstrations enabling extensive testing of the different SESAR JU U1 and U2 solutions.

Here below are described the scenarios performed during the demonstration activities.

A.3.1 Scenario 1: Middelheim - UZA

Scenario overview

Operational scenario name:

Toxico screening

Operational scenario summary:

A patient is submitted in the ED of the Middelheim hospital. Anamnesis of the patient rises suspicion for drug abuse. A urine sample is taken from the patient and sent to the UZA for a toxicology screening (and confirmation). Given the patient critical physical state, the test needs to be performed with high urgency. (Test is performed 24/24 in UZA and can be requested with high urgency (response time: 1h)

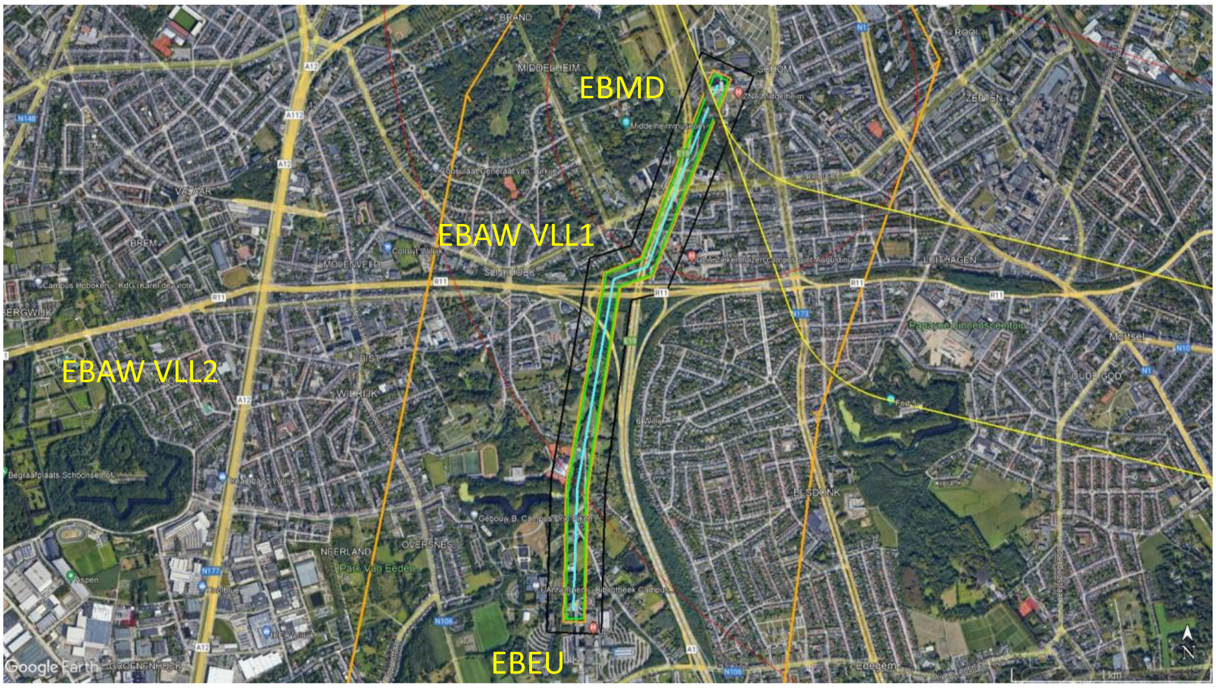

Figure 6. Scenario 1 Flight plan detail

Operating method:

Technical Platform: SABCA

Operator: Helicus

Order step specific to this scenario:

The Emergency Department of the Middelheim hospital orders Helicus, through the C2C order intake interface, to transport a urine sample by UAS from the Middelheim hospital to the clinical laboratory of the UZA university hospital.

Scenario execution generic for all Medical Cargo scenarios:

The Helicus C2C automatically generates a flight plan based on the pre-defined landing and take-off locations and considering airspace information (static and dynamic airspace configuration as well as live traffic) from the USSP as well as ground risk and weather information.

The Helicus C2C submits a flight request to the USSP through an API, passing a priority identifier based upon the 'Time frame' and 'Priority' using a UAS that is available at the departure location and that is capable of executing the requested mission.

At the same time, Helicus starts the pre-flight check process.

The USSP evaluates, prioritises and deconflicts (checks for conflicts with other flightplans) the Helicus flight request from other flight requests in the same airspace during the same timeframe. The USSP also coordinates with ANSP when required and sends an approval for the flight to the Helicus C2C through an API.

USSP flight confirmation and pre-flight checks need to be received through the API, in under a minute since they are the driver to confirm to the hospital that a UAS transport is possible within the requested time frame.

When the UAS transport is possible within the requested timeframe, the C2C sends a message to the hospital to invite them to bring the medical cargo to then UAS take-off location.

The hospital brings the medical cargo to the UAS take-off platform.

Following receipt of the USSP approval and successful completion of the pre-flight checks, including loading the cargo, the Helicus C2C sends the automatically generated flight plan to the UAS and initiates automatic execution of the flight by issuing a 'take-off' command following a take-off clearance has been received from the USSP. Verification that the eID (INVOLI for Antwerp, DRONIQ for MAHHL) tracker is correctly present and that eID transmission is successful is part of the pre-flight checklist.

During the flight the USSP receives live position data of the Helicus mission both through the C2C telemetry API as well as from the eID tracker on board of the UAS.

The C2C DAA algorithm permanently evaluates the live traffic information received from the USSP and compares trajectories of other live traffic with the Helicus UAS trajectory and executes an avoidance manoeuvre when a conflict is detected within the pre-defined conflict time threshold.

The C2C permanently evaluates dynamic airspace reconfiguration. When (new) dynamic airspace constraints are received from the USSP, the C2C evaluates whether those constraints do impact the Helicus UAS mission. This evaluation is done based on:

- Location: Is a new dynamic geofence located on the UAS flightpath ahead or is the UAS inside such a geofenced area?
- Priority: Does the dynamic geofence apply to this medical UAS given its priority?

When conflicting geofence areas are detected in pre-flight, the C2C calculates a new flight path from current location, uploads this to the UAS and executes it. During in-flight phase, the UAS will have to land and a new flight path will be generated so that it can be executed without any conflict with geozones.

As soon as the GCS API is ready, during the flight, the USSP is passing ATC commands from the ANSP to the C2C through this API. Those commands could be: "Return", "Hold" (360 or hover when possible), "Land as soon as practical".

Upon arrival and landing at the pre-defined landing location at the arrival hospital, the C2C sends a flight closure message to the USSP and performs post flight checks.

Flight closure specific to the scenario

The C2C informs the hospital that the medical delivery is present to be collected.

The hospital collects the medical cargo.

The C2C closes the flight plan.

Services addressed:

U1 services			
Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring (N/A)	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 7: Scenario 1 addressed services

Operational scenario overview:

Operational Scenario 1: Middelheim - UZA			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Urban	
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation.
	Controlled/Uncontrolled or N/A	Controlled	EBAW CTR
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	
	VLL/Above VLL/All or N/A	VLL	Below 400ft AGL
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	SkeyDrone
Density of drones	Number of drones	1	SABCA rotorcraft
	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	Rotorcraft	
Judgement of acceptability	ATC	Y	
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	
	Certification	TBD	
	X, Y, Z, Mix or N/A	Z	

Airspace	Cross-border (Y/N)	N	

A.3.2 Scenario 2: Sint Vincentius - Middelheim

Scenario overview

Operational scenario name:

Frozen Section transport

Operational scenario summary:

An oncology patient is undergoing a surgical intervention in the OR of Sint Vincentius hospital. The surgery is meant to remove a tumour. To be sure all the carcinogen tissue is removed after surgery, a sample of the surrounded tissue is sent to the central pathology lab of ZNA Middelheim. The surgeon and patient await the results while the patient is still on the operating table. The surgery will be finished, and patient will be closed up only after the pathologist gives green light. Efficient and fast transport is therefore key.

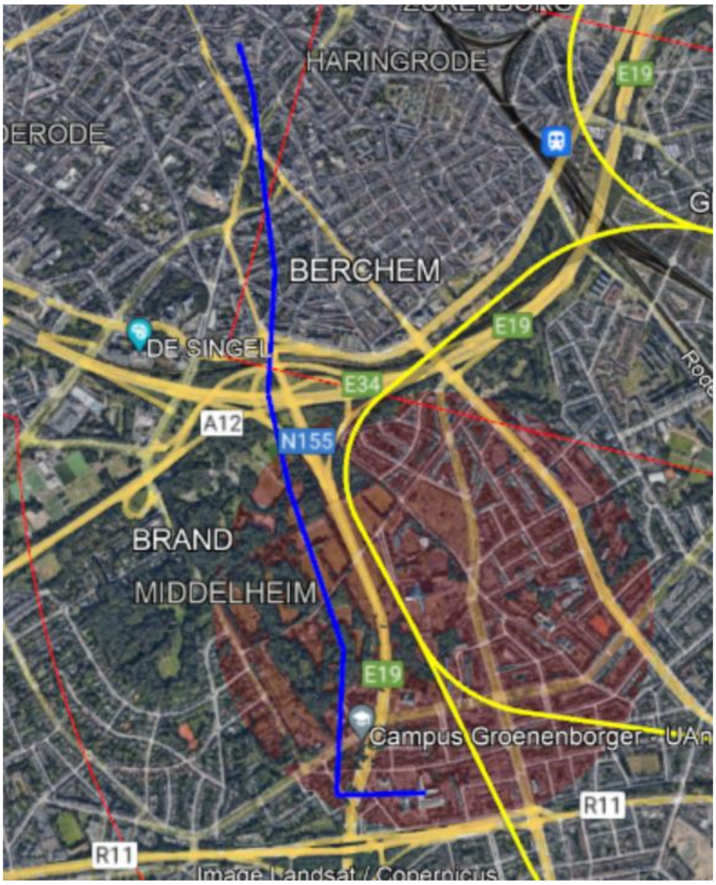

Figure 7 Scenario 2 Flight plan detail

Operating method:

Technical Platform: SABCA

Operator: Helicus

Order step specific to this scenario:

The Operating Room at the Sint-Vincentius Hospital orders Helicus, through the C2C order intake interface, to transport a human tissue sample by UAS from the from the Sint-Vincentius Hospital to the Anatomic pathology lab at the Middelheim Hospital.

Scenario execution generic for all Medical Cargo scenarios:

Scenario execution is following the same steps as seen in scenario 1.

Flight closure specific to the scenario

The C2C informs the hospital that the medical delivery is present to be collected.

The hospital collects the medical cargo.

Services addressed:

U1 services			
Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring (N/A)	Communication Infrastructure Monitoring (N/A)

Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 8. Scenario 2 tested services

Operational scenario overview:

Operational Scenario 2: Middelheim - Sint Vincentius			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Urban	
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation.
	Controlled/Uncontrolled or N/A	Controlled	EBAW CTR
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	
	VLL/Above VLL/All or N/A	VLL	Below 400ft AGL
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	SkeyDrone
	Number of drones	1	SABCA rotorcraft

Density of drones	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	Rotorcraft	
Judgement of acceptability	ATC	Y	
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	
	Certification	TBD	
Airspace	X, Y, Z, Mix or N/A	Z	
	Cross-border (Y/N)	N	

A.3.3 Scenario 3: St Augustinus – UZA

Scenario overview

Operational scenario name:

Toxicon screening UZA

Operational scenario summary:

A patient is submitted in the ED of the St Augustinus hospital. Anamnesis of the patient rises suspicion for drug abuse. A urine sample is taken from the patient and sent to the UZA for a toxicology screening (and confirmation). Given the patient critical physical state, the test needs to be performed with high urgency. (Test is performed 24/24 in UZA and can be requested with high urgency (response time: 1h)

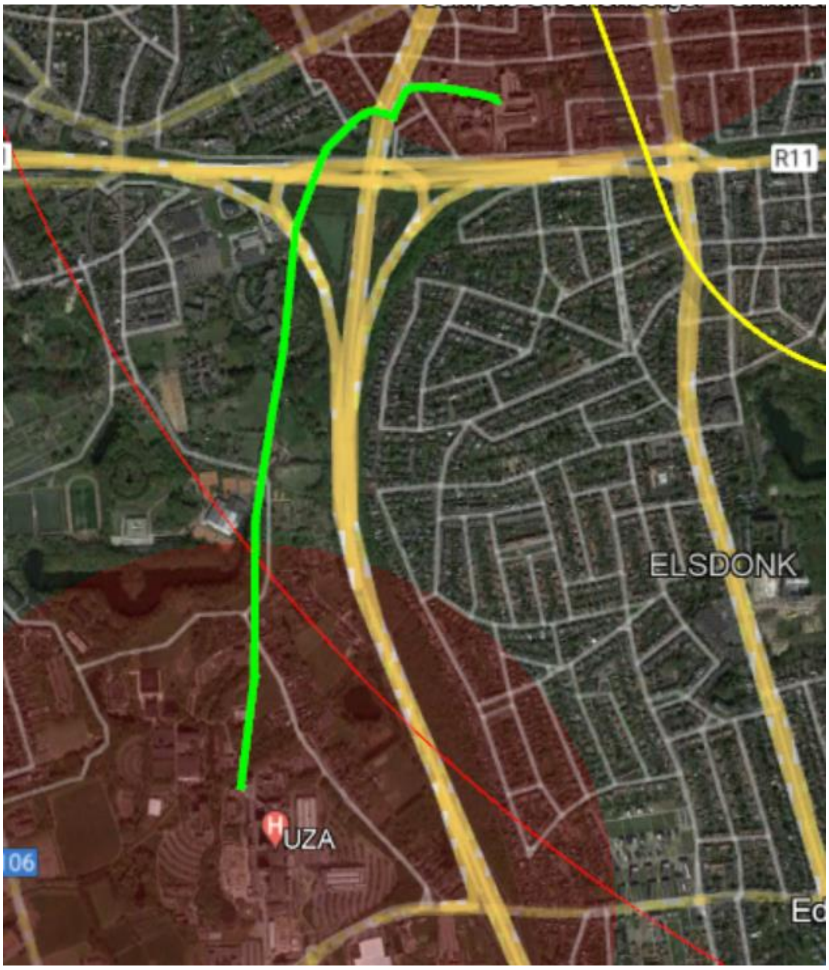

Figure 8 Scenario 3 Flight plan detail

Operating method:

Technical platform: SABCA

Operator: Helicus

Order step specific to this scenario:

The Operating Room at the Sint-Vincentius Hospital orders Helicus, through the C2C order intake interface, to transport a human tissue sample by UAS from the from the Sint-Vincentius Hospital to the Anatomic pathology lab at the St Augustinus Hospital.

Scenario execution

Scenario execution is following the same steps as the Scenario 1.

Flight closure specific to the scenario

TheC2C informs the hospital that the medical delivery is present to be collected.

The hospital collects the medical cargo.

Services addressed:

U1 services			
Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring (N/A)	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 9. Scenario 3 tested services

Operational scenario overview:

Operational Scenario 3: Sint Augustinus - UZA			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Urban	
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation.
	Controlled/Uncontrolled or N/A	Controlled	EBAW CTR
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	
	VLL/Above VLL/All or N/A	VLL	Below 400ft AGL
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	SkeyDrone
Density of drones	Number of drones	1	SABCA rotorcraft
	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	Rotorcraft	
Judgement of acceptability	ATC	Y	
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	

EUROPEAN PARTNERSHIP

Co-funded by the European Union

	Certification	TBD	
Airspace	X, Y, Z, Mix or N/A	Z	
	Cross-border (Y/N)	N	

A.3.4 Scenario 7: UZ Antwerp - Marienborgh

Scenario overview

Operational scenario name:

AED Football

Operational scenario summary:

The Emergency dispatching unit (112) gives the command to dispatch an AED drone to a location where a patient suffered a cardiac arrest.

Figure 9. Scenario 7 details

Operating method:

Technical platform: TUDelft

Operator: Helicus

Order step specific to this scenario:

A person witnessing someone suffering a cardiac arrest at the Football field is calling Emergency centre 112 using the 112 app. Thanks to the 112 App, Emergency Centre 112 has the exact location of where the victim suffered the cardiac arrest. Emergency Centre 112 dispatches the Medical Urgency Group at the UZA hospital and passes on the exact location of the victim using GNSS coordinates.

The Medical Urgency Group at the UZA hospital requests Helicus to send an AED drone to the victim ahead of the arrival of the MUG team and passes-on the exact GNSS location of the victim.

Scenario execution

Scenario execution is following the same steps as the scenario 1.

In addition, a return flight from the emergency location is being prepared and submitted by the C2C.

Flight closure specific to the scenario

The AED drone arrives at the victim's location. Thanks to the instructions provided by the AED itself, the witness, who had been applying CPR, is able to help the victim with the AED after which the MUG team arrives and further stabilizes the patient.

After the flight, the AED UA is picked-up from the field.

Services addressed:

U1 services			
Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance	Accident/Incident reporting	Navigation Infrastructure Monitoring	Communication Infrastructure Monitoring

(N/A)	(N/A)	(N/A)	(N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 10. Scenario 7 tested services

Operational scenario overview:

Operational Scenario 7: UZA - Marienborgh (TUDelft)			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Urban	
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation.
	Controlled/Uncontrolled or N/A	Controlled	EBAW CTR
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	
	VLL/Above VLL/All or N/A	VLL	Below 400ft AGL
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	SkeyDrone
	Number of drones	1	TUDelft rotorcraft

Density of drones	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	Rotorcraft	
Judgement of acceptability	ATC	Y	
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	
	Certification	TBD	
Airspace	X, Y, Z, Mix or N/A	Z	
	Cross-border (Y/N)	N	

A.3.5 Scenario 11: Sint Augustinus – Middelheim

Scenario overview

Operational scenario name:

Frozen Section transport

Operational scenario summary:

An oncology patient is undergoing a surgical intervention in the OR of Sint Augustinus hospital. The surgery is meant to remove a tumour. To be sure all the carcinogen tissue is removed after surgery, a sample of the surrounded tissue is sent to the central pathology lab of ZNA Middelheim. The surgeon and patient await the results while the patient is still on the operating table. The surgery will be finished and patient will be closed up only after the pathologist gives green light. Efficient and fast transport is therefore key.

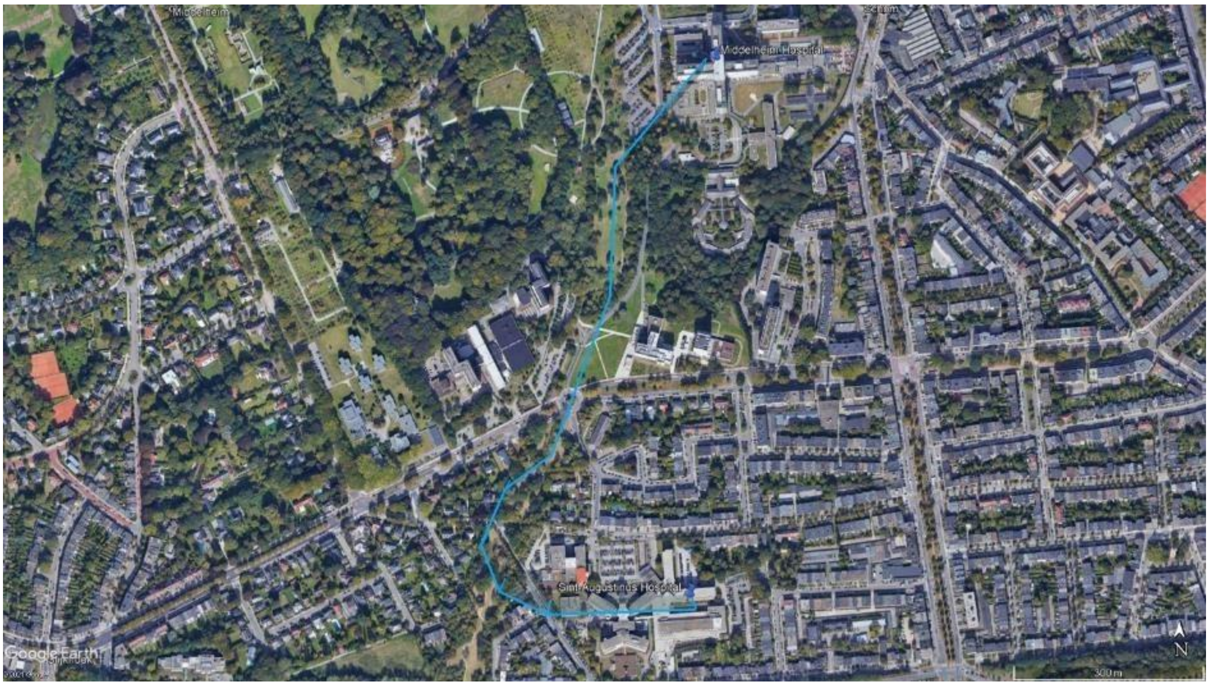

Figure 10. Scenario 11 details

Operating method:

Technical platform: SABCA

Operator: Helicus

Order step specific to this scenario:

The Operating Room at the Sint-Augustinus Hospital orders Helicus, through the C2C order intake interface, to transport a human tissue sample by UAS from the from the Sint-Augustinus Hospital to the Anatomic pathology lab at the Middelheim Hospital.

Scenario execution generic for all Medical Cargo scenarios:

Scenario execution is following the same steps as seen in the scenario 1.

Flight closure specific to the scenario

The C2C informs the hospital that the medical delivery is present to be collected.

The hospital collects the medical cargo.

Services addressed:

U1 services			
Registration	e-Identification	Geo-Awareness	Registration Assistance

(Assumed)	(Assumed)	(Assumed)	(Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring (N/A)	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 11. Scenario 11 tested services

Operational scenario overview:

Operational Scenario 11: Middelheim - Sint Augustinus (SABCA)	***Comments***

Environment	Urban/Rural/Sub-Urban/Mix or N/A	Urban	
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation.
	Controlled/Uncontrolled or N/A	Controlled	EBAW CTR
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	
	VLL/Above VLL/All or N/A	VLL	Below 400ft AGL
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	SkeyDrone
Density of drones	Number of drones	1	SABCA rotorcraft
	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	Rotorcraft	
Judgement of acceptability	ATC	Y	
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	
	Certification	TBD	
Airspace	X, Y, Z, Mix or N/A	Z	
	Cross-border (Y/N)	N	

A.3.6 De-risking scenarios Droneport

During the Droneport de-risking activity demonstration was created by combining scenarios as shown in the table below.

	SC2	SC3	SC7	SC11
SC2		☑	☑	
SC3	☑		☑	
SC7	☑	☑		
SC11				

Table 12. Scenarios combination

Scenario combination (drone number)	Priority category	Drones
2 (blue) A-B	A2, Airborne, Cargo, T	SABCA
3 (green) B-C	A1, Ground, Cargo, T+1	FlyXdrive
7 (white) C-D	B1, Ground, Cargo, T+2	TuDelft

Point of interest

- Priority rule decision making
- Route deconfliction at strategic or tactical level, vertiport availability coordination
- Dynamic reconfiguration of airspace

Drone 2 arrives vertiport B, the same place number 3 departs. Drone 7 departs from vertiport C, where 3 need to land, making it ideal to manage the different priority categories.

The added value to this combination is to demonstrate the dynamic reconfiguration of airspace. Indeed, the flightpath of drone 2 is in close proximity to a VFR circuit (simulated VFR arrival which will be managed adapting U-space airspace structure.

Trajectory presentation

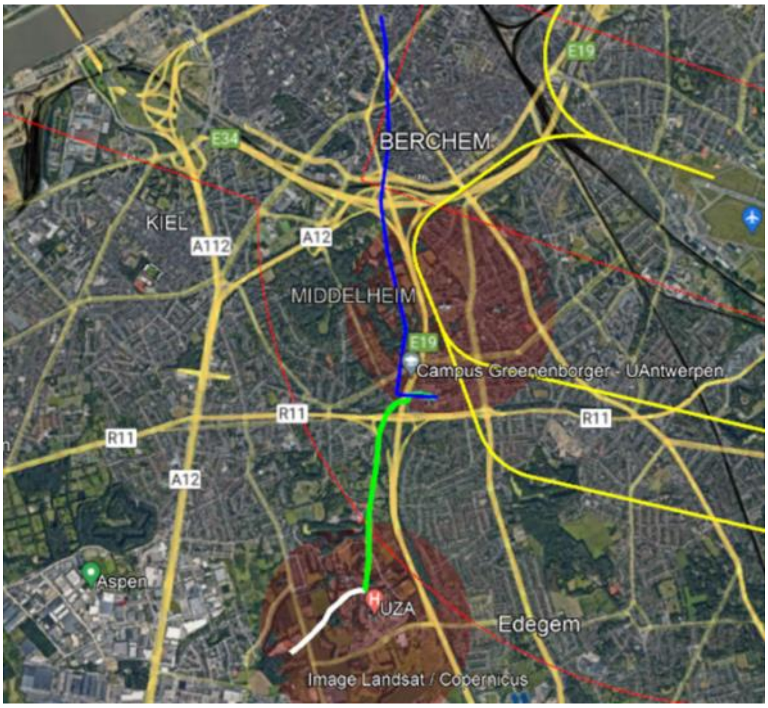

Figure 11. Trajectory presentation

Script

T: Drone number 2 departs from vertiport A. Shortly after departure a change in airspace configuration by ANSP will lead to a change in flight parameters. The drone has to continue its flight with regard to the dynamic reconfiguration of airspace.

T+1: During the flight of drone 2, a flight request for drone 3 is filled. Drone 2 is landing at vertiport B, the same vertiport where drone 3 has to depart. As drone 2 has a lower priority than 3, drone 2 will have lose time in order to let drone 3 depart. Drone 3 is foreseen to land at vertiport C.

T+2: Once drone 3 is airborne, flight request for drone 7 is filed. Drone 3 arrives at the same location at about the same time as drone 7 is foreseen to depart.

Data communication flow

U-space service	task	Data required	originator	recipient
Flight authorization service	strategic deconfliction	Flight authorisation requests	Drone operator (Via C2C)	USSP
Flight authorization service	Be aware of dynamic reconfiguration of airspace	Dynamic airspace status	ANSP	USSP

Table 13Data communication flow

- **Real urban Demonstrations at Antwerp.**

Same as above

Demonstration #1 will be the execution of scenario 11.
Demonstration #2 will be combination of scenarios 2, 3

	SC2	SC3	SC7	SC11
SC2		☑	⍰	
SC3	☑		⍰	
SC7		⍰		
SC11				☑

Table. Combination of scenarios for Antwerp exercise

A.4 Demonstration Exercise #1 Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Impact on Assessment
EXE1-ASM-VLD-SAFIR-Med-001	Airspace users	Operational	Airspace users and ANSP are fully involved to support demonstrations requiring cooperation between manned and unmanned flights. Pre-flight	Involvement of ANSP and airspace users is required to minimize risks related to the execution of the demonstration flights.	High
EXE1-ASM-VLD-SAFIR-Med-002	Operational Authorisations	Operational	Helicus has the corresponding authorisations from the BCAA to perform the intended demonstration flights with the FlyXDrive, HyFly, SABCA and TUDelft UAS platforms in Antwerp. Pre-flight.	Without authorizations no demo flights are possible.	High
EXE1-ASM-VLD-SAFIR-Med-003	Operational Authorisations	Operational	EHang has the corresponding authorisations from the FCAA (DGAC) to perform the intended demonstration flights in Antwerp. Pre-flight.	Without authorizations no demo flights are possible.	High
EXE1-ASM-VLD-SAFIR-Med-004	Pilot training	Operational	All Remote Pilots have the required training and/or licenses as per the applicable Operational Authorisation to operate the drones intended for the demonstration flights. Pre-flight	When Remote Pilot training levels and/or license requirements are not met, the pilot is not allowed to fly a drone for the BVLOS missions overpopulated area.	High
EXE1-ASM-VLD-SAFIR-Med-005	C2C - UTM integration	Technical	The Belgian UTM SkeyDrone is integrated with the Helicus C2C through one or more API's (Live traffic, Airspace, Dynamic Airspace, ...)	The C2C is architecturally centralising environmental information in real-time to allow implementing ground-based Detect and Avoid as well as SAFIR-MED integrated mission monitoring	High

EXE1-ASM-VLD-SAFIR-Med-006	Approval Radio license	Operational	Long-range, high-power data links require licenses to operate. Where required a license from the Belgian radio network authority BIPT is required.	Without approval of the to-be-used frequencies, no demo flights are allowed.	High
EXE1-ASM-VLD-SAFIR-Med-007	Helicus C2C platform available and able to exchange information with other platforms	Technical	The integration of the UA platforms with the Helicus C2C platform should be available and able to exchange the required information between them. Pre-flight, In-flight	Without the availability of the required C2C platform and the other platforms and their ability to exchange the required information, the demonstration flights cannot be performed.	High
EXE1-ASM-VLD-SAFIR-Med-008	Drone, pilot and operator availability	Operational	The intended drones, pilots and operators are ready and available during the demonstration flights. Pre-flight	Execution of scenario's depend on the readiness and availability of drones, pilots and operators.	High
EXE1-ASM-VLD-SAFIR-Med-009	Drone flight route design	Operational	The routes and procedures for the drone operations are appropriately designed and approved by all relevant authorities (overflight, distance from building, etc.) Pre-flight	The flight routes are designed in such a manner to minimize the risks related to the demonstration flight.	Medium
EXE1-ASM-VLD-SAFIR-Med-010	U-space regulation	Operational	The U-space regulation will not be into effect during the demonstrations. Therefore, all it needs to be assumed as if those U-space regulations are in place for the purpose of the SAFIR-MED project.	There will be limited services, areas of responsibilities, etc. We might expect some changes once the U-space regulation is established that may affect the content of this document.	High
EXE1-ASM-VLD-SAFIR-Med-011	Tracker compatibility with drones	Technical	Trackers are available, integrated on the drones and the tracking output is interfaced with UTM and the C2C INVOLI tracker to be used for the	Real-time position of the drones is needed, even as a backup information retrieved via GPS.	High

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			Belgium case. Droniq tracker to be used for the German case. Pre-flight		
EXE1-ASM-VLD-SAFIR-Med-012	Weather conditions	Operational	Weather conditions are suitable for the operations. Pre-flight, In-flight	Drone operations can only be performed in suitable weather conditions (e.g., no storm). For this project, a back-up wee has been set up in case there is bad weather during the demonstration trials.	Medium
EXE1-ASM-VLD-SAFIR-Med-013	Support local authorities	Operational	Helicus as an operator gets the support from local authorities on the trajectories in the Antwerp area	To ensure validation of the designed flight routes based upon local information and to allow securing the intended routes where needed, the support from local authorities is required. The support from local authorities (municipal, province, …) is required.	High
EXE1-ASM-VLD-SAFIR-Med-014	U-space regulation	Operational	U-space services are simulated for all SAFIR-MED Operational Environments	U space regulation will not yet be in effect and U-space areas will not all have been defined. For SAFIR-MED trials and demonstration it needs to be simulated that all operational environments are covered by U-space	High

Table 14: Demonstration Assumptions overview

A.5 Deviations from the planned activities

During the preparation and execution of the Antwerp Demonstration, several deviations occurred from the described activities in the SAFIR-Med Demonstration Plan. This section provides a summary of the main deviations, split into the following 3 categories:

- Deviation at the level of the Demonstration Approach
- Deviations at the level of the SAFIR-Med Architecture technical implementation
- Deviations at the level of the U-space Services and Capabilities

Deviations at the level of the Demonstration Approach

Taking into account the late delivery or even the lack of delivering the operational authorizations, demonstration planning needed be adapted frequently.

- The first phase consisted of a de-risking activity. Instead of performing actual flights in reserved areas at the DronePort facilities all available UAS, UTM systems, UTM interfaces, SDSP and ATS providers were integrated in a tabletop exercise. SAFIR-Med prioritises safety and considers successful completion of testing at DronePort to be a necessary precondition for moving to the second phase.
- The second phase consisted of a real urban demonstration. During these demonstrations the number of real flights was gradually increased in relation to the acquired operational authorisations, therefore we can further subdivide the demonstrations into 2 categories:
    - A first set of demonstrations were conducted in a hybrid way. Meaning drones were managed out of Antwerp but were actually flown at their local testing facilities. During these demonstrations some flights were conducted live, others were simulations without hardware in the loop. This way of working enabled the demonstration participants to conduct more complex operations while remaining within the comfort of their own known test environment.

The second set of demonstrations involved live flights conducted by the UAS systems holding a valid operational authorisation in Belgium. These flights were conducted in a Real Urban environment, demonstrating UAS operations with a viable integrated UTM solution, in segregated airspace near the airport of Antwerp in Belgium.

Deviations at the level of the SAFIR-Med Architecture technical implementation

In this section we will elaborate on the deviations on the proposed Architecture in the DEMOP.

- *Tracking:*
    - Hardware: In the DEMOP we had foreseen 2 tracking devices during the Antwerp demonstrations, the Unifly BLIP and the Involi Kivu. During the demonstrations only the Involi KIVU was used. In addition to this limitation, and due to the frequent adaptations of the demonstration planning, only 1 Involi sensor was deployed. This sensor was able to cover RemoteID, ADS-B and FLARM. Mode-S would have required

2 additional sensors installed to be able to triangulate positions. Therefor mode-S was not supported during the demonstration in Antwerp. In normal airspace environment this would have been problematic but considering the fact that the demo environment was limited to atypical airspace by the BCAA safety was not impacted.

- Software Integration: Next to the planned integration of the Involi system with the USSP system, a direct integration of the tracking data was developed providing a direct feed to the C2C.

– *Multiple operators: The SAFIR-MED architecture included a second, simulated Operator. This operator was not part of the Antwerp demonstration. Separate tests will be performed using the simulated Operator in a separate test campaign.*

– *CISP:* As explained in the DEMOP the CISP was not part of the demonstrations. Communications with the ANSP were handled directly using procedure during the demonstrations. Skeyes (ANSP) took on the role of CISP in addition to the role of ANSP.

Deviations at the level of the U-space Services and Capabilities

N/A

A.6 SESAR U-space services addressed by Exercise

A.6.1 Deviations with respect to U-space services definition

Here below you will find description on the deviations with respect to the U-space services as described in the EU 2021/664 compared to how they were provided

U-space service	SESAR Solution ID and Title		Solution/service addressed or assumed?	Deviations
Network identification service	**US1-01**	Registration	Assumed	Network identification of the operation will in a medical environment include pre-defined priorities taken into account several aspects of the operation.
	US1-02	e-Identification	Assumed	
	US1-04	Registration assistance	Assumed	
	US2-17	Digital Logbook	Assumed	
	US1-03	Geo-Awareness	Assumed	Within the activities conducted geo-awareness

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Geo-awareness service	**US2-01**	Geo-fence provision (incl. dynamic geo-fencing)	Addressed	service did not take place within the project environment as you would have in a U-space eco-system.
UAS flight authorisation service	**US2-03**	Strategic Conflict Resolution	Addressed	Strategic deconfliction of the different operations within the SAFIR Med project was done on the basis of the pre-defined prioritisation criteria. These criteria were defined during the scenario elaborations for the de-risking activities at DronePort.
	US2-06	Operation plan preparation/optimization	Addressed	
	US2-10	Procedural Interface with ATC	Assumed	
	US2-12	Operations plan processing	Assumed	
	US3-02	Tactical Conflict Resolution	Assumed	
Traffic information service	**US2-05**	Tracking and position reporting	Addressed	Within the SAFIR Med eco-system surveillance data was not interchanged between the ANSP and the USSP
	US2-08	Traffic Information	Addressed	
	US2-11	Surveillance data exchange	Addressed	
Conformance monitoring service	**US2-07**	Monitoring	Addressed	During the hybrid activities and live demonstrations at Antwerp the remoteID and flight authorizations enabled the USSP to monitor the conformance of the conducted operations. There was no technical solution in place

	to advice the UAS if he would have been leaving its operational volume.

A.7 Demonstrations Exercise #1 Results

Demonstration Exercise Objective ID	Objective Title	Success Criterion ID	Success Criterion	Sub-operating environment	Exercise Results	Demonstration Objective Status
EXE1-OBJ-VLD-SAFIR-Med-101	Operational acceptability of U-space services	EXE1-CRT-VLD-SAFIR-Med-101-100	The **roles and responsibilities** of the involved actors (individual and at the level of the team) are clear and acceptable under U-space services (U1 and U2) in nominal situations	Urban and Sub-Urban Operating Environments and in nominal situations	The execution of the scripted scenarios in the form of tabletop exercises during the DronePort de-risking activities created a clear framework setting out the roles and responsibilities of the involved actors. These learnings facilitated further demonstration executions at Antwerp.	OK
		EXE1-CRT-VLD-SAFIR-Med-101-200	The **tasks and procedures** of the involved actors (individual and at the level of the team) are clear and acceptable under U-space services (U1 and U2) in nominal, situations	Urban and Sub-Urban Operating Environments and in nominal situations	The framework created during DronePort de-risking activities included the tasks accompanying the responsibilities of the U-space eco-system participants.	OK
		EXE1-CRT-VLD-SAFIR-Med-101-300	The **technical systems** proposed are **usable and acceptable** to end users for tested U-space services (U1 and U2) in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	Only USSPs where involved in the current nominal form. The de-risking activities at DronePort and the different executions of the Antwerp demos taught us that the lack of automation increases the need for different levels of training (procedural and RTF) of the end user.	Partially OK

		EXE1-CRT-VLD-SAFIR-Med-101-400	The technical systems proposed support the **end users' performance** in order to achieve their tasks in an efficient, accurate and timely manner for tested U-space services (U1 and U2) in nominal situations..	Urban and Sub-Urban Operating Environments and in nominal situations	De-risking activity demonstrated the need for a more automated system in order to be able to adhere to the objectives described in this criterion. Man-machine interaction and the need for verbal communication slows down the process heavily, imposing a capacity limitation. This highly impacts the amount of personnel required for the USSP and thus impacting economical sustainability	Partially OK
		EXE1-CRT-VLD-SAFIR-Med-101-500	The **communication load and phraseology** associated to U-space services (U1 and U2) are acceptable in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	Due to the limited level of automation the amount of verbal coordination is high. Communication and phraseology were not on level of aviation standard, complexifying the operation. The need for verbal communication should be limited as much as possible as this has a large impact on training and U-space capacity	Partially OK
		EXE1-CRT-VLD-SAFIR-Med-101-600	The **training and transition** needs associated to U-space services (U1 and U2) are identified and documented for all future users in nominal situations	Urban and Sub-Urban Operating Environments and in nominal situations	The training needed highly depends on the amount of automation and the required amount of verbal coordination. C2C usage training material was created as part of this activity SkeyDrone: Is there a manual describing how to use the UTM system?	OK

EXE1-OBJ-VLD-SAFIR-Med-201	U-space services safety	EXE1-CRT-VLD-SAFIR-Med-201-100	Demonstrate the safe integration of drones from pre-flight to post flights, through increased awareness to all airspace users, strategic deconfliction, conformance monitoring in nominal situations	Urban and Sub-Urban Operating Environments and in nominal situations	Visualisation of the operation and tracking by the USSP makes it possible to in a later stage communicate (conformity- non conformity) to the ANSP and other airspace users. This communication was out of scope with regard to the project technical development objectives.	Partially OK
		EXE1-CRT-VLD-SAFIR-Med-201-200	Demonstrate that the U-space services (U1 and U2) contribute to the limitation of air risk in VLL airspace in nominal situations	Urban and Sub-Urban Operating Environments and in nominal situations	As the risk for a UAS-to-UAS mid-air encounter is drastically reduced due to the strategic deconfliction, you can state that the ground risk is reduced as well. The same way of thinking is valid regarding the segregation between manned and unmanned due to the use of dynamic airspace reconfiguration. Operational Authorisations were granted by the BCAA based upon Ground Risk mitigation measures (amongst others). Routes were designed based upon BCAA approved ground risk mitigation rules. As this route design was done through a very time-consuming manual process, automatic route creation is required for a viable automated service. This was demonstrated/tested during the Droneport table top de-risking activities. At the level of the tactical air risk mitigation, the detect and avoid has been tested in a simulated way. The intruding drone was simulated.	OK

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		EXE1-CRT-VLD-SAFIR-Med-201-300	Demonstrate that the U-space services and (U1 and U2) contribute to the limitation of ground risk in nominal situations	Urban and Sub-Urban Operating Environments and in nominal situations	During the actual flights, ground risk mitigation measures were conducted during the planning phase of the flights.	OK
		EXE1-CRT-VLD-SAFIR-Med-201-400	Demonstrate that the U-space services (U1 and U2) contribute to the limitation excursion into no-drone zones nearby to the VLL airspace in nominal situations	Urban and Sub-Urban Operating Environments and in nominal situations	For every drone operation a no drone zone was created at the level of the UTM. This way it was possible to make sure no other drone could plan an operation in the same airspace volume. The NO drone zone included a buffer keeping an operation with its conflict free portion of airspace. Planning of flight characteristics outside the limit of this allocated airspace is not possible.	OK

EXE1-OBJ-VLD-SAFIR-Med-301	U-space system performance assessment	EXE1-CRT-VLD-SAFIR-Med-301-100	The UTM system provides the information required for U-space services (U1 and U2) as it is needed and when it is needed in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	US1-01/US1-02: registration information and identification are made available through data provided by the UTM platform. US2-03: the strategic deconfliction was a human intervention made on the estimation done by the USSP operator. Data required to perform this task was the flight authorisation request. The resolution was presented by the USSP operator via coordination through the UTM platform. The inserted data was automatically made available in the planning tool of the Command-and-Control centre. US2-05/US2-08: Tracking of the manned and unmanned traffic was supported by the deployment of Involi tracking system. During some of the flights tracking was rather limited and data on the UAS position was not available. Some technical issues caused the data stream to interrupt or not start-up without an extra technical, human, intervention. US2-11: surveillance data, relevant operational data on manned traffic was not part of a data stream set up between ANSP and USSP.	Partially OK

		EXE1-CRT-VLD-SAFIR-Med-301-200	For all U-space services (U1 and U2), the UTM system performs as expected even when used to supervise simultaneously multiple drones in nominal situations (by a single or by multiple drone pilots)	Urban and Sub-Urban Operating Environments and in nominal situations	At the moment multiple drones were operated simultaneously the amount of data exchanged via the UTM system was rather limited.	OK
		EXE1-CRT-VLD-SAFIR-Med-301-300	The various systems (e.g., trackers, data recorders, aeronautical data, displays) are interoperable enough for the end users to benefit from all U-space services (U1 and U2) in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	The data provided by the Involi trackers can be shared within the U-space eco-system, increasing situational awareness and flight safety.	OK
EXE1-OBJ-VLD-SAFIR-Med-401	U-space standard and regulations	EXE1-CRT-VLD-SAFIR-Med-401-100	The impact of all U-space services (U1 and U2) on operational or technical standards in nominal situations (creation or changes of existing ones) is documented.	Urban and Sub-Urban Operating Environments and in nominal situations	Within this document section 3.2.1 findings on the impact with regard to operational and technical standards are elaborated.	OK
		EXE1-CRT-VLD-SAFIR-Med-401-200	The impact of all U-space services (U1 and U2) on regulations in nominal situations. (Compatibility with or need for change) is documented	Urban and Sub-Urban Operating Environments and in nominal situations	Within this document section 3.2.1 findings on the impact with regard to regulations are elaborated	OK

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EXE1-OBJ-VLD-SAFIR-Med-501	Performance assessment of U-space services	EXE1-CRT-VLD-SAFIR-Med-501-100	Demonstrate that the U-space services (U1 and U2) in nominal situations. improve the cost effectiveness of flight preparation in reducing the associated time/effort/cost	Urban and Sub-Urban Operating Environments and in nominal situations	During all phases of de-risking and demonstration executions was well clear that the time effort and cost will highly depend on the level of automation. Every human interaction to the system requires training, will limit the capacity and therefore impact the cost-effectiveness of the U-space eco-system. At this moment the integration of the UAS platforms is not at the required level to enable multiple tasks to be automated. Currently the drone needs to be specifically prepared before each and every flight. This means besides the Command-and-Control operator a person needs to be physically near the drone to enable the preparation for departure. Integration of the package to be transported is a manual intervention as well.	Ok
		EXE1-CRT-VLD-SAFIR-Med-501-200	Demonstrate that the U-space services (U1, and U2) in nominal situations. Improve the flight efficiency, e.g., as the integration of aeronautical data and flight preparation in a same system reduces the potential margins / deviation from the most optimal trajectory that drones can fly	Urban and Sub-Urban Operating Environments and in nominal situations	As this was not developed and thus demonstrated this shall be added to the items of deviation.	NOT Ok

		EXE1-CRT-VLD-SAFIR-Med-501-300	Demonstrate that the U-space services (U1, and U2) in nominal situations contributes to increasing the capacity in drones' airspace through enabling more simultaneous flights (e.g., through strategic deconfliction before and during flight time, through the possibility to visualise flights in real time and avoid obstacles if any)	Urban and Sub-Urban Operating Environments and in nominal situations	U space services enable the coordination of conflicting flight requests. The flight authorization service deconflicts the UAS enabling both operations to take place in a safe and secure manner.	Ok

Table 15. Exercise 1 Demonstration results

A.7.1.1 Results impacting regulation and standardisation initiatives

This section will be provided on the Final DEMOR.

A.7.1.1 Results per KPA

Operational feasibility

At the current level of system integration and automation it is not possible to claim this way of working to be operationally feasible. High level of human interventions prevents the U-space airspace capacity to be increased.

In order to reach a level of sustainable operational feasibility further development will be required. Cost efficiency will play a key role to this. Limiting the number of drone flight or requiring a large staffing of USSP operational environment will have a negative impact on this aspect.

Acceptability

This KPA is part of the exercise objectives and will be discussed in the analysis of exercise results, OBJ-VLD-SAFIR-Med-100, Operational acceptability of U-space services.

Safety

This KPA is part of the exercise objectives and will be discussed in the analysis of exercise results, OBJ-VLD-SAFIR-Med-200, U-space services safety.

Security

N/A

Human performance

While all human actors managed to perform their tasks successfully using the available tools during the demonstrations, there is still room for improvement for human performance in a way that the risk of errors will be decreased, and the processes will take place in a more efficient manner. System integration and further automation is necessary for future flights. When multiple human actors are involved in certain processes then the procedure slows down and more errors arise. Moreover, in order to accommodate better communication between all actors it is important to conduct a standard phraseology training before the flights and to clarify roles and responsibilities of each member during each mission briefing, especially when last-minute changes are required. Weather conditions (high temperatures, sunlight compromising monitors readability, etc.) and lack of user-friendly design in available software can reduce human performance. More exercises are necessary in order to be able to define more precisely the factors that affect human performance and suggest more effective countermeasures.

Cost-efficiency

Due to need of the human interference during the demonstration execution, the cost and the time increased.

A.7.2 Analysis of Exercise Results per Demonstration objective

A.7.2.1 EXE1-SAFIR-Med-OBJ-100 Results

During multiple exercises, tabletop, hybrid on multiple locations and live demonstrations several services were tested. The de-risking activities at Droneport helped define the roles and responsibilities for the involved U-space eco-system participants.

The strategic deconfliction ensured flight authorization were providing a conflict free routing. At this stage of technical development evaluating the operations volume is a human intervention. This leads to the need for coordination and predefined coordination procedures. During the exercises this was performed via voice communication leading to the need for a basic phraseology knowledge.

The direct electronic data connection between drone operators, in this case command and control centre, and the UTM enabled both parties to monitor the flight status of the UAS. Deployed traffic tracking equipment enabled visualisation of manned and unmanned traffic in the UTM platform, providing the possibility for traffic information service.

A.7.2.2 EXE1-SAFIR-Med-OBJ-200 Results

The services tested within the demonstration focus on the pre-tactical and tactical mitigation layer. As from the moment flight authorisations are submitted, until the flight has been terminated in the UTM platform, the details of the operations are available for the involved U-space actors.
Additionally, as from the moment the drone activates the flight authorization the drone’s position in picked up by the tracking infrastructure and added to the available data set regarding these operations. The available air picture, including manned and unmanned traffic increases situational awareness toward the airspace users, reducing the air risk. By obtaining a flight authorization request as described in the EU 2021/664 the drone operator ensure itself to be presented a conflict free trajectory. Continuous conformance monitoring, which in this case is comparing the actual location of the drone to the authorised operational volume enables the USSP to advise the drone operator of unintended possible excursion of the flight.

A.7.2.3 EXE1-SAFIR-Med-OBJ-300 Results

During de-risking activities at DronePort we have learned that we are the reaching the limit of what is possible taking into account the more complex scenarios we have been testing as a tabletop exercise. Supervising multiple drones at the same time increased the workload on all actors required to perform manipulations in the different platforms. Further automation will make it possible to mitigate these difficulties.

Further improvements on the UTM and Command-and-Control platform integration made it possible to make available different types of data regarding the intended operations available to all stakeholders in a user-friendly way, limiting the number of required inputs.

A.7.2.4 EXE1-SAFIR-Med-OBJ-400 Results

This section will be provided on the Final DEMOR

A.7.2.5 EXE1-SAFIR-Med-OBJ-500 Results

Tabletop de-risking activities enabled the drone operators to test the interaction with regard to the dynamic reconfiguration of airspace. This flexible segregation of airspace enables the drone operator to continue the mission taking into account new airspace characteristics instead of having to abord the operation completely, irrefutably improving drone efficiency.

Not to be taken into account is the amount of preparation and coordination between local ATC and the project participants. This coordination is related to the current way of working when conducting large scale operations within controlled airspace.

Using the UTM platform as a single point of contact for the drone operator enables the necessary coordination to be conducted in a more efficient way. Reducing the amount of pre-flight preparation and coordination.

A.7.3 Unexpected behaviour/Results

Please refer to section Appendix A.5 Deviations from the planned activities

Adverse weather caused no demonstration flight during the DronePort demonstration day.

Due to absence of authorisations, only SABCA was able to fly a demonstrations in Antwerp during the Antwerp demonstration week. As new authorisations came through, back-up demonstrations were held in Antwerp. Flights were executed for those trajectories for which authorisations were obtained.

A.7.4 Confidence in Results of Demonstration Exercise #1

A.7.4.1 Limitations and Impact on the level of Significance

Different elements are having positive and negative impact on the level of significance of the results gathered within this DEMOR.

During the de-risking activities at DronePort the pre-described scenarios enabled the clear description of the communication procedures required for safe operations within U-space airspace. These clearly defined roles and responsibilities were thoroughly tested during table top exercises, hybrid activities conducted in multiple EU countries at the same time and the actual live demonstrations in Antwerp.

Each way of conducting tests and/or demonstrations has its advantages and its disadvantages. Table top exercises will enable all participants to test procedures and systems in more complex situations without taking actual higher risks. This on the other hand doesn’t test all elements that make up a drone operation in its normal operating environment.

The findings that we have gathered during the live demonstrations in Antwerp are findings and result based on a limited number of flights. The level of significance is thereby largely impacted.

A.7.4.2 Quality of Demonstration Exercise Results

Seen the number of experienced practitioners in all different domains of the demonstrations (ANSP, experienced operators, drone manufacturers, future USSP), different elements of what makes up safe and secure drone operations were evaluated from different point of views. This ensured that valuable feedback could be gathered for the evaluation of results and reporting.

After each and every demonstration a dedicated feedback session ensured initial lessons learned from the demonstration could be identified.

A.7.4.3 Significance of Demonstration Exercise Results

The live demonstrations were conducted within atypical airspace. This creates an environment where the drone is to be able to conduct its operations with the risk of other, non-participating traffic. This creates an environment which is fundamentally different from how the future U-space will work.

As the area of operation was confined to a rather small portion of reserved airspace, the amount of infrastructure required to be able to pick up remoteID signal and provide U-space services was limited as well. This made it easier to ensure ourselves of the tracking coverage provided. Nevertheless, at some instances the tracking of the drone was lost even after positive establishment of the remoteID contact in the UTM platform. The tracking coverage validation is an element that should not be forgotten when scaling up operations, it is a necessary part in order to build up the confidence in the system and services.

Appendix B EXE#2 Aachen plan

B.1 Demonstration Exercise Description and Scope

In the demonstration task for the MAHHL region, it was planned to conduct different scenarios to test different U-Space services and assumed typical situations for transporting medical goods by drone.

The second demonstration exercise should take place in the MAHHL (Maastricht (NL), Aachen (GER), Heerlen (NL), Hasselt (BE) and Liege (BE)) area. The region contains hospital heliports and among others the local airport Aachen – Merzbrück (EDKA). This demonstration was planned to be part of joint activities of the EU region MAHHL-UAM initiative and required a Permit-to-Fly for cross-border operation BVLOS between the Netherlands and Germany. The University Hospital Aachen (UKA) was planned to be the central hub for the MAAHL operations. The BVLOS demonstration were supported by RWTH Aachen University with respected to the Airspace Integration and Specific Operation Risks Assessment as well as from the City of Aachen.

The operational scope of this trial in terms of actors and processes focused on:

- Medical parcel transport between medical facilities
- Permit-to-Fly for a cross-border flight to ensure safety and security (SORA process)
    - The key study objectives and scenarios were:
- Demonstration the added value of the U-space services to support this type of activities in all phases (pre-flight, in-flight, post-flight);
- Demonstrate that a U-space provider, which provide the necessary U-space services in its respective spatial areas can support the trial activities planned for the SAFIR-Med scenarios across multiple UAS drone operators. The operations will also be supported by the Helicus C2C on manufacturer side.

The study technique and platform were:

- Set of specific drone operators and drone platforms specific for SAFIR-Med Demonstrations to have the Permit-to-Fly to operate.
- UAV platforms: HyFly, FlyXDrive, SABCA, TUDelft.
- Set the federated UAM ecosystem architecture, core are UTM systems of skeydrone and Droniq. And for the MAHHL region especially the UTM-Version of Droniq.
- Set the integration Helicus C2C with all the UAV platforms.

B.2 Summary of Demonstration Exercise #2 Objectives and success criteria

The demonstration objectives and success criteria can be found in the SAFIR-Med DEMO Plan D2.1 edition 01.00.03 under the section 5.2.3 Demonstration Objectives.

B.3 Summary of Demonstration Exercise #2 Scenarios

B.3.1 Solution scenario 13: University Hospital Aachen - City Golf Course

Scenario overview

Operational scenario name:

AED-transport

Operational scenario summary:

At the city golf course, a member suffers an cardiac arrest. Bystanders inform the Aachen emergency dispatch, and the dispatch will send a doctor and an ambulance to the scene. To help with the resurrection measures the bystanders take until the ambulance or the doctor arrives the AED-drone, which is stationed at the UKA is also dispatched. The AED-copter starts off the helipad at the UKA and from there flies east above the hospital parking lot and after leaving the close vicinity of the UKA it flies northeast to land at the city golf course where the bystanders can use the AED to help the patient in cardiac arrest. The time between take off and the arrival at the scene will be about 2 minutes.

Figure 20. Scenario 13 detail

Operating method:

Technical Platform: TUDelft

Operator: Helicus

In scenario 13 (University Hospital Aachen - City Golf Course) operated by HELICUS/flyXdrive was planned: After the AED-drone by TU Delft is dispatched the Helicus C2C plans a routing from the UKA to the city golf course and after the routing is submitted to and approved by the Droniq UTM-System the AED copter starts and performs the BVLOS flight. The landing site at the golf course will be manually predefined in the scope of the demonstration. During the flight the AED-drones position will be continuously transmitted to the Droniq-UTM via the Droniq Hook-on-Device. As the complete flight will be conducted in class G airspace no special communication point with the ATM are necessary. Nether the less close contact with the responsible coordinator for the helipad at the UKA will be necessary to avoid a conflict with the rescue operations. As no helicopters are stationed at the UKA itself all in- and outgoing transports leave a sufficient timeframe, in case a helicopter transport is scheduled to abort the take-off or to start and clear the helipad before the helicopter arrives at the UKA.

Services addressed:

U1 services			
Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring (N/A)	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)

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Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 26. List the service(s) addressed by the scenario.

Operational scenario overview:

Operational Scenario 13: University Hospital Aachen - City Gold Course			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Sub-Urban	Except for the direct surrounding of the UKA there the environment is urban, but this area may be controlled
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation (e.g., emergency helicopters).
	Controlled/Uncontrolled or N/A	Uncontrolled	
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	Cloud be performed using VLOS operations, but that is not scope of the project
	VLL/Above VLL/All or N/A	VLL	
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	Droniq
Density of drones	Number of drones	1	TU Delft AED-drone
	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	rotorcraft	TU Delft AED-drone
	ATC	N/A	Flight does not involve controlled airspace

Judgement of acceptability	Public Safety	Yes	
	Hobbyist	N/A	
	City	Yes	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Yes	
	Certification	N/A	
Airspace	X, Y, Z, Mix or N/A	Y	
	Cross-border (Y/N)	N	

Reference Scenario:

After the collapse of the patient somebody goes to the main building of the golf course where the AED is stored and walks back. Depending to the persons speed and the location of the emergency this may take several minutes longer than the time the AED drone needs to arrive at the scene.

B.3.2 Solution scenario 16: Zuyderland MC Heerlen – University Hospital Aachen

Scenario overview

Operational scenario name:

Medical tissue transport

Operational scenario summary:

The flight from Heerlen starts at the Zuyderland MC Heerlen. Close to the VFR Reporting point "Sierra" but outside of the Maastrich CTR in class G airspace. Afterwards the TW-neo crosses with the A76 a major highway and shortly after it overflies a power line. The risk reduced routing afterwards takes a turn to stay eastwards of Simpelveld and first crosses the train tracks that connect Simpelveld with Maastrich and then the N281. It stays under the lower limit of the Maastricht TMZ at 1200 ft AMSL at all times. Shortly after crossing the N281 the UAS reaches German airspace close to Aachen – Orsbach and crosses the surrounding agriculture land and then reaches the UKA, where it lands on the Helipad of the hospital. From where the sample that was loaded in Heerlen is brought to the central laboratory of the UKA. The whole flight time will be about 10 minutes.

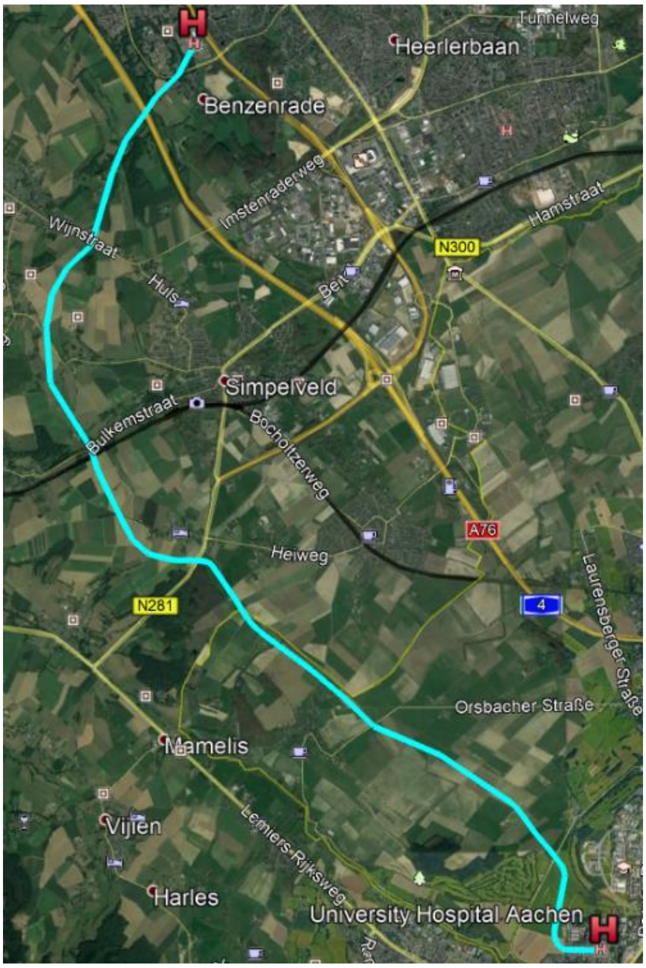

Figure 21. Scenario 16 detail

Operating method:

Technical platform: FlyXDrive

Operator: Helicus

In scenario 16 (Zuyderland MC Heerlen – University Hospital Aachen) operated by HELICUS/flyXdrive was planned: The Helicus C2C after being tasked with a transport of a medical probe from the Zuyderland MC Heerlen to the University Hospital Aachen will automatically plan flight operation between the two hospitals taking. The flyXdrive's TW-Neo onboard Systems will afterwards plan a detailed routing, which will be uploaded to the Droniq UTM-System via its direct interface. After gaining a permit to start from both Helicus C2C and the UTM System the TW-neo will take off and perform the planned BVLOS flight. During the flight the TW-neo will continuously publish its position using the on board FLARM-module and the integrated interface to the Droniq UTM. As the complete flight will be conducted in class G airspace no special communication point with the ATM are necessary. As the flight is conducted close to the Maastrich CTR and TMZ the ATM at Maastricht will be informed of the operations. Nevertheless, close contact with the responsible coordinator for the helipad at the UKA will be necessary to avoid a conflict with the rescue operations. As no helicopters are stationed at the UKA itself all in- and outgoing transports leave a sufficient timeframe, in case a helicopter transport is scheduled to either divert to an alternative landing site around the UKA or to land and clear the helipad.

Services addressed:

U1 services			
Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution	Collaborative Interface with ATC	Dynamic capacity Management	

(Assumed)	(N/A)	(N/A)	

Table 27. List the service(s) addressed by the scenario.

Operational scenario overview:

Operational Scenario 16: Zuyderland MC Heerlen – University Hospital Aachen			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Rural	Except for the direct surrounding of the hospitals there the environment is urban, but these areas may be controlled
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation (e.g. emergency helicopters).
	Controlled/Uncontrolled or N/A	Uncontrolled	
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	
	VLL/Above VLL/All or N/A	VLL	
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	Droniq
Density of drones	Number of drones	1	flyXdrive TWneo
	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	Hybrid	flyXdrive TWneo
Judgement of acceptability	ATC	N/A	Flight does not involve controlled airspace
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	
	Certification	N/A	
Airspace	X, Y, Z, Mix or N/A	Y	

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	Cross-border (Y/N)	Y	

Reference Scenario:

In the reference scenario the transport would be performed by car. Assuming light traffic the car will need about 20 Minutes for the route from Zuyderland MC to the University Hospital. Especially in the morning and afternoon it may take significantly longer as the routing involves streets with heavy traffic during commute hours.

B.3.3 Solution scenario 17: University Hospital Aachen – Model Air Field Orsbach

Scenario overview

Operational scenario name:

Antidote dispatch

Operational scenario summary:

A person was stung by a wasp while being highly focused in steering his model aircraft. As he is highly allergic an antidote is needed. Due to the urgent situation the emergency dispatch dispatches a transport drone to the site. The aircraft will start off the helipad at the UKA Aachen flying eastwards of the vicinity of the UKA. Afterwards it flies to the northeast and lands at the Model Airfield Orsbach. Where the transported antidote can be administered. The flight duration will be about 3 minutes from takeoff to landing.

Figure 22. Scenario 17 detail

Operating method:

Technical platform: SABCA or FlyXDrive

Operator: Helicus

In scenario 17 (University Hospital Aachen – Model Air Field Orsbach) operated by SABCA or flyXdrive was planned: After the transported is dispatched the Helicus C2C plans a routing from the UKA to Model Airfield Orsbach. Depending of the dispatched aircraft the routing is submitted to Droniq UTM-System either by the Helicus C2C or the TW-neo itself. In case the TW-neo is dispatched it will continuously publish its position using the on board FLARM-module and the integrated interface to the Droniq UTM. If the system manufactured by SABCA is used the position will be transmitted to the UTM system using the Droniq Hook-on-Device. As the complete flight will be conducted in class G airspace no special communication point with the ATM are necessary. As the flight is conducted close to the Maastricht CTR and TMZ the ATM at Maastricht will be informed of the operations. Nether the less close contact with the responsible coordinator for the helipad at the UKA will be necessary to avoid a conflict with the rescue operations. As no helicopters are stationed at the UKA itself all in- and outgoing transports leave a sufficient timeframe, in case a helicopter transport is scheduled to abort the take-off or to start and clear the helipad before the helicopter arrives at the UKA.

Services addressed:

U1 services			
Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring (N/A)	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 28. List the service(s) addressed by the scenario.

Operational scenario overview:

Operational Scenario 17: University Hospital Aachen – Model Air Field Orsbach			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Rural	Except for the direct surrounding of the UKA there the environment is urban, but this areas may be controlled
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation (e.g. emergency helicopters).
	Controlled/Uncontrolled or N/A	Uncontrolled	
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	Could also be perfomed using eVLOS but that is not scope of the project.
	VLL/Above VLL/All or N/A	VLL	
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	Droniq
Density of drones	Number of drones	1	flyXdrive TWneo or multicopter by SABCA
	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	Hybrid or rotorcraft	flyXdrive TWneo (hybrid) or multicopter by SABCA (rotorcraft)
Judgement of acceptability	ATC	N/A	Flight does not involve controlled airspace
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	
	Certification	N/A	
Airspace	X, Y, Z, Mix or N/A	Y	
	Cross-border (Y/N)	Y	

Reference Scenario:

Without the support of UAS the allergic person would need to wait for the ambulance and the doctor to arrive at the scene. At the given location this this will take depending on the available ambulance and the traffic situation between 7 and 12 Minutes.

B.3.4 Solution Scenario 18: Franziskus Hospital Aachen – University Hospital Aachen

Scenario overview

Operational scenario name:

Urgent rare blood type supply

Operational scenario summary:

After an accident a severely injured person is transported to hospital. In a first examination it was found that banked blood of a rare type is needed but is not available at the hospital, as it was earlier transferred to one of the remote surgery wards for a planned surgery which can be postponed until new banked blood can be retrieved from a far of blood bank. A drone is dispatched from the University Hospital Aachen – Franziskus building to transport the needed blood supply to the emergency room at the UKA. After the drone was dispatched and the blood was loaded, the UAS takes off at University Hospital Aachen – Franziskus and fly towards the southeast avoiding the densely populated in the South-West of Aachen. After having cleared this secti rare type is needed but is not available at the hospital, as it was earlier transferred to one of the remote surgery wards for a planned surgery which can be postponed until new banked blood can be retrieved from a far of blood bank. A drone is dispatched from the University Hospital Aachen – Franziskus building to transport the needed blood supply to the emergency room at the UKA. After the drone was dispatched and the blood was loaded, the UAS takes off at University Hospital Aachen – Franziskus and fly towards the southeast avoiding the densely populated in the South-West of Aachen. After having cleared this section, it crosses the railway tracks of the Ronheider Ramp. It continues to fly other agricultural land before entering the airspace above the Vaalserquatier, where it crosses the federal road B1. It afterwards stays eastwards of the populated area and reaches the University Hospital Aachen after turning westwards and crossing the parking lot. It lands on the helipad, from where the blood is taken to the ER where the patient will arrive shortly. The flight time is about 5 Minutes

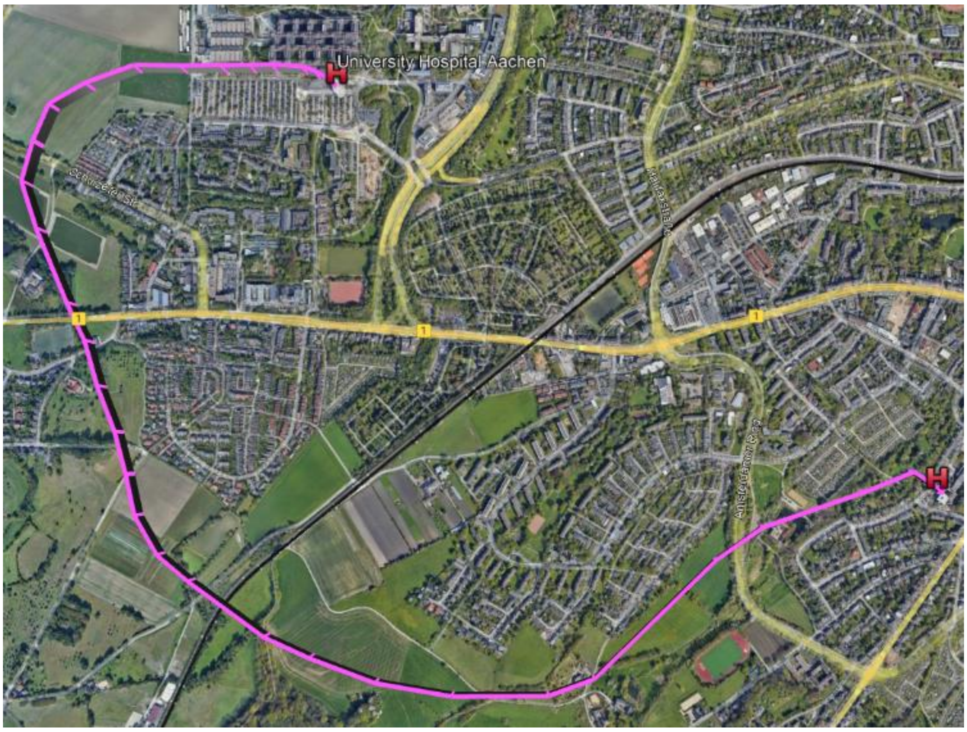

Figure 23. Scenario 18 detail

Operating method:

Technical platform: SABCA

Operator: Helicus

In scenario 18 (Franziskus Hospital Aachen – University Hospital Aachen) operated by SABCA was planned: After the transported is dispatched the Helicus C2C plans a routing from the University Hospital Aachen – Franziskus to the University Hospital Aachen main building. The C2C will approval for the routing from the Droniq UTM-System and upload the routing to the UAS. The system manufactured by SABCA will transmit its current position to the UTM system using the Droniq Hook-on-Device. As the complete flight will be conducted in class G airspace no special communication point with the ATM are necessary. Nether the less close contact with the responsible coordinator for the helipad at the UKA will be necessary to avoid a conflict with the rescue operations. As no helicopters are stationed at the UKA itself all in- and outgoing transports leave a sufficient timeframe in case a helicopter transport is scheduled to either divert to an alternative landing site around the UKA or to land and clear the helipad.

Services addressed:

U1 services

Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring (N/A)	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 29. List the service(s) addressed by the scenario.

Operational scenario overview:

Operational Scenario 18: Franziskus Hospital Aachen – University Hospital Aachen			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Mix	The direct surrounding of the UKA Franziskus is urban. The environment switches to sub-urbun after leaving the vincitiy of the hospital and switches to rural after the UAS crosses the Amsterdamer Ring. While crossing the Vaalserquartier the environment is sub-urban. Between the Vaalserquartier and the UKA the environment is rural again. The direct surrounding of the UKA is urban again.
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation (e.g. emergency helicopters).
	Controlled/Uncontrolled or N/A	Uncontrolled	
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	
	VLL/Above VLL/All or N/A	VLL	
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	Droniq
Density of drones	Number of drones	1	multicopter by SABCA
	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	rotorcraft	multicopter by SABCA
Judgement of acceptability	ATC	N/A	Flight does not involve controlled airspace
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	
	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	
	Certification	N/A	
	X, Y, Z, Mix or N/A	Y	

Airspace	Cross-border (Y/N)	N	

Reference Scenario:

Without the availability of UAS this transport would be performed by car. The optimal route with a clear road takes about eight minutes, but heavy traffic in the narrow streets of Aachen may increase this time significantly during commute hours.

B.3.5 Solution scenario 19: University Hospital Aachen – Rhine Maas Hospital Würselen

Scenario overview

Operational scenario name:

Urgent rare blood type supply

Operational scenario summary:

After an accident a severely injured person is transported to hospital. In a first examination it was found that banked blood of a rare type is needed but is not available at the hospital. A drone is dispatched from the University Hospital Aachen to transport the needed blood supply to the emergency room at the Rhine Maas Hospital. After the drone was dispatched and the blood was loaded, the UAS takes off at University Hospital Aachen helipad and after clearing the vicinity of the hospital, the UAS will turn northwards while staying east of the RWTH Campus Melaten. North of the campus area it turns eastwards and crosses the railway line between the Stations Aachen West and Kohlscheid. After crossing the railway tracks the UAS fly in parallel to the state route L231 and crosses the L232 on the intersection with the L231. It then flyes over an agricultural land towards the industrial area Soers. It stays northwards of it while keeping south of the A4. After the junction "Aachen – Mitte" the UAS crosses the A4 at nearly a right angle. Afterwards it stays northwards of the A4 while flying roughly parallel to it. After crossing the L23 it turns northwards an crosses the populated area around the Rhine Maas Hospital and the L23 again. It lands in the designated area at the Rhine Maas Hospital, from where the blood is take to the ER where the patient will arrive shortly. The time the UAS will need for the fligth will be about 9 minutes.

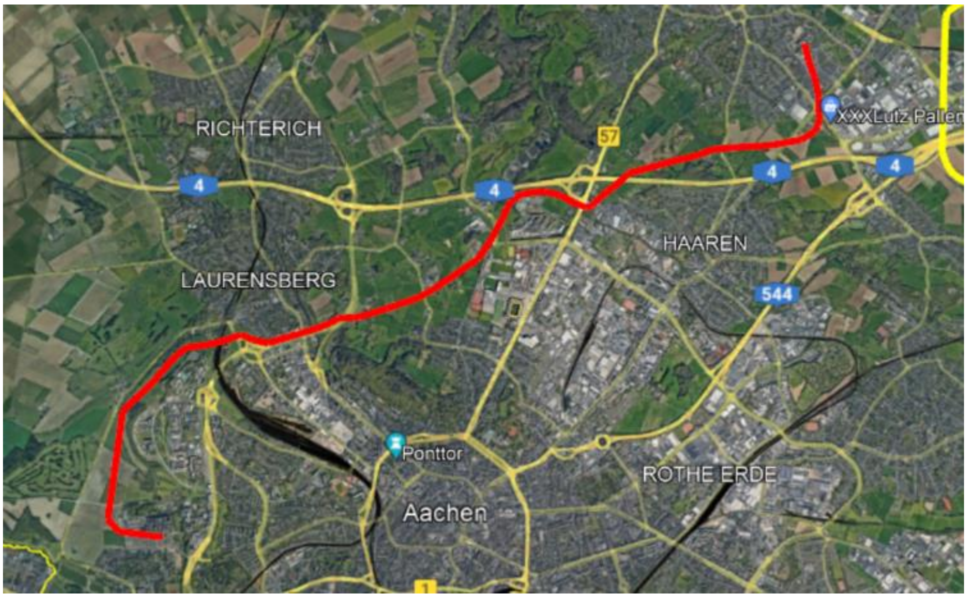

Figure 24. Scenario 19 detail

Operating method:

Technical platform: HyFly

Operator: Helicus

In scenario 19 (University Hospital Aachen – Rhine Maas Hospital Würselen) operated by HyFly was planned: After the transported is dispatched the Helicus C2C plans a routing from the University Hospital Aachen to the Rhine Maas Hospital. The C2C will approval for the routing from the Droniq UTM-System and upload the routing to the UAS. The system manufactured by HyFly will transmit its current position to the UTM system using the Droniq Hook-on-Device during the complete flight. The planned routing is close to the Aachen Merzbrück airfield which operates without a CTR. As the routing stays well clear of the visual approach and path direct interference is unlikely. Nether the less close contact to Aachen Info (the local tower) is established. Aachen Info will be informed regarding the operation prior to the start of the flight and again when the UAS crosses the A4. Additionally close contact with the responsible coordinator for the helipad at the UKA will be necessary to avoid a conflict with the rescue operations. As no helicopters are stationed at the UKA itself all inand outgoing transports leave a sufficient timeframe, in case a helicopter transport is scheduled to abort the take-off or to start and clear the helipad before the helicopter arrives at the UKA. The Rhine Maas Hospital may also have emergency helicopter operations ongoing. Therefor close contact with the responsible coordinator for the helipad at the Rhine Maas Hospital will be necessary to avoid a conflict with the rescue operations. As no helicopters are stationed at the Rhine Maas Hospital itself all in- and outgoing transports leave a sufficient timeframe, in case a helicopter transport is scheduled to either divert to an alternative landing site around the UKA or to land and clear the helipad.

Services addressed:

U1 services

Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring (N/A)	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)
U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 30. List the service(s) addressed by the scenario.

Operational scenario overview:

Operational Scenario 19: University Hospital Aachen – Rhine Maas Hospital Würselen			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A	Mix	The direct surrounding of the UKA is urban. After leaving it the UAS crosses an rural area. After reaching the train tracks the environment becomes sub-urban. Between the L260 and the Soerser Weg the environment is rural again. After the Soerser Weg the environment becomes sub-urban until the A4 is crossed. The flight path until the L23 is crossed the first time is in a rural environment again, while the next part is sub-urban. The direct vicinity of the hospital is urban again.
Airspace	Unmanned/Manned/Mix or N/A	Mix	Airspace will be used by UAS and manned aviation (e.g. emergency helicopters).
	Controlled/Uncontrolled or N/A	Uncontrolled	
Type of flight	Manual/Partly Automated/Fully Automated or N/A	Fully Automated	
	VLOS/BVLOS/Mix or N/A	BVLOS	
	VLL/Above VLL/All or N/A	VLL	
	Simulation/Flight trials/Mix or N/A	Flight trials	
U-space providers	Number of USSP or SDSP providing this service	1	Droniq
Density of drones	Number of drones	1	By HyFly
	Max. number of simultaneous flights	1	
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A	hybrid	By HyFly
Judgement of acceptability	ATC	TBD	The proposed flight is close to the VFR approach of EDKA and there for the involvement of "Aachen Info" is necessary.
	Public Safety	Y	
	Hobbyist	N/A	
	City	Y	

	VLOS prof. Drone operator	N/A	
	BVLOS prof. Drone operator	Y	
	Certification	N/A	
Airspace	X, Y, Z, Mix or N/A	Y	
	Cross-border (Y/N)	Y	

Reference Scenario:

This kind of transport is currently performed by car and under rare circumstances by helicopter. If the blood is transported by car, the transport will take about 18 minutes. This time might be prolonged by heavy traffic enroute. To avoid this the helicopter stationed in Aachen-Merzbrück could be used. It takes the helicopter about 7 to 10 minutes from being alarmed until it arrives at the UKA and after that another 5 minutes to reach the Rhine-Maas-Hospital.

B.3.6 Scenarios combinations

These scenarios were combined into two demonstration flights, divided into Demonstration #4 and #5. The scenarios broke down as follows:

- Demonstration #4 should be a combination of scenarios 13,16 and 18.
- Demonstration #5 should be a combination of scenarios 17 and 19

	SC13	SC16	SC17	SC18	SC19
SC13		☑		☑	
SC16	☑			☑	
SC17				☐	☑
SC18	☑	☑	☐		
SC19			☑		

B.3.7 Flown Scenario 1: Non-cross border Zuyderland MC Heerlen – University Hospital Aachen

Scenario overview

Operational scenario name

Non-Cross border Medical tissue transport

Operational scenario summary:

The flight was supposed to start close to the Zuyderland MC Heerlen. Due to the missing operational authority from the Dutch the flown scenario started directly behind the border between the Netherlands and Germany on the German side. The UAS crosses the surrounding agriculture land and then reaches the UKA, where it lands on a field close to the Helipad of the hospital. The whole flight time will be about 5 minutes.

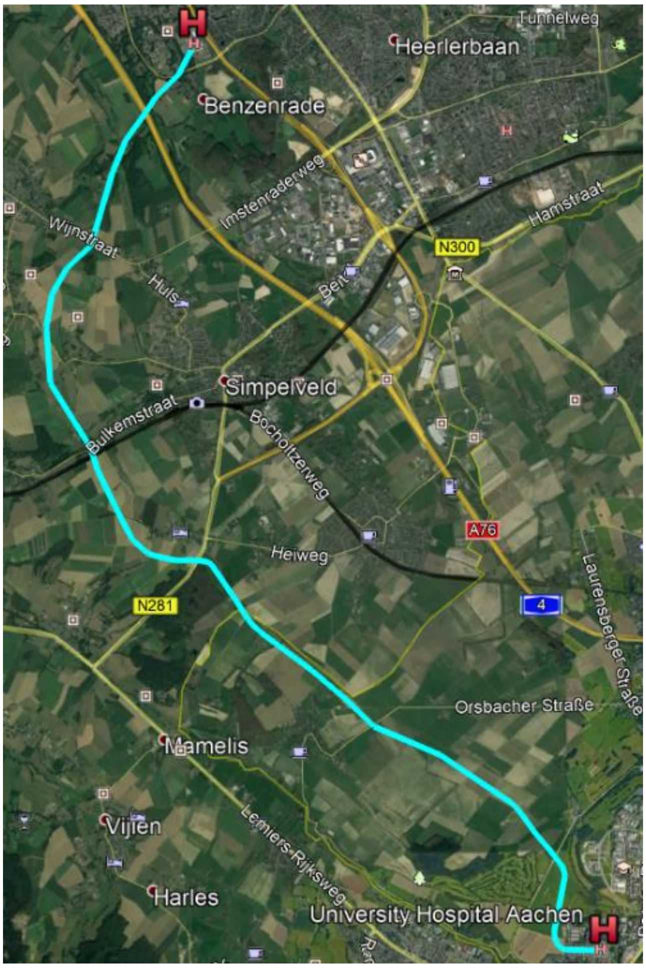

Figure 12. Scenario 1 Flight plan detail

Operating method:

Technical Platform: flyXdrive

Operator: flyXdrive

The Helicus C2C was tasked with a transport of a medical probe from the Zuyderland MC Heerlen to the University Hospital Aachen, which will automatically plan flight operation between the starting point and the UKA. The TW-Neo's support systems plan a detailed routing, which was uploaded to the Droniq UTM-System via its direct interface. After gaining a permit to start from the UTM System the TW-Neo took off and performed the planned BVLOS flight. During the flight the TW-Neo continuously published its position using the on board FLARM- and cellular-network-module and the integrated interface to the Droniq UTM.

As the complete flight was conducted in class G airspace no special communication point with the ATM are necessary. Nevertheless, close contact with the responsible coordinator for the helipad at the UKA was necessary to avoid a conflict with the rescue operations. As no helicopters are stationed at the UKA itself all in- and outgoing transports leave a sufficient timeframe, in case a helicopter transport is scheduled to either divert to an alternative landing site around the UKA or to land and clear the helipad.

Services addressed:

U1 services			
Registration (Assumed)	e-Identification (Assumed)	Geo-Awareness (Assumed)	Registration Assistance (Assumed)
U2 services			
Geo-fence provision (incl. dynamic geofencing)	Emergency management (N/A)	Strategic Deconfliction	Weather information (N/A)
Tracking and position reporting	Operation plan/Preparation optimisation	Monitoring	Traffic Information
Drone Aeronautical Information Management (Assumed)	Procedural Interface with ATC (Assumed)	Surveillance data exchange	Operation plan processing (Assumed)
Risk Analysis assistance (N/A)	Accident/Incident reporting (N/A)	Navigation Infrastructure Monitoring	Communication Infrastructure Monitoring (N/A)
Digital logbook (Assumed)	Legal recording (N/A)	Geospatial information service (N/A)	Population density map (N/A)
Electromagnetic interference information (N/A)	Navigation coverage information (N/A)	Communication coverage information (N/A)	Citizen Reporting Service (N/A)

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U3 services			
Tactical Conflict Resolution (Assumed)	Collaborative Interface with ATC (N/A)	Dynamic capacity Management (N/A)	

Table 16. List the service(s) addressed by the scenario.

Operational scenario overview:

Operational Scenario 1:			***Comments***
Environment	Urban/Rural/Sub-Urban/Mix or N/A		Rural
Airspace	Unmanned/Manned/Mix or N/A		Mix
	Controlled/Uncontrolled or N/A		Uncontrolled
Type of flight	Manual/Partly Automated/Fully Automated or N/A		Fully Automated
	VLOS/BVLOS/Mix or N/A		BVLOS
	VLL/Above VLL/All or N/A		VLL
	Simulation/Flight trials/Mix or N/A		Flight trials
U-space providers	Number of USSP or SDSP providing this service		1
Density of drones	Number of drones		1
	Max. number of simultaneous flights		1
	Type of drones: rotorcraft/fixed wing or hybrid/ mixed traffic or N/A		Hybrid
Judgement of acceptability	ATC		N/A
	Public Safety		Y
	Hobbyist		N/A
	City		Y
	VLOS prof. Drone operator		N/A
	BVLOS prof. Drone operator		Y
	Certification		N/A
Airspace	X, Y, Z, Mix or N/A		Y
	Cross-border (Y/N)		N

Reference Scenario:

In the reference scenario the transport would be performed by car. Assuming light traffic the car will need about 20 Minutes for the route from Zuyderland MC Heerlen to the University Hospital. Especially in the morning and afternoon it may take significantly longer as the routing involves streets with heavy traffic during commute hours.

B.4 Demonstration Exercise #2 Assumptions

Identifier	Title	Type of Assumption	Description	Justification	Impact on Assessment
EXE2-ASM-VLDSAFIR-Med-001	Operational Authorisations	Operational	Helicus is able convert BCAA authorisations to Germany and the Netherlands using EASA article 13 to perform the intended demonstration flights with the FlyXDrive, HyFly, SABCA and TUDelft UAS platforms in the MAHHL region. Pre-flight.	Without authorizations no demo flights are possible. There were severe delays in the issuance of permits by the national authority	High
EXE2-ASM-VLD-SAFIR-Med-002	Cross-border flight	Operational	Helicus, as the operator, gets a permit for the Antwerp demonstration and uses the Art. 13 to get flight permits to Germany and the Netherlands.	Helicus will be the operator, as it now has the legislative framework for that in Germany. Unifly will interface with Droniq, the USSP for the German case, to extend the Area of Responsibility to cover the area where the cross-border flight will take place. No permission was given by the Dutch authority	High
EXE2-ASM-VLD-SAFIR-Med-003	C2C - UTM connection	Technical	The German UTM-Provider Droniq is available within the Helicus C2C through one Droniq UTM display running at the C2C.	The C2C is architecturally centralising environmental information in close-to real-time to allow implementing ground-based Detect and Avoid as well as SAFIR-MED integrated mission monitoring	High

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EXE2-ASM-VLD-SAFIR-Med-004	Support local authorities	Operational	Helicus as an operator gets the support from local authorities on the trajectories in the MAHHL region	To ensure validation of the designed flight routes based upon local information and to allow securing the intended routes where needed, the support from local authorities is required. The support from local authorities (municipal, regional, …) is required in both Germany as well as in the Netherlands.	High
EXE2-ASM-VLD-SAFIR-Med-005	Cross-border flight	Operational	Droniq is covering all SAFIR-MED UTM services for cross-border flights between Germany and in the Netherlands, as well as within Germany and within the Netherlands	Integrated UTM services for the Netherlands are required to allow SAFIRMED cross-border flights between Germany and the Netherlands as well as for flights within Germany and within the Netherlands No flights into Dutch airspace were allowed due to lack of permission.	High

Table 17: Demonstration Assumptions overview

B.5 Deviations from the planned activities

During the execution of the Aachen/MAHHL Demonstration, several deviations occurred from the described activities in the SAFIR-Med Demonstration Plan. This section provides a summary of the two main deviations, split into the following two categories:

- Deviations at the level of Operational Authorisations
- Deviation at the level of the Demonstration Approach

Deviations at the level of the Operational Authorisations

Reason one, and also the most important reason, was the delay in the allocation of Article 13 acceptance permits, as well as the national permitting situation in Germany. This led to a delay in the demonstration, which was originally scheduled for the end of August 2022 and then postponed to End of October 2022.

Unfortunately, it was not possible to obtain a permit for the Dutch airspace in time, therefore the cross-border aspect of the demonstration is omitted. The flights will therefore take place purely in German airspace. Due to the fact that the cross-border flights were not flown the analysis of cross-border behaviour of mobile coverage on the drone is not part of the analysis.

After national approval was granted for flights by flyXdrive and TU Delft under flyXdrive operations, flights were scheduled for Oct. 24, 2022. However, at the same time, approval could not be obtained for the other project partners SABCA, HyFly and Ehang under Article 13. This will continue to be attempted during the reminder of the project so that flights may still be possible in January 2023 by partners flyXdrive, HyFly, SABCA and TU Delft. This would then of course be acknowledged in the final report.

Figure 13. The flyXdrive operated UAV landing at University Hospital of Aachen (UKA) after its 3.5 km BVLOS flight in the SAFIR-Med MAHHL demonstration.

Deviations at the level of the Demonstration Approach

Second major but subordinate reason for deviation from the demonstration schedule is weather. Postponing the flights to the end of October has increased the probability of bad weather. This also occurred on 24.10.2022 could not be followed due to bad weather. Therefore, another postponement of the flights to Wednesday, 26.10.2022 has been arranged, but here only the partner flyXdrive can perform its demonstration flight due to logistical reasons. TU Delft is therefore cancelled for the demonstration date here.

To what extent the weather will play a role in the envisaged flights under Article 13 in January 2023 remains an open question.

B.6 SESAR U-space services addressed by Exercise

B.6.1 Deviations with respect to U-space services definition

Due to the significantly scaled-down demonstration execution in terms of drones in the air, U-Space services in general could not be tested with the intensity as planned.

In terms of deviations from planned U-Space services, consider the following:

- The U1 services were assumed in all flown scenarios.
- The U2 services could not be fully tested, in particular the strategic deconfliction could only be tested partially, since only one operator was in the air during the demonstration and thus no conflict with another UAS arose. But strategic deconfliction could be tested with other general aviation participants in the air. Operation Plan and Preparation Optimization, on the other hand, could be successfully tested through the direct integration of the flyXdrive UAS into the Droniq UTM.
- The U3 services could not be tested because no tactical deconfliction was possible (due to lack of possible counterparts in the air).

Below you will find description on the deviations with respect to the U-space services as described in the EU 2021/664 compared to how they were provided

U-space service	SESAR Solution ID and Title		Solution/service addressed or assumed?	Deviations
Network identification service	**US1-01**	Registration	Assumed	Network identification of the operation will in a medical environment include pre-defined priorities taken into account several aspects of the operation.
	US1-02	e-Identification	Assumed	
	US1-04	Registration assistance	Assumed	
	US2-17	Digital Logbook	Assumed	
Geo-awareness service	**US1-03**	Geo-Awareness	Assumed	Within the activities conducted geo-awareness service did not take place within the project environment as you would have in a U-space eco-system.
	US2-01	Geo-fence provision (incl. dynamic geo-fencing)	Assumed	

UAS flight authorisation service	**US2-03**	Strategic Conflict Resolution	Partially Addressed	Strategic deconfliction of the different operations within the SAFIR Med project was done on the basis of the pre-defined prioritisation criteria.
	US2-06	Operation plan preparation/optimization	Addressed	
	US2-10	Procedural Interface with ATC	Assumed	
	US2-12	Operations plan processing	Assumed	
	US3-02	Tactical Conflict Resolution	Assumed	
Traffic information service	**US2-05**	Tracking and position reporting	Addressed	Within the SAFIR Med eco-system surveillance data was not interchanged between the ANSP and the USSP
	US2-08	Traffic Information	Addressed	
	US2-11	Surveillance data exchange	Addressed	
Conformance monitoring service	**US2-07**	Monitoring	Addressed	During the hybrid activities and live demonstrations at Aachen the remote ID and flight authorizations enabled the USSP to monitor the conformance of the conducted operations. There was no technical solution in place to advice the UAS if he would have been leaving its operational volume.

B.7 Demonstrations Exercise #2 Results

Demonstration Exercise Objective ID	Objective Title	Success Criterion ID	Success Criterion	Sub-operating environment	Exercise Results	Demonstration Objective Status
EXE2-OBJ-VLD-SAFIR-Med-101	Operational acceptability of U-space services	EXE2-CRT-VLD-SAFIR-Med-101-100	The roles and responsibilities of the involved actors (individual and at the level of the team) are clear and acceptable under U-space services (U1 and U2) in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	The roles and responsibilities required for the operations (Remote Pilot, U-Space Observer) are well defined and contributed to safe flight operations during the MAHHL demonstration flight.	Ok
		EXE2-CRT-VLD-SAFIR-Med-101-200	The tasks and procedures of the involved actors (individual and at the level of the team) are clear and acceptable under U-space services (U1 and U2) in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	The tasks and responsibilities were clearly assigned and included all necessary actions, as well as coherent procedures for conducting the flight operations.	Ok

		EXE2-CRT-VLD-SAFIR-Med-101-300	The technical systems proposed are usable and acceptable to end users for tested U-space services (U1 and U2) in nominal situations	Urban and Sub-Urban Operating Environments and in nominal situations	The Droniq/Unifly UTM system was successfully used to display, analyse, and authorize the flight route and to display the UAV location. Some steps required manual action at the USSP. The C2C received telemetry data from the UAV, but was affected by the intermittent mobile network connection in the flight area.	Partially Ok
		EXE2-CRT-VLD-SAFIR-Med-101-400	The technical systems proposed support the end users' performance in order to achieve their tasks in an efficient, accurate and timely manner for tested U-space services (U1 and U2) in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	A web-API was used to upload the previously prepared flight plan to the UTM system, which proved to be advantageous over manual input to the UTM's web GUI.	Partially Ok
		EXE2-CRT-VLD-SAFIR-Med-101-500	The communication load and phraseology associated to U-space services (U1 and U2) are acceptable under all operating conditions in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	The USSP's digital API was used during the demonstration flights to increase the grade of automation and to minimize the need for additional (verbal) communication. The not-yet automated flight authorization process slightly delays take-off after the flight plan upload, though.	Partially Ok

		EXE2-CRT-VLD-SAFIR-Med-101-600	The training and transition needs associated to U-space services (U1 and U2) are identified and documented for all future users in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	The amount of required training strongly depends on the used system/interface to the USSP. In this demonstration, the U-Space services training was included in the general remote observer training.	Ok
EXE2-OBJ-VLD-SAFIR-Med-201	U-space services safety	EXE2-CRT-VLD-SAFIR-Med-201-100	Demonstrate the safe integration of drones from pre-flight to post flights, through increased awareness to all airspace users, strategic deconfliction, conformance monitoring in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	Visualisation of the operation and tracking by the USSP makes it possible to communicate (conformity-non conformity) to the ANSP and other airspace users in a later stage. This communication was out of scope with regard to the project technical development objectives.	Partially Ok

		EXE2-CRT-VLD-SAFIR-Med-201-200	Demonstrate that the U-space services (U1 and U2) in nominal situations contribute to the limitation of air risk in VLL airspace	Urban and Sub-Urban Operating Environments and in nominal situations	The demonstration flight route was uploaded to the UTM system and the resulting flight geography was manually verified and authorized by the USSP. Therefore, no other UAS was permitted in the same airspace volume. Further, ADS-B transmitter could be monitored in the UTM system to identify manned air traffic with a risk of collision. Both measures reduce the air risk.	Ok
		EXE2-CRT-VLD-SAFIR-Med-201-300	Demonstrate that the U-space services and (U1 and U2) in nominal situations contribute to the limitation of ground risk	Urban and Sub-Urban Operating Environments and in nominal situations	During the actual flights, ground risk mitigation measures were conducted during the planning phase of the flights.	Ok

		EXE2-CRT-VLD-SAFIR-Med-201-400	Demonstrate that the U-space services (U1 and U2) in nominal situations contribute to the limitation excursion into no-drone zones nearby to the VLL airspace	Urban and Sub-Urban Operating Environments and in nominal situations	For every drone operation a no drone zone was created at the level of the UTM. This way it was possible to make sure no other drone could plan an operation in the same airspace volume. The NO drone zone included a buffer keeping an operation with its conflict free portion of airspace. Planning of flight characteristics outside the limit of this allocated airspace is not possible.	Ok

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EXE2-OBJ-VLD-SAFIR-Med-301	U-space system performance assessment	EXE2-CRT-VLD-SAFIR-Med-301-100	The UTM system in nominal situations provides the information required for U-space services (U1 and U2) as it is needed and when it is needed.	Urban and Sub-Urban Operating Environments and in nominal situations	US1-01/US1-02: registration information and identification are made available through data provided by the UTM platform. US2-03: Strategic deconfliction was not part of this demonstration. US2-05/US2-08: The limited availability of mobile cellular network along the flight route affected the provision of reliable UAS localization to the UTM system during more than 50% of the flight. US2-11: surveillance data, relevant operational data on manned traffic was not part of a data stream set up between ANSP and USSP.	Partially Ok
		EXE2-CRT-VLD-SAFIR-Med-301-200	For all U-space services (U1 and U2), the UTM system performs in nominal situations as expected even when used to supervise simultaneously multiple drones (by a single or by multiple drone pilots)	Urban and Sub-Urban Operating Environments and in nominal situations	In this demonstration, only one UAS was operated due to missing flight authorizations that were not issued in time.	Ok

		EXE2-CRT-VLD-SAFIR-Med-301-300	The various systems (e.g., trackers, data recorders, aeronautical data, displays) are interoperable enough for the end users to benefit from all U-space services (U1 and U2) in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	An integrated custom GUI was used with the API to connect to the UTM system and provided an ergonomic interface to the operators.	Ok
EXE2-OBJ-VLD-SAFIR-Med-401	U-space standard and regulations	EXE2-CRT-VLD-SAFIR-Med-401-100	The impact of all U-space services (U1 and U2) on operational or technical standards (creation or changes of existing ones) is documented in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	Within this document section 3.2.1 findings on the impact with regard to operational and technical standards are elaborated.	OK
		EXE2-CRT-VLD-SAFIR-Med-401-200	The impact of all U-space services (U1 and U2) in nominal situations. on regulations (compatibility with or need for change) is documented.	Urban and Sub-Urban Operating Environments and in nominal situations	Within this document section 3.2.1 findings on the impact with regard to operational and technical standards are elaborated.	OK

EXE2-OBJ-VLD-SAFIR-Med-501	Performance assessment of U-space services	EXE2-CRT-VLD-SAFIR-Med-501-100	Demonstrate that the U-space services (U1 and U2) improve the cost effectiveness of flight preparation in reducing the associated time/effort/cost in nominal situations.	Urban and Sub-Urban Operating Environments and in nominal situations	During all phases of preparing and demonstration executions was well clear that the time effort and cost will highly depend on the level of automation. Every human interaction to the system requires training, will limit the capacity and therefore impact the cost-effectiveness of the U-space eco-system. At this moment the integration of the UAS platforms is not at the required level to enable multiple tasks to be automated. Currently the drone needs to be specifically prepared before each and every flight. This means besides the Command-and-Control operator a person needs to be physically near the drone to enable the preparation for departure.	Ok

		EXE2-CRT-VLD-SAFIR-Med-501-200	Demonstrate that the U-space services (U1 and U2) in nominal situations improve the flight efficiency, e.g., as the integration of aeronautical data and flight preparation in a same system reduces the potential margins / deviation from the most optimal trajectory that drones can fly.	Urban and Sub-Urban Operating Environments and in nominal situations	As this was not developed and thus demonstrated this shall be added to the items of deviation.	NOT Ok
		EXE2-CRT-VLD-SAFIR-Med-501-300	Demonstrate that the U-space services (U1 and U2) in nominal situations contribute to increasing the capacity in drones' airspace through enabling more simultaneous flights (e.g., through strategic deconfliction before and during flight time, through the possibility to visualise flights in real time and avoid obstacles if any)	Urban and Sub-Urban Operating Environments and in nominal situations	U space services enable the coordination of conflicting flight requests. The flight authorization service deconflicts the UAS enabling operations to take place in a both safe and secure manner.	Ok

Table 18: Exercise 2 Demonstration Results

B.7.1.1 Results per KPA

Operational feasibility:

Due to the extremely limited test program and the lack of flight permits by Helicus operational feasibility could not be evaluated.

Acceptability

This KPA is part of the exercise objectives and will be discussed in the analysis of exercise results, OBJ-VLD-SAFIR-Med-100, Operational acceptability of U-space services.

Safety

This KPA is part of the exercise objectives and will be discussed in the analysis of exercise results, OBJ-VLD-SAFIR-Med-200, U-space services safety.

Security:

N/A

Human performance:

Due to the extremely limited test program human performance could not be evaluated.

Cost-efficiency:

Due to the extremely test program and the lack of flight permits by Helicus cost-efficiency could not be evaluated.

B.7.1.2 Results impacting regulation and standardisation initiatives

Due to the limited scope of the demonstration no feasible results that would impact regulation or standardisation initiatives could be derived.

B.7.2 Analysis of Exercise Results per Demonstration objective

After the execution of the flights within MAHHL-Region, the quality of the information submitted to the UTM-System were analysed in detail within the Droniq UTM by Droniq. A special focus was planned to the position information and the changing of mobile networks during the cross-border mission phase the analysis. Due to the fact that the cross-border flights were not flown this analysis could not be made.

It shall provide a general analysis of the results, including rationale of the results, potential deviations with respect to the expected performance benefits, possible reasons and relationship between the results and the appropriate assumptions.

B.7.2.1 EXE2-OBJ-VLD-SAFIR-Med-101 Results

Several services were tested during the live demonstration. Roles and responsibilities were clearly assigned and proofed adequate to the conducted operations. At this stage of technical development evaluating the operations volume is a human intervention, which was requested at the USSP via their API, making communication more efficient in comparison to voice communication.

During the project timeline, no cross-border flight permits (as designated by AMC1 Article 13) were granted to the partners. Therefore, only one German project partner was involved in the demonstration flights, flying with their own operational authorization and skipping the planned route sections over Dutch territory. As a consequence, tactical conflict handling could not be demonstrated.

The direct electronic data connection between drone operator and the UTM enabled both parties to monitor the flight status of the UAS, as long as mobile cellular network was available. The traffic information service of the UTM system further provided an overview of the prevailing manned and unmanned air traffic situation.

B.7.2.2 EXE2-OBJ-VLD-SAFIR-Med-201 Results

The services tested within the demonstration focus on the flight authorization and observation layer. From the moment flight authorisations are submitted, until the flight has been terminated in the UTM platform, the details of the operations are available for the involved U-space actors. Additionally, as from the moment the drone activates the flight authorization the drone's position in transmitted by the tracking device and added to the available data set regarding these operations.

The available air picture, including manned and unmanned traffic increases situational awareness toward the airspace users, reducing the air risk. By obtaining a flight authorization request as described in the EU 2021/664 the drone operator ensure itself to be presented a conflict free trajectory. Continuous conformance monitoring, which in this case is comparing the actual location of the drone to the authorised operational volume enables the USSP to advise the drone operator of unintended possible excursion of the flight.

B.7.2.3 EXE2-OBJ-VLD-SAFIR-Med-301 Results

The UTM system worked as assumed during the flights, so the fXd-UAS was registered within the UTM system, the identification was visible during the flight and displayed to all involved stakeholders within the UTM display. No strategic deconfliction was made, due to the fact that there were no conflicts foreseen due to the lack of other UAS in the air while planning and during the flight. The limited cellular connection in parts of the flight time affected the localization of the UAS and the display of the UAS.

B.7.2.4 EXE2-OBJ-VLD-SAFIR-Med-401 Results

The U-Space services planned for the demonstration flight were displayed through the UTM Display to all relevant stakeholders during the flight. Traffic information about the surrounding air traffic were display within the live air traffic view in the UTM, the flight was authorized through the USSP Droniq before take-off, the identification was always shown in the system and geo-awareness was given by the fact of having all necessary geozones in the UTM system for Germany.

B.7.2.5 EXE2-OBJ-VLD-SAFIR-Med-501 Results

The cost effectiveness by using the U-space services was shown in the preparing of the flight but due to a lack of automation between different UAS could not be really shown during the flight. At this moment the integration of the UAS platforms is not at the required level to enable multiple tasks to be automated. This means besides the Command-and-Control operator a person needs to be physically near the drone to enable the preparation for departure.

B.7.3 Unexpected behaviour/Results

Due to the connectivity issues identified during the Aachen demonstration, the demonstration of the electronical position information of the UAS within the UTM was interrupted. Hence, conformance monitoring, traffic information, tracking and position reporting, network identification did partly not work as expected. The UAS was visible via FLARM during the complete flight by sensors installed at the Mobile Mission Command Station and the building of the Institute of Flight System Dynamics at RWTH Aachen but this data was not uploaded to the UTM-System, because no Ground-Based Situational Awareness Antenna connected to the UTM was set-up during the flight.

B.7.4 Confidence in Results of Demonstration Exercise #2

B.7.4.1 Limitations and Impact on the level of Significance

As explained on section B.7.3, a limitation during the Aachen flight was the poor network connectivity issues for which the UAS was not visible all the time during while performing its flight.

Due to the lack of authorizations for Helicus by the CAAs, not all the planned scenarios and flights were carried out. It has been agreed to postpone those flights to a further date and set up a due date to get all the authorization required by the CAA so that the flights can be performed.

B.7.4.2 Quality of Demonstration Exercise Results

Due to the extremely limited flight tests due to the lack of flight permits for all Helicus operated UAS the demonstration exercise's quality is not sufficient to draw major conclusions from the flight operations. The process of flight authorisation requests and the resulting conclusions and recommendations are of good quality.

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B.7.4.3 Significance of Demonstration Exercise Results

Due to the extremely limited flight tests due to the lack of flight permits for all Helicus operated UAS the demonstration exercise's significance is not sufficient to draw major conclusions from the flight operations. As the process of flight authorisation requests were performed in parallel by two partners there is significance in the findings of this process.

Appendix C Operating environment and Requirements related to Solutions and addressed services

The Operating method, what we called the Demonstration execution, is already explained as part of the section 3.3.2 of this demonstration report. This was used as the script for performing the difference exercises.

What the SAFIR-Med Consortium will be presenting in this section is the detailed operational environment referring to the U-space services used on this project as well as the maturity level that it was supposed to reach.

C.1 Operational Service and Environment Definition

This section will provide an overview of the operation environment that is applicable to the solution that this demonstration report will provide.

C.1.1 Detailed Operational Environment

Since SAFIR-Med project is a demonstration project, the aim is to reach TRL7 according to the SESAR guidelines.

C.1.1.1 Operational Characteristics

On the attached document, a detailed description of the Operational environment is described.

SAFIR-Med U-space
services Project Scena

C.1.1.2 Roles and Responsibilities

On below table, a list of the main actors involved in the use of Operational Activities can be found:

Entity	U-space actor	Responsibility
USSP	USSP representative	– Receives 'weather, static and dynamic airspace configuration, manned traffic data' and sends to Operator – Receives flight plan from Operator, verifies the flightplan and coordinates

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		with ANSP and Geozone managers – Performs strategic deconfliction – Provides flightplan approval to Operator – Receives flightplan activation request from Operator, performs final checks, approves the flight to the Operator and shares the flight status with the CISP – Creates TNDZ (temporary no drone zone) around the drone in flight – Maintains 2-way communication with Operator during the flight (network id, – Receives flight termination request from the Operator and passes it on to the CISP – Advises termination provision of U-Space services after closure of the flightplan
CISP		– Receives Manned traffic data from the ANSP and passes it on to the USSP – Provides weather, static and dynamic airspace configuration to the USSP – Facilitates flight plan coordination activities by USSP with Geozone managers – Receives flight status information from the USSP
ANSP	ANSP representative	– Provides Manned traffic data to the CISP

		– Responds to flight plan coordination requests from the USSP through the CISP
Geozone manager		– Responds to flight plan coordination requests from the USSP through the CISP
Operator	Mission leader	– Receives flight order from medical facility – Requests C2C Observer to generate flight plan and submits to USSP – Informs Crew coordinator of expected flight – Receives flight plan approval from USSP and coordinates with Crew coordinator – Receives flight readiness confirmation from Crew coordinator – Instructs C2C Observer to upload flight-plan to the drone – Requests activation of the flight plan to the USSP – Receives flight plan activation approval from the USSP and passes it on to the Crew coordinator and the C2C Observer, instructing take-off – Receives take-off confirmation from the Crew coordinator – Passes flight status (in-flight) to the USSP – Maintains two-way communication with USSP and Crew coordinator

		– Receives landing confirmation from Crew Coordinator – Passes flight status (landed) to USSP
Operator	C2C observer	– Generates flight plan and submits to USSP – Performs pre-tactical deconfliction – Receives weather, static and dynamic airspace configuration, manned traffic data from the USSP – Uploads flight plan to the UA (drone) – Receives take-off authorisation from the Mission Leader and sends take-off command to the drone
Operator	Crew coordinator	– Receives information from the Mission Leader regarding an expected flight – Receives flight plan approval information from the Mission Leader – Coordinates pre-flight checks with Remote Pilot
Operator	Remote Pilot	– Coordinates pre-flight checks with Crew coordinator – Remains stand-by to take manual control of the drone when required

Table 19. Roles and Responsibilities

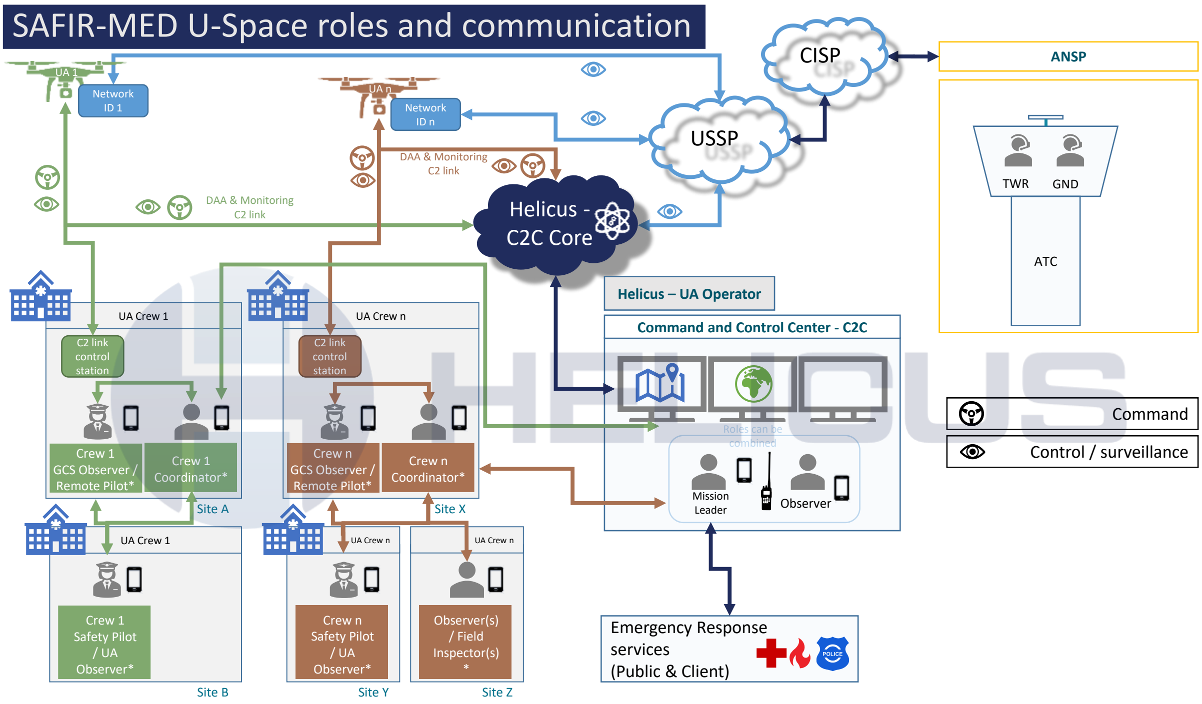

Figure 14 SAFIR-MED U-Space roles and communication

C.1.1.3 CNS/ATS/U-space description

The U-space architecture must support the vision of the U-space blueprint [1] and related principles: U-space relies on a very high level of automation, connectivity and digitalisation for both the drone and the U-space systems. To go a step further, the U-space architecture is defined as:

- **Service Oriented Architecture**: A Service Oriented Approach shall be applied to ensure that the solutions are built based on a set of services with common characteristics.
- **Modular**: the architecture shall be decomposed in self-contained but complementing elements (Functional Blocks) which contain a meaningful set of functionalities with the required inputs/outputs that can be reused or replaced. In addition, these functional blocks allow to cope with and adapt to an increasing demand in terms of new needs or services (scalability)
- **Safety Focused**: the architecture shall always consider the safety of its stakeholders or of other people and places that may be affected by U-space operations.
- **Open**: a system architecture shall be developed which is component-based and relies on published or standardized interfaces based on SWIM principles[1] to make adding, upgrading or swapping components easier during the lifetime of the system. Some other expected benefits of an open architecture are to facilitate reuse, to increase flexibility, to reduce costs and time to market, to foster competition, to improve Interoperability and to reduce risks.
- **Standard-based**: whenever there are exchanges between roles, the interfaces have to be defined and based on open standards.
- **Interoperable**: the main purpose of the interoperability is to facilitate homogeneous and non-discriminatory global and regional drone operations. This relies on the connectivity between the various U-space systems.

- **Technology agnostic**: to allow platform independent design, the architecture shall be described independently of the later implementation specifics, e.g. platforms, programming languages and specific products, which shall be consistent with the operational architecture.
- **Based on evolutionary development (incremental approach):** architecture work is an incremental and iterative process, building upon the previously consolidated baseline.
- **Automated and digitalised**: the architecture shall be developed to facilitate the delivery of safe and secure U-space services with a high degree of automation and digitalisation of the processes as manual operations will be too labour intensive.
- **Allowing variants**: the architecture work shall allow variants and alternative solutions to be described. The principles listed in this document and later in the CONOPS aim for ensuring interoperability between different implementations.
- **Deployment agnostic:** architecture work shall support the business and regulatory framework established.
- **Securely designed:** architecture work shall address security issues such as cyber-security, encryption needs and consequences, and stakeholder authentication.

As illustrated in the figure below, this leads to a set of principles that drive any implementation of a U-space architecture

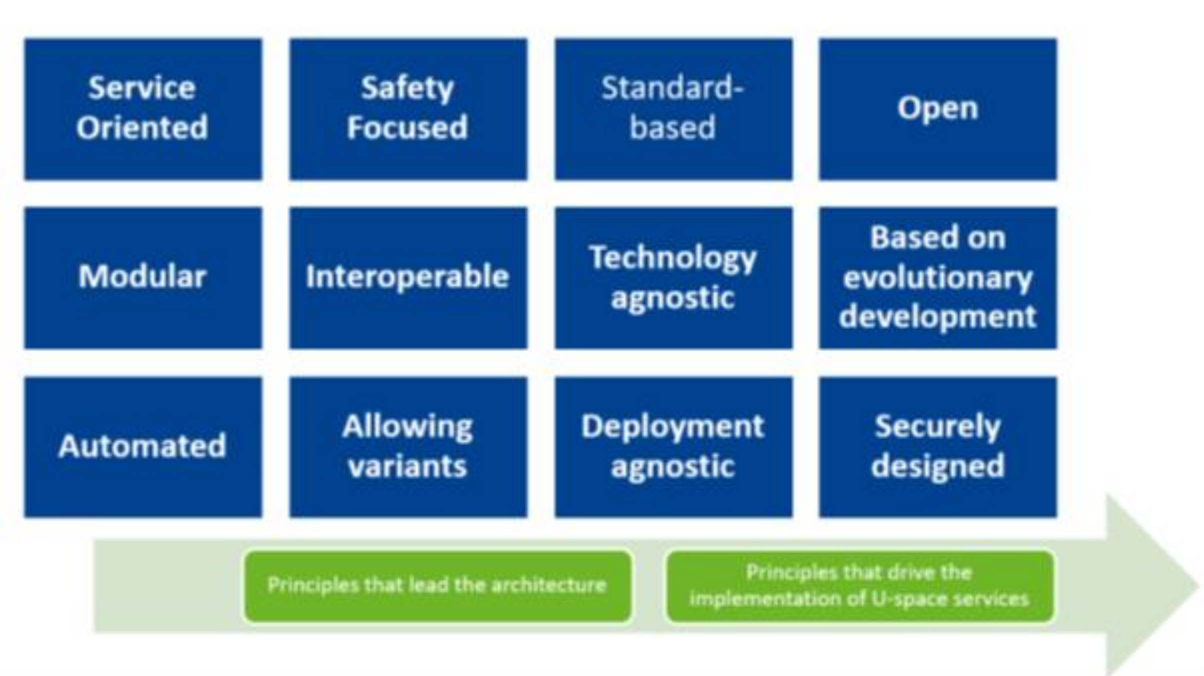

Figure 15. Principles that drive the implementation of a U-space architecture

These principles are phrased here and in the related appendix in the form of a checklist to enable a U-space architect to confirm that any proposed service meets the criteria for inclusion as a service.

1. **Safe:** The service is designed to minimise the risk to third parties on the ground, other airspace users, and passengers. It is supported by appropriate safety management systems and

processes.

2. **Reusable:** The service can be used in a multiple of operational scenarios and (where appropriate) by other U-space services.

3. **Autonomous units of business functionality:** The service provides a business function that may be independent of other services.

4. **Contract-based:** The interface and policies are strictly described by a standardised interface service contract.

5. **Loosely coupled:** The service contract is designed to be as independent of the service implementation as possible.

6. **Platform-independent:** Both the consuming and service systems can be on any platform that supports the service transport and interface requirements.

7. **Discoverable and location independent:** The service is located through a discoverable service registry/catalogue and accessed via universal resource locators, and therefore may move over time without disruption to consuming systems.

8. **Accessible:** The service is publicly accessible (with authentication or not as appropriate) for direct use. Public/semi-public interfaces (with registration or not) exist for use by third party applications. Access to the service is open to all (except in case of security breach, level of security being defined by regulation and/or standards).

9. **Interoperable with ATC:** U-space data sent to ATC complies to ATC requirements (including cyber-security and certification of the information as requested by the ATC systems) in order to minimise the impact on ATM due to the emergence of U-space.

10. **Auditable:** Recordings and real-time data are preserved and made available for investigation purposes if requested. Service performance can be monitored and audited at national/European level by authorized agencies. Authorities may make recorded data available for research, training and system development - with an appropriate anonymization / obfuscation.

11. **Liable:** The service design allows the determination of who is responsible for any service failure or incorrect-untruthful data sharing.

12. **Data validity:** The service ensures data are valid in the timeline they have to be valid. This covers the data integrity as well.

13. **Performance based:** The service-to-service providers complies with the level of performance required by the authority. The service-to-service providers offers a quality-of-service level secured by a Service Level Agreement. The service is robust, with the necessary in-build resilience from a safety and security perspective (e.g. no single point of failure and filtering to ensure subsystems only have to handle data that matters to them) and need to be affordable

to the users. The service must be delivered according to the appropriate time constraints. The latency of a service response must comply with the identified level of performance.

14. **Automated and digitalised:** The service has a high degree of automation and digitalisation in order to enable rapid response and ensure low costs. Human intervention is at a minimum: humans implement policies, monitor limits/alerts provided by automation, and intervene upon exceptions or when unsafe or unlawful operations are reported by automation.

15. **Standards-based:** The service is designed, implemented and consumed using standards that are appropriate to the nature of the service being provided.

16. **Secure:** The service is cyber-resilient and assures strong authentication of all actors.

17. **Sustainable:** The service is designed to minimise, when and where relevant, the environmental impact of unmanned aircraft operations, including noise, and to protect the privacy of citizens.

18. **Scalable:** The service is designed to scale in various dimensions, including (but not restricted to) the number of users or services, the number of concurrent flights, the number of business use cases supported, the geographical areas where U-space is deployed. The more generic set-up the better. Anything that requires tailoring to specifics of national or regional nature should be configurable (parametrized) and certainly not hard-coded.

C.1.1.4 Applicable standards and regulations

The applicable standards and regulation to this project are:

- EU 2019/947 regulation
- EU 2019/945 regulation
- EU 2021/664 regulation

C.1.2 Detailed Operating Method

C.1.2.1 Previous Operating Method

The Previous Operating Method can be found in the SAFIR-Med DEMO Plan D2.1 edition 01.00.03 under the section 4.4 Demonstration Objectives.

C.1.2.2 New SESAR Operating Method

Please refer to section 3.3.2 of this Demonstration Report..

C.1.2.3 Differences between new and previous Operating Methods

There are no big differences between the previous and the new operation method. Nevertheless, on below table you can find the differences.

Demo Plan	Demo Execution	Impacted by the SESAR Solution
Order step		
A medical facility (Medical) orders Helicus (Medical UAS operator), through the Helicus C2C order intake interface, to transport medical cargo between two medical sites.	Manual creation of order in C2C	1
Flight execution		
Flight-plan generation: The Helicus (Medical UAS operator) C2C automatically generates a flight plan, based upon pre-defined landing and take-off locations and taking into account airspace information (static and dynamic airspace configuration as well as live traffic) from the USSP as well as ground risk and weather information.	Manual creation of flight-plan in C2C	1
Flight-plan submission: The Helicus (Medical UAS operator) C2C submits a flight request to the USSP through an API, passing a priority identifier based upon the 'Time frame' and 'Priority' and using a UAS that is available at the departure location and that is capable of executing the requested mission.	Manual input of the flight plan into UTM system	1
Pre-flight checks: In parallel with b., Helicus (Medical UAS operator) executes the pre-flight check process		0
Flight-plan processing: The USSP evaluates, prioritises and deconflicts (checks for conflicts with other flightplans) the Helicus flight request from other flight requests in		1

the same airspace during the same timeframe.		
ANSP coordination: The USSP also coordinates with ANSP when required	No ANSP coordination for the MAHHL region done	1
Flight-plan approval: The USSP sends an approval for the flight to the Helicus C2C through an API.	Authorization was given in the Droniq UTM display	1
Drone transport confirmation: The Helicus C2C sends a confirmation to the medical facility that transport by drone is possible within the required time-frame. Pre-flight checks, Flight-plan processing, ANSP coordination and Flight-plan approval need to be completed and confirmed to the C2C in under a minute, since this information is key to inform the medical facility that transport by drone is possible within the required time-frame. In case transport by drone is not possible, the medical facility needs to have the time to organise alternative transport. Also, those steps are on the critical path for loading the medical cargo onto the drone.		0
Cargo handling at departure location: The hospital brings the medical cargo to the UA take-off location		0
Cargo loading: The medical cargo is loaded onto the UA		0
Flight-plan upload: Following receipt of the USSP approval and successful completion of the pre-flight checks, including loading the cargo, the Helicus C2C sends the		1

automatically generated flight plan to the UAS		
Flight-plan execution:		
Readiness confirmation: The Helicus C2C sends a flight readiness confirmation to the USSP		1
Position through Telemetry transmission: The Helicus C2C start sending UA telemetry information to the USSP to provide real-time UA position information		1
Position through Remote-ID: The on-board remote ID device sends position information to the USSP		1
Geo awareness: The USSP sends real-time geo-awareness information to the Helicus C2C		1
Live traffic information		1
Dynamic airspace configuration changes		1
Take-off clearance: The USSP sends a take-off clearance to the Helicus C2C	Flight activation was given through Droniq UTM display	1
Take-off command: The Helicus C2C sends a 'take-off' command to the UA		1
Take-off: The UA takes off and automatically executes the uploaded flightplan		1
DAA: The C2C DAA algorithm permanently evaluates the live traffic information received from the USSP and compares trajectories of other live traffic with the Helicus UAS trajectory and executes an avoidance manoeuvre when a		1

conflict is detected within the pre-defined conflict time threshold.		
Airspace evaluation: The C2C permanently evaluates dynamic airspace reconfiguration. When (new) dynamic airspace constraints are received from the USSP, the C2C evaluates whether those constraints do impact the Helicus UAS mission. This evaluation is done based on:		1
Location: Is a new dynamic geofence located on the UAS flightpath ahead or is the UAS inside such a geofenced area?		1
Priority: Does the dynamic geofence apply to this medical UAS given its priority?		1
When conflicting geofence areas are detected in pre-flight, the C2C calculates a new flight path from current location, uploads this to the UAS and executes it. During in-flight phase, the UAS will have to land and a new flight path will be generated so that it can be executed without any conflict with geozones.		1
ATC commands: When GCS API ready, during the flight, the USSP is passing ATC commands from the ANSP to the C2C through the API. Those commands could be: “Return”, “Hold” (360 or hover when possible), “Land as soon as practical”.	No ATC commands passed (?)	1
Landing: Upon arrival and landing at the pre-defined landing location at the arrival hospital, the C2C sends a flight closure message to the USSP		1

Flight closure		
Drone arrival confirmation: The C2C informs the hospital that the medical delivery is present to be collected.		0
Cargo handling at arrival location: The hospital collects the medical cargo.		0
Post flight checks: Helicus carries out post flight checks		0
Flight plan closure: The C2C closes the flight plan.		1

Summarizing it, these are the main differences impacted by the SESAR solution:

Activities that are impacted by the SESAR Solution	Current Operating Method	New Operating Method
Order step	A medical facility (Medical) orders Helicus (Medical UAS operator), through the Helicus C2C order intake interface, to transport medical cargo between two medical sites.	Manual creation of order in C2C
Flight plan generation	The Helicus (Medical UAS operator) C2C automatically generates a flight plan, based upon pre-defined landing and take-off locations and taking into account airspace information (static and dynamic airspace configuration as well as live traffic) from the USSP as well as ground risk and weather information.	Manual creation of flight-plan in C2C
Flight execution	Flight-plan submission: The Helicus (Medical UAS operator) C2C submits a flight request to the USSP through an API, passing a priority identifier based upon the 'Time frame' and 'Priority' and	Manual input of the flight plan into UTM system

	using a UAS that is available at the departure location and that is capable of executing the requested mission.	
Flight execution	ANSP coordination: The USSP also coordinates with ANSP when required	No ANSP coordination for the MAHHL region done
Flight execution	Flight-plan approval: The USSP sends an approval for the flight to the Helicus C2C through an API.	Authorization was given in the Droniq UTM display
Flight execution	Take-off clearance: The USSP sends a take-off clearance to the Helicus C2C	Flight activation was given through Droniq UTM display
ATC Commands	When GCS API ready, during the flight, the USSP is passing ATC commands from the ANSP to the C2C through the API. Those commands could be: "Return", "Hold" (360 or hover when possible), "Land as soon as practical".	No commands were passed between the USSP and the GCS during the demonstration execution

Table 20: Differences between new and previous Operating Method

C.2 Safety, Performance and Interoperability Requirements (SPR-INTEROP)

This section will be provided on the Final Report

C.2.1 Operational requirements

Human Performance Assessment

The current version of the Human Performance Assessment encompasses the results obtained in the demonstration flights performed over populated areas through questionnaire data.

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.

For the conduction of the following analysis relevant documents were used as references. Guidelines from "SESAR Human Performance Assessment Process V1 to V3- including VLDs" deliverable from the PJ19- Content Integration project for HPA were followed and "PODIUM Demonstration report for VLD - Part IV -Human Performance Assessment Report" D1.1 from PODIUM project was also taken into account.

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	activity conducted	results / evidence
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	Open	SAFIR-Med HPA questionnaire	The roles and responsibilities proposed for the demonstration activities covered all the actors that have participated.
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	Open	SAFIR-Med HPA questionnaire	The tasks corresponding to all actors involved in the demonstration have been defined prior to the demonstration activities.
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	Open	SAFIR-Med HPA questionnaire	The proposed roles and responsibilities in the demonstration activities were clear to all actors. The demonstration was scripted to the detail of every single action/interaction in a playbook. Roles were defined and presented upfront during briefing.

	nominal, non-nominal and degraded modes of operations			
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	Open	SAFIR-Med HPA questionnaire	The operating methods (procedures) were appropriate for normal operating conditions.
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	SAFIR-Med HPA questionnaire	The operating methods did not fully cover abnormal operating conditions. In one case a crane was put next to a building but was not presented in the NOTAM. Additional checks had to be performed to make sure the flight could go on. In another case high temperatures resulted in early termination of the demonstration. Other abnormal operating conditions were handled effectively.
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	Open	SAFIR-Med HPA questionnaire	The content of operating methods was in principle clear and consistent. Communication could be improved in terms of consistency, since a lot of communication is required between human actors instead of machine-to-machine.
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	Open	SAFIR-Med HPA questionnaire	In principle operating methods were followed in an accurate, efficient and timely manner but improvements can be made through further automation and more practice.
Arg. 1.3.1: The potential for human error is reduced to a tolerable level				
1.3.1-1	The potential for human error is not reduced as far as possible.	Open	SAFIR-Med HPA questionnaire	The potential for human error was not reduced as far as possible due to the lack of automation. There is room for improvement as a lot of human interference was needed during the demos resulting in increased risk of human error.
Arg. 1.3.2: Tasks can be achieved in a timely manner.				
1.3.2-1	Tasks cannot be achieved in an accurate and timely manner	Open	SAFIR-Med HPA questionnaire	Tasks were achieved as accurately and on time as possible. If more automation and less human intervention was present, tasks would most likely be performed faster and more efficiently, as participants mentioned.
Arg. 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable.				
1.3.3-1	The level of workload is unacceptable under the new working practices and	Open	SAFIR-Med HPA questionnaire	The level of workload was Acceptable.

	related tasks			
Arg. 1.3.4: The level of trust in the new concept/the new procedures is appropriate.				
1.3.4-1	The level of trust in the Uspace related systems and procedures is not appropriate	Open	SAFIR-Med HPA questionnaire	More integration between systems required. System availability is not easy to monitor. Problems with remote ID reliability were experienced
1.3.4-2	The level of trust in the data provided by UTM system is not appropriate	Open	SAFIR-Med HPA questionnaire	See Arg. 1.3.4-2. Coverage study of remote ID receivers would be necessary when fully implementing U-space.
Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.				
1.3.5-1	The level of situational awareness is unacceptable under the new working practices and tasks	Open	SAFIR-Med HPA questionnaire	The level of situational awareness was acceptable under the new working practices and tasks. Participants mentioned that exchange of live traffic information with the C2C is key as well as robust and monitored systems.
Arg. 1.3.6: Human performance satisfies the expected TA target levels.				

1.3.6-1	Safety requirements on human performance are not satisfied	Open	SAFIR-Med HPA questionnaire	Safety requirements on human performance were satisfied.
1.3.6-2	Security requirements on human performance are not satisfied	Open	SAFIR-Med HPA questionnaire	Participants agreed that more automation and software integration required. There is room for improvement of this aspect.
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	Open	SAFIR-Med HPA questionnaire	The level of workload induced by the allocation of tasks between the human and the machine was acceptable. The workload was manageable Due to the airspace not being crowded. For more crowded environments more automation and systems integrations is required.
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	Open	SAFIR-Med HPA questionnaire	No major problems were caused because of automated functions so participants show a general level of trust. However, some minor problems (eg inactive API) raise the need for further test and validations before flights.

	appropriate			
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	Open	SAFIR-Med HPA questionnaire	Participants mentioned that live traffic information was not covering all airspace users (i.e. mode-S) and that there was not any info provided by the UTM.
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	Open	SAFIR-Med HPA questionnaire	The information was delayed in some cases due to human involvement that slowed down the process.
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	Open	SAFIR-Med HPA questionnaire	There is still room for improvement. Especially switching between many screens made monitoring challenging.

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	information requirements of the human (pilots, operators, regulators etc.)			
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	Open	SAFIR-Med HPA questionnaire	Input devices (e.g. keyboard, mouse, touch screens etc.) in principle corresponded to HF principles. However, high temperature affected performance of input devices.
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	Open	SAFIR-Med HPA questionnaire	Visual displays and other type of output devices in principle adhered to HF principles. However, sunlight affected usability of screens and switching between many screens was also mentioned as a challenge.
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	Open	SAFIR-Med HPA	Alarms and alerts were lacking user friendliness and the actors did have access

	Alarms and alerts are not consistent with HF principles		questionnaire	to an immediate and intuitive overview of the entire mission.
Arg. 2.3.5: Workstations adhere to ergonomic principles				
2.3.5-1	Workstations do not adhere to ergonomic principles	Open	SAFIR-Med HPA questionnaire	There is still room for improvement as actors mentioned that the location (rooftop) and weather (high temperature) were affecting their performance
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	Open	SAFIR-Med HPA questionnaire	See Arg. 2.3.2-1, Arg. 2.3.3-1 & Arg. 2.3.4-1
Arg. 2.3.7: The user interface design reduces human error as far as possible				
2.3.7-1	BENEFIT: The user interface	Open	SAFIR-Med HPA	The user interface lacks design features that will help reduce human errors.

	design reduces human errors as far as possible		questionnaire	
Arg. 3.1.1: Changes to existing roles in the team are identified (including roles that become obsolete).				
3.1.1-1	Changes to existing roles in the team are not identified	Open	SAFIR-Med HPA questionnaire	Actor mentioned that there is room for improvement, especially when changes take place in a short notice.
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	Open	SAFIR-Med HPA questionnaire	Last minute changes made it difficult to follow the trained scenarios for some actors. Changes coordinated in advance did not have a negative impact on participants.
3.2.1-2	The division of responsibilities between all actors involved is not clear and/ or acceptable	Open	SAFIR-Med HPA questionnaire	The division of responsibilities between all actors involved was clear in general, but there is room for improvement when changes in task allocation is required.

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	Open	SAFIR-Med HPA questionnaire	Actors mentioned that audio communication would be a good idea for support. All communication should be at system level and clearly presented to the actors
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	Open	SAFIR-Med HPA questionnaire	See Arg. 1.3.1-1
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	Open	SAFIR-Med HPA questionnaire	Intra-team and inter-team communication supported the information requirements of team members through a dual layered audio team communication set-up (one inter and one intra-team layer).

	requirements of team members (drone pilotssupervisors/ drone-pilots and operators, drone-pilots/ ANPS and drone operators/regulators)			
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	Open	SAFIR-Med HPA questionnaire	Not all actors where sufficiently trained in standard RTF phraseology. More training and practice required. With automation that requirement could be reduced.
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	Open	SAFIR-Med HPA questionnaire	No changes during flights

	not acceptable			
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 acceptable to all affected human actors	Open	SAFIR-Med HPA questionnaire	Changes in roles and responsibilities were 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	Open	SAFIR-Med HPA questionnaire	There were locally defined.
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	Open	SAFIR-Med HPA questionnaire	Different training for each actor based on their past experience and skills

Recommendations

From the above remarks the following recommendations surface:

1. Until sufficient experience is gained it would be useful to clarify the roles and responsibilities of involved actors during each mission briefing.
2. Human intervention should be minimized in order to reduce human error. More automation will not only reduce human errors but also speed up the processes.
3. Participants should receive a standard phraseology training before flights.
4. Emphasis on user friendliness with the introduction of design features for better usability of interfaces.
5. Visualisation of UTM data is necessary for the pilot and GCS operator for long BVLOS flights.
6. System integration is important for future flights.

C.2.2 Safety –related requirements

A thorough risk assessment was conducted for the flight demonstration. Helicus was responsible for the flight permits in DronePort, Antwerp and Aachen, while flyXdrive carried out a separate risk assessment for the flights with the TWneo and the AEDdrone of the TUD in Aachen. The separate risk assessment for parts of the missions in Aachen is due to the fact that flyXdrive, as a manufacturer based in Germany, was able to submit the application directly to the German Civil Aviation Authority (Luftfahrtbundesamt) and thus receive feedback from them more quickly. This in turn accelerated the approval process.

The risk assessment is based on EU2019/947. The focus of this risk assessment is to minimise personal injury on the ground and among other airspace users. For this purpose, the risks arising on the ground and in the air are first classified. Basic measures to reduce the respective risk, such as developed emergency plans and measures to reduce impact energy, are identified and taken into account. In the next step, the necessary measures in software and hardware are derived from the overall risk and it is checked whether these are fulfilled by the respective aircraft or process.

All measures and assessments by the respective responsible persons are submitted to and reviewed by the supervisory authorities so that any weaknesses can be identified and the necessary improvements can be made.

As local conditions can only be checked by local authorities, flight permits can only be issued by local authorities. This ensures that all local details are taken into account. Every operator must first go through the process in its home country (Belgium for Helicus and Germany for the flyXdrive) and then transfer the flight permit to other countries. The second step of transferring a flight permit is designed in a way that not the whole permit needs to rechecked but the local authority only checks if the assumptions made for the original flight permit are also valid for the local situation. This process is regulated in article 13 of the EU2019/947.

As the flight permit process was a very challenging process as the regulations and risk assessment are quite new and only valid since the 1st of January 2021, with some local implementations only being established in late 2021. Therefore, the project partners were responsible for one of the first requests of this kind in Belgium, Germany and the Netherlands. Resulting it proofed challenging to perform the risk assessment in way that the authorities accept.

There have been several different risk assessments for different geographic locations. The table below gives a short overview of the flight permits requested. Most of those were custom risk assessments specially created for the UAS involved (in the table marked with SORA), but for some flight permits Helicus used a predefined risk assessment (PDRA) as published by the EASA. Predefined risk assessments have been created by the EASA, to give operators the possibility to reduce the work load for the risk assessment as he may use the predefined assessment and must only prove that the assumptions made in the assessment are valid.

Partner	Permission Type	Article 13	Country	Relevant AC	Status
Helicus	PDRA-S01	No	BE	FlyXdrive TWneo HyFly 25 and 25D, SABCA X8 TU Delft AEDdrone	Approved
Helicus	SORA BVLOS Populated	No	BE	SABCA X8	Approved
Helicus	SORA BVLOS Populated	No	BE	flyXdrive	Declined
Helicus	SORA BVLOS Populated	No	BE	HyFly	Declined
Helicus	SORA BVLOS controlled ground	No	BE	TUDelft	Submitted
FlyXdrive	SORA BVLOS Sparsely Populated	No	DE	FlyXdrive TWneo TU Delft AEDdrone	Approved
Helicus	PDRA-S01	Yes	DE & NL	FlyXdrive TWneo HyFly 25 and 25D, SABCA X8 TU Delft AEDdrone	Submitted
Helicus	SORA BVLOS Populated	Yes	DE & NL	SABCA X8	Submitted
FlyXdrive	SORA BVLOS Sparsely Populated	Yes	NL	FlyXdrive TWneo	Submitted

C.2.3 Security –related requirements

As explained on the Demonstration Plan of this project, security was not conducted in this project. Hence, this section does not apply.

C.2.4 Performance –related requirements

This section will be provided on the Final Report

C.2.5 Standard and Regulation –related requirements

This section will be provided on the Final Report

C.3 Cost and Benefit Mechanisms

C.3.1 Stakeholders identification and Expectations

As part of SAFIR-MED, functional requirements have been collected from 3 types of stakeholders on the user side of the U-Space services:

- The medical community that is in demand for medical transportation flights by UAS
- Helicus as operator of medical UAS transportation flights
- The city of Aachen with its inputs from MAHHL cities and the UIC2 (UAM Initiative Cities Community) and the city of Antwerp as representative of local authorities

The functional requirements from the medical community and from Helicus are there to ensure that the medical use case can be organised in a way that makes it valuable for the end-customer, the medical care community.

The Medical stakeholders, hospitals and other medical organisations, are the U-space end-customers. Their need for urgent and on-demand medical transport by UA is translated into the performance expectations that the Medical UAS operator has of U-space services.

The Medical UAS operator is the direct U-Space customer and needs to be able to respond quickly and efficiently to an urgent on-demand medical transport request. Operating in densely populated urban environments, where the Medical stakeholders are mostly located, increases both air and ground risk. The Medical UAS operator expects of the U-space services offered that they help mitigate risk and increase safety to an acceptable level.

Local authorities are close to their citizens and are playing a key role to capture and mitigate the concerns within local communities. Their functional requirements are key to ensure continued public acceptance.

ID	Stakeholder	Involvement	Why it matters to stakeholder	Performance expectations	Addressed within SAFIR - MED
R001	Medical	U-space end-customer	End beneficiary	Operational feasibility: Time: U-space processing and approval times need to allow medical UAS to depart within one minute from request time	Yes (depending on CAA conditions)
R002	Medical	U-space end-customer	End beneficiary	Operational Feasibility: Airspace: Free routing is required to allow fast delivery at non-predefined locations	Yes (see conops)
R003	Medical	U-space end-customer	End beneficiary	Operational Feasibility: Priority: Medical transport drones need to get priority as much as possible over certain other air traffic, both manned and unmanned	Yes (in case SERA Art 4 is applicable)

ID	Stakeholder	Involvement	Why it matters to stakeholder	Performance expectations	Addressed within SAFIR - MED
				to allow timely delivery of urgent medical material	
R004	Medical	U-space end-customer	End beneficiary	Operational Feasibility: Reliable: The U-space service needs to be always-up so that medical transport can be performed at any time of the day or night, every day of the week. In cased of downtime, alternate procedures need to be available.	No
R005	Medical	U-space end-customer	End beneficiary	Acceptability: Cost effective: U-space services should not cause a financial burden	No
R006	Medical UAS operator	U-space customer	Beneficiary	Operational Feasibility: Integrated: UTM systems need to be integrated with UAS operator systems	Yes
R007	Medical UAS operator	U-space customer	Beneficiary	Operational Feasibility: Automated: Approval of flight requests need to come automatically	No
R008	Medical UAS operator	U-space customer	Beneficiary	Operational Feasibility: Time: Approval of flight requests need to come in a sub-minute timeframe	No
R009	Medical UAS operator	U-space customer	Beneficiary	Operational Feasibility: Reliable: U-space services need to be reliable and always available and supported	No
R010	Medical UAS operator	U-space customer	Beneficiary	Operational Feasibility: Available: U-space services need to be available in all locations where medical facilities are located and	No

ID	Stakeholder	Involvement	Why it matters to stakeholder	Performance expectations	Addressed within SAFIR - MED
				everywhere in between them	
R011	Medical UAS operator	U-space customer	Beneficiary	Acceptability: Cost effective: U-space services need to be cost effective in order to not cause any competitive disadvantage versus other transportation modes	No
R012	Medical UAS operator	U-space customer	Beneficiary	Operational Feasibility: Priority: Medical UAS transport needs to be prioritised over other transport by drone as well as over some manned aviation	Yes
R013	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Operational Feasibility: Reliable: MAHHL is a cross-border region. Therefore U-space services need to be able to work seamlessly and uninterrupted cross-country borders	Yes
R014	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Operational Feasibility: Available: To allow UAS services to be deployed effectively to remote areas, U-space services need to be available in remote areas as well as in the urban environment	No
R015	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Operational Feasibility: Time: U-space processing and approval times need to be completed in under a minute	No
R016	Local and Regional Authorities	Local Authority	Impacted by U-Space,	Operational Feasibility: Airspace: Free routing is required to allow fast	Yes

ID	Stakeholder	Involvement	Why it matters to stakeholder	Performance expectations	Addressed within SAFIR - MED
			contributor to U-Space	delivery at non-predefined locations	
R017	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Operational Feasibility: Priority: An AED drone needs to get priority over other air traffic	Yes
R018	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Operational Feasibility: Integrated: Local authorities must have the possibility to provide input into the UTM environments	Yes
R019	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Operational Feasibility: Time: Input by local authorities must be in real-time to allow immediate response for example in the case of airspace that needs to be closed around an accident or incident location	Yes
R020	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Acceptability: Integrated: Local authorities must have visibility on UAS operations taking place above their territory	Yes
R021	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Security: U-space services need to be secure	No
R022	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Acceptability: Integrated: Local authorities need to have the possibility to indicate areas that are noise sensitive and therefore should be overflown at a higher altitude, less frequently, not at night	No
R023	Local and Regional Authorities	Local Authority	Impacted by U-Space,	Operational feasibility: Exceptions for medical drones need to be	Yes

ID	Stakeholder	Involvement	Why it matters to stakeholder	Performance expectations	Addressed within SAFIR - MED
			contributor to U-Space	possible to allow them to fly through local U-space restricted or prohibited zones	
R024	Local and Regional Authorities	Local Authority	Impacted by U-Space, contributor to U-Space	Acceptability: Local authorities need to be able to limit the number of UAS flying over certain areas per day. Even for medical drones there need to be rules in place	No

Table 21: Stakeholder's expectations

C.3.2 Benefits mechanisms

As top 5 societal benefits, the EASA study on the societal acceptance of Urban Air Mobility operations indicates[1]:

- **Improved emergency response time**
- Reduction of traffic jams
- Reduction of local emissions
- **Development of remote areas**
- Creation of new jobs

Only the topics in **bold and underlined** are applicable for this user requirements document and will be covered.

For the city of Aachen, the following benefits are clearly in scope:

- Faster
- Cleaner
- Extended connectivity

Regional collaboration:
Extended connectivity means that collaborations can become possible between hospitals that could not collaborate before, due to the distance between them. Given medical urgency, the radius for viable collaboration between medical actors is quite small. See also the functional requirements from the medical community.

[1] Slide 9 of https://www.easa.europa.eu/sites/default/files/dfu/uam_press_briefing-slides.pdf

In the context of the MAHHL region (Maastricht, Aachen, Hasselt, Heerlen, Liège), collaboration between hospitals inside this large region could become possible when the time to travel and transport between medical facilities could be reduced through urban air mobility.
Requirement: MAHHL is a cross-border region. Therefore U-space services need to be able to work seamlessly and uninterrupted cross-country borders.

Development of remote areas is important:
Around Aachen there are areas where hospitals are present but not always the very specialized staff nor a broad variety in medical supplies.
Urban air mobility could bring supplies and doctors to remote medical facilities so that patients that cannot be transported can be helped better. With that, medical care can be improved for people that are living further away from specialised hospitals.
Requirement: To allow UAS services to be deployed effectively to remote areas, U-space services need to be available in remote areas as well as in the urban environment.

AED availability:
In case of a cardiac arrest, reanimation needs to start as soon as possible with survivability rates diminishing with 10% per minute[2]. A defibrillator (AED) can be very effective when available on time.
Since defibrillators cannot be brought to patients in need on-time and since there are not sufficient numbers of AED available at the location where they are needed, Aachen has even set-up a network of medical aid workers to mitigate that problem through the initiative Aachen Rettet[3].
A defibrillator, carried to the patient by drone could increase the survivability of cardiac arrest outside of the hospital.
To make this way of transporting an AED a viable solution, the AED needs to be brought to non-predefined destinations within minutes.

Requirement:
- Time: U-space processing and approval times need to be completed in under a minute
- Airspace: Free routing is required to allow fast delivery at non-predefined locations
- Priority: An AED drone needs to get sufficient priority over other air traffic both manned as well as unmanned to allow timely delivery of urgent medical cargo

[2] https://www.nap.edu/catalog/21723/strategies-to-improve-cardiac-arrest-survival-a-time-to-act

[3] https://regionaachen.de/gesundheit/digitalisierung/region-aachen-rettet/

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Appendix D Communication and Dissemination activities record

D.1 Communication & dissemination of the event and fights in Droneport, St Truiden

Media / Title	Link
SAFIR–Med website News Section	https://www.safir-med.eu/safir-med-operational-events
SAFIR–Med website 2nd press release	https://www.safir-med.eu/2nd-press-release?utm_campaign=f0c78fe3-3370-4d30-8b43-389a756b3cfe&utm_source=so&utm_medium=mail_lp
SAFIR–Med website 5th Newsletter	https://www.safir-med.eu/newsletter-5
Social Media_LinkedIn	2/21/22 - https://www.linkedin.com/feed/update/urn:li:activity:6901488371127189504 3/5/22 - https://www.linkedin.com/feed/update/urn:li:activity:6905751286256672769 3/9/22- https://www.linkedin.com/feed/update/urn:li:activity:6907206300703571968 3/16/22 - https://www.linkedin.com/feed/update/urn:li:activity:6909828039061168129 3/17/22 - https://www.linkedin.com/feed/update/urn:li:activity:6910203602561032192 3/22/22 - https://www.linkedin.com/feed/update/urn:li:activity:6911928875753029632 4/7/22 - https://www.linkedin.com/feed/update/urn:li:activity:6917776545562398720 4/7/22 - https://www.linkedin.com/feed/update/urn:li:activity:6917781560054157312

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	4/7/22 - https://www.linkedin.com/feed/update/urn:li:activity:6917826561962323969 4/7/22 - https://www.linkedin.com/feed/update/urn:li:activity:6917928374908633089 4/8/22 - https://www.linkedin.com/feed/update/urn:li:activity:6918073829214801920 4/8/22 - https://www.linkedin.com/feed/update/urn:li:activity:6918075979986788352 4/8/22 - https://www.linkedin.com/feed/update/urn:li:activity:6918081041135988736 4/8/22 - https://www.linkedin.com/feed/update/urn:li:activity:6918081754952007680 4/8/22 - https://www.linkedin.com/feed/update/urn:li:activity:6918095008172511232 4/11/22- https://www.linkedin.com/feed/update/urn:li:activity:6919167261681278976 4/1//22- https://www.linkedin.com/feed/update/urn:li:activity:6919203190567510017 4/1//22 - https://www.linkedin.com/feed/update/urn:li:activity:6919237435759439872 4/11/22 - https://www.linkedin.com/feed/update/urn:li:activity:6919237825863262208 4/13/22 - https://www.linkedin.com/feed/update/urn:li:activity:6919895964510019584 4/15/22- https://www.linkedin.com/feed/update/urn:li:activity:6920619145554202624 4/24/22 - https://www.linkedin.com/feed/update/urn:li:activity:6924037561455628289 4/25/22- https://www.linkedin.com/feed/update/urn:li:activity:6924249808333324288 4/26/22 - https://www.linkedin.com/feed/update/urn:li:activity:6924579542535688192 4/28/22 - https://www.linkedin.com/feed/update/urn:li:activity:6925330340458692608

	4/29/22 - https://www.linkedin.com/feed/update/urn:li:activity:6925669561002274816 4/29/22 - https://www.linkedin.com/feed/update/urn:li:activity:6925743978969473024 5/2/22 - https://www.linkedin.com/feed/update/urn:li:activity:6926788121669820416 5/2/22 - https://www.linkedin.com/feed/update/urn:li:activity:6926834402043797505 5/4/22 - https://www.linkedin.com/feed/update/urn:li:activity:6927506168185503744 5/5/22 - https://www.linkedin.com/feed/update/urn:li:activity:6927851009704607744 5/9/22 - https://www.linkedin.com/feed/update/urn:li:activity:6929308698494255104 5/11/22 - https://www.linkedin.com/feed/update/urn:li:activity:6930049609821995008 5/13/22 - https://www.linkedin.com/feed/update/urn:li:activity:6930744714677628928 5/13/22 - https://www.linkedin.com/feed/update/urn:li:activity:6930774292334800897 5/16/22 - https://www.linkedin.com/feed/update/urn:li:activity:6931837845498146816 5/18/22 - https://www.linkedin.com/feed/update/urn:li:activity:6932564050207760384 5/19/22 - https://www.linkedin.com/feed/update/urn:li:activity:6932928370879967232 5/20/22 - https://www.linkedin.com/feed/update/urn:li:activity:6933287463566102528 5/20/22 - https://www.linkedin.com/feed/update/urn:li:activity:6933287489444962304 5/23/22 - https://www.linkedin.com/feed/update/urn:li:activity:6934375568645742592 5/25/22 - https://www.linkedin.com/feed/update/urn:li:activity:6935109805447507968

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Youtube / SAFIR-Med Conference, April 2022	https://youtube.com/playlist?list=PLYu5bEoI_wgGx22nJyGatQYnhkR8_Yd8K

Table 20: Dissemination of event & flights in Droneport, St. Truiden

D.2 Communication & dissemination of the event and flights in Antwerp

Media / Title	Link / date
SAFIR–Med website News Section	https://www.safir-med.eu/1st-bvlos-flight-authorisation-over-populated-area **22/06/22**
SAFRI-Med 3rd Press release, May 2022	"The SAFIR-Med Executive Conference presents a series of medical flight trials in the complex Antwerp airspace"
SAFIR-Med 1st Press release, Febr. 2021	"Europe launches large-scale demonstrations for medical drones"
SAFIR–Med website 6th Newsletter	https://www.safir-med.eu/newsletter-6

SAFIR-Med 7th Newsletter	https://www.safir-med.eu/newsletter-7
SAFIR-Med website News section	https://www.safir-med.eu/safir-med-demonstration-flights-in-antwerp
Social Media_LinkedIn	27/10/21 - https://www.linkedin.com/feed/update/urn:li:activity:6859051791468789760 1/14/22 - https://www.linkedin.com/feed/update/urn:li:activity:6887696940981608448 1/28/22 - https://www.linkedin.com/feed/update/urn:li:activity:6892731084074008576 3/10/22 - https://www.linkedin.com/feed/update/urn:li:activity:6907580481404051456 5/18/22 - https://www.linkedin.com/feed/update/urn:li:activity:6932564063096872960 5/25/22 - https://www.linkedin.com/feed/update/urn:li:activity:6935114658479546368 5/28/22 - https://www.linkedin.com/feed/update/urn:li:activity:6936240455697223680 5/31/22 - https://www.linkedin.com/feed/update/urn:li:activity:6937284358651174913 6/1/22 - https://www.linkedin.com/feed/update/urn:li:activity:6937657687996297218 6/1/22 - https://www.linkedin.com/feed/update/urn:li:activity:6937722678921338880 6/3/22 - https://www.linkedin.com/feed/update/urn:li:activity:6938449806998560768 6/6/22- https://www.linkedin.com/feed/update/urn:li:activity:6939452462596558848 6/6/22 - https://www.linkedin.com/feed/update/urn:li:activity:6939455952454610944 6/6/22 - https://www.linkedin.com/feed/update/urn:li:activity:6939456165210677248

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6/20/22 - https://www.linkedin.com/feed/update/urn:li:activity:6944503156307324928

6/23/22 - https://www.linkedin.com/feed/update/urn:li:activity:6945622000992190464

6/24/22 - https://www.linkedin.com/feed/update/urn:li:activity:6946038253380640768

6/27/22 - https://www.linkedin.com/feed/update/urn:li:activity:6947123078434836481

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7/21/22 - https://www.linkedin.com/feed/update/urn:li:activity:6955748950314287105

7/21/22 - https://www.linkedin.com/feed/update/urn:li:activity:6955787071550607361

7/22/22 - https://www.linkedin.com/feed/update/urn:li:activity:6956102797683494913

7/22/22 - https://www.linkedin.com/feed/update/urn:li:activity:6956181382196854784

7/28/22 - https://www.linkedin.com/feed/update/urn:li:activity:6958343351905497088

8/16/22 - https://www.linkedin.com/feed/update/urn:li:activity:6965203398602207232

8/24/22 - https://www.linkedin.com/feed/update/urn:li:activity:6968078719651393536

	8/31/22 - https://www.linkedin.com/feed/update/urn:li:activity:6970685441201070080 9/1/22 - https://www.linkedin.com/feed/update/urn:li:activity:6970964345681829888 9/5/22 - https://www.linkedin.com/feed/update/urn:li:activity:6972418789107724288 9/5/22 - https://www.linkedin.com/feed/update/urn:li:activity:6972446768802226176 9/5/22 - https://www.linkedin.com/feed/update/urn:li:activity:6972514629344215042 9/6/22 - https://www.linkedin.com/feed/update/urn:li:activity:6972871773952307200 9/7/22 - https://www.linkedin.com/feed/update/urn:li:activity:6973150613178068992
Youtube / SAFIR-Med Conference, Antwerp, June 2022	https://youtube.com/playlist?list=PLYu5bEoI_wgHdSGkNiw0HRgNoryhzJ5_a
YouTube video / The first European BVLOS flight over city was realised by the SAFIR-Med project	https://youtu.be/nqd1WSK3H4E

Table 21: Dissemination of event & flights in Antwerp

D.3 Communication & dissemination of the event and flights in the MAHHL region

Media / Title	Link / date
SAFIR–Med website News Section	SAFIR-Med Technical Meeting and Demo Event on September 1st, in Aachen

SAFIR–Med website 6th Newsletter	https://www.safir-med.eu/newsletter-6
Social Media_LinkedIn	27/10/21 - https://www.linkedin.com/feed/update/urn:li:activity:6859051791468789760 12/01/21 https://www.linkedin.com/feed/update/urn:li:activity:6871750468201140224 12/03/21 - https://www.linkedin.com/feed/update/urn:li:activity:6872475244930576384 1/14/22 - https://www.linkedin.com/feed/update/urn:li:activity:6887696940981608448 2/15/22 - https://www.linkedin.com/feed/update/urn:li:activity:6899309454421295104 3/10/22 - https://www.linkedin.com/feed/update/urn:li:activity:6907580481404051456 4/14/22 - https://www.linkedin.com/feed/update/urn:li:activity:6920240458430357505 5/30/22 - https://www.linkedin.com/feed/update/urn:li:activity:6936929891141513216 5/31/22 - https://www.linkedin.com/feed/update/urn:li:activity:6937284358651174913 6/22/22 - https://www.linkedin.com/feed/update/urn:li:activity:6945252792726921216 6/28/22 - https://www.linkedin.com/feed/update/urn:li:activity:6947429136856449024 7/12/22 - https://www.linkedin.com/feed/update/urn:li:activity:6952502567780151296 7/13/22- https://www.linkedin.com/feed/update/urn:li:activity:6952864952713912320 7/20/22 - https://www.linkedin.com/feed/update/urn:li:activity:6955401721003061249 7/28/22 https://www.linkedin.com/feed/update/urn:li:activity:6958422219215515648

8/1/22- https://www.linkedin.com/feed/update/urn:li:activity:6959750316435095552

8/4/22 - https://www.linkedin.com/feed/update/urn:li:activity:6960837479365029888

8/14/22 - https://www.linkedin.com/feed/update/urn:li:activity:6964662181980176384

8/17/22 - https://www.linkedin.com/feed/update/urn:li:activity:6965530741514350593

8/30/22- https://www.linkedin.com/feed/update/urn:li:activity:6970235179499945984

8/30/22 - https://www.linkedin.com/feed/update/urn:li:activity:6970355095972528129

9/2/22 - https://www.linkedin.com/feed/update/urn:li:activity:6971329138808774656

9/2/22 - https://www.linkedin.com/feed/update/urn:li:activity:6971329177836744704

9/2/22 - https://www.linkedin.com/feed/update/urn:li:activity:6971329274557419521

9/5/22 - https://www.linkedin.com/feed/update/urn:li:activity:6972446768802226176

9/9/22 - https://www.linkedin.com/feed/update/urn:li:activity:6973893290328776704

9/12/22 - https://www.linkedin.com/feed/update/urn:li:activity:6974951812831297536

9/13/22- https://www.linkedin.com/feed/update/urn:li:activity:6975317906276397056

9/14/22 - https://www.linkedin.com/feed/update/urn:li:activity:6975673699920146432

9/14/22 - https://www.linkedin.com/feed/update/urn:li:activity:6975696854785097728

9/15/22 - https://www.linkedin.com/feed/update/urn:li:activity:6976035878951350272

9/16/22 - https://www.linkedin.com/feed/update/urn:li:activity:6976397802088095745

	10/17/22 - https://www.linkedin.com/feed/update/urn:li:activity:6987634364893261824

Table 22: Dissemination of event & flights in MAHHL region

D.4 Communication & dissemination of the simulations for Prague and Athens

Media / Title	Link / date
Social Media_LinkedIn	11/16/21 - https://www.linkedin.com/feed/update/urn:li:activity:6862347450401730560

Table 23: Dissemination of the simulations

D.5 Other Communication Activities

a. #SafirMedDemo campaign (ongoing)

Various Linkedin & Twitter posts (same as above)

https://www.linkedin.com/feed/hashtag/?keywords=safirmeddemos

https://twitter.com/hashtag/SAFIRMedDemos?src=hashtag_click

Insert beneficiary's logos below, if required and remove this sentence

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