Autonomy-as-a-Service
UNMANNED LIFE

AUTONOMOUS SEARCH AND RESCUE

Case Study

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Magenta

City of Vienna

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CONTEXT

Unmanned Life's automatic search and rescue solution aims at minimizing the heavy reliance on manned helicopters as well as professional divers in the field of search and rescue. The platform which is described in detail below will reduce the associated costs as well as the time required in emergency response.

Unmanned Life's core product, a breakthrough, 5G enabled, AI for Autonomy software platform, deploys and manages automatic, connected, intelligent mixed multi-robot teams for Smart Cities and Industry 4.0 use cases. These Autonomy-as-a-Service teams are composed of different types of robots with different capabilities and tools, working together collaboratively as a swarm on complex missions. Unmanned Life's software platform is network agnostic allowing it to switch between different networks such as 5G, 4G LTE and Wi-Fi based on the environmental conditions. This software platform that can be deployed on the cloud as well as the edge uses its AI processing modules to deploy mission-critical services and provide insights via a single management interface. In the context of this project, Unmanned Life will deploy a swarm of drones that will assist first responders in saving the lives of drowning people. The drones will possess different capabilities such as live-video streaming of an area where a person is suspected to be drowning as well providing relief by delivering a life jacket to the drowning person.

Unmanned Life's vision is that public safety and emergency responses, like many other processes, will be automatic and fully integrated from detection of an emergency to the provisioning of rescue services. Unmanned Life's Autonomy-as-a-service platform aims to be the heart of these systems by integrating and managing end to end automatic processes.

The key advantages of the platform for the emergency response sector include:

- **Mission-specific swarm solutions**
- **One management interface**
- **Network Agnostic and Environment-Tolerant**
- **Hardware-agnostic**
- **Hybrid Multi-Cloud Interoperable AI Platform**

THE PROBLEM

At present, drowning is the 3rd leading cause of unintentional injury death worldwide, accounting for 7% of all injury-related deaths. While estimates of people dying from drowning vary from 320,000 to 1.2 million annually, it is a certainty that drowning is a global burden that affects all economies and regions. To tackle this issue, currently, first responders use a combination of manned helicopter flights as well as a team of trained divers.

Although Austria has one of the best air rescue systems with 23,000 operations annually, the costs of deploying a manned helicopter can easily reach several thousand euros. According to the Vienna Fire Department, on average they receive approximately 180 distress calls annually of people drowning in the Danube. Since the fire department is required to respond to each distress call, they end up spending significant man-hours and financial resources while deploying helicopters. In an age where first response agencies globally are facing budget cuts, reducing costs while ensuring the fire department's ability to deliver effective operational performance is a key need.

City of Vienna

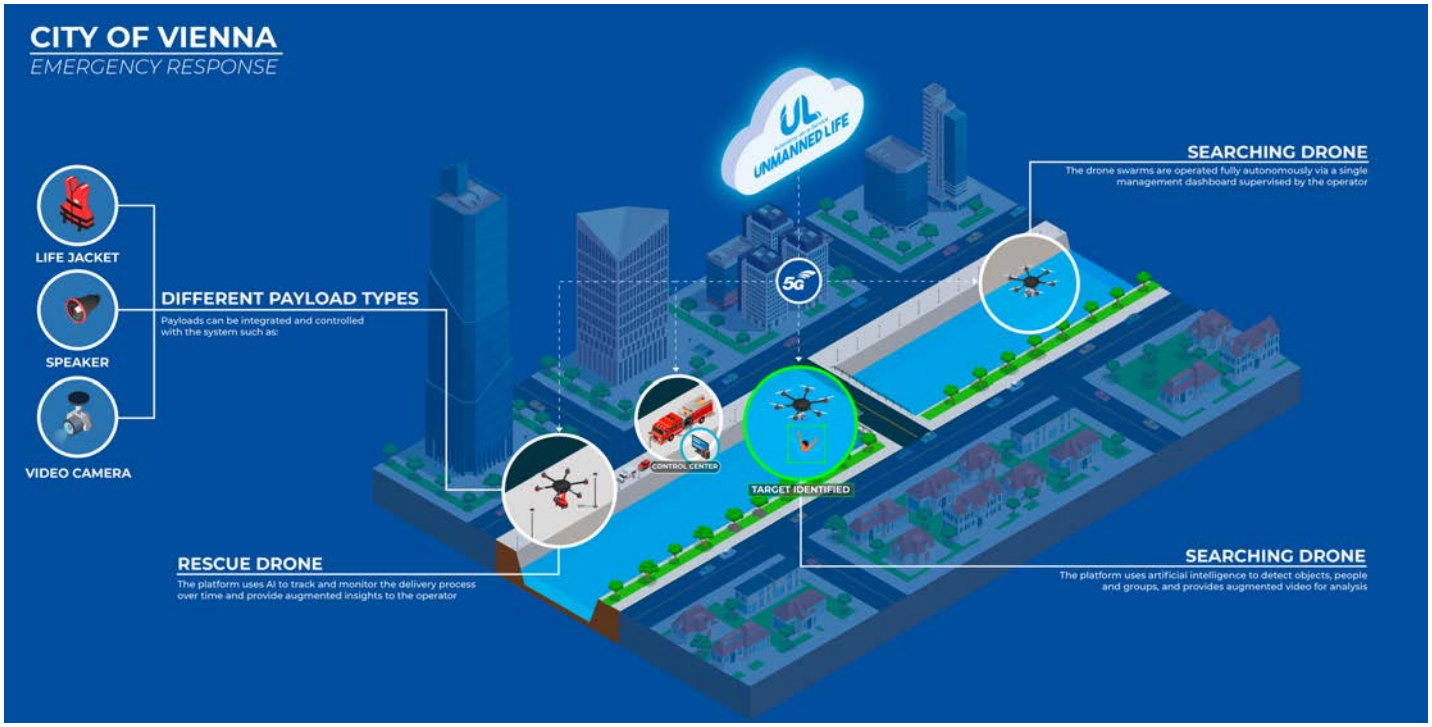
SOLUTION OVERVIEW

To solve this key pain point, Unmanned Life collaborated with Magenta Telekom, Stadt Wien and Austrocontrol to deploy its autonomous search and rescue product which consisted of a fleet of three autonomous drones equipped with multiple sensors and payloads. These autonomous drones were controlled and managed by Unmanned Life's software platform hosted on an edge infrastructure that enabled their seamless orchestration. In addition, the Vienna Fire Department was provided with a management dashboard that enabled them to configure and deploy the drones and view critical mission insights.

As our software platform can orchestrate drone fleets over different types of networks like WIFI, 4G and 5G, within this deployment we collaborated with Magenta Telekom whose commercial 5G network was used to control the autonomous drone fleet.

Within the deployment, two autonomous drones capable of streaming HD video in real-time provided the Vienna Fire Department with critical on-the-ground insights by scanning the Danube. Potential individuals in distress were identified by our AI algorithms running in the backend and this information was relayed to the fire department through our management interface. Once confirmed by the end-user, the third drone autonomously took off and delivered a life jacket to the location of the identified individual.

By managing the end-to-end process from identification to providing an effective response, our product ensured that the Vienna Fire Department did not need to rely on mobilizing manned helicopters and a team of experienced divers to save the lives of drowning individuals.



OBJECTIVES

The objectives of the project were:

Automatic mixed drone swarm as an emergency response tool:

- Search drones
- Rescue drone:
  - Floatation device

Integration of the Magenta Telekom 5G network and Unmanned Life Autonomy-as-a-Service platform for drone control, sensor data and video streaming.

Video streaming from the drone.

Web interface for monitoring.

AI-assisted person detection system

Parcel transport and drop from the drone

ACTIONS

The actions of the project were:

Install drones with all the required sensors to enable them for automatic control

Install and configure drones with UL-ACE software

Install drones with the required payloads:

- Streaming camera
- Gripper
- Speaker

Construction of a system integration box for deployment from a fire fighting vehicle

Develop the software front-end for the operator interface for search and rescue

Develop the operator interface for search and rescue

Integration with Magenta Telekom 5G network

Develop the algorithms for the video analysis

OUTCOME

The outcomes of the project were:

Successful pilot demonstrating 5G enabled automatic drone to search and rescue solution assisting firefighters to find and support missing people in the water using real-time video streaming and AI on the edge, delivery of life jacket.

Marketing video of the pilot

https://www.youtube.com/watch?v=28x77X4CSIs

ROLES AND RESPONSIBILITIES

There were multiple stakeholders involved in this project who were responsible for providing expertise in their respective fields to ensure the successful deployment of the automatic search and rescue solution.

Stakeholder	Responsibilities

Unmanned Life	• Overall Technical delivery of the project:
	  ◦ Design
	  ◦ Integration
	  ◦ Trials
	  ◦ Commissioning and Release
	• Technical project management of the project.
	• Procurement of drones.
	• Assisting Vienna Fire Department and the city of Vienna in the application and securing of Austro Control drone flight permits.

Magenta	• Support to enable Unmanned Life's solution integration onto Magenta's 5G network. • 5G network and connectivity for command and control of UAS. • 5G Smartphones and SIM cards • Internet backhaul • Mobile base station (containing hardware components of 5G base station).
Vienna Fire Department	• Validation of various phases of solution as end user. • Integration and deployment of pilot solution as a part of the fire department's emergency response operations. • Support with identifying and securing test and demonstration site. • Applying and securing Austro Control drone flight permits.
City of Vienna	• Administrative Support. • Stakeholder Management & Coordination. • Provision of appropriate work/office space when project team is delivering in Vienna. • Support in securing of Austro Control drone flight permits. • Support with identifying and securing test and demonstration site.
austro CONTROL	• Advise, guidance and steer to procure waiver/permits for drone flights. • Advise, guidance and steer with regards to selection of appropriately specification drones and drone flights in general.

KEY BENEFITS

The key benefits of our product included:

Faster response times:

Our autonomous drones were deployed within a matter of minutes, decreasing the overall time to respond to distress calls.

Lower Cost:

Since the first responders would not need to rely on expensive manned helicopters and a team of experienced divers, this leads to significantly lower costs by using our autonomous search and rescue product.

Reduced personnel on-the-ground:

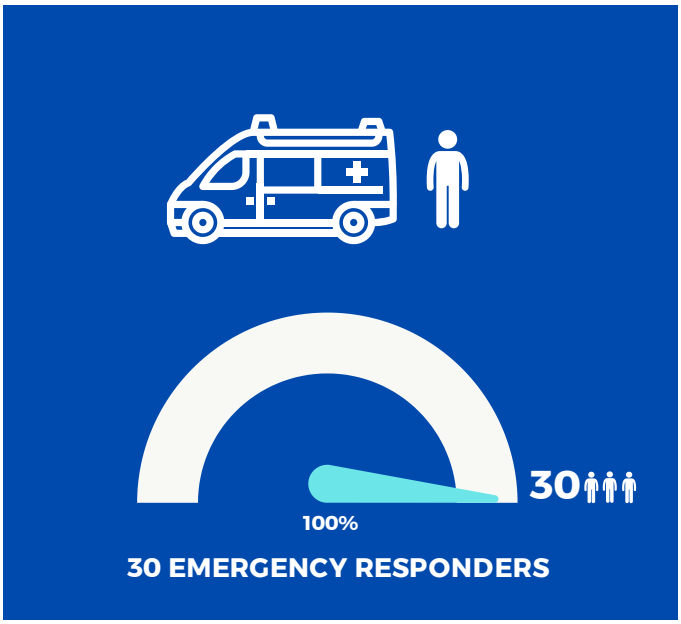
A centralised interface means a single individual can be more efficient in in-person detection. Fewer divers and pilots reduce the risk of serious injury when responding to calls.

More Accurate:

Using advanced equipment allow drones to identify targets that are difficult to spot, perform 360-degree assessment, and provide a more reliable data to the command centre to assess the situation

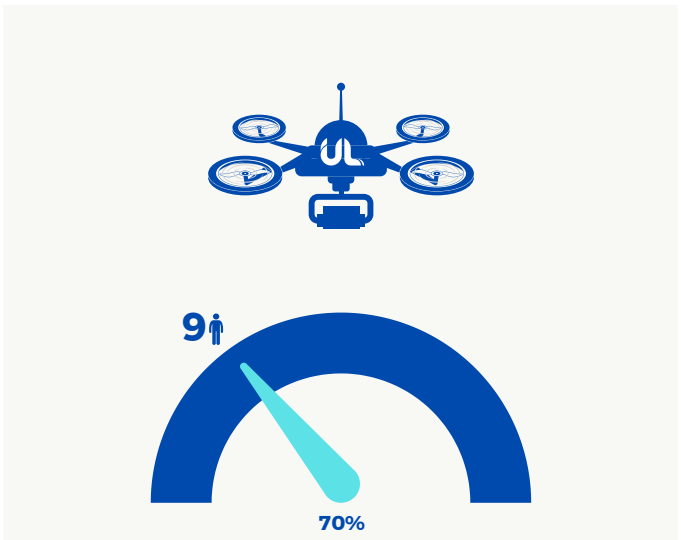
Standard Search and Rescue Operations vs Unmanned Life Autonomous Solution

REGULAR SEARCH AND RESCUE OPERATIONS



30 EMERGENCY RESPONDERS

AUTONOMOUS DRONE BASED OPERATIONS



REDUCED TO 9 EMERGENCY RESPONDERS

SOLUTION IMPLEMENTATION

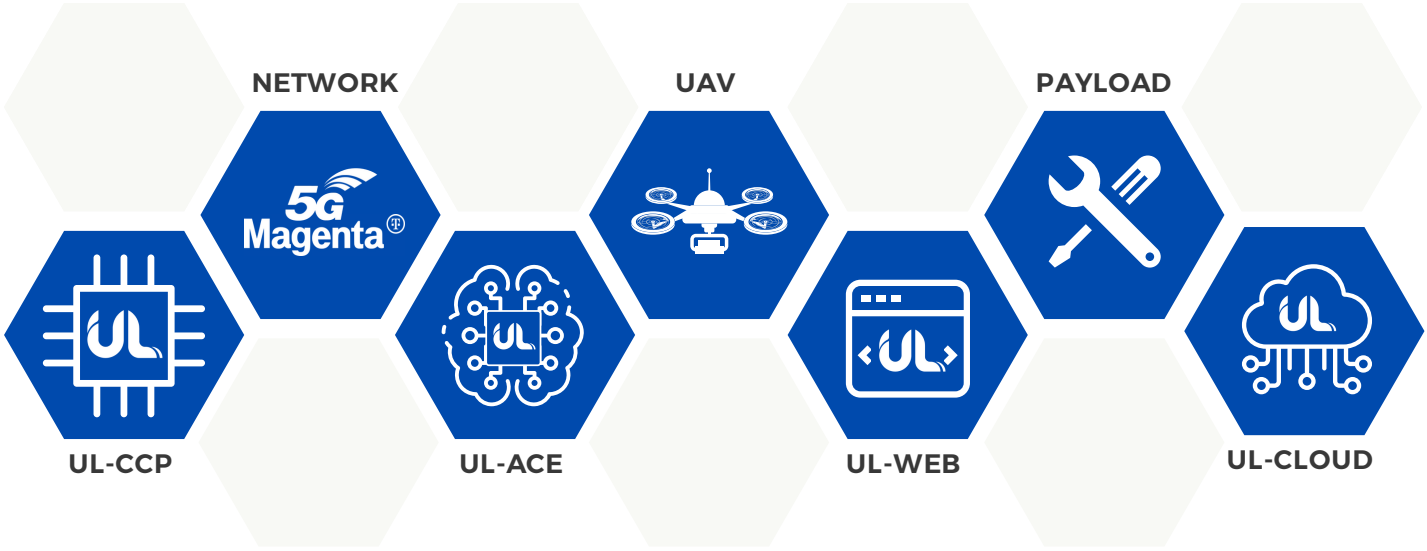
This chapter provides an insight into the solution design and architecture used by Unmanned Life for the 5G enabled automatic drone search and rescue as well as a detailed narrative for the pilot to demonstrate the solution functionality.

Solution Architecture

Below you can see the solution architecture of the 5G enabled automatic drone search and rescue solution.

Autonomous Drone Search and Rescue Solution Architecture

The solution is composed of different modules all with a specific function, each module stands on its own and when combined as per above architecture enables the Automatic Drone Search and Rescue Solution.



Autonomous Drone Search and Rescue Modules

Unmanned Life Search & Rescue Modules

UL-CCP

The Unmanned Life Central Control Platform referred to in this document as the UL-CCP is a software platform that is located at the heart of this solution and integrates and manages all the systems involved in the solution process via the edge and/or cloud-enabling the cloud-based Autonomy-as-a-Service solution. This module can be seen as a mediator connecting different components of this solution.

In this specific architecture, the UL-CCP was installed on a system integration box, referred to as SIB in this document. The SIB is the box that merges the communication system with the UL-CCP and provides the portal for the first response team. The SIB can be seen as an extension to the first response vehicle augmenting it with Automatic Drone Search and Rescue.

UL-ACE

The Unmanned Life automatic control endpoint, referred to in this document as UL-ACE, is a computing unit installed on a UAV in addition to a flight controller. This computing unit provides higher processing power than the flight controller and enables higher-level automatic control by sending C2 commands to the flight controller.

The automatic control endpoint also communicates with a central command platform (UL-CCP) that coordinates the individual actions of a group of automatic vehicles, hosted on a local server, on the network edge, or in the cloud. This communication can take place over Wi-Fi, 4G, or 5G. Using a 5G network as in this pilot extended the capabilities of the system by:

- Allowing the automatic control endpoint to offload latency-critical processing tasks to the central command platform
- Facilitating the transfer of real-time, high-bandwidth sensor data like high-quality video streams

UL-WEB

The UL-WEB module provides a portal to business information systems and operators based on WebSocket and REST API. This allows users to collect data to populate databases for process analysis or in the case of Automatic Drone Search and Rescue it provides the human-machine interface or HMI via the REST API.

Unmanned Life designed and built a custom web interface with the focus on Automatic Drone Search and Rescue which allowed the operator to:

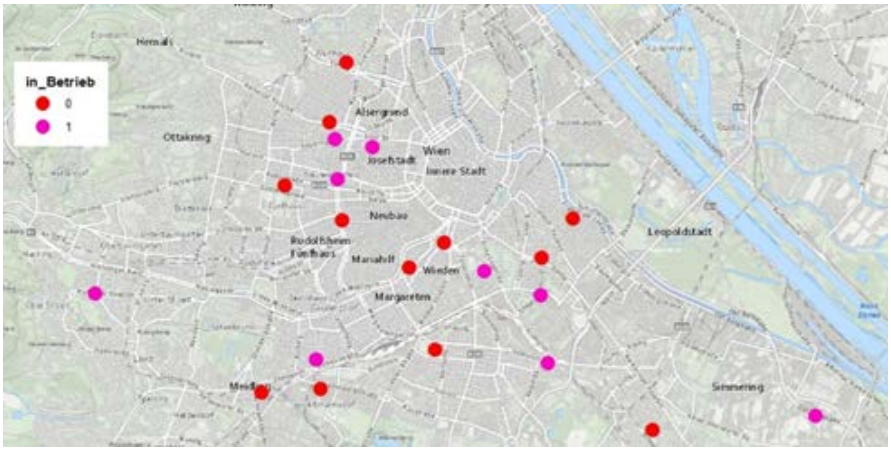
- Control the system, including confirming person detection based on the AI analysis.
- Monitor the system
- Follow the video feed of the search drones

Network

The solution contains various wireless modules which require stable and reliable communication; hence the network plays an important role in the solution. The solution used 5G technology provided by Magenta Telekom to ensure this reliable and stable communication.

The network used the existing 5G network available in the City of Vienna using a temporary extension of this network provided by Magenta to ensure coverage on the trial site.

Magenta is currently in the process of deploying 5G in various locations in the city of Vienna as can be seen in the image below.



Current Magenta 5G roll out in the city of Vienna

Each fixed public 5G gNB or 5G radio node have a fixed coverage area. The area selected for the pilot is marked in yellow in the above image and is not covered by any of the current public 5G gNB.

To extend the fixed network, Magenta provided a temporary 5G base station which created a backhaul to the existing infrastructure. The mobile base station was installed near the pilot site and allowed us to extend the 5G coverage and provide coverage in the area of the pilot.

UAV

The UAV or drone can be remotely controlled or flown automatically through the UL-CCP software via the UL-ACE installed on the drone, working in conjunction with onboard sensors and GPS and is used as a tool to carry the payload required for specific use cases such as cameras for surveillance or inspection. In this solution, the UAS were used as tools to enable search and rescue functionalities.

Three drones were used for the pilot:

- 2 medium-sized search drones - ModalAI m500 with VOXL Cameras
- 1 large-sized rescue drone - DJI M600

The search drones are designed based on flight endurance as they must scan large areas and hence have a low payload capacity.

The rescue drone is designed for maximum payload capacity as they need to transport the floatation device and hence have a lower flight endurance.

Payload

Each UAV is installed with specific payloads which will enable the desired functionality and turn each drone into an automatic tool.

The following payloads were used for the Automatic Drone Search and Rescue solution:

- Search drone: ModalAI m500
  - Camera for video streaming to the edge: VOXL Camera
- Rescue drone:
  - Gripper to carry and drop the floatation device: Life Jacket

The search function allowed the deployment of both search drones as an intelligent collaborative swarm to optimize the search efficiency using the footage of the onboard camera to detect drowning people in the water from the air.

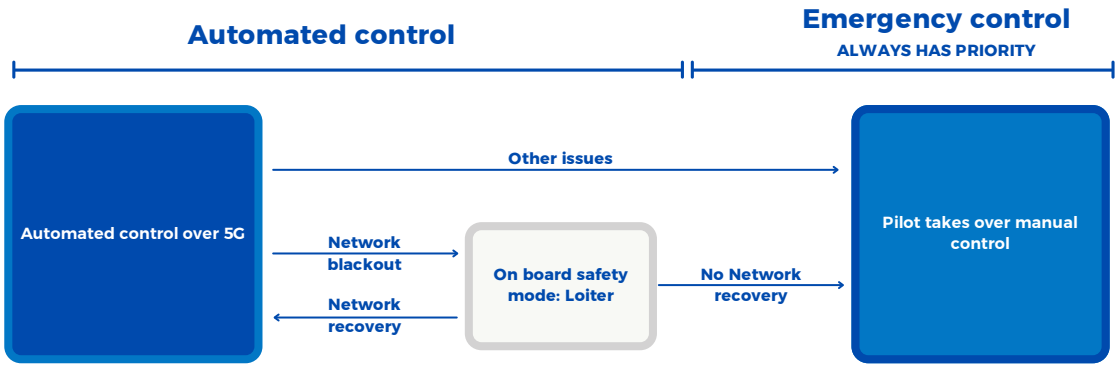
The rescue function allowed the launch of an automatic drone loaded with a life jacket to the location of the drowning person as a first rescue measure before the first responders can reach the location.

Trial

Trial flight approval

Before the trials took place, the required flight approval had to be secured. The documentation for the flight approval was prepared by Unmanned Life with the support of AustroControl and filed by the City of Vienna or the firefighting department. The flight approval was a pre-flight condition that needed to be received before the trial could take place.

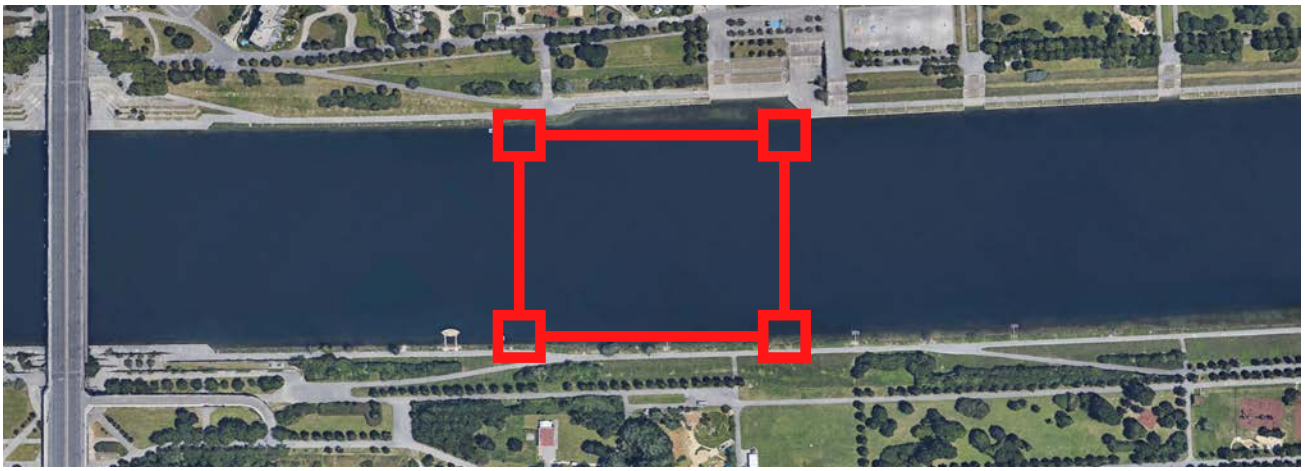
Safety was key for the trails and close collaboration with experts in the field of drones and legislation ensured all safety aspects are checked and in place. On top of that, the solution was designed with multiple layers of safety and security built into the system. The list below provides an overview of the rollback control layers implemented in the system:



Rollback Control Layers

Trial preparation

The approximate area below was used to execute the Automatic Drone Search and Rescue trial based on all the dependencies provided by the firefighting department, the City of Vienna, Unmanned Life and Magenta Telekom.



Trial location

Trial Initiation

Once all supporting systems and the communication system were in place, the trial was initiated and a diver of the firefighting department was positioned in the canal to simulate a drowning person.

Diver simulating the drowning individual

Systems power up

The operator powered up all systems:

- 3 Drones: The battery was connected to the drone upon which the drones powered up and the onboard systems booted up automatically. Once all systems were booted the drones established connections with the Magenta 5G network.
- SIB: The SIB was plugged into the power supply of the first response vehicle. Once connected the systems powered and the UL-CCP and the UL-WEB automatically booted up and established connection.
- As soon as all the systems were connected with the Magenta 5G network the drones were discovered by the UL-CCP and were visible on the UL-WEB interface and ready for deployment.

Configure search area

The UL-WEB interface had a map available of Vienna which allows the operator to focus and zoom in on the search area. The operator then selected the search area by a simple selection of the area via the interface.

Search area selected by the operator

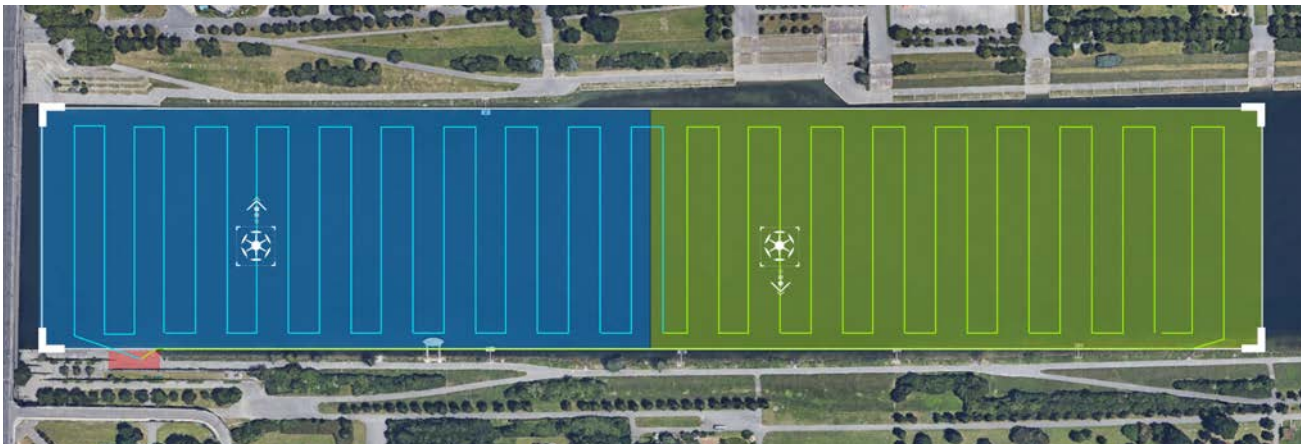
Launch search drones

After selecting the search area, the operator had access on the interface to the search launch button. Once the button was clicked, both search drones automatically took off and flew to the allocated search area provided by the UL-CCP.

Setting up search drones

Automatic searching

Arriving at the allocated area, the search drones surveyed their respective areas following an automatically generated path. The path is managed from the edge device and the drones will always be aware of the location and situation of the other drones in the system.



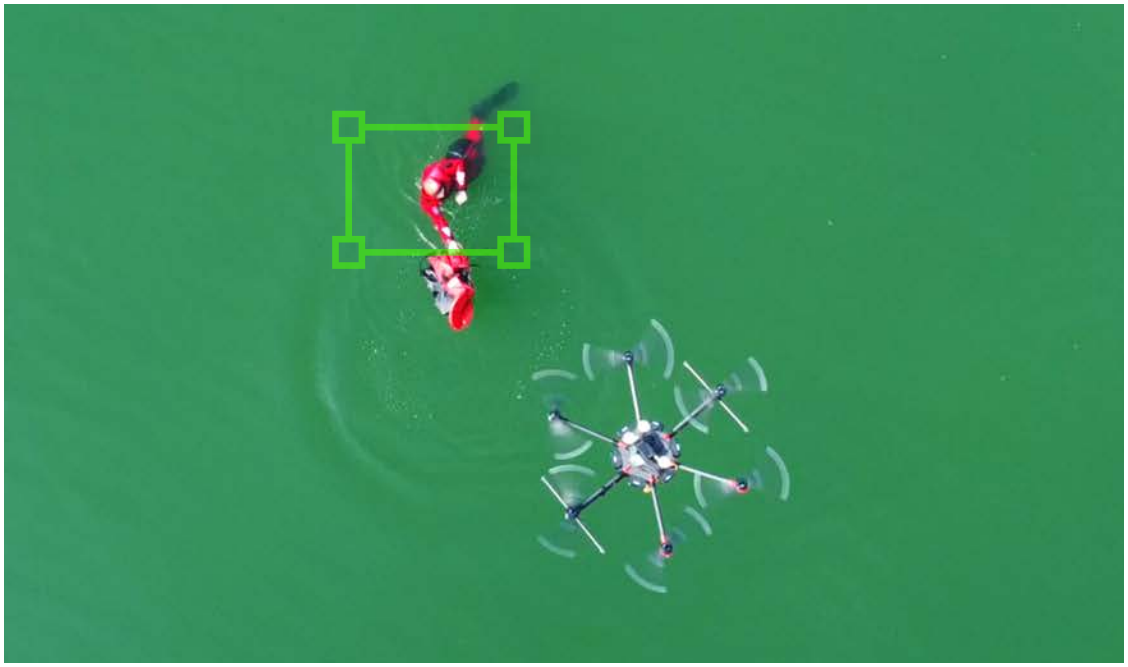
Automatic searching following calculated paths

Person detection

The cameras installed on the search drones streamed the video footage to the UL-CCP and the footage was made visible for the operator on a display at the control center.

A two-layered system was used for the detection of a drowning person:

- Visual inspection by the operator: In case the operator saw a person in the water he had the possibility to pause the drones and confirm that a person has found in this location.
- AI-assisted inspection: The video footage was also analyzed, and AI was applied to detect potential people in the water. Every detection was indicated on the screen for confirmation from the operator.
    - If the detection was not a person, the operator discarded this and the system will use this input to learn and the drone will continue the search.
    - If the detection was a person, the operator can confirm this and the system will use this input to learn and the drone will inform the UL-CCP of the location of the person



AI detection and indication of person

Launch rescue drone

Upon detection of a human, the operator launched the rescue drone by pushing the rescue drone launch button on the interface. Once the button is clicked the rescue drone automatically took off and flew to the location scanned by the search drone.

Autonomous rescue

The rescue drone flew directly to the location of the person and when arriving on location it automatically lowered its altitude in preparation for dropping the life jacket. When the drone reached dropping altitude it ejected the rescue jacket.

During this operation, the search drone stayed on standby to provide visuals to the operator of the situation. Simultaneously a rescue team was dispatched to help the victim.

Ending rescue mission

Once the rescue team arrived at the location of the victim and the situation was stabilized, the operator clicked end mission on the interface and all the drones returned to the base station and landed on the location they initially took off from. Once landed the drones disarmed which is the end of the mission.

Trial Implementation Flow Chart

High-level flow chart that illustrates the trial steps described above

HOW THE PROJECT WAS MANAGED

This six-month project was broken down into multiple phases allowing for regular checkpoints and milestones to ensure the end product delivered on the customer's expectations:

Design

Within this phase, our team designed the product based on the requirements of the Vienna Fire Department. This phase required a deep engagement with the end-user and a tight collaboration with all stakeholders.

Development, Testing, and Integration

In this phase, we procured the required drones while simultaneously commencing the anticipated software configuration in line with the requirements. The drones once delivered were assembled and tested with our software platform. In addition, within this phase, we integrated our software platform with Magenta Telekom's 5G infrastructure in Vienna.

Flight Permits

While our engineering team focused on the technical aspects of the delivery, the project management team collaborated with Austrocontrol, Austria's CAA authority to apply for the required permits to conduct the trials.

Trials

Having completed the development, testing, and integration exercise and acquiring permits from Austrocontrol, our delivery team travelled on-site to conduct full-scale tests of the product in readiness for the final trials. We also trained the Vienna Fire Department personnel in deploying the mission under the strict supervision of our engineering team.
Upon successful testing, the product was officially demonstrated to all project stakeholders including a wider audience of relevant partners.

Pilot Handover

Following successful trials, our business team is currently in discussions with the Vienna Fire Department to hand over our autonomous search and rescue product for an extended pilot.

WATCH OUR VIDEO
https://www.youtube.com/watch?v=28x77X4CSIs

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