“NOVEL INTEGRATED SOLUTION OF OPERATING A FLEET OF DRONES WITH MULTIPLE SYNCHRONIZED MISSIONS FOR DISASTER RESPONSES”

RespondDrone

D15.4 RESPONDRONE Concept / Mock-up

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Glossary of terms and abbreviations used	
Abbreviation / Term	**Description**
CEA	Commissariat à l'énergie atomique et aux énergies alternatives
CNN	Convolutional Neural Network
DL	Data link
GIS	Geographical Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
LTE	Long Term Evolution Network, 4G wireless communications standard
NFZ	No flight zone
POI	Point of Interest
RTP	Real-time Transport Protocol
RTSP	Real Time Streaming Protocol
RW/FFW	Rewind / Fast Forward
STANAG	Standardization Agreement
TMM	Traffic & Mission Management Component
UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicle. Used interchangeably with 'drone' in this document
UDP	User Datagram Protocol

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1. Executive Summary

With this deliverable we intend:

- To explain the ResponDrone concept.
- To provide a first visual and narrative approach to how ResponDrone, once it is developed, will answer to the First Responders' needs and requirements, which were described in D15.2 Report of Field Studies and D3.1 Requirements report.
- To describe a vision of how a first responder's operation will be executed with this platform.

ResponDrone Concept

The purpose of ResponDrone is to create, based on the First Responders' needs in disaster areas, a useful platform that allows them to improve their daily operations, and to operate efficiently in times of large-scale emergencies. This shall be achieved by developing tools that enable improving First Responders' situation assessment, reducing their response, deployment and information gathering times, and improving their planning, decision and coordination capabilities in a user friendly and standardized way. ResponDrone will focus on adding information and other services via multi-UAV missions.

Mock-ups

The mock-ups are created based on both the First Responders' needs and the partners expertise and know-how, to demonstrate an effective platform. The foreseen systems to be developed created from this conjunction of needs and available expertise will be:

1. UAV Platform:
    a. Multi-UAV system mock-up.
2. Data management platform:
    a. Web desktop interface.
    b. Web mobile interface.
    c. Team and mission management.
    d. Video analysis service.
    e. Communication Relaying Service.
    f. Decision Support Service.

In this deliverable, mock-ups of the above systems and how they interoperate are presented.

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2. ResponDrone Concept

ResponDrone intends to design and create a useful multi-UAV platform for First Responders that allows them to improve their daily operations, and to operate efficiently in times of large-scale emergencies.

The improvement of First Responders' operations will be achieved by upgrading their situation assessment, reducing time necessary for response, deployment and information gathering, and enhancing their planning, decision and coordination capabilities, which will be realized with a set of tools that will be presented in this document. A large part of the improved situational awareness will come from a well-integrated and safe multi-drone solution.

The platform is built based on the real needs of different profiles of First Responders from all across Europe, Armenia and Israel, which were gathered in a multi stage process (see "D15.2 Report of Field Studies", Annex 1 "Summary of the Design Thinking Workshop", and "D15.5 Functional Design").

ResponDrone aims at becoming a standard in First Response for Emergency Situations, thereby facilitating the collaboration between First Responder entities from different regions, with different backgrounds and diverse roles.

Although the platform aims at becoming a standard, as it is being built to display information from a variety of sources in a standardized user interface, it would be naive to think that every country is going to change its emergency operation procedures or equipment to adopt the ones we are about to propose.

To address this potential barrier, we will design ResponDrone with an agnostic, modular and flexible architecture that allows us to reduce dependencies between specific parts of the system. It will be possible to substitute the different elements of the systems for others. Interfacing will be simple in order to enable the quick and easy integration and operability of different hardware modules, software services, sources of information or combinations of them.

This way, if a country or a First response unit wants to use, for example, their already existing vehicle localisation services, this could be integrated into ResponDrone and used natively in conjunction with the rest of the components, which are already integrated.

Based on the requirements gathered from the end users, and taking into account the expertise and know-how of the technological partners, the following basic architecture (Figure 1 and Figure 2) was built to address the problems and needs of the First Responders.

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Figure 1 shows the overall simplified architecture of ResponDrone. Each box represents a component (or a user, in the case of First Responders or Commanders) that will be developed, improved and integrated within the ResponDrone framework. Those initial components are succinctly described below and further explained in the document:

- Web interface & web services (IAI): it is the user interface and the services related to it, such as video analysis or maps generation
- Flight Plan Analysis and Definition (DLR): responsible for generating safe flight plans considering external risks and factors.
- Airborne Network Control (Inesc Tec): it will provide on-demand coverage to the First Responders, provided optimized dynamic positions for UAV-mounted communications relays.
- Video Processing (Thales): this component will analyze video from the UAV to mine information from it (i.e. fires location, floods evolution or objects location).
- UAV Platform (Alpha): UAVs will have the task of carrying the payloads (cameras, communications relays, aid kits…) to a specific location in order to deliver on-site support.
- Decision support (CEA): a configurable service designed to speed up and automatize decision making, making use of all the information and previous experience available.

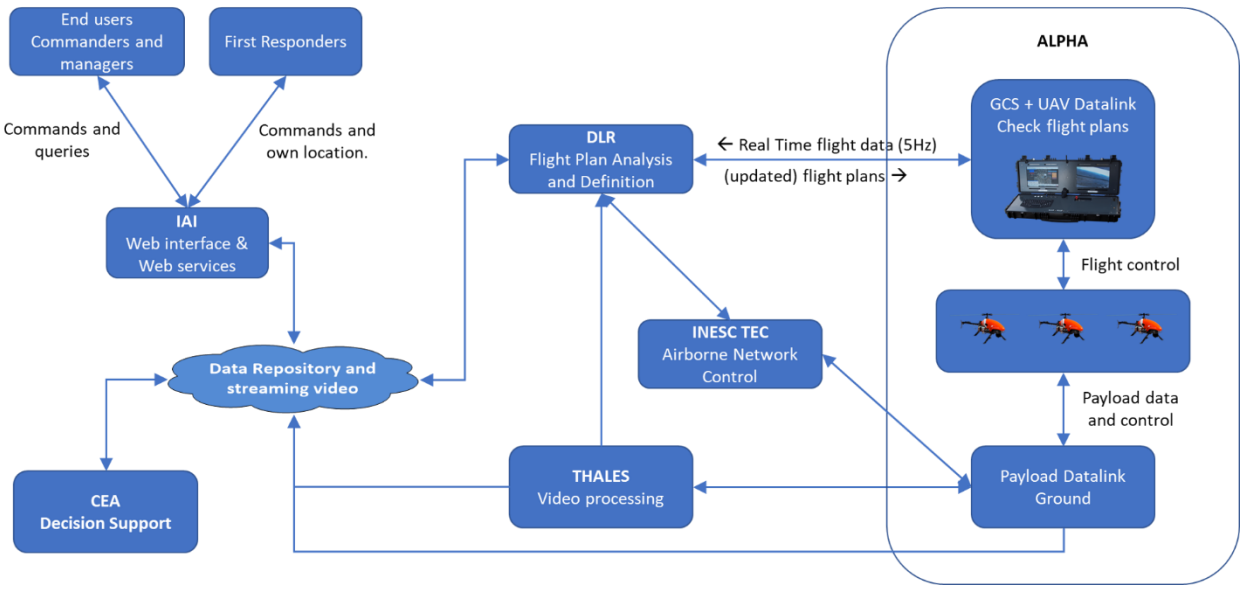

Figure 1: Platform basic architecture

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On the other hand, Figure 2 shows the UAV payload's configuration that has been initially selected to answer end-user's requirements.- The information will be sent from the air to the ground through the different datalinks (DL).

The initial set is composed of three different technologies that are briefly described hereunder:

- A release system (Alpha) that enables the on-ground First Responders to deliver and receive goods on position, like specific tools or medicines.
- A camera system (Thales) that enables air situation assessment and feeding the video analysis algorithms to be developed in the project.
- A communication relay system (Inesc Tec), that will generate a smart and dynamic distribution of network relays, enabling connectivity when and where it is needed.

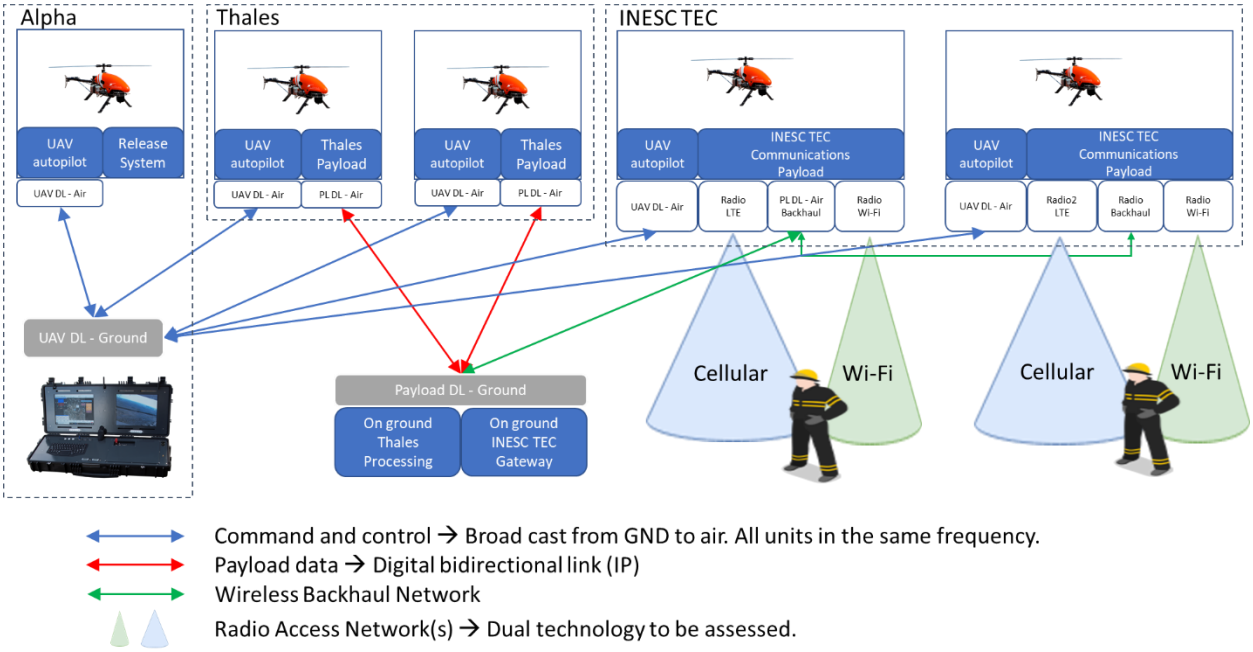

Figure 2: UAV Level Basic Architecture

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3. Mock-Ups Introduction

In the following sections, mock-ups of the different parts of the concept system are presented.

The mock-ups have been designed taking into account the First Responders' and other stakeholders' requirements, presented in "D15.2 Report of Field Studies", Annex 1 "Summary of the Design Thinking Workshop", and then analysed in depth in "D15.5 Functional Design". Additionally, the previous experience of both users and designers was a valuable input.

The main purpose of these mock-ups is to provide a first approximation to how the system will be and how it will operate. This is done in order to have a basis for both the demonstration of the envisioned system to potential users and for the discussions and improvements in the course of the project.

4. UAV Platform Mock-up

4.1 Multi-UAV Platform

The Multi-UAV platform has been designed in order to serve the First Responders in three different initial ways:

- Providing aerial imaging and video analysis.
- Acting as a communication relay, to provide ad-hoc coverage based on the users' needs.
- To deliver packages (e.g. small tools, medical equipment, blankets, floatation devices, etc.).

Nevertheless, the drone platform (as the rest of the system) will be designed with an agnostic and modular approach in order to facilitate the integration of new systems and payloads that could potentially increase the operational and tactical capabilities of the UAV technologies.

Figure 3: Multi-UAV system mock-up

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The Multi-UAV system will help First Responders to:

- **Improve their situation awareness and information gathering time:** By using a Multi-UAV system, First Responders will be able to gather more information faster. The main foreseen source of information from the drones will be aerial imaging which is useful to perform a fast situation analysis, localizing victims and hazards, creating 3D maps of the area, etc.
- **Improve their response time and effectiveness:** With a better and earlier situation awareness, First Responders can make better prioritisation of tasks and a more precise allocation of resources. Additionally, the aerial imagery helps to the prompt identification and management of hazards while they can still be controlled.
- **Improve their logistics capabilities:** making use of the drones for delivery of goods on demand.
- **Improve their planning:** The aerial study of the emergency development will ease forecasting its evolution, identifying needs and planning the use of resources accordingly.
- **Improve their reporting and information access on-ground:** By providing ad-hoc networks that can back-up communications when the main infrastructure is not available.
- **Improve the resources usage and cost efficiency:** The Multi-UAV system will be highly automated and designed to be operated by the same number of operators that a single UAV system would require. Additionally, it will use only one ground control station for several UAVs. Both features will decrease the acquisition and operational costs of a multi-UAV system.

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5. Data Management Platform Concept and Mock-ups

5.1 Web Desktop Interface

The desktop interface will be the main interface of the system. From this user interface, the command centre will be able to give orders, plan the different actions in real time, evaluate situation status, see availability and location of resources, forecasting, control and make use of different services, etc.

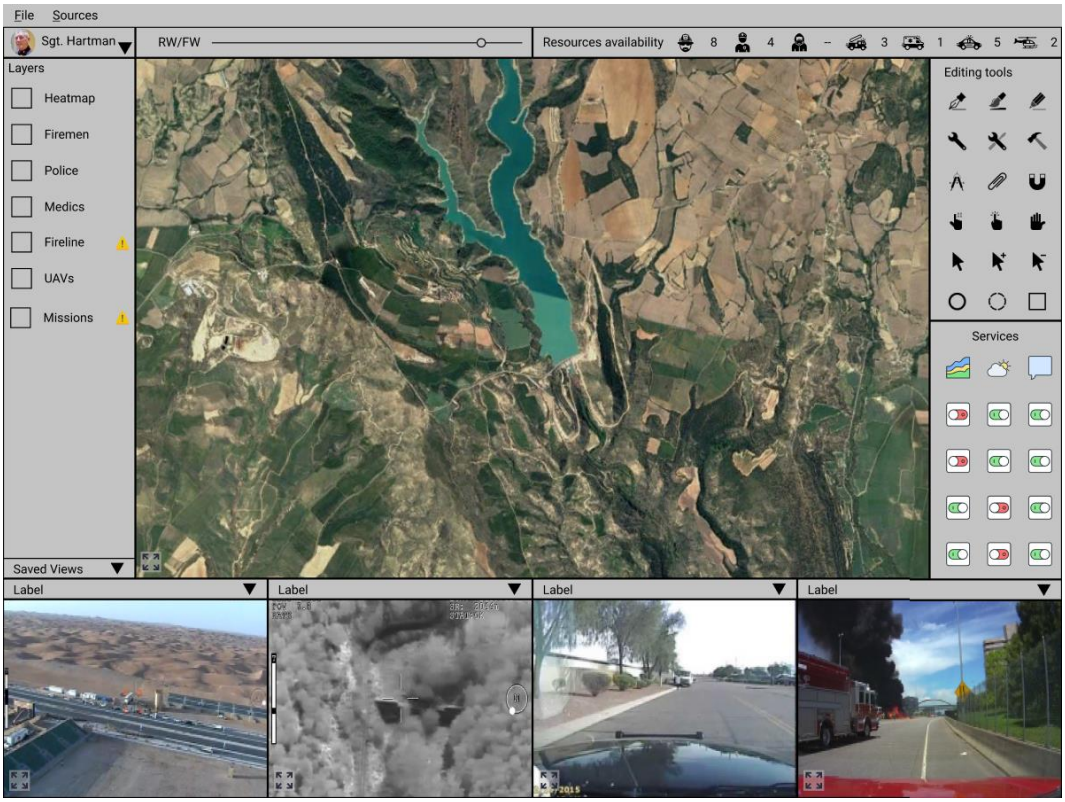

Figure 4: Desktop Main Interface Mock-up

An interactive mock-up of the web interface was created, and can be accessed using a web browser here (text URL can be consulted at chapter 6 - References).

The different parts of this user interface are described below. These are potential features, those set at launch as well as a feature roadmap will be defined later during the project (e.g. in D3.2 Preliminary Architecture and Concept):

- **Map**: It is the central view.
  - Resources, hazards, targets and other points of interest are shown over it.
  - It can be auto-generated with drone imagery or loaded from an existing one.

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    - Orders for UAV and autonomous platforms can be indicated over it.
- **Data layers**
    - Control the type of information shown in the map. Different layers can be used as overlays.
    - Warnings can appear on the layers to call for attention.
    - Saved views provide quick access to preferred view configuration. (User dependant).
- **Editing tools:** Used to interact with the map:
    - Give orders.
    - Add points of interest or targets.
    - Mission planning.
    - Select and allocate resources.
    - Etc.
- **Services**: Services add intelligence to the system.
    - These services can have an interface in a new window (e.g. decision support).
    - These services can add layers or functionalities over existing layers.
- **Camera feed:**
    - Detachable, to reorganize in a different screen, or to add more.
    - Allows temporary maximization of the screen.
- **User access control**: Provides permissions control over:
    - Editing tools.
    - Layers.
    - Services.
    - Cameras.
    - Configuration options.
- **Resources availability:** It provides information about the resources available at the moment, to ease planning and resource allocation.
- **Timeline (RW/FFW):**
    - When dragged backwards it displays past information. It can be overlaid to compare with the current situation.
    - When dragged forward it gives predictions if services with this feature are activated (e.g. fire line location).

By using this interface, the command centre of First Responders (as well as other decision makers) will be able to improve their:

- **Situational awareness:** the interface offers a clear view of the situation and allows the visualization of different imagery sources (cameras on UAVs, vehicles, people, buildings, etc.) in one space. Information can be displayed or hidden on demand, easing the visualization of concrete items or in crowded situations.

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- **Planning capabilities:** The platform will offer the possibility of performing several actions over the resources and targets, such as: selecting, giving orders, creating groups, allocating resources or groups to a target, adding new targets or points of interest, etc. Furthermore, the interface will be able to show predictions, easing the allocation of resources based on the development of the emergency.
- **Coordination:** The unique user interface, where all the information can be accessed, will ease the coordination between different First response groups with similar or different roles in an emergency. It will also ease the coordination with different off-site stakeholders, as it will be cloud based and it will offer remote access and operation.
- **Reporting**: As the platform can be accessed remotely, it can be used for reporting to higher level decision makers the exact situation in near-real time. Additionally, services to generate periodic automatic reports in a specific format could be implemented.

5.1.1 Other Views

Figure 5 depicts the main user interface with an IR-generated heatmap as an example on the map display.

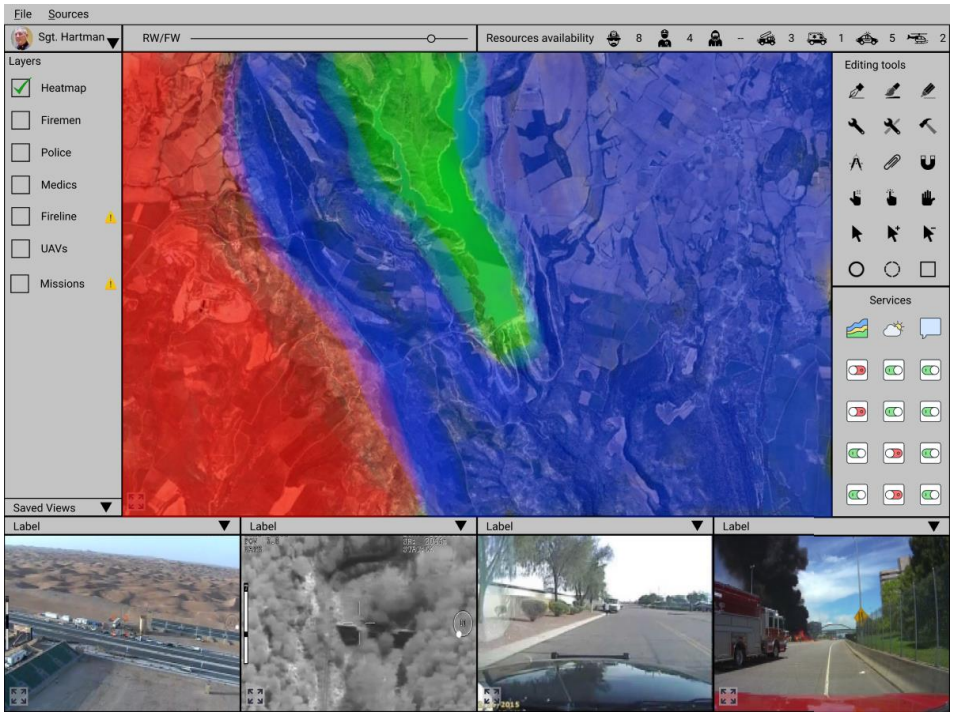

Figure 5: Desktop Main Interface Mock-up: IR-Generated Heatmap Example

In Figure 6 a mission example is shown. Over it, we can find different icons for:

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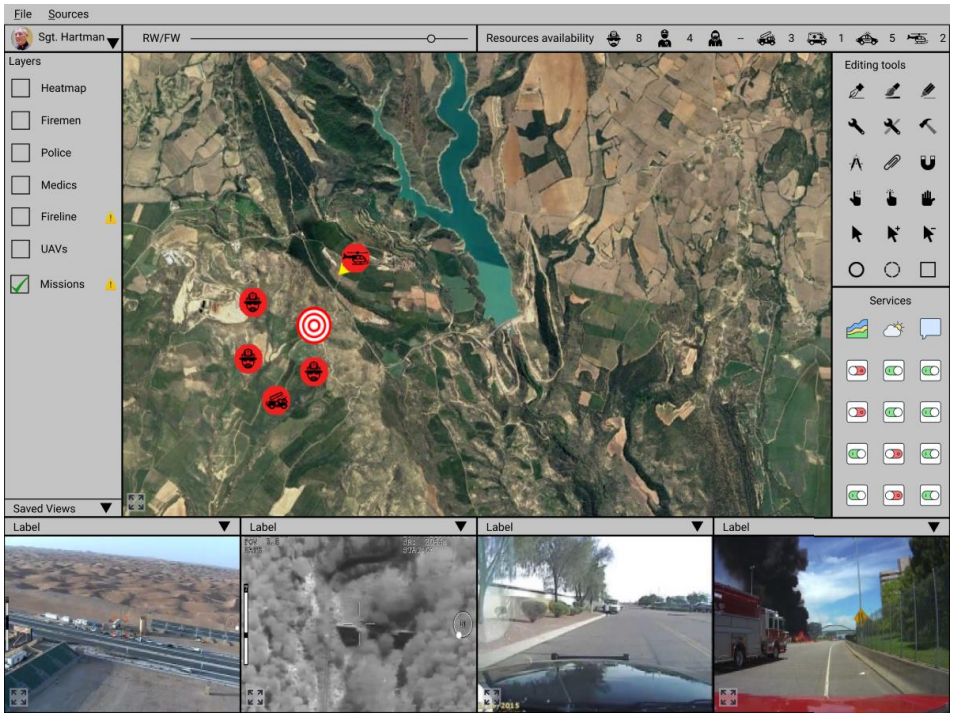

Figure 6: Desktop Main Interface Mock-up: Mission Example

Figure 7 shows the main user interface with a live video-feed overlaying the map display.

Figure 7: Desktop Main Interface Mock-up: Large Video-feed view

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5.2 Web Mobile Interface

The mobile interface (Figure 8) will serve First Responders in the field. From this user interface, the users will be able to send reports, receive tasks from the commanding center, evaluate the current situation, see availability and location of resources, control and make use of different services, etc.

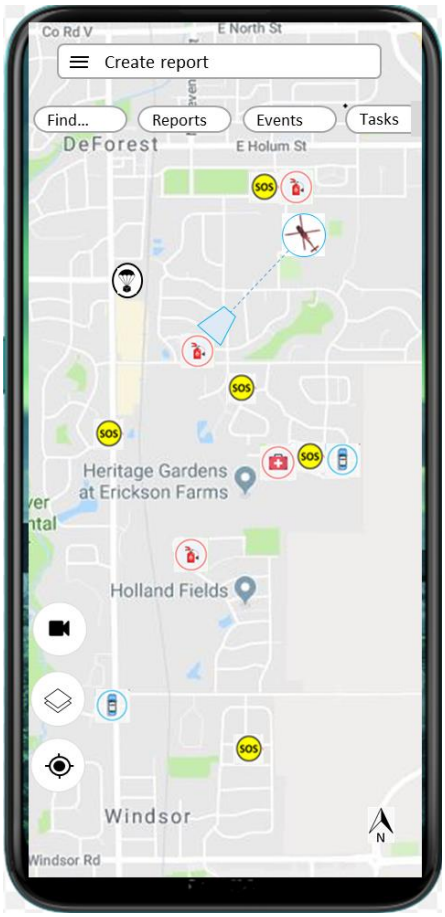

Figure 8: Mobile Main Interface Mock-up

The different parts of this user interface are described below. These are only potential features, the feature set at launch as well as a feature roadmap will be defined later during project implementation:

- **Map**: It is the central view.
  - Resources, First Responders, air vehicles, etc., are shown over it.
  - Orders for UAV and autonomous platforms can be indicated over it.
- **Services**
  - Services add intelligence to the system (i.e. live video, chat, imagery, etc).

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  - Services are available from the main menu.
  - Services can add new layers or functionalities over existing layers.
- **Live Video**
  - Possible icon
  - Opens a list of all the available live video feeds from which the user is able to select.
  - The displayed video can cover the screen when rotated to horizontal view.
- **Layers manager**
  - Possible icon
  - Controls the type of information shown in the map. Different layers (e.g. heatmap, fire line, etc.) can overlap
  - Warnings can appear on the layers to call for attention.
  - Saved views provide quick access to preferred view configuration (User dependant).
- **Center map**
  - Possible icon
  - Center the map on own location
- **Find/Reports/Events/Tasks/etc.**
  - Allows **the user to search, read and edit reports, images, events, tasks, etc.**

By using this interface, the First Responders will be able to improve their:

- **Situational awareness:** the interface offers a clear view of the situation and allows the visualization of different imagery sources (cameras on UAVs, vehicles, people or buildings). Information can be displayed or hidden on demand, easing the visualization of concrete items or in crowded situations.
- **Reporting/communication capabilities:** The platform will offer the possibility to communicate with the commanding center, send reports with attached images and video clips, receive mission tasks and ask for assistance.
- **Coordination:** As happens with the web interface, the mobile interface, where all the information can be accessed, will ease the coordination between different First response units with similar or different roles in an emergency situation.

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Figure 9 illustrates a mock-up of the mobile device for the First Responders to be used in the field with a live video stream at the bottom.

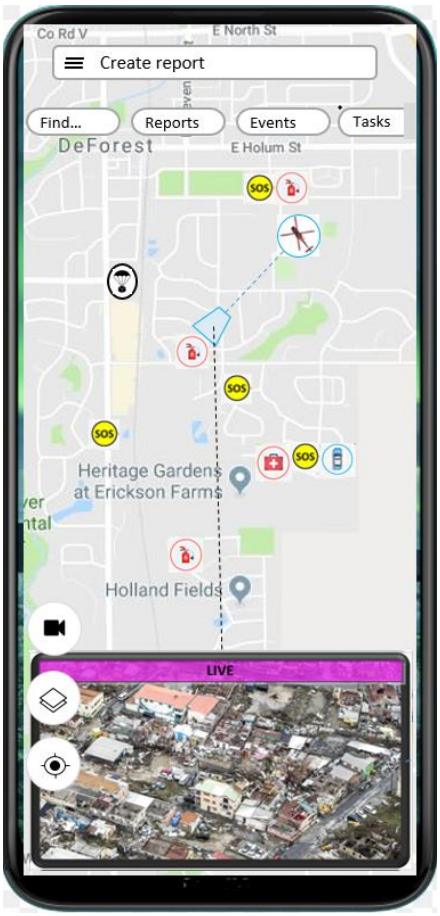

Figure 9: Mobile Main Interface Mock-up with a live video stream

5.3 Team and Mission Management

The aspect of team and mission management entails the planning of routes for both First Responders and UAS according to the assigned mission (i.e., the requirements stemming from the First Responders, video feed of a POI, etc.) and the specific circumstances, which include areas of risk for First Responders and/or UAS. For instance, a fire can pose a danger to First Responders operating in its vicinity, as well as for UAS flying over it. However, risks can also stem from the operation of UAS itself. For instance, a UAS flying over a gathering of people or the escape route for victims is a risk itself, since a malfunction of the UAS can cause a crash and damage to property, health or, in the worst case, loss of life.

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The team and mission management therefore are responsible for ensuring a minimal risk operation of UAS in the First Response scenario. For this, multiple trajectory plans (i.e., multiple ways of achieving a mission goal) are evaluated with respect to the inherent risk. Each risk level is recorded, and the plan with the lowest risk level is chosen. An illustration is shown in Figure 10, where three plans are shown, with the risk levels of 9, 6, and 2, respectively. In this case, the third plan (Plan C) has the lowest risk level and would be the plan to use for this mission. The risk model defined as an abstract framework in D2.1 will be defined in a more concrete way in later deliverables and forms the basis for this procedure.

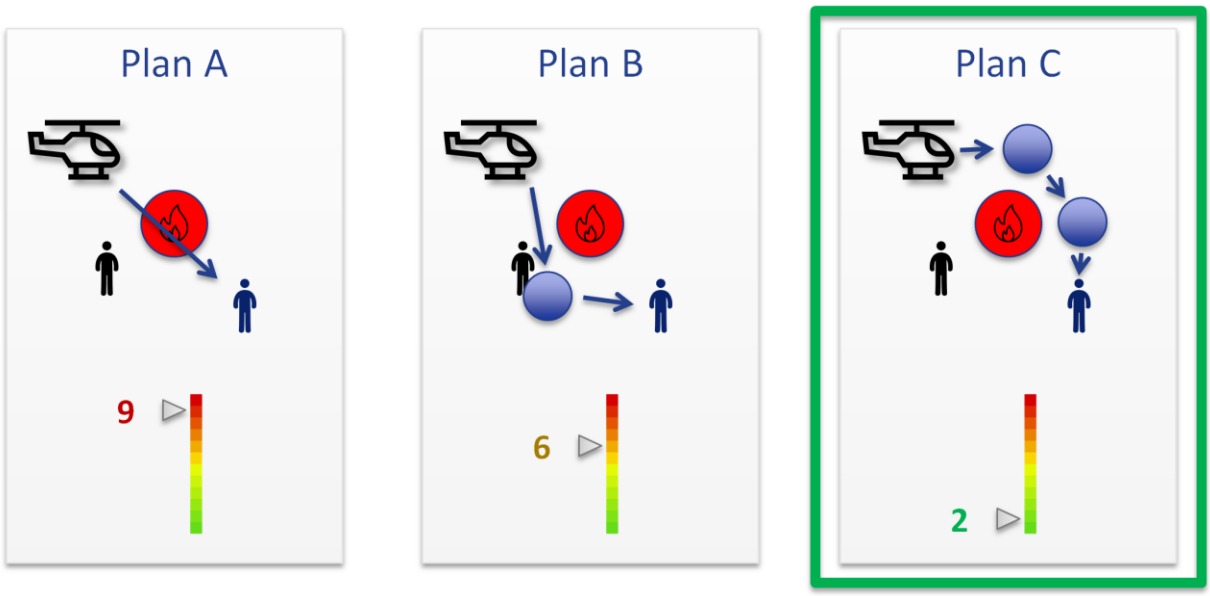

Figure 10: Three plans with the same mission goal and varying risk levels

For instance, Figure 11 shows the initially planned route of two drones over an area where a stadium contains a gathering of people. The stadium has therefore been defined as a (dynamic) no-fly zone (NFZ). The missions of the two drones, however, bring the drones close to each other during a certain amount of time (mission time 01:56 – 02:08 as calculated by the conflict detection algorithm). Therefore, the TMM component must plan a mitigation strategy for ensuring that the two UAS trajectories are deconflicted and maintain sufficient separation. Figure 12 shows an example of such a mitigation strategy using vertical separation, where drone 1 (blue trajectory) uses a higher altitude to maintain separation from drone 2 (yellow trajectory). Drone 2 has an unchanged trajectory. Figure 13 shows an overview of the entire process.

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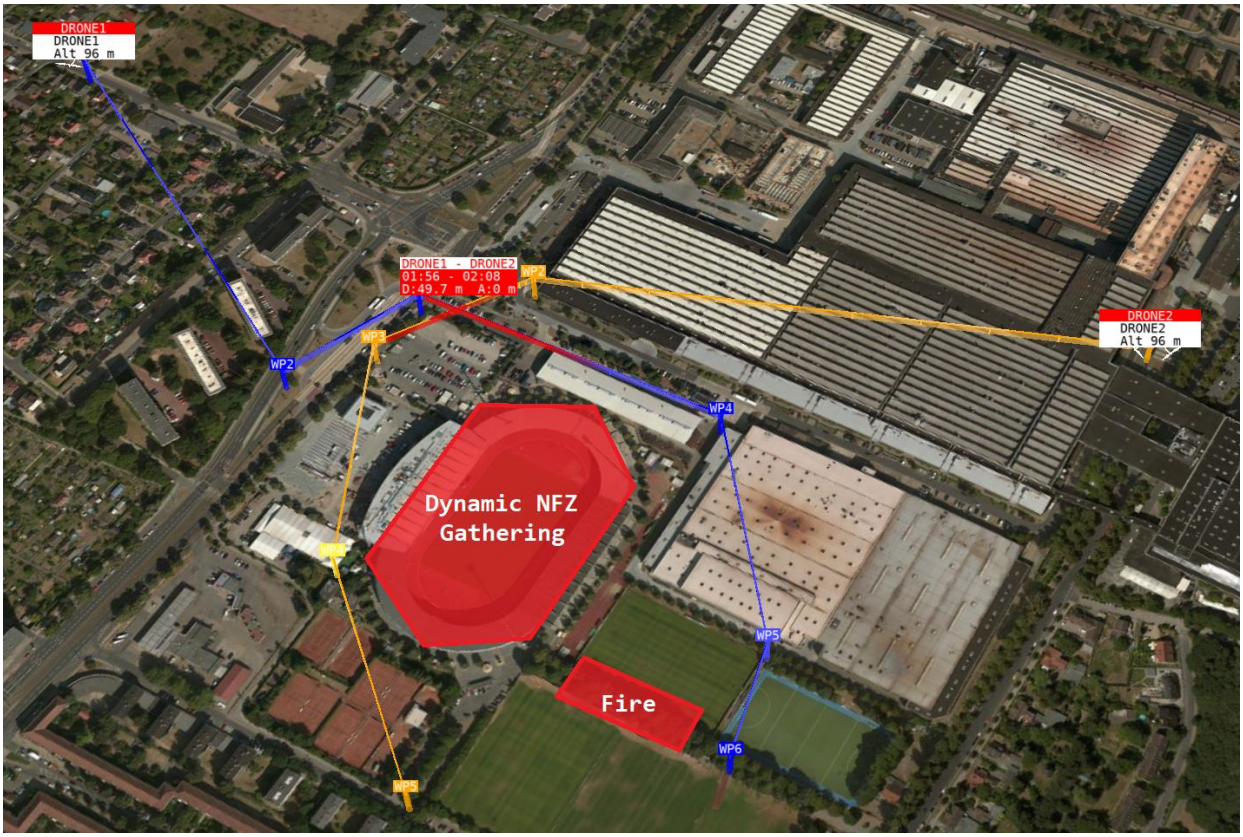

Figure 11: Initial mission plan with conflicting UAS trajectories

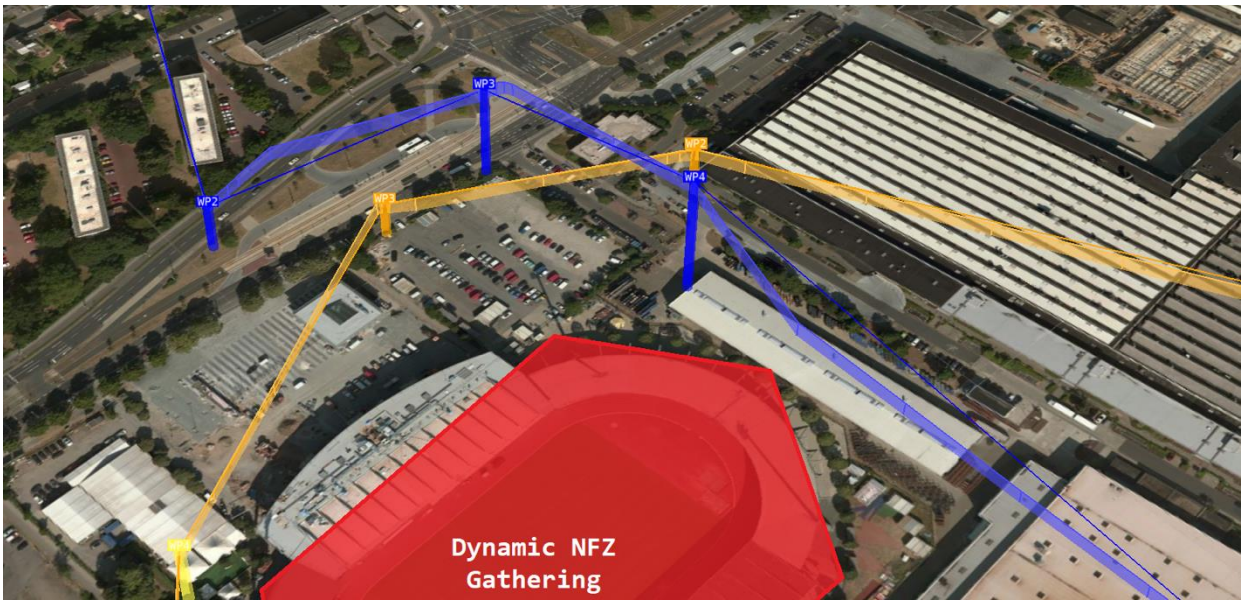

Figure 12: Deconflicted UAS trajectories

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Figure 13: Team & Mission Management

5.4 Video Analysis Service

Image and Video analysis is of utmost importance to help First Responders. It helps answering to a set of their requirements, named as listed in D3.1 "Requirements report" (R for Requirement). It makes it possible to improve situational awareness before and during the intervention (R7: Use of AV in all stages of a disaster). In addition, it allows them to speed up some missions that can be crucial as time is often a critical factor. Hereafter, an overview of targeted functionalities is presented.

Based on First Responders' requirements, the following algorithms will be studied and developed:

1. **Global image geo-registration**: Based on metadata (GNSS position of the UAV, orientation of the camera) and the image itself, the registration of each image will be done. Image registration is the process of transforming different sets of data into one coordinate system. Registration is necessary in order to be able to compare or integrate the data obtained from these different measurements. This is for example mandatory in order to compare with precise images of the same place acquired at different times (R5: Mobile application with updated maps + R16: Calculate latitude and longitude of ground objects).
2. **Fire detection:** The objective is to detect in real time for each image where the fire is, and where burnt areas are. Processing will be based on deep learning solution, more precisely on Convolutional Neural Network (CNN) A CNN is a class of deep neural networks, most commonly applied for image analysis. They can address many problems: object detection, image segmentation, image classification, etc. This is nowadays the better class of algorithms for image processing. Before using a CNN, it is required to train the network during a learning stage. During this learning stage, it is required to get many labelled images (i.e. with their ground truth) that are representative of all the scenarios that we want to address. Once the network has been taught it can be used

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during the inference stage. In the case of fire detection, the output of the algorithm will be a segmented image (with a confidence level for each pixel, if required).

3. **Person detection for Search & Rescue mission but also to monitor First Responders:** Outputs of this algorithm will be some bounding boxes in the image reference (R18: Object recognition + R22: AV for improving search and rescue missions).
4. **Detection of flooding areas:** To have a good situational awareness and to monitor flood evolution, it is required to precisely map flooding areas. The output of this algorithm will be a segmented image (with a confidence level for each pixel, if required). (R20: Flash flood analysis).
5. **3D mapping**: To help First Responders obtaining a good situational awareness, 3D mapping of the intervention areas will be studied. The output of this algorithm is a 3D model that can be analyzed by First Responders (e.g. in order to find an entrance on a partially collapsed building). (R24: Use of AV for initial mapping (Ortho and 3D) of the disaster area).

All algorithms outputs will match with STANAG 4609 standard as this standard is used by First Responders.

It must be noted that depending on technical constraints, video analysis will be done either on-board UAV or on-ground.

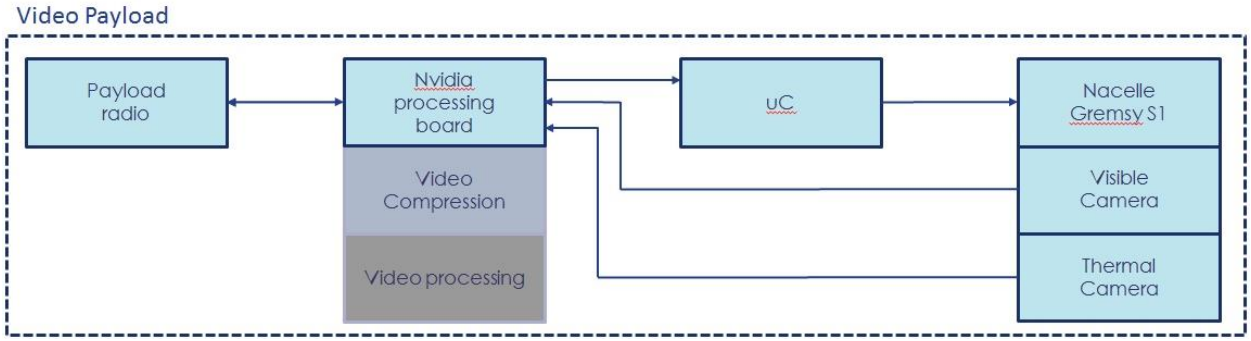

Figure 14: Video payload

As illustrated by Figure 14, the video payload will include:

- A 2-axis gimbal.
- A Full HD camera with a minimal optical zoom of x30, so that First Responders can have the possibility to zoom on specific location.
- A thermal camera.
- A powerful processing unit, i.e. Nvidia© Xavier NX™, on which some of the previous algorithms will be executed.
- A radio data link to transmit timestamped compressed video and associated metadata (resulting from the video algorithm) to the ground.

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Video and metadata will be received on ground (Figure 15). Videos will be available to any client thanks to the use of a RTSP server. The data will be stored in the cloud as well, when connection is available. Moreover, received images and videos could be analyzed in real-time or afterwards.

Metadata produced by video algorithms will be stored in the cloud. It will be possible to interact with the video analytics algorithms through dedicated web services.

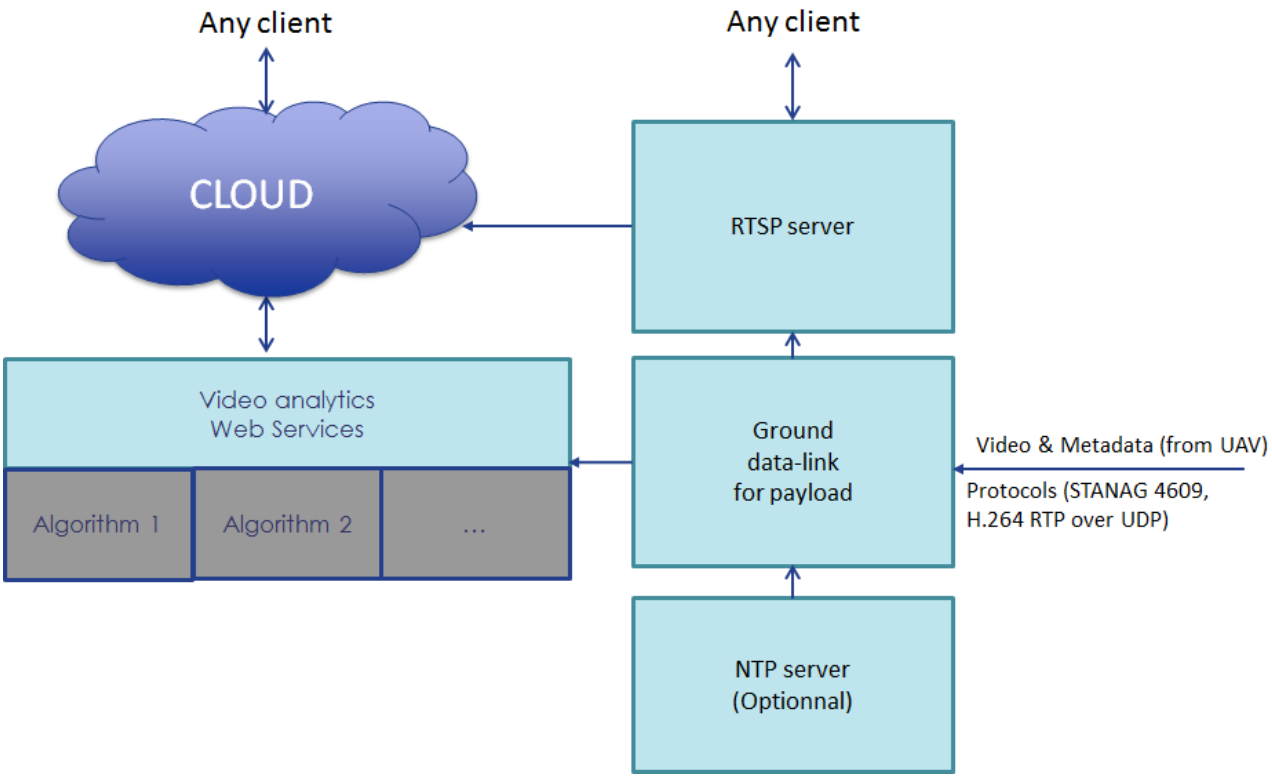

Figure 15: On-ground Video Station (OGVS)

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5.5 Communication Relaying Service

In First Response scenarios, communications cannot be taken for granted, since existing communications infrastructures are very often affected by the disaster itself (e.g., destroyed by fire or overloaded). Damaged communications infrastructures greatly affect the coordination and operational efficiency of First Responders.

To overcome this problem, the ResponDrone platform will offer a *Communications Relaying Service* which uses drones to transport *INESC TEC's Communications Payload* and deploy, on-demand, an airborne private wireless network infrastructure (LTE + Wi-Fi) for First Responders. This private and independent network will allow the First Responders to communicate among themselves and also to access the ResponDrone platform and use its services. The *Communications Relaying Service* can be requested, on-demand, by an on-field commander to answer the dynamic communications needs of the scenario. For this service, two types of missions to transport the communications relaying equipment will be offered:

1. **Area coverage** – this type of mission allows a user to select, on the map, the area where she/he predicts there will be First Responder users needing communications coverage. This type of mission is especially useful at the beginning of operations, even before the First Responders arrive to the field, ensuring connectivity from the start. This type of mission is also useful when the area of operation of the First Responders is very focused on a static location. Figure 16 shows the mock-up for this type of mission, where a user can use the following sequence of interaction:

    a. Select the "Communications Relaying Service" icon in the Services menu group (blue icon with a cell tower, left side of the screen);
    b. A "Communications Relaying Service" popup opens showing the number of available communications relays (e.g., 3);
    c. Select the "New Comms Mission", and a new popup window opens allowing to select the type of mission "Area Coverage";
    d. Select the area where communications coverage is needed.
    e. Finally, the ResponDrone platform analyses the number of relays needed based on the expected coverage of each relay and asks for user confirmations to deploy the mission.

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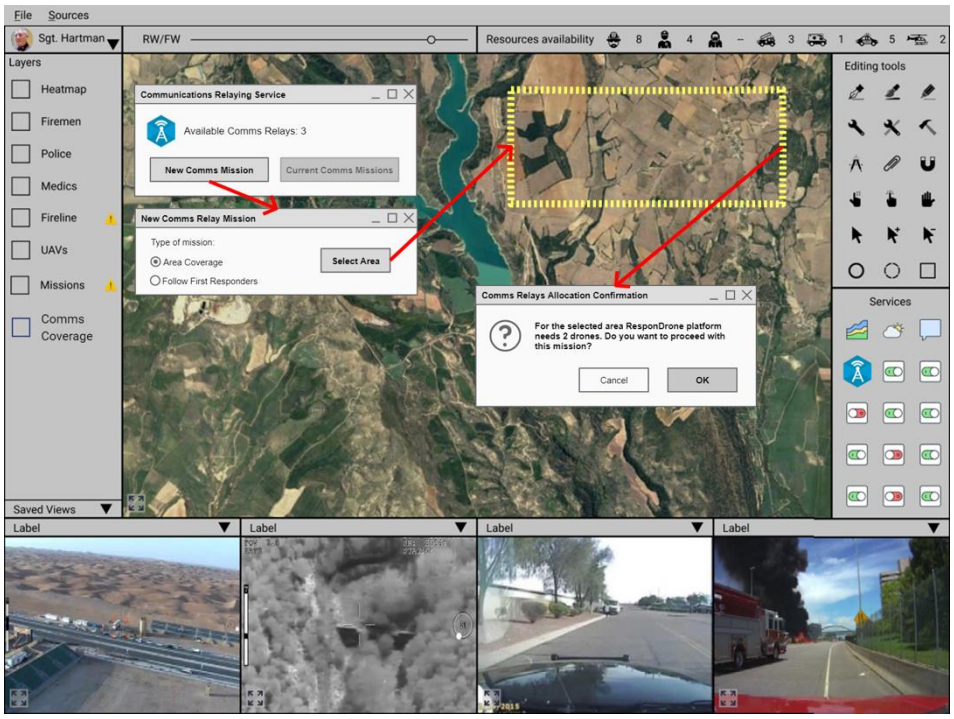

Figure 16: Mock-up for the type of mission "Area Coverage": starting by selecting the area to deploy communications.

Figure 17 presents a mock-up showing a mission "Area coverage" already running. The blue icons represent the location of the drones transporting the communications payload. The green circle represents the expected coverage area. Figure 18 depicts a mock-up showing the list of active missions, presenting their types, the number of drones used, and the mission duration (elapsed time since deployed). In this window, the user can change the type of mission and change the area in which he wants network coverage to be provided. This allows fine-tuning the location of the relays.

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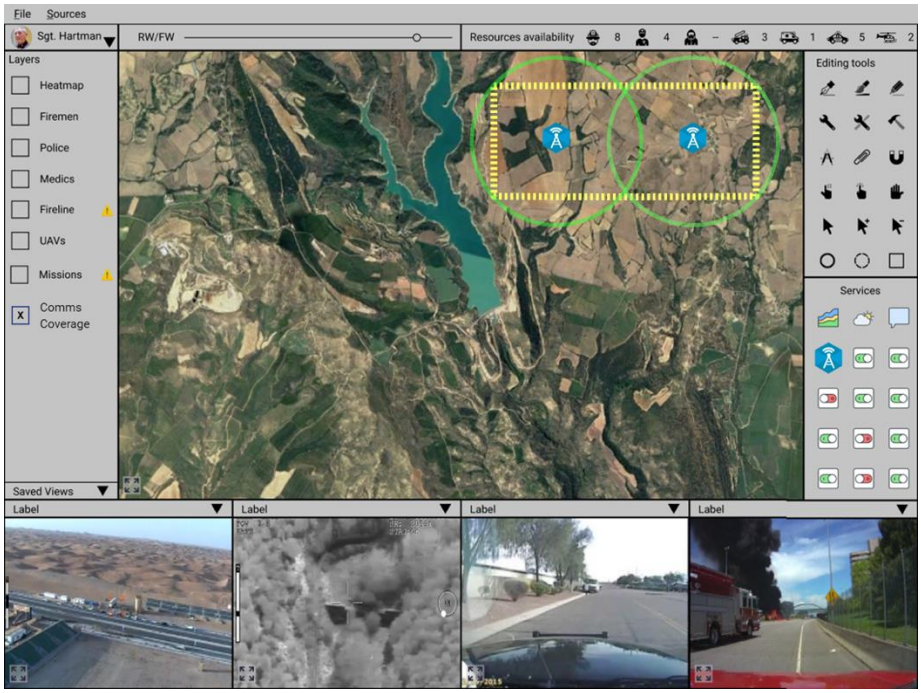

Figure 17: Mock-up for the type of mission "Area Coverage": mission already running.

Figure 18: Mock-up for the type of mission "Area Coverage": listing missions, changing mission types, and editing areas.

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2. **Follow First Responders** – this type of mission allows a user to select a group of First Responders that need communications coverage. The ResponDrone platform is able to automatically and dynamically adapt the location of the communications relays to follow the First Responders, optimizing the quality of service offered by the network. This type of mission is very important for highly dynamic scenarios where teams of First Responders could be changing position frequently (e.g., as a wildfire keeps spreading). Figure 19 shows how a user can select this type of mission by following the following sequence of interactions:

1. Select the "Communications Relaying Service" icon in the Services menu group (blue icon with a cell tower, left side of the screen).
2. Select a "New Comms Mission", which opens a new popup to select the type of mission needed.
3. Select the "Follow First Responders" type of mission.
4. Select the First Responders that the relay should follow during operation. The ResponDrone platform will present the necessary relay UAVs to perform the operation and ask for confirmation to proceed with the new mission.

Figure 19: Mock-up for the type of mission "Follow First Responders": starting the mission.

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Figure 20 presents a mock-up showing the new mission in effect. Note that the "Comms Coverage" layer is selected as visible, and the system interface is able to present both "Communications Relaying Service" missions at the same time.

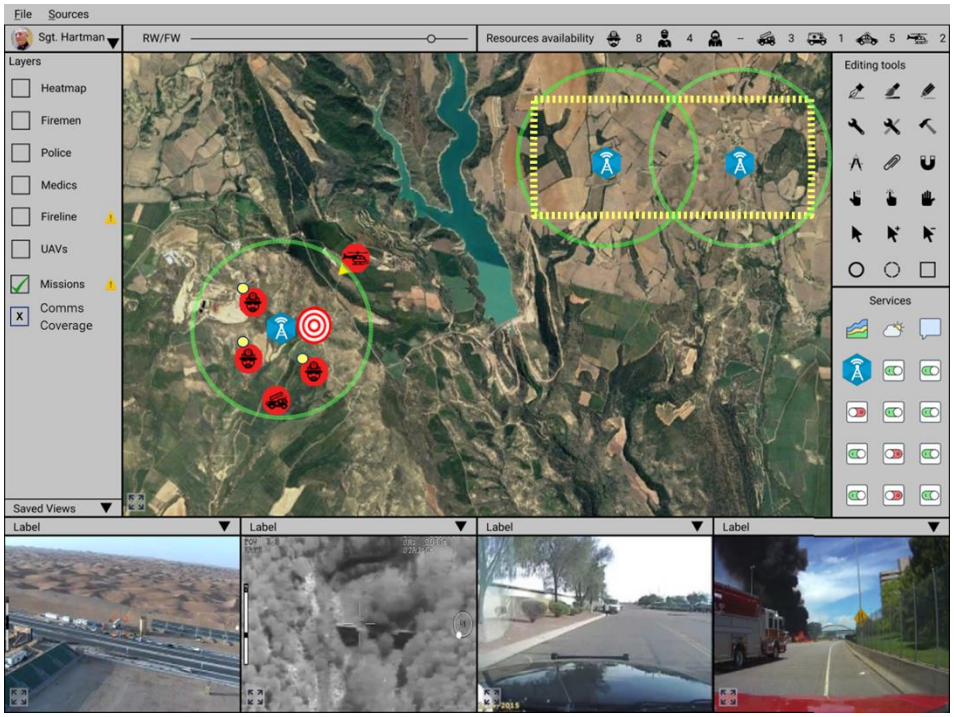

Figure 20: Mock-up for the type of mission "Follow First Responders": mission already running

5.6 Decision Support Service

There will be a service for supporting decision making through situational assessment or recommendation of decisions according to the modeled knowledge and the analyzed data.

Decision support service will be launched only from the desktop interface by clicking on its corresponding icon on the service palette. It will be available on the web interface, and when clicked, a new window will pop-up.

The decision support service relies on ExpressIF, the fuzzy expert system developed at CEA. ExpressIF aims at modeling expert knowledge with rules written as close as natural language as possible in order to reproduce automatically a human expert reasoning on data (Poli & Boudet, 2017). ExpressIF has several advantages compared to other Fuzzy Expert Systems found in the literature:

- It can use classical operators such as AND, OR and NOT, but also various operators for temporal, spatial, or even spatio-temporal reasoning. These operators can be seen as

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the vocabulary, which can be used in the rules, representing knowledge in an even more natural syntax.
- It can connect to a target information system.
- It can monitor online input values. The system is said causal, i.e. at time t, the decision is made over the past values.

Rules of ExpressIF are based on Fuzzy logic (Zadeh, 1965). This logic is a multi-valued logic which truth values are comprised in the range [0,1], instead of the classic two values “true” and “false”. Thus, it can handle the uncertainty of the knowledge (e.g. a «hot temperature» or a «long distance») and the possible inaccuracy of input values. ExpressIF is able to reason with a wide heterogeneity of input variables:

- Numerical continuous (like a temperature);
- Numerical discrete (like a counting variable);
- Boolean (true / false);
- Categorical (like the type of an event in a typology);
- Positions or regions in an image;
- Signals (like a measurement in time)
- Spatio-temporal information (positions in time)

The output of fuzzy decision rules can be numerical (as a score) or categorical (as a recommendation).

According to the type of the crisis and end-users needs, one or several services will be available to support decision making of First Responders, among them the commanders. Interviews of end-users have to be conducted in order to understand in more detail their needs, how they analyze a situation or what conclusions can be drawn from a situation. Thus, the goal of these services will be defined later in work package 6. For instance, a decision support service may help the commanders to assess faster the situation and help anticipating possible hazards. Different scenarios will be included and formalized during the project.

There will be two ways of using this service: preparatory and an on-site usage:

- The **preparatory usage** consists in writing rules that represent the expertise of the end-users in different situations and that will be used during the online phase. The preparatory stage will use a web-based application for rule authoring that will implement the same concepts as our current editor. The goal is to allow people with different operating systems to use the rule editor. With the web-based editor, the predefined rules can be updated, changed or customized by decision makers before the crisis. Thus, the behavior of the service is totally customizable with the rules. Screenshots of the current version of the rule editor are shown from Figure 21 to Figure 23.

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- The **on-site usage** will consist in making the decision during the crisis by applying automatically the rules to the situation. The responsible of decision-making will call the decision-making service that will contact the other services and databases, including a GIS, to fetch all information needed. It will recommend decisions, compute scores or raise alerts according to the predefined rules. The results will be computed on the fly and may change from time to time.

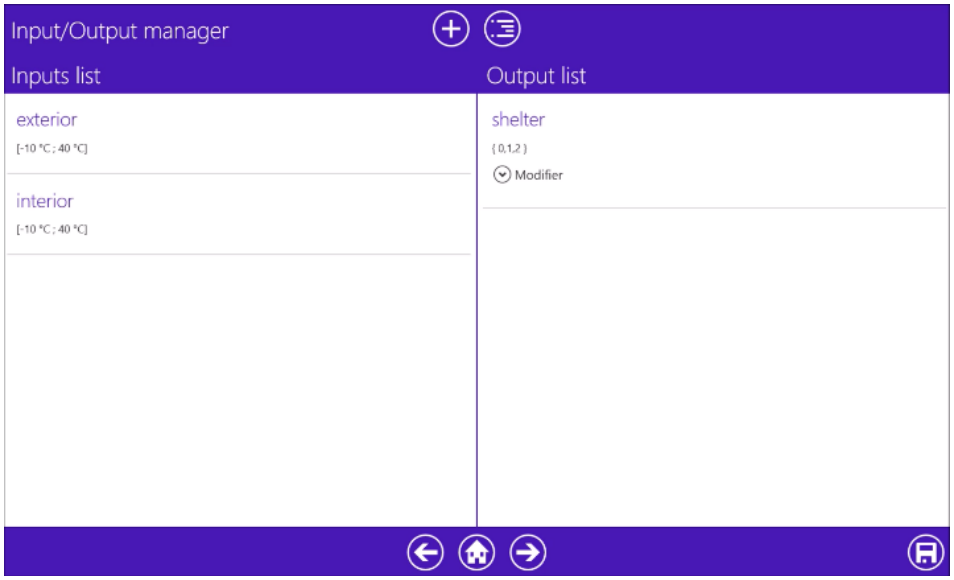

Figure 21: ExpressIF Rule Editor for Windows: input / output lists. Used during preparatory phase

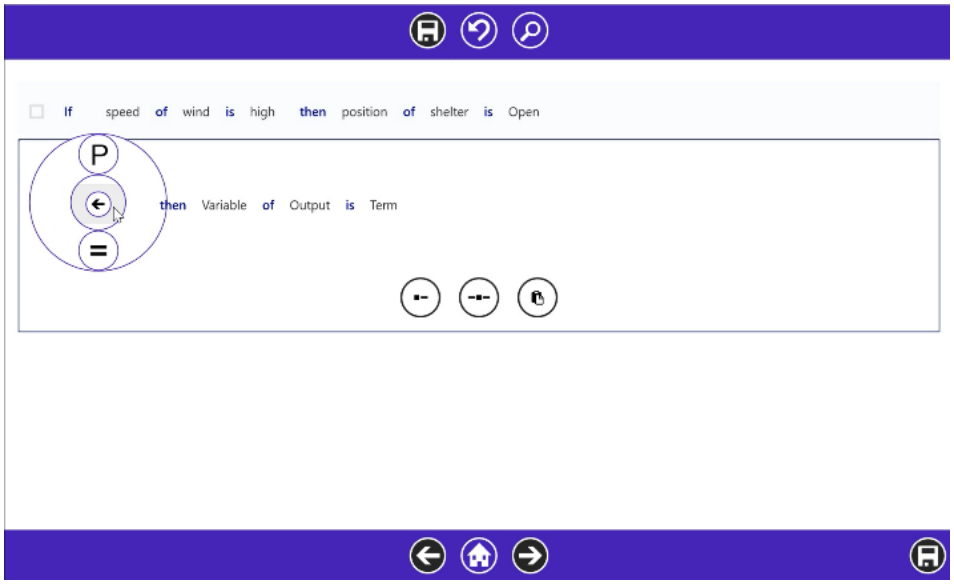

Figure 22: ExpressIF Rule Editor for Windows: editing of a rule. Used during preparatory phase

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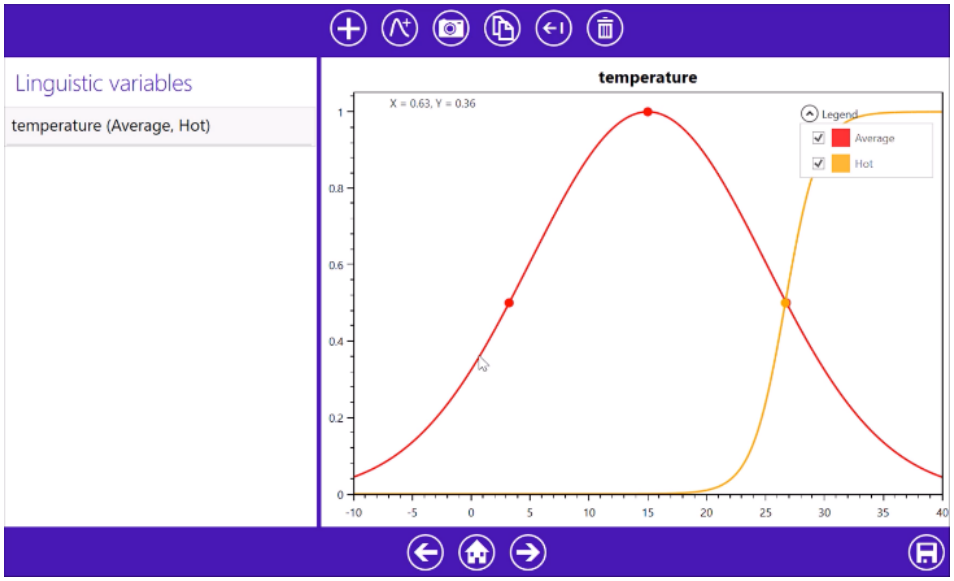

Figure 23: ExpressIF Rule Editor for Windows: editing of vocabulary used during preparatory phase

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6. References

- Annex 1 - Summary of the Design Thinking Workshop
- ResponDrone - D15.2 Report of Field Studies
- ResponDrone - D15.5 Functional Design
- ResponDrone - D3.1 Requirements report
- Web interface responsive mock-up: https://bit.ly/2u05Wlr

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Annex 1
Summary of the Design Thinking Workshop

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“NOVEL INTEGRATED SOLUTION OF OPERATING A FLEET OF DRONES WITH MULTIPLE SYNCHRONIZED MISSIONS FOR DISASTER RESPONSES”

ResponDrone

Summary of the Design Thinking Workshop

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Project website	https://respondroneproject.com/

Deliverable Information	
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Work package title	Studies of disaster response operations
Deliverable number	-
Deliverable title	-
Description	Summary of the Design Thinking workshop
Lead beneficiary	DLR
Lead Author(s)	Max Friedrich
Contributor(s)	Michael Borkowski
Revision number	V1.0
Revision Date	
Status (Final (F), Draft (D), Revised Draft (RV))	

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Dissemination level (Public (PU), Restricted to other program participants (PP), Restricted to a group specified by the consortium (RE), Confidential for consortium members only (CO))	PU

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Introduction to Design Thinking

Design thinking is a set of tools and methods to solve design problems in a way that is convincing to the user of the designed system.
In situations where a problem (in ResponDrone: the system to be designed) is complex, not well-defined and there are many stakeholders, it is particularly hard to design a system that satisfies all requirements. A big challenge for the system developers is to align the functionality of the new system with the actual needs of the end users.
In order to avoid building a system that correctly meets what the system developers deem to be valid requirements but fails to address actual requirements, Design Thinking focuses on frequent validation against the user point of view (avoid "building the wrong thing right").
The six-step iterative Design Thinking process combines engineering methodology with experimental aspects from the teaching of design. The core elements of the Design Thinking mindset are multidisciplinary teams (people), variable space (place) and the Design Thinking process. Ideas are created in brainstorming and rapid prototyping sessions, followed by validation against the user's needs.
The aim of the Design Thinking workshop was to create potential mock-ups of the ResponDrone system that specifically take into account the ideas and needs of the end users, i.e., first responders. Figure 1 illustrates the design thinking process and methods. As depicted in Figure 2, the first two phases of the design thinking process deal with identifying and understanding the problem space. The last three phases specifically focus on the solution space and aim to create solutions for the problems identified in the first two phases.

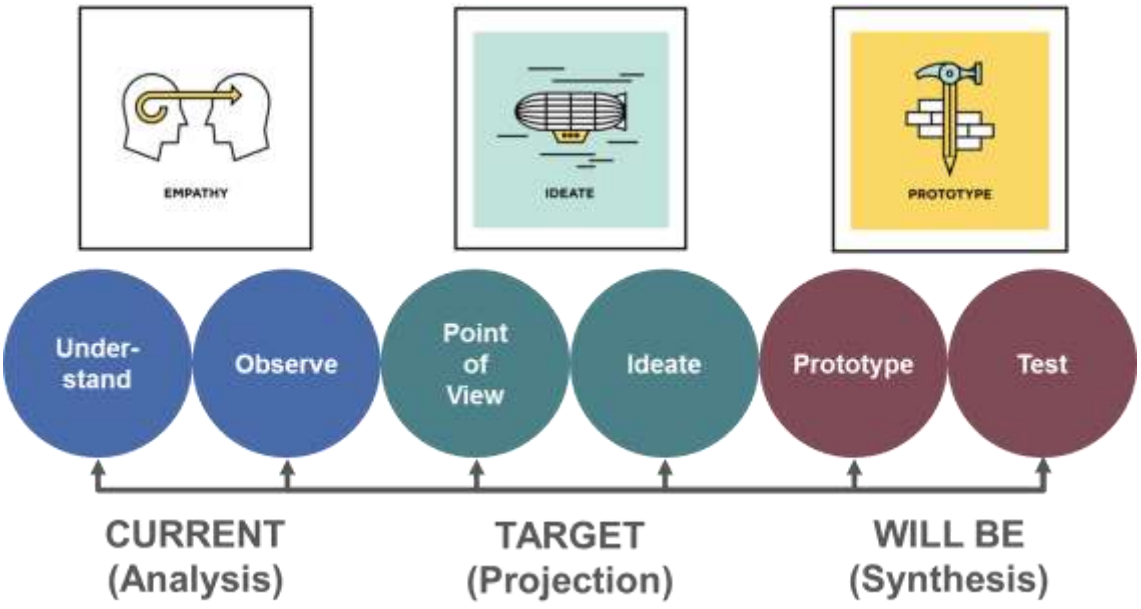

Figure 1. Design Thinking methodology.

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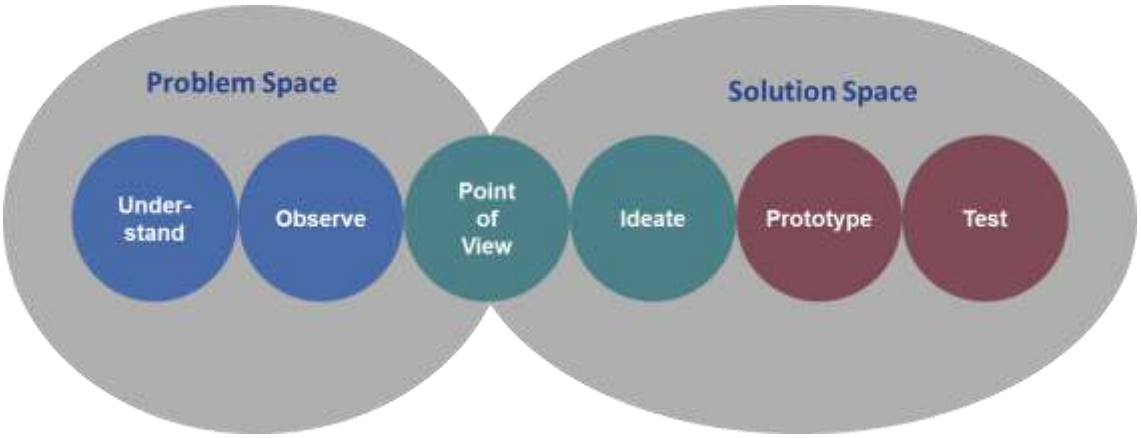

Figure 2. Problem and solution space.

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Applied methodology

In the workshop, the design thinking methodology was applied in order to create potential mock-ups of the ResponDrone system that specifically take into account the ideas and needs of the end users. The 16 participants were divided into three groups where the aim was to reach a good balance of end users, developers and researchers in each group. The applied methods and their targeted outcomes are presented in Table 1. A detailed description about the methods and how they were applied is outlined below.

Table 1. Applied methods

Phase	Method	Aim
Understand	**Context Map**	Understand the context.
	Stakeholder Map	Identify relevant stakeholders
Observe	**What? How? Why?**	- Understand what the stakeholders do, how they do it and why they do it. - Identify gaps/ problems.
	Interview	
Point of View	**Persona**	Identify gaps/ problems.
	Customer Journey Map	Identify typical processes, the persona‘s needs and aspects related to her/ his behavior.
	How Can We?	Define the problem.
Ideate	**Rapid Idea Visualization**	Generate as many solutions as possible that solve the initial problem and satisfy the persona‘s needs.
Prototype	**Lego bricks, drawing…**	Create simple representative models of one particular solution.
Test		- Check if the prototype solves the initial problem and satisfies the needs of the persona. - Identify the (technological) steps that need to be taken in order to implement the solution.

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Context Map

The context map was created in order to understand the context of the domain for which the ResponDrone system will be designed. The method used for creating the context map was brainstorming. Each group conducted a brainstorming for the term “Disaster Management”. At this point, the following rules were introduced which the groups were asked to follow during the brainstorming:

- No criticism
- Focus on quantity
- Be visual
- One person speaks at a time
- Encourage wild ideas
- Combine and improve ideas

Figure 3. Context map template for the term "Disaster Management"

Stakeholder Map

The stakeholder map was created to identify all relevant people or parties that are involved in disaster management. In a first step, a second brainstorming session was conducted for the different roles that are involved in disaster management. The participants decided upon the three most important roles. Each group was then assigned one of the three chosen roles. The groups created a stakeholder map for their assigned role and specified the relationships of each identified stakeholder. See Figure 5 for an illustration of the method.

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Figure 4. Brainstorming template for the term "Roles in disaster Management".

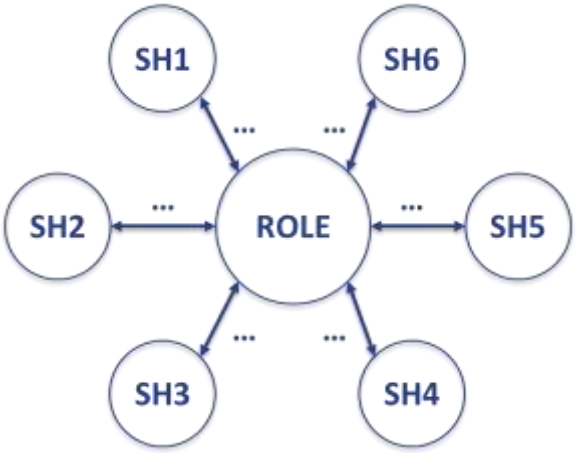

Figure 5. Stakeholder map template.

What? How? Why?

In the next step, the participants investigated the activities of their assigned role in terms of what representatives of this role do during a disaster management mission, how they do it and why they do it. This method served as means to deepen the understanding of the work that the role conducts during a disaster management mission.

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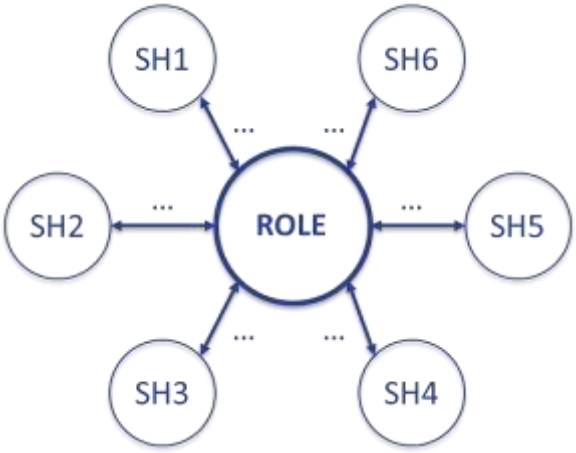

Figure 6. Illustration of the *What? How? Why?* method. The focus lies explicitly on the role in the center and her/ his activities.

Interview

The design thinking methodology foresees an interview with a subject matter expert in the field in order to further understand the activities that are being conducted during a disaster management mission. Since it was not possible to visit a disaster site and interview a subject matter expert, the groups chose one person that fitted their assigned role best. The other group members prepared and conducted an interview aiming to deepen their understanding about the *What*, *How* and *Why* of activities.

Persona

Based on the conducted interview and the interviewee a persona was created who will be the future user of the system. This method serves as means to deepen the understanding of the group's assigned role and empathize with the person. The groups were asked to include the following characteristics for describing the persona:

- Name
- Picture (drawing)
- Age
- Personality
- Family
- Strengths/ weaknesses

Customer Journey Map

A customer journey map was created in order to identify typical processes, the persona's needs and aspects related to her/ his behaviour. The groups were given the template presented in Figure 7 and were asked to fill in the cells.

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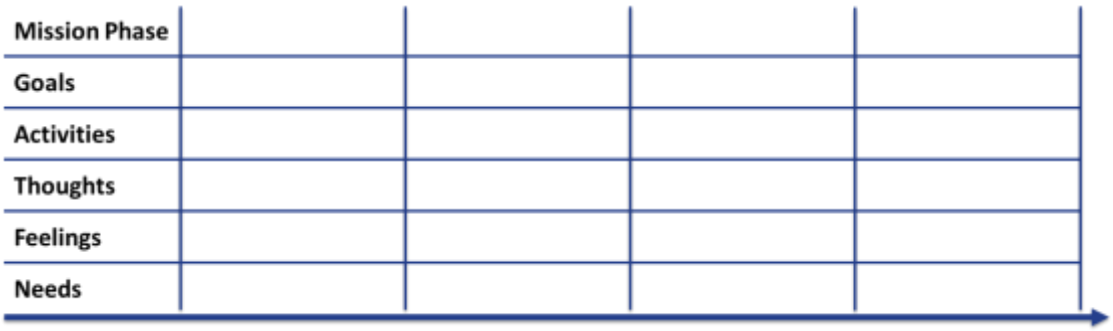

Figure 7. Customer Journey Map template.

How Can We?

Based on the customer journey map, the groups derived specific needs of their persona and identified the problems that need to be solved. These needs were written down in the form of "How can we…" questions. The following questions served as templates:

How can we…
…help [*PERSONA*] in/to…
… assist [*PERSONA*] in/to…
…make it easier for [*PERSONA*] to…
…accelerate [*PHASE/ACTIVITY*] in order for [*PERSONA*] to…
…improve [*PHASE/ACTIVITY*] in order for [*PERSONA*] to…

Ideate

In the ideate phase, the groups created as many solutions as possible that address the identified problems and satisfy the derived needs of the persona. The groups followed the steps outlined below:

1. Individual brainstorming: Ideas for Solutions.
2. Presentation of ideas to the group.
3. Clustering of similar ideas.
4. Choose ONE idea.
5. Draw 8 rough draft design solutions for the idea.
6. Choose ONE draft design solution.
7. Draw a refined and more accurate draft of the design solution.

Prototype

In this phase, the groups were asked to choose one of the derived solutions of the Ideate phase and build a simple but representative prototype of the solution. For this purpose they were given paper and pencil, presentation walls, flip charts and lego bricks.

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Test

During the test phase, each group presented their identified problems, their persona and the solution prototype to the other groups. The other groups were asked to check if the prototype solves the initial problem and satisfies the needs of the persona.

Discussion

In the next step, each prototype was investigated in more detail and the (technological) steps that would be needed to be taken in order to implement the solutions were identified.

Results

The reported results are limited to the identified roles in disaster management, the stakeholder maps, customer journey maps, the "How can we" questions, the results of the ideation phase as well as the prototypes.

Roles

The identified roles are presented in Table 2.

Table 2. Roles in disaster management

Role	Example
High-level decision maker	Government, regional authority, local authority, mayor, minister
Operational decision maker	Communicating officer, incident commander, operating leader, coordinator
In the field	Firefighters, police, meds, search and rescue
The public	Victims, other population
Media & support	Journalists, reporters, secretary

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Stakeholder map

Group 1 – The Public

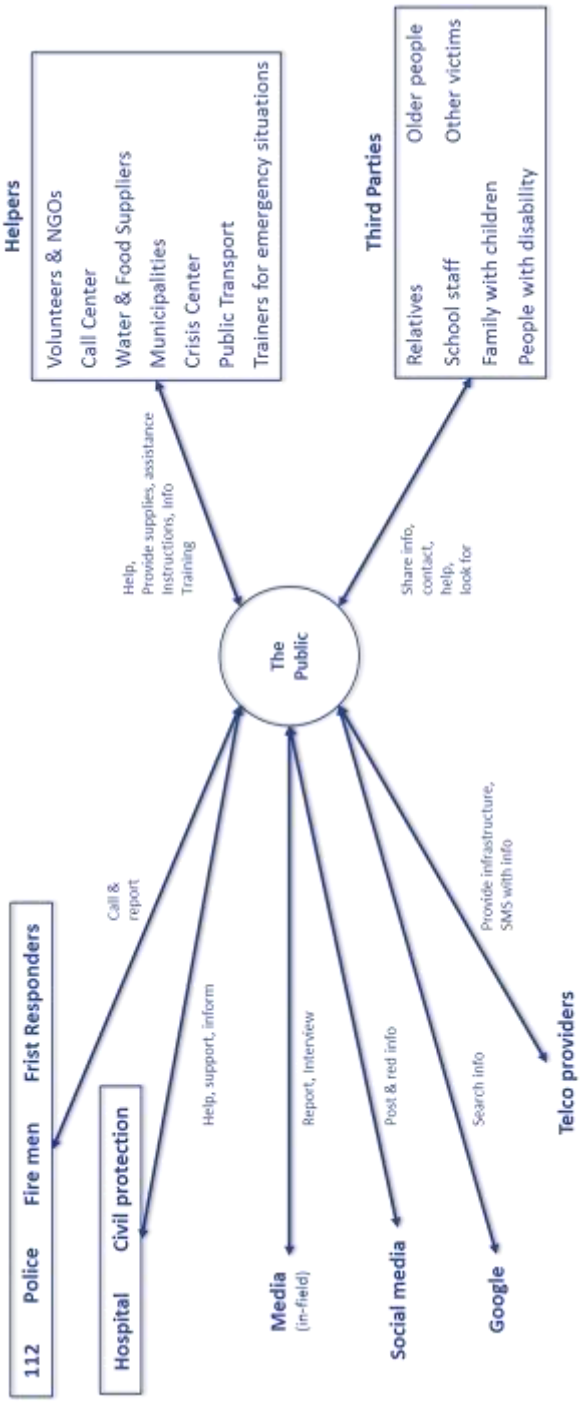

Figure 8. Stakeholder map - The Public.

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Group 2 – Inter-Agency Command Center

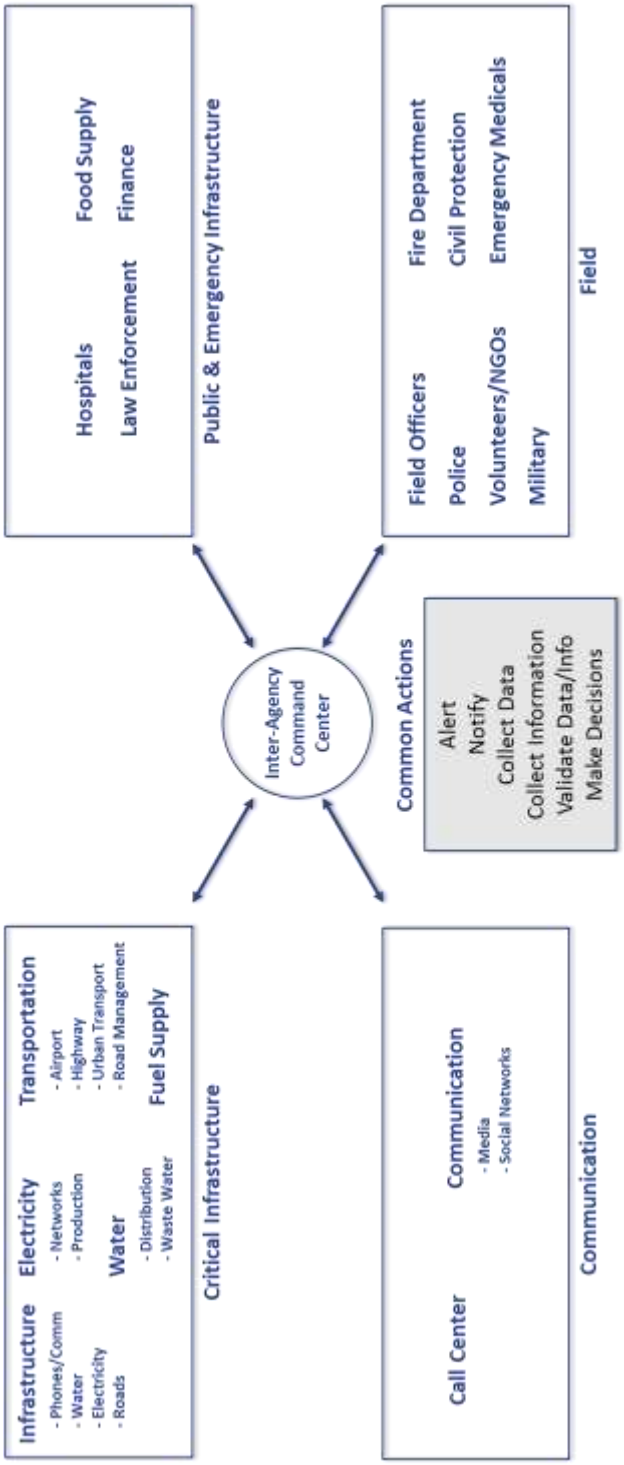

Figure 9. Stakeholder map - Inter-Agency Command Center.

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Group 3 – Units in the Field

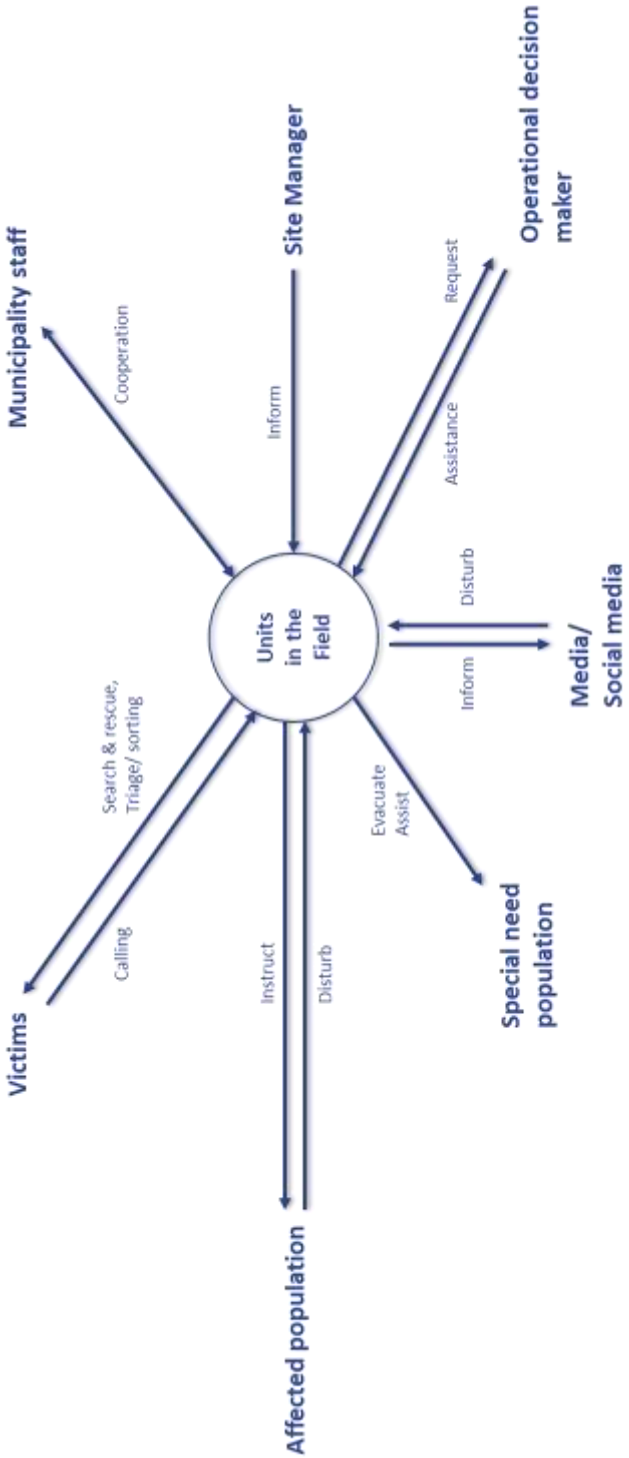

Figure 10. Stakeholder map - Units in the Field.

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Customer journey map

In this section the customer journey maps of each group are presented.

Group 1 – The Public

Table 3. Customer journey map – The public.

Mission Phase	Awareness	Emergency	Recovery
Goals	- Survive - Save what is possible	- Survive - Keep calm	- Return home - Health recovery - Economic recovery
Activities	- Call for information - Call for help - Check for relative's conditions - Inform authorities	- Evacuate - Communicate about condition - Check for relative's conditions - Help others	- Rebuild - Evaluate losses
Thoughts	- For relatives - For own life - Will I die?	- For belongings - When will the situation end?	- For the future
Feelings	- Fear - Stress	- Worried about after - Sad - Angry - Uncertainty	- Frustration - Apathy - Relieve
Needs	- Information - Evacuate - Help	- Information - Emergency shelter - Food, water etc. - Health care - Help	- Information - Money - A place to stay

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Group 2 – Inter-Agency Command Center

Table 4. Customer journey map – Inter-Agency Command Center.			
Mission Phase	**Chaos**	**Stability**	**Aftermath**
Goals	- Overview	- Minimize impact	- Bring victims to normal life
Activities	- Data collection - Assign rescue missions	- Prioritize - Monitor the activities and data - Response planning	- Infrastructure & healthcare insurance - Damage assessment - Psychological support - Planning end of the mission
Thoughts	- Structure of the incident command	- Be ahead for a few hours	- How to bring the community together
Feelings	- Eager to help	- I hope I am in control	- To make a difference
Needs	- To calm down - Information	- Scenarios - Feedback from the field	- Resources

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Group 3 – Units in the Field

Table 5. Customer journey map – Units in the Field.				
Mission Phase	**Receiving the task/ driving to the site**	**First assessment on-site and planning**	**Rescue operation**	**Handover**
Goals	- Reach quickly - Understand the disaster - Assign the main roles	- Setting priorities	- Save lives and manage hazards - Mission continuity (team turnover)	- Getting back to stability
Activities	- Drive to site - Brief personnel	- Plan and ask resources	- Set the tasks - Communicate with CC: resources and report - Readjustments - Logistics - Search victims - Rescue victims	- Area cleaning - Feedbacks
Thoughts	- Chaos - Not enough info	- Reality	- Faster	- What can be improved?
Feelings	- Adrenaline - Confusion	- Terrified - Stressed out - I don't have time	- Pressure	- Satisfied - Frustrated
Needs	- More visual information	- Location of victims - Which to rescue first? - Information on any additional hazard	- Equipment - Resources - Time	- Mission continuity - Resources

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How can we?

In this section the "How can we" questions that each group phrased are presented.

Group 1 – The Public

Awareness phase

How can we…

- Help John to have information?
- Assist John to evacuate?
- Help John?
- Calm down John?
- Give John information about the people he cares about?
- Make John feel safe?
- Make it easier for John to request information?
- Assist John to save what is possible?
- Help john to survive?
- Report John's status to the people who care about him?

Emergency phase

How can we…

- Give John a shelter?
- Cover Johns basic needs (food, water, etc.)?
- Help John feel better?
- Reduce Johns uncertainty?
- Provide John with quick healthcare?
- Give John information about his belongings' situation?
- Give John information about the status of the emergency?
- Gove John a safe helping role (purpose)?
- Help John to deal with his feelings, e.g. panic, anxiety?

Recovery phase

How can we…

- Help John to get economic/ health/ psychological support?
- Help John to find a mid-term place to stay?
- Accelerate the rebuilding process for John?
- Ease the evaluation process of John's losses?
- Help John to rebuild his life?

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Group 2 – Inter-Agency Command Center

How can we…

- Help Achyle to get an overview
- Help Achyle to calm down in the chaos phase?
- Assist Achyle to define scenarios?
- Make it easier for Achyle to give better information to the authorities?
- Accelerate situation assessment?
- Assist Achyle to optimize the assignment of rescue missions?
- Accelerate the process of bringing the community back together?
- Assist Achyle to be ahead of the events for a few hours by providing data and predictions?
- Make it easier for Achyle to manage the existing resources in the aftermath phase?
- Assist Achyle to minimize the impact?
- Help Achyle to learn from the recent experience?

Group 3 – Units in the Field

How can we…

- Help Sam to reach the disaster site?
- Assist with more visual information?
- Help Sam to have a clearer picture of the situation?
- Help to set more quickly the tasks and objectives?
- Make it easier for Sam to have access to the information (maps, precise locations, images, heat maps…)?
- Accelerate the understanding of the situation to plan more quickly and effectively?
- Accelerate the localization/ search of victims?
- Improve Sam's reporting to operational level?
- Accelerate the planning of additional needs of resources?
- Improve the setting of tasks?
- Reduce the time for rescue?
- Help to analyze any additional risks that can occur to Sam's team?
- Make it easier/ improve decision making to save more lives?
- Improve the feedback phase?

Summary of the topics addressed in the "How can we" questions

The main topics addressed in the above questions are outlined below. These topics can be regarded as major needs that need to be covered with new systems assisting first responders and the general population in disaster response missions.

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Main topics

- Improve response time of rescue missions.
- Improve awareness of the current situation at the disaster site and how the situation will evolve in the near future.
- Improve decision making with respect to assigning tasks to rescue missions and managing resources in the field.
- Enable/ accelerate reporting to relevant parties/ stakeholders (e.g. higher authorities and population).
- Providing a comprehensive overview of available resources in order to optimize the planning of resources usage on site.
- Getting safely into and out of the disaster site as well as operating safely at the disaster site.
- Validate incoming uncertain information (e.g. a phone call from a citizen reporting a fire)
- Provide healthcare & psychological support for victims.
- Provide shelter and food supplies for victims during a disaster.
- Damage mitigation.
- Ease rebuilding after a disaster.

Ideate

In this section, the ideas, the groups created are presented.

Group 1 – The Public

- Push SMS for information.
- Emergency radio.
- Droppable walkie-talkies.
- Call centre for psychological help.
- Info via radio, internet, GSM-network.
- Audio instructions using drones.
- Search with drones.
- A website that informs in real-time.
- Guide for roles of victims to help.
- Send tools.
- Evacuation board.
- Advertise information incl. pictures.
- Connect to relatives.
- Mobile GSM-cell with drones.
- Real time aerial video feed.

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- Information system multi-platform (2-way).
- Provide list of relatives and their conditions via an App.
- App for security SMS.
- Medication/ food/ water location map.
- Map with real time evacuation routes.
- AR-extraction point route on location.
- 3D maps.
- Provide anti fire foam.
- Provide individual protection equipment.
- Provide barriers to prevent to water to enter homes.
- Provide floatation devices / safe inflatable capsule.
- Send drones for man lift.

Group 2 – Inter-Agency Command Center

Overview

- Define a map of all existing resources visually.
- Allow to make assignments on the screen.
- 3D map of the disaster area

Scenario

- Provide easy and quick way of defining scenarios manually.
- A system that uses AI to make predictions and/ or recommendations on all possible scenarios.

Interface

- A system that analyzes the data, helps to create and short summary and is able to export it.
- The first responder can send data directly to the system which analyzes the data visually.
- Radio & internet relay.
- Real time information on resources (e.g. vehicles etc.).

Characteristics

- Dissemination and pre-processing of data.
- Make use of previous experiences and official plans
- High definition images.
- Form and movement recognition.
- Heart beat detections.

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Group 3 – Units in the Field

- High resolution cameras.
- Life locator sensors/ Sensors to locate victims.
- Access to satellite images.
- Thermal camera.
- Access to observer's camera/ street camera.
- Large range of captors.
- Logistic delivery.
- Use of several drones at the same time.
- Low altitude + high altitude drones.
- Use the drones for early warning through a load speaker.

- Mobile device with maps.
- On site images on mobile before arrival on site.
- Access to drone cameras.
- Web site.
- User friendly interface.
- Shared screen with operational command post.

- Access to a library (maps, buildings or city maps) to compare before and after.

- Automatic forest fire monitoring and detections with drones.
- Maps with possible hazards.
- Automatic detection of people on site.
- Quick identification of roads that need to be closed.
- Decision making system.
- Communication system.
- Route planner using online maps taking traffic into account.
- Automatic traffic light switcher for first responders.
- Driving direction app.

- Data layers.
- Data center.
- Analytical drone mapping.
- Storage capacity for video + images.

- Uniform picture for forces/ forces
- Geo-location of other units/ forces on map.
- Regulation reduction.

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- Resource equipment software.

Prototypes

Group 1 – In the Field

Group 1 created two prototypes, the first one being an inflatable, floating modular capsule which can be dropped from a drone (see Figure 11 and Figure 12). The other prototype was a web site, where victims of a disaster can get real time information and post information (see Figure 13). In order for the victims to get access to the web site, drones are used to provide a communication network. The concept is illustrated in Figure 14.

Figure 11. Lego prototype 1 - The Public: The floating capsule.

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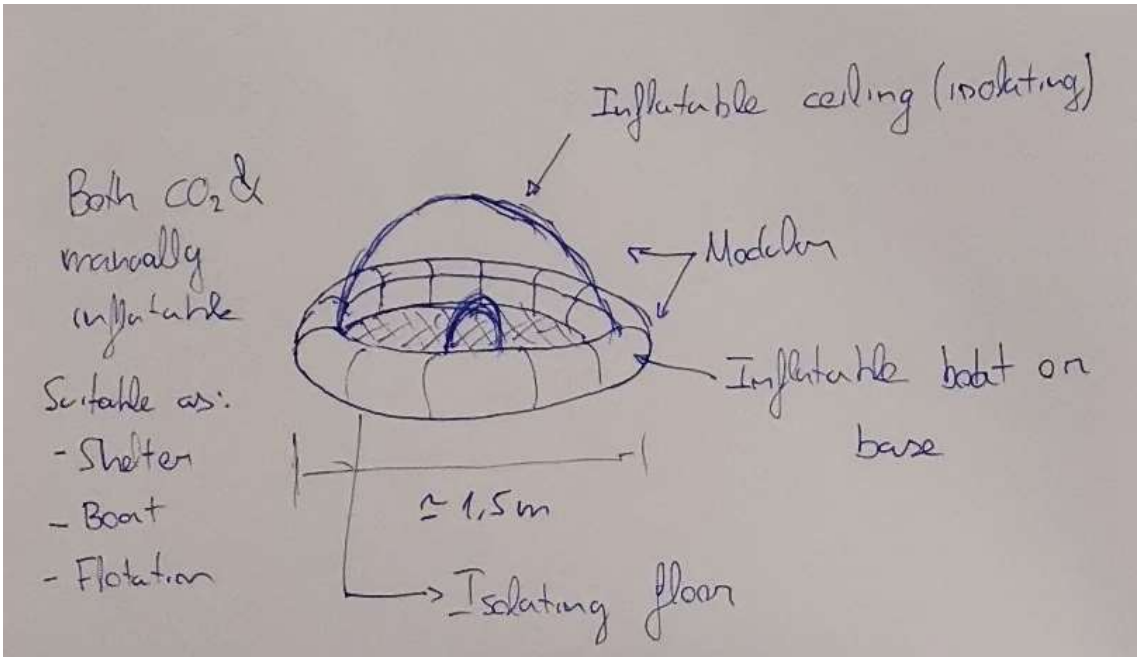

Figure 12. Drawing of prototype 1 - The public: The floating capsule.

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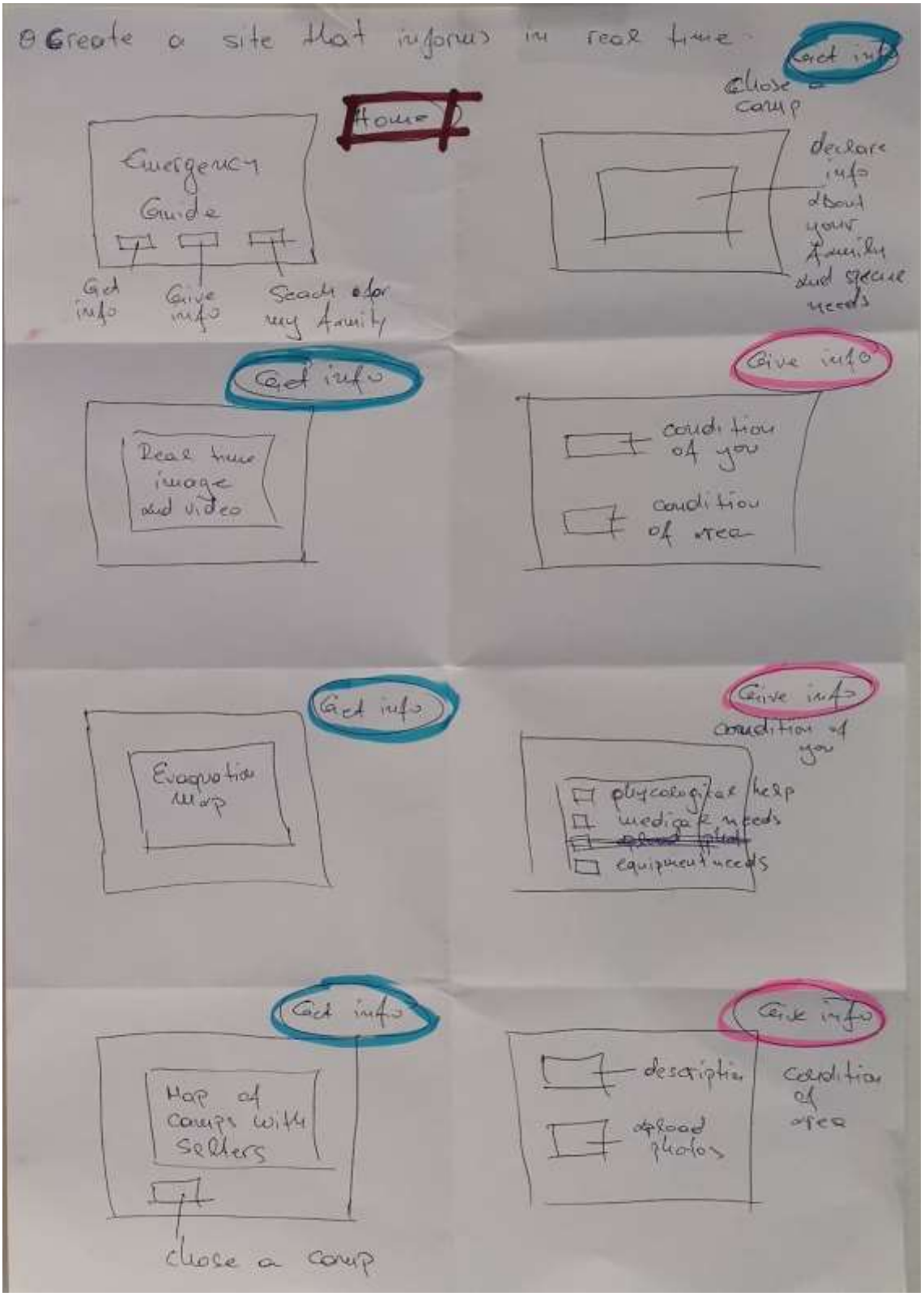

Figure 13. Prototype 2 - The Public: Web site with real time information.

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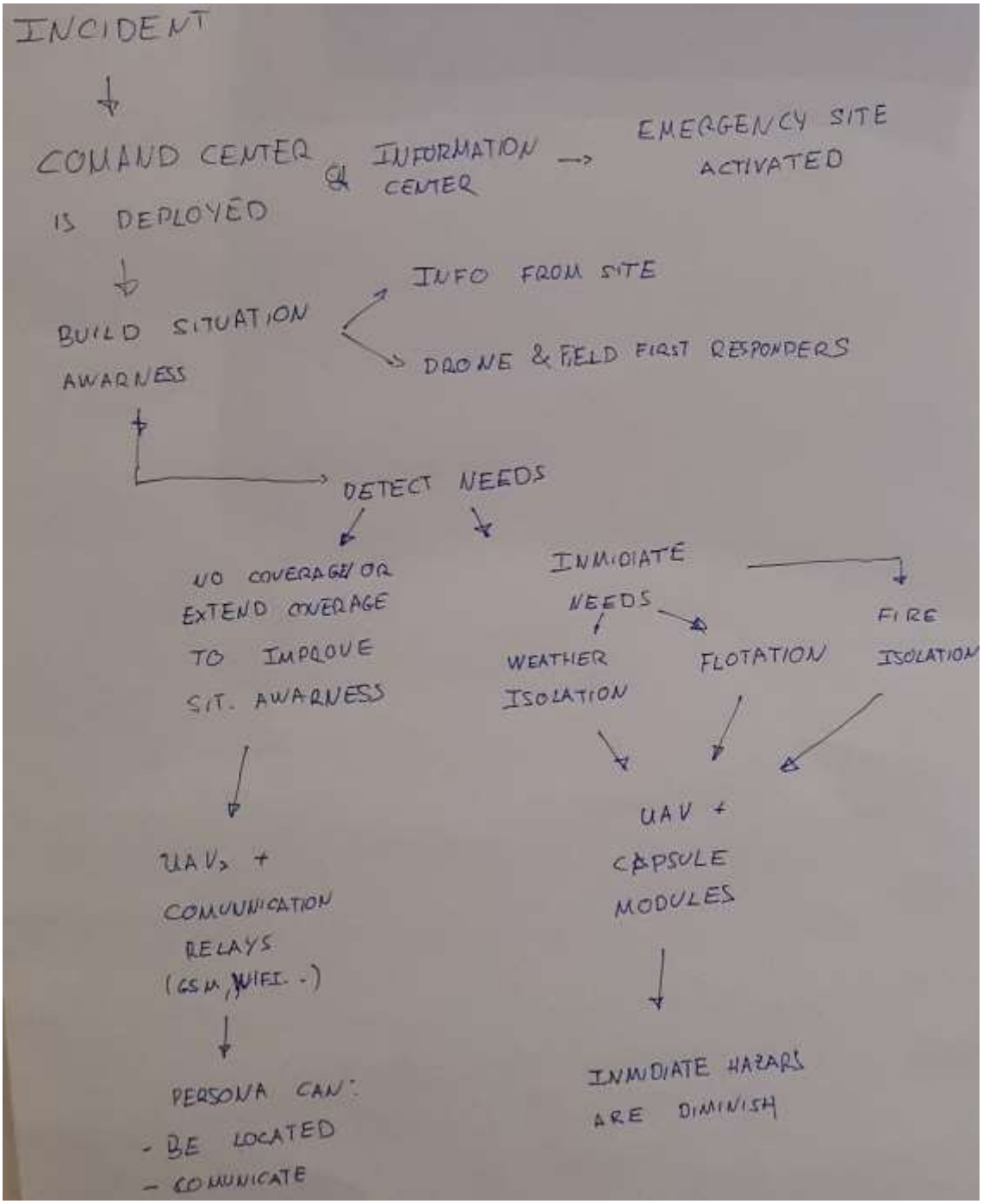

Figure 14. Prototype concept - The Public.

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Group 2 – Inter-Agency Command Center

The core idea of the prototype for the inter-agency command center is the usage of drones that gather relevant information from the disaster site and distribute the information to all relevant stakeholders. The information is processed and visualized on screens in form of a (3D-) map of the disaster area. Through the usage of predictive algorithms the first responders can go forward in time and see how the disaster is expected to evolve. It is also possible to go back in time and review past events.

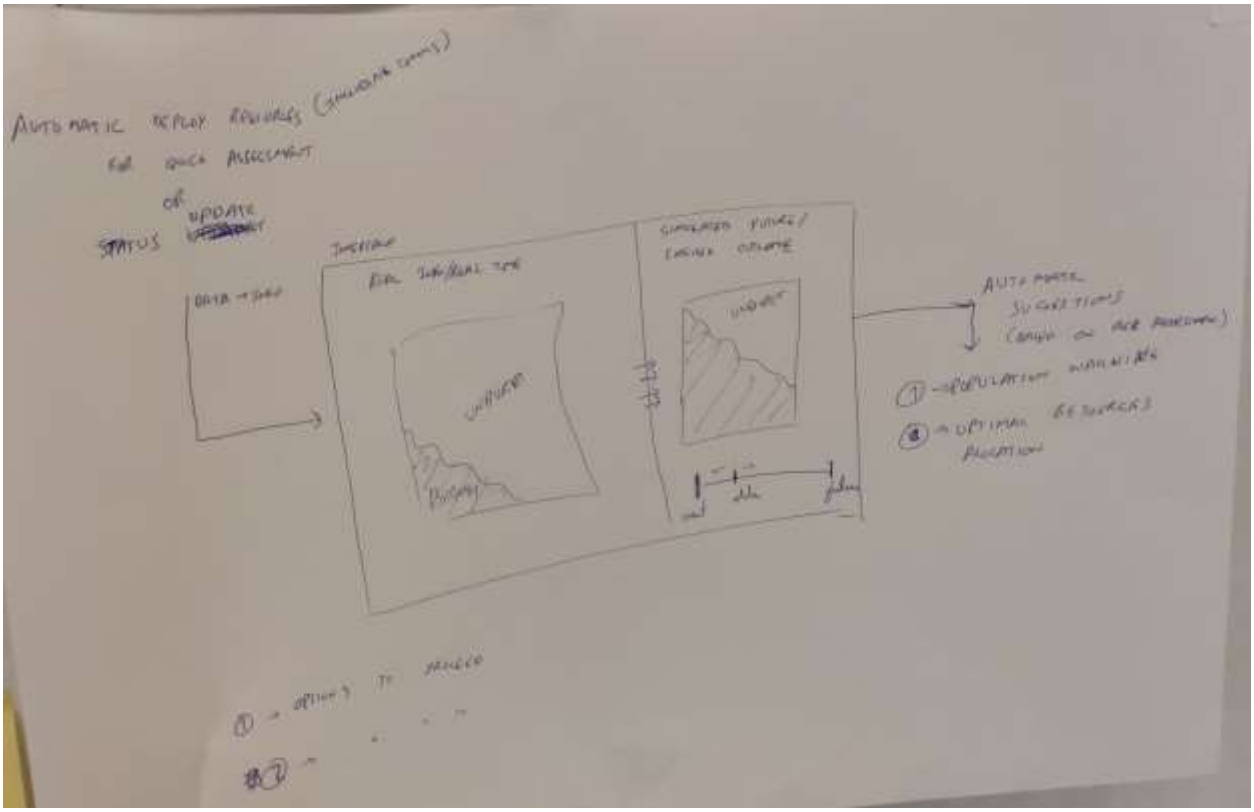

Figure 15. Prototype - Inter-Agency Command Center. Drawing of the concept (1).

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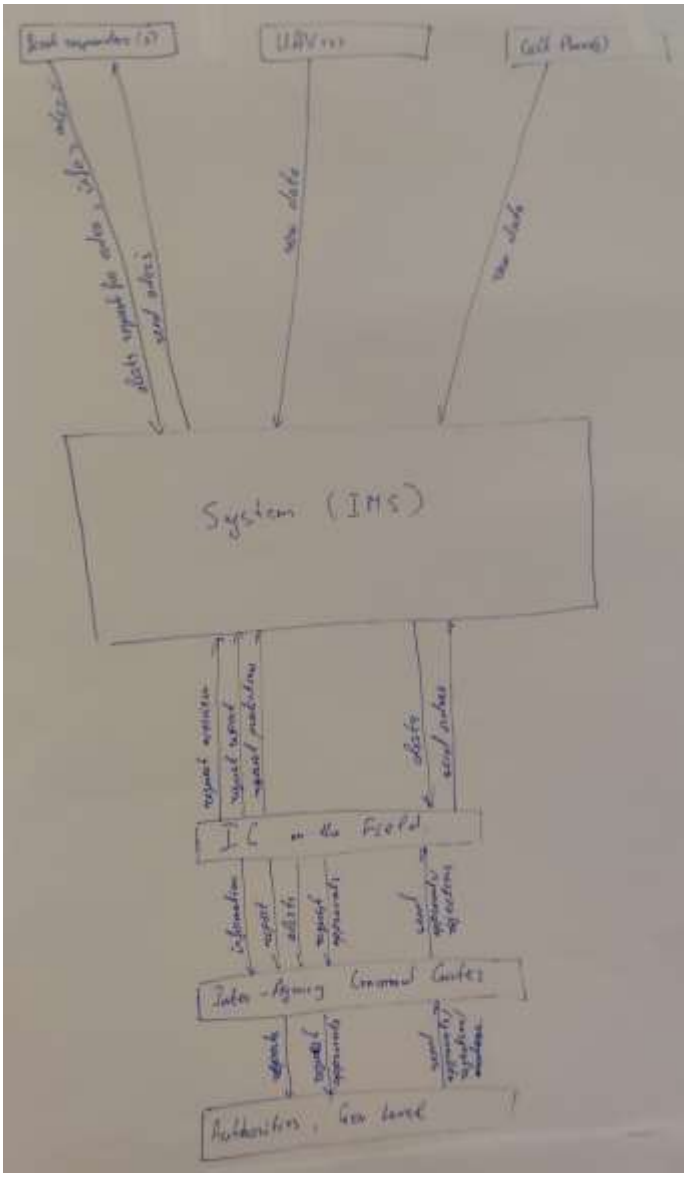

Figure 16. Prototype - Inter-Agency Command Center. Drawing of the concept (2).

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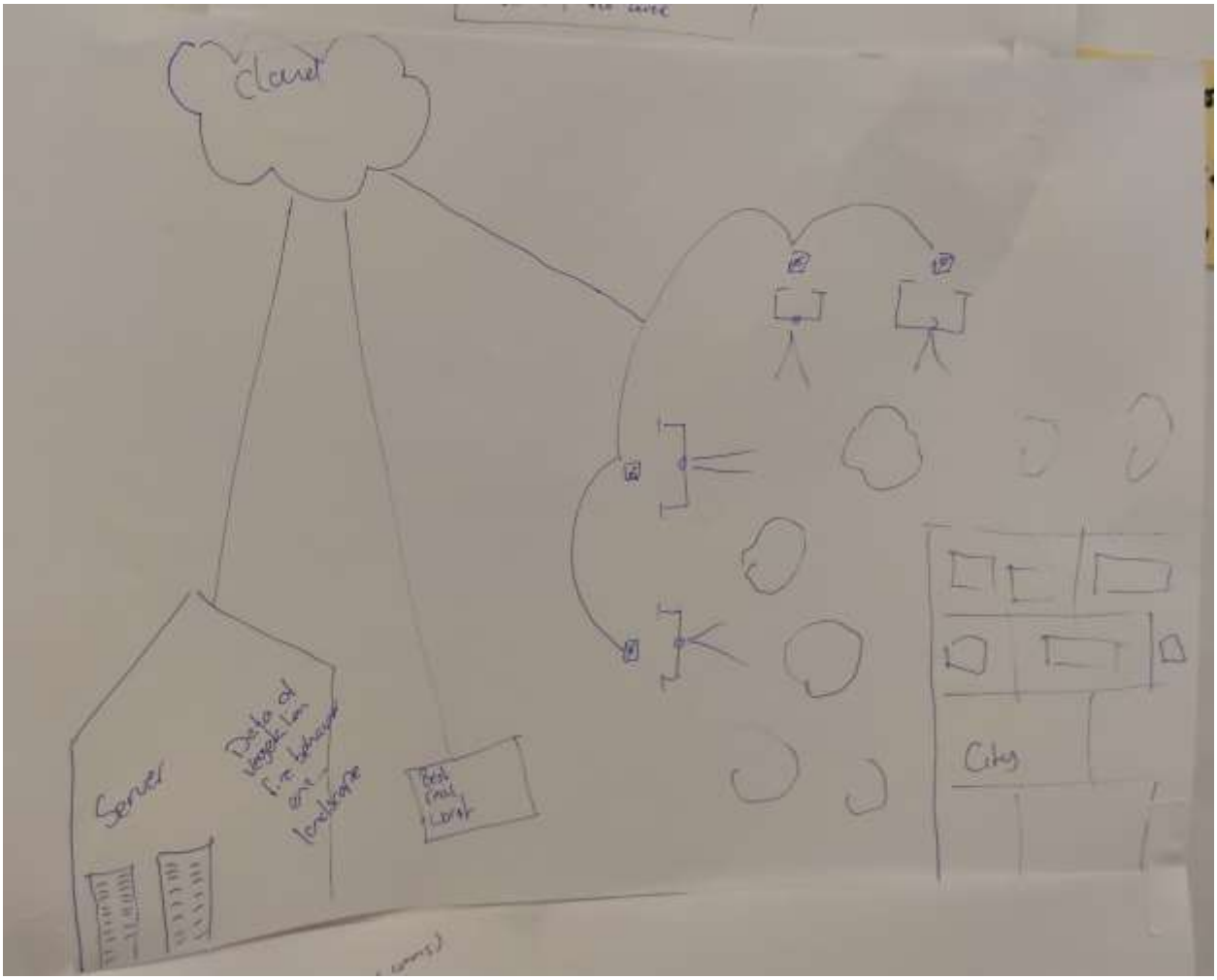

Figure 17. Prototype - Inter-Agency Command Center. Drawing of the concept (3).

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Figure 18. Prototype - Inter-Agency Command Center. Lego illustration of the prototype.

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Group 3 – Units in the Field

The prototype of group 3 is similar to the prototype of group 2. The group focused on the graphical layout of the human-machine interface (HMI) of the system. The HMI shows a map of the disaster area and allows the first responder to see where resources (e.g. other units, ambulance, fire trucks, food and water supplies etc.) as well as points of interest such as hazards, victims or accessible roads are located. The HMI enables the first responder to choose between different layers of information and allows her/ him to see the predicted future state of the situation as well as go back in time. All information is being transmitted in real time. Furthermore, the first responder can get visual confirmation of information through camera pictures on board of drones or vehicles deployed in the disaster area. Figure 19 shows an illustration of the HMI.

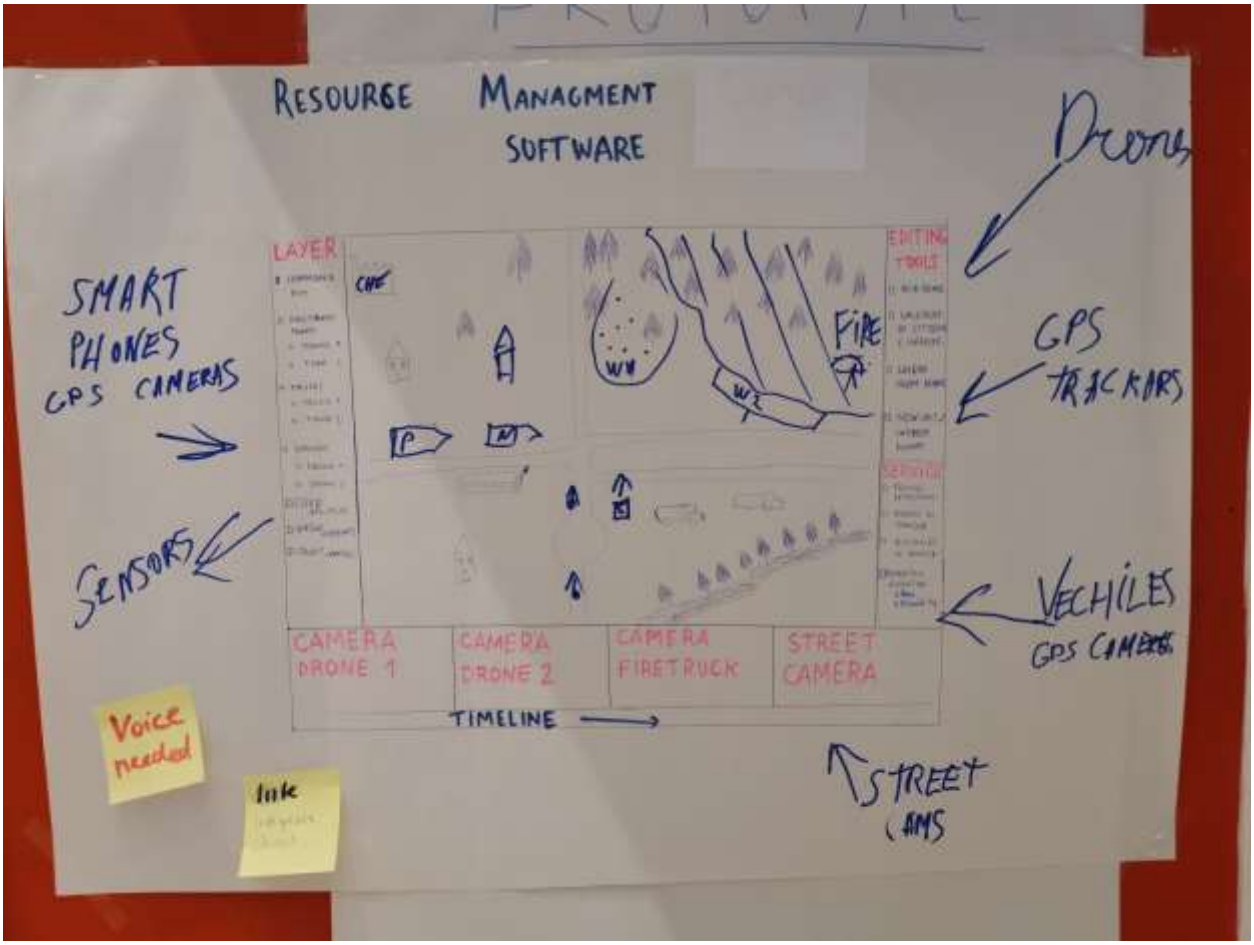

Figure 19. Prototype - Units in the Field.

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Discussion

The results clearly show the need for the constant provision of real time information to all stakeholders. The information needs differ slightly between the public and the first responders but both seem to have the need of being kept up to date on current occurrences in the disaster area, on the conditions of relatives or first response units deployed in the disaster area, of the status and current location of available resources etc. Each group proposed to use drones for (1) gathering relevant information from the disaster area and (2) providing a communication network in the disaster area in order to (3) distribute the information in real time to all relevant stakeholders.

From the results and the testing phase that was conducted right after the prototyping phase, specific functions that the system shall possess and important challenges that need to be addressed were identified. The functions and challenges are outlined below:

- The system shall be able to provide highly accurate real time information to as many stakeholders as possible. This function bears several challenges.
    - In order to ensure reliability of information, data needs to be validated before it is being distributed to the stakeholders. Especially uncertain information (e.g. a phone call) needs confirmation in order to avoid that corrupt data enters the system.
    - In order to enable the proposed “going back and forth in time” feature using e.g. a timeline embedded in the HMI (see Figure 19), the whole system needs to be 4D compatible.
    - A major challenge will be to provide enough processing power. Especially in areas that have been struck by a disaster network connection cannot be taken for granted, especially in large scale disaster areas. As such, in order for the system to work, a highly reliable (possibly local) and high bandwidth communication network needs to be established in the disaster area and means for connecting to the internet need to be provided. However, the system shall be deigned to be functional also without internet connection.
- The system shall be flexible and open to information from already existing data sources. As such, it has to be assured that different modules and interfaces for data input can be added and removed flexibly (without impairing its functioning).
- The system shall be deployable fast and easily. If drones are being used, major challenges include the current legal constraints and regulations which oftentimes make it difficult or even impossible to quickly deploy drones when a disaster occurs.
- The system shall be reasonably priced. This means that software that needs highly priced licences shall be avoided.

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Meeting Minutes

Agenda		
Date	**Time**	**Title**
Day 1: Tuesday 12th November	**09:00 – 10:00**	**Introduction to Design Thinking Workshop** *DLR* Welcome & General Introduction Participant Introduction The Basics of Design Thinking
	10:00 – 12:00	**Working Session** *All* Design Thinking Phase 1: Understand Design Thinking Phase 2: Observe
	12:00 – 13:30	**Lunch**
	13:30 – 16:30	**Working Session** *All* Design Thinking Phase 2: Observe (continued) Design Thinking Phase 3: Point of View
	16:30 – 17:00	**Conclusion / Wrap-Up of Day 1** *DLR*
Day 2: Wednesday, 13th November	**10:00 – 12:30**	**Working Session** *All* Design Thinking Phase 4: Ideate Design Thinking Phase 5: Prototyping
	12:30 – 14:00	**Lunch**
	14:00 – 16:45	**Working Session** *All* Design Thinking Phase 6: Testing
	16:45 – 17:15	**Conclusion / Wrap-Up** *DLR*

Day 1-Tuesday 12/11/2019

- Welcome by Host and organiser was followed by a quick presentation of each participant (position, individual skills, other).

- Introduction to the Basics of Design Thinking highlighted the drive to turn the Workshop into a milestone to building something that would be useful.

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- Discussions were expected to raise questions which will inevitably generate different answers by participants but also a framework to establish a system that would be useful.

- The Workshop was divided into 2 sessions (a) Problem Space and (b) Solution space and follow a succession of 6 steps (1) Understand (2) Observe (3) Point of view (4) Ideate (5) Prototype (6) Test.

- Participants were divided into 3 groups (representing the roles Public, Inter-Agency Command Centre, Units in the Field) of about 6-7 persons each and went on through a series of intense interactive exercises with completing the three steps of the first session.

- Starting point was to understand and identify the problem. Brainstorming, generation of context maps, creation, selection and distribution of key roles, drawing an inclusive Stakeholder map, capturing the web of relationships between the various actors involved were some of the fundamental activities carried out by the 3 groups. What, How and Why it is done were the reference questions that the designated representatives of the 3 groups sought to answer.

- The problem space session resulted in further connecting End User, Science/Research and Industrial partner organisation team members, produced a set of questions that will be used by Coordinator/Management team to establish the requirements of the system and initiated a bottom-up approach that is expected to contribute to delivering solutions that combine excellence and value.

- The key take-aways of the first day were
  - Understanding the context
  - Identifying key stakeholders
  - Highlighting the *What/How/Why* that guide the customer journey and contribute to the target projection

Day 2-Wednesday 13/11/2019

- After a quick recap of the previous day, the meeting started with a Brainstorming session within the 3 groups, which was based on freely articulating ideas, as many as possible, and preferably in a visual manner.

- Participants would present their idea to the group, post them on the dashboard and seek to generate a synthesis of the Will be.

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- The *Units in the field* group tackled the problem of the visualisation of resources. Select what to see, include services based on Artificial Intelligence, know where buildings and supplies as well as people are, were some of the points raised.

- Disaster is like a Black Box which an Integrated Resource Management System using input from multiple sources (Drones, GPS, street cameras, smartphones, sensors, a.s.o) should be able to open and allow us to see before action is taken.

- Open group – The *Inter-Agency Command* group created the persona of Achyle, Incident Commander. Incidents can be divided into 3 phases (1) Chaos (2) Stability and (3) Aftermath. The problem that needs to be solved is the lack of overview. Suggested paths were focus on short-term prediction, simulation and regulation of the information transmitted.

- The public group named their persona John as anyone can be a victim of a disaster incident. The problem of disaster incident victims is to be found and to be supported with useful information. The first thing to do in such cases is to locate people.

- The common thread for all 3 groups is that the information wanted had to be map-based. Different and many layers and sets of information were required but not all had to be accessible to all. Obviously, First Responder Commanders do not have the same requirements as the broad public.

- Sensors need to be open to all sorts of information.

- Mapping must be permanently updated, implies the existence of both Geo-located and Orthographic maps, data collected need to be rapidly converted to information that will support action on the ground.

- The RESPONDRONE platform needs to draw from different baselines of information, access data from existing sources while favouring the development of new ones. Baseline models and processing capacity will be enhanced by simulation models highlighting the *Will be*.

- The issue of connectivity was recognized as a very important one that could be dealt with also by other means than drones.

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Concluding Remarks of participants

- RESPONDRONE must avoid making a system that cannot be used on the field, it should build something simple and useful. First, we need to understand though that Disaster Management is a completely different activity.

- The participant considers Workshop as a very useful exercise that helps participants from all WPs and very different Partner organisations to get “on the same page”, a feature that is usually missing from projects.

- Design has to deal with different approaches, yet time is limited, a little more than 2 years. Therefore the question is simple: Which requirements can be answered now, which need to be dealt with later?

- A bottom-up approach was introduced and is apparently working. A “wish list” can be gradually elaborated.

- The participant gathered input that can be used for Mock-Up design. Noted that there seemed to be insufficient focus on the interaction between the three (3) groups.

- The participant considers that a sizeable market exists and RESPONDRONE can make a package that will be helpful to both the project and the End-Users. We must build a Drone that can be useful.

- Still a lot of work needs to be done in order to develop a user-friendly, multi-level system. RESPONDRONE may want to consider carrying out an exercise to test the platform in real-life conditions.

- Workshop was a well-organized process which led to an excellent summary of WP15 and pinpointed the importance of aligning cutting-edge technologies with End-Users. We need to be realistic and open to the future.

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