H2020 – Secure societies - Protecting freedom and security of Europe and its citizens

SU-DRS02-2018-2019-2020– Technologies for first responders – Research and Innovation Action (RIA)

# Emerging technologies for the Early location of Entrapped victims under Collapsed Structures & Advanced Wearables for risk assessment and First Responders Safety in SAR operations

## D1.3 Definition, evaluation and refinement of the S&R CM governance model

| | |
|---|---|
| **Workpackage:** | WP1 – First responders Requirements and Governance model |
| **Authors:** | PUI |
| **Status:** | Final |
| **Due Date:** | 30/06/2021 |
| **Version:** | 1.00 |
| **Submission Date:** | 30/06/2021 |
| **Dissemination Level:** | PU |

**Disclaimer:**

This document is issued within the frame and for the purpose of the Search and Rescue project. This project has received funding from the European Union's Horizon2020 Framework Programme under Grant Agreement No. 882897. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the European Commission.

This document and its content are the property of the Search and Rescue Consortium. All rights relevant to this document are determined by the applicable laws. Access to this document does not grant any right or license on the document or its contents. This document or its contents are not to be used or treated in any manner inconsistent with the rights or interests of the Search and Rescue Consortium or the Partners detriment and are not to be disclosed externally without prior written consent from the Search and Rescue Partners. Each Search and Rescue Partner may use this document in conformity with the Search and Rescue Consortium Grant Agreement provisions.

(*) Dissemination level.-PU: Public, fully open, e.g. web; CO: Confidential, restricted under conditions set out in Model Grant Agreement; CI: Classified, Int = Internal Working Document, information as referred to in Commission Decision 2001/844/EC.

# Search and Rescue Project Profile

**Grant Agreement No.:** 882897

| | |
|---|---|
| **Acronym:** | Search and Rescue |
| **Title:** | Emerging technologies for the Early location of Entrapped victims under Collapsed Structures & Advanced Wearables for risk assessment and First Responders Safety in SAR operations |
| **URL:** | https://search-and-rescue.eu/ |
| **Start Date:** | 01/07/2020 |
| **Duration:** | 36 months |

## Partners

| | | |
|---|---|---|
| | NATIONAL TECHNICAL UNIVERSITY OF ATHENS (NTUA) Co-ordinator | Greece |
| AiDEAS | AIDEAS OÜ (AIDEAS) | Estonia |
| SIMAVI Software Imagination & Vision | SOFTWARE IMAGINATION & VISION S.R.L (SIMAVI) | Romania |
| GRUPPO Maggioli | MAGGIOLI SPA (MAG) | Italy |
| Konnekt-able | KONNEKT-ABLE TECHNOLOGIES LIMITED (KT) | Ireland |
| THALES | THALES ITAIA Italia SPA (THALIT) | Italy |
| Atos | ATOS IT SOLUTIONS AND SERVICES IBERIA SL (ATOS) | Spain |
| HELLENIC INSTITUTE OF TRANSPORT CERTH / HIT | ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH) | Greece |

| | | |
|---|---|---|
|  | UNIVERSITA DEGLI STUDI DI CAGLAIRI (UNICA) | Italy |
|  | UKEMED GLOBAL LTD (UGL) | Cyprus |
|  | PUBLIC SAFETY COMMUNICATION EUROPE FORUM AISBL (PSCE) | Belgium |
|  | UNIVERSITA DEGLI STUDI DI FIRENZE (UNIFI) | Italy |
|  | DEUTSCHES FORSCHUNGSZENTRUM FUR KUNSTLICHE INTELLIGENZ (DFKI) | Germany |
|  | UNIVERSITA CATTOLICA DEL SACRO CUORE (UCSC) | Italy |
|  | VRIJE UNIVERSITEIT BRUSSEL | Belgium |
|  | SYNYO GmbH (SYNYO) | Austria |
|  | UNIVERSITEIT HASSELT (UHASSELT) | Belgium |
|  | SPOLECZNA AKADEMIA NAUK (SAN) | Poland |
|  | GIOUMPITEK MELETI SCHEDIASMOS YLOPOIISI KAI POLISI ERGON PLIROFORIKIS ETAIREIA PERIORISMENIS EFTHYNIS (UBITECH) | Greece |

| Search and Rescue End-Users | | |
|---|---|---|
| | ELLINIKI OMADA DIASOSIS SOMATEIO (HRT) | Greece |
| | ENOSI PTYCHIOYCHON AXIOMATIKON YPAXIOOMATIKON PYROSVESTIR OY SOMATEIO (EPAYPS) | Greece |
| | JOHANNITER-UNFALL-HILFE EV (JOHAN) | Germany |
| | JOHANNITER OSTERREICH AUSBLIDUNG UND FORSCHUNG GEMEINNUTZIGE GMBH (JOAFG) | Austria |
| | CONSIGLIO NAZIONALE DELLE RICERCHE | Italy |
| | POMPIERS DE L'URGENCE INTERNATIONALE (PUI) | France |
| | ASOCIATA CLUSTERUL ROAMN RENTRU PROTECTIE SI ECOLOGIE IN DOMENIUL MATERIALELOR CHIMICE, BIOLOGICE, RADIOLOGICE/NUCLEARE SI EXPLOZIVE (PROECO) | Romania |
| | SERVICIO MADRILENO DE SALUD (SERMAS) | Spain |
| | FUNDACIÓN PARA LA INVESTIGACIÓN E INNOVACIÓN BIOSANITARIA DE ATENCIÓN PRIMARIA (FIIBAP) | Spain |
| | ESCUELA ESPANOLA DE SALVAMENTO Y DETECCION CON PERROS (ESDP) | Spain |

# Document History

| Version | Date | Author (Partner) | Remarks/Changes |
|---|---|---|---|
| 0.10 | 07/01/2021 | Iliana Korma Philippe Besson (PUI) | ToC |
| 0.11 | 11/01/2021 | Sabrina Scheuer (Johhaniter) | Minor Comments on ToC |
| 0.12 | 11/01/2021 | Giorgos Vafeiadis (Ubitech) | Comments on ToC |
| 0.12 | 12/01/2021 | Pantelis Velanas (MAG) | Comments on ToC |
| 0.12 | 15/01/2021 | Alexandru Dumitrascu (PROECO) | Comments on ToC |
| 0.20 | 08/02/2021 | Iliana Korma – Philippe Besson (PUI) | Finalisation of ToC |
| 0.30 | 13/04/2021 | Iliana Korma – Philippe Besson (PUI) | Content update (v2) |
| 0.31 | 16/04/2021 | Pia Ferner (Johhaniter) | Content for Sections 4 & 5 |
| 0.31 | 19/04/2021 | Alexandru Dumitrascu (PROECO) | Content for Sections 2.1, 2.2 & 4 |
| 0.31 | 19/04/2021 | Giorgos Vafeiadis (Ubitech) | General Comments on content update (v2) |
| 0.40 | 19/04/2021 | Marta Burgos González (ESDP) | Content for Section 4 |
| 0.41 | 20/04/2021 | Waleed Serhan (SAN) | Content for Section 3 |
| 0.41 | 20/04/2021 | Marco Guerri (Thalit) | Content for Section 3 |
| 0.41 | 23/04/2021 | Iosif Vourvachis (HRT) | Content for Section 4 |
| 0.41 | 26/04/2021 | Pia Ferner (Johhaniter) | Content for Section 4 |
| 0.41 | 11/05/2021 | Ioannis Benekos (CERTH) | Content for Section 2.3 |
| 0.50 | 13/05/2021 | Iliana Korma – Philippe Besson (PUI) | Ready for Review |
| 0.51 | 17/05/2021 | Marco Guerri (THALIT) | Internal Review 1 |
| 0.51 | 17/05/2021 | Jose Gato (ATOS) | Internal Review 2 |

| | | | |
|---|---|---|---|
| 0.60 | 31/05/2021 | Iliana Korma – Philippe Besson (PUI) | Updated Version – Final |
| 0.70 | 14/06/2021 | Christodoulos Santorinaios (NTUA) | Quality Control |
| 1.00 | 30/06/2021 | Christos Ntanos (NTUA) | Final version to be submitted |

**Table 0-1: Task 1.2 Contributors**

| # | Organisation | Name |
|---|---|---|
| 1 | PUI France | Philippe Besson |
| | | Iliana Korma |
| 2 | UBITECH | George Vafeiadis |
| 3 | SUMMA | Cristina Horrillo |
| 4 | PROECO | Alexandru |
| 5 | SAN | Weelhan |
| | | Kasia |
| 6 | THALIT | Marco Guerri |
| 7 | HRT | Iosif Vourvachis |
| 8 | JOAFG | Pia Ferner |
| | | Georg Aumayr |
| | | Sabrina Scheuer |
| 9 | CERTH | Ioannis Benekos |
| 10 | ESDP | Susana Izquierdo |
| | | Ana Aldea |
| 11 | SERMAS | Ana Cintora |
| 12 | CNR | Fabio Cibella |
| 13 | JOAFG | Georg Aumayr |
| | | Pia Ferner |
| | | Sabrina Scheuer |

# Executive Summary

The main purpose of this deliverable is to define the SnR Governance model. In this first deliverable related to the Definition, evaluation and refinement of the S&R CM governance model, we will try to give the specification of the S&R Governance model including short description from CRISYS that SnR model is based upon. The vision of EU will be described in details and we will try to describe a common framework to assess the users' needs and integrate the responses.

Furthermore, we will present the Interoperability framework between emergency organizations with common, accepted and validated Standard Operating Procedures, that will promote more efficient, multinational and multi-organisational disaster response actions, and will be fully compatible with (i) the actual existing SOP within the organisations – end users included in the project, EU MS and International Organisations (ii) technological framework and (iii) interoperability concepts.

Nine end – users from various EU countries have come together to describe their Standard Operating Procedures used in their countries and the results are well described in the following sections. The respective questionnaire has been answered, helping us to find out about the similarities and differences in the standard operating procedures from our end users.

# Table of Contents

**1 Introduction ..... 12**

**1.1 Purpose & Scope ..... 12**

**1.2 Structure of the Document ..... 12**

**2 First Responders' Requirements & Gap Analysis ..... 14**

**2.1 Existing Technologies (state-of-the-art) ..... 14**

**2.2 End-users' requirements ..... 29**

**2.3 Gap analysis ..... 34**

**3 Specifications of S&R Governance Model ..... 40**

**3.1 S&R Operational Model ..... 40**

**3.2 S&R Emergency Management System (EMS) integrated solutions ..... 45**

**3.3 Actual existing Standard Operating Procedures (EU MS & International Organisations) ..... 50**

3.3.1 European Standard Operating Procedures ..... 50

3.3.2 International Standard Operating Procedures – International USAR Response Cycle ..... 51

3.3.3 Standard Operating Procedures (SOP) within S&R ..... 59

**4 Interoperability Framework ..... 69**

**4.1 Interoperability concepts ..... 69**

4.1.1 Situation Awareness Model ..... 69

4.1.2 Situation Awareness Model Utilization ..... 69

**4.2 Technological Framework – architecture ..... 71**

4.3.1 Operational sensors and support equipment ..... 71

4.3.2 Operational context ..... 71

4.3.3 Interoperability relations in S&R missions ..... 72

4.3.4 Human interoperability in S&R operations ..... 73

4.3.5 The conceptual model for the integrated delivery of public services ..... 74

4.3.6 Security and privacy ..... 75

**5 Common Vision ..... 77**

**Annex I: References ..... 80**

**Annex II: Standard Operating Procedures Questionnaires ..... 82**

# List of Figures

Figure 2-1: Leader Scan ..... 16
Figure 2-2: BioRadar BR 402 ..... 17
Figure 2-3: Sewerin Aquaphon A100 ..... 17
Figure 2-4: Savox Searchcam 3000 ..... 18
Figure 2-5: Tythus ..... 18
Figure 2-6: Coyote III ..... 19
Figure 2-7: SOURYU-I ..... 25
Figure 2-8: SOURYU-II ..... 25
Figure 2-9: Multi-unit rescue robot ..... 25
Figure 2-10: Rescue mobile robot "RESDOG" ..... 25
Figure 2-11: UMRS (Utility Mobile Robot for Search)-V-S2 ..... 26
Figure 2-12: UMRS (Utility Mobile Robot for Search-V-M3 ..... 26
Figure 2-13: Micro Traces ..... 26
Figure 2-14: Micro VGTV ..... 26
Figure 2-15: Bujold ..... 27
Figure 2-16: Urbie Hybrid5T ..... 27
Figure 2-17: AMOEBA-I ..... 27
Figure 2-18: ROBRNO ..... 28
Figure 2-19: IUTMicrobot ..... 28
Figure 2-20: Coyote III micro rover ..... 28
Figure 2-21: Seerkur Jr. ..... 28
Figure 2-22: S&R project vision on first response equipment ..... 30
Figure 2-23: RESCUE-MIMS on-board DFKI robotic platform Seekur Jr ..... 31
Figure 2-24: Coyote III micro rover ..... 32
Figure 2-25: Portable RESCUE MIMS (Peli case) ..... 33
Figure 2-26: The normalized importance score of each studied feature on improving community resilience ..... 36
Figure 2-27: Schematic recommendation on how to proceed and best use the findings ..... 39
Figure 3-1: CONCORDE ..... 46
Figure 3-2: Command Centre Mixed Reality (MR) Conference Table ..... 47
Figure 3-3: CONCORDE Incident MGT system ..... 48
Figure 3-4: DSS Algorithm example ..... 48
Figure 3-5: Map Services and Android Application ..... 50
Figure 3-6: The International USAR Response Cycle ..... 52
Figure 4-1: SA Service Endpoint ..... 70

Figure 4-2: Technological Level [1] ..... 71
Figure 4-3: Key entities acting in an S&R operation and interoperability relations..... 73
Figure 5-1: : EIF Conceptual Model ..... 77
Figure 5-2: How EU CMP works ..... 78

# List of Tables

Table 0-1: Task 1.2 Contributors ..... 6
Table 2-1: Benchmarking of existing state-of-the art technologies for entrapped victims and detecting chemicals ..... 22
Table 2-2: Benchmarking of mass spectrometry based portable instruments ..... 22
Table 2-3: Benchmarking of UAVs ..... 24
Table 2-4: Terrestrial Search and Rescue Robots ..... 28
Table 2-5: Technologies for first responders ..... 34
Table 2-6: Five most important feature for different category of responders ..... 38
Table 3-1: CONCORDE EMS features ..... 47

# 1 Introduction

## 1.1 Purpose & Scope

The S&R crisis governance model will be linked to existing databases to provide functionality for capturing Risk Assessment (e.g. comparable functions for disaster type, location, radius, impact and threats). The component will be based on a library of terms, business rules and methods to support these types of analysis identified and implemented in WP3 (T3.1 and T3.2). The content of the library reflects unified community definitions of risk and other parameters utilised to characterise a disaster or crisis event.

The S&R CM will allow for increased situational awareness and early warning of major disaster incidents with ad-hoc, innovative and dynamic solutions. The common operating framework will also support wider training and education activities for emergency responders. In fact, the majority of emergency responders are not overtly involved in EU response through the Mechanism but may become either direct beneficiaries of EU aid or have to face event consequences that have already been experienced, a 'lessons learnt' programme delivered online.

The S&R CM concept will allow for a wider definition which includes the capability to (a) collect static and dynamic data on the basis of standards and protocols and (b) all relevant static and dynamic data suppliers that are relevant to various disaster types.

Nine end users of S&R project have been invited to complete a questionnaire developed for the purposes to identify and register the operational procedures of these end users from 6 EU countries (Greece, Romania, Spain, France, Italy, ) that are involved in this project. It has to be mentioned that 70 questions were prepared related to these procedures that will be analysed in the specific section below.

## 1.2 Structure of the Document

In this deliverable we intend to definition, evaluate and refine the S&R CM governance model as defined in Task 1.4 of S&R project. This deliverable is part of WP1 called First responders Requirements and Governance model which covers the whole period of the project's duration. We will present the users' needs in research and technical issues, use case scenarios and user perspectives. The gap analysis will be presented as described in the previous tasks.

Great emphasis will be given in the specifications of the S&R Governance model regarding its operational model and its emergency management system integrated solutions. All the above-mentioned will be developed according to the actual existing Standard Operating Procedures (SOP) from EU MS and International organisations and the accountabilities and responsibilities of all the organizations involved the crisis management domain.

One more important task that will be analysed in this document refers to the Interoperability framework between the emergency organisations. In order to clearly understand the clear concept of this framework, we are going to analyse the common, accepted and validated Standard Operating Procedures, that will promote more efficient multi-national and multiorganizational disaster response actions, and will be fully compatible with (i) the actual existing SOP within specific organizations, EU MS and International Organizations (ii) technological framework and (iii) interoperability concepts.

The EU common vision will be utmost importance closing this document. The end users – partners of S&R project have collaborated closely in the development of this deliverable in order to contribute to the S&R Governance Model and the Interoperability framework between emergency organizations.

# 2 First Responders' Requirements & Gap Analysis

## 2.1 Existing Technologies (state-of-the-art)

The first major task of S&R project was to gather information on existing technologies used in SAR operations relevant to location of entrapped victims and identify the limitations and gaps, as well as the future needs. All these above-mentioned have been part of the State-of-the art review on existing SAR technologies for the early location of entrapped victims which belong to the definition phase of the project. The partners managed to define the requirements and the specification of the S&R platform and how it can comply with current European societal values, fundamental rights and applicable legislation, including in the area of privacy, personal data protection and free movement of persons.

'The right tools for the job'' will reduce the time needed to recover casualties from collapsed structures. There have been substantial enhancements in the tools and systems available for the recovery of people from wrecked cars, and the time for specialist rescue tools is long overdue. The current state-of-the-art relies too much on adapted construction of civil engineering equipment. Using such tools in a USAR setting, places extreme physical demands on the rescuer, who tires rapidly and so needs to be constantly substituted to prevent exhaustion.

This situation delays rescue and reduces the chances of survival. The weight and designs of the current generation of tools is critically limiting. For example, the current maximum lengths of power hoses associated with pneumatic equipment are too short to enable such tools to be used deep inside collapsed structures, and also too short to ensure that fumes and exhausts from the generators do not disrupt the USAR operations inside the rubble. Innovation in battery-driven systems and designs to give lighter tools is also needed. Enhanced designs and materials for tools that move, cut, break- and chip-reinforced concrete, brick and cladding without putting survivors' safety at risk and exhausting the rescuer will also reduce rescue times. Such systems, ideally, will have flexible functionality to adapt to different materials and thicknesses, as well as, enable drilling in the direction that is considered optimum (which may often mean drilling into overhead structures).

This is A rescuer's charter of priorities for more efficient USAR operations:

- Correct decision-making at the beginning at political level (clear picture of what has happened, scale of disaster, available resources inside the country, need for requesting help);
- Early detection and location;
- Safety of rescuers;
- Better concrete cutting tools;
- Better logistics (detailed description of the tools needed, especially at the point of arrival);
- Better information and planning;
- Tools that can be easily deployed;

- Satellite support;
- Collaboration among international rescue teams;
- Adaptability of tools to events;
- Fast transportation of rescue teams to the scene of disaster Improving situation awareness;
- Accurate knowledge of the disaster scale;
- Better use of existing technologies and methods;
- Better training;
- Context information;
- Obtaining information from the media.

The envisaged improvements in performance may be delivered through the use of lasers, high-water pressure systems, automated stabilization and anchoring, and even controlled micro-explosions.

Innovations and enhancements needed to create a new generation of rescue, need to be led in partnership with the manufacturers of rescue equipment. Currently, the supply chain and market for extrication tools is fragmented and, as noted above, mostly focused on tools used in building construction. Few companies have the knowledge and insight required to guide their inherent expertise to develop tools for USAR operations, and they will need to pay attention to the priorities of rescuers.

Although a number of mature and emerging technologies for USAR exist and have been proven in a variety of scenarios, not necessarily involving collapsed buildings, most approaches and systems have not been properly tested, validated nor proven in applications regarding collapsed structures. Methods for enhancing USAR systems' efficacy and reliability may be seen to be based on effective integration of complementary technologies onto a single platform.

Such an approach has the following advantages:

- provision of a fast overview of the location of voids and, potentially, victims;
- improvements in the accuracy and sensitivity through orthogonal sensing approaches; reduction of false alarm incidence rates;
- provision of flexibility in deployment, with a single deployment for multiple search and rescue responses;
- enabling technology-based responses to be combined with com-munity input;
- provision of new applications and markets for existing technologies.

All this equipment will be hands-free, ergonomically optimized and can be integrated to the protective clothing.

This feature allows you to First Responder with the ability to detect, monitor, and analyzed passive and active threats and hazards at incident scenes in real time.

As well, provide First Responder with the ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.

By the way, one of the key objectives of S&R is to develop and promote the underlying framework (interoperability amongst systems and equipment, training and awareness) so that responders at all levels of command have access, familiarize and evaluate how to deploy innovative solutions.

**Benchmarking of available commercial products will also be included.**

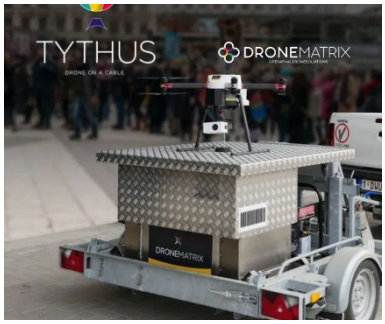
On the market, there is for every type of technology, there are a multitude of offers.

Respecting the norms of business ethics and deontology, there is not enough information's on the manufacturer's website to make an adequate comparison to other products, especially regarding the production costs and the starting price in negotiating the sale of such a technique.

Out of the questionnaires from users, partners of private companies or voluntary services, some summaries were made regarding the standards of current technology that can be used in the design of new technologies that correspond to future needs in the field of R&D (see Table 2-1).

| Technique | Advantages | Limitations |
|---|---|---|
| LEADER Scan | Easy to use, lightweight, carrying bag, screen visibility, wireless tablet reading, Control of the sensor from the box, Display of the movement detected at the depth detected, Real-time and Automatic modes, Selection of the depth, Strong or weak movement indicator, Oscillogram for the details of the movements, Data recording, Record replay, Right-handed mode / left-handed, Brightness adjustment, Charge level.   **Figure 2-1: Leader Scan** | Functioning of the wifi signal, random results with false positives, influence of movements of moving materials (wind), risk of detection of other stakeholders, wifi signal quality, |

| | | |
|---|---|---|
| BioRadar BR 402 |  <br>**Figure 2-2: BioRadar BR 402**<br>Accordingly, to described function following operation fields are<br>possible:<br>• search for buried persons after disasters (rescue services)<br>• detection of hidden persons in cars and trucks (border control, transfer into and out of security areas)<br>• detection of movements in underground unmetallic channels and cavities<br>• detection of persons inside buildings from outside (building security) | Very weight: approx. 18 kg<br>The equipment transmits radar waves, which are reflected by all things in front of it, received back and evaluated by the BioRadar, but does not know if it is a man under those rubble or a medium or large animal (a dog for example).<br>Battery capacity is not the best |
| Sewerin Aquaphon A100 | High protection class (IP67), Ear protection function, Filter optimization, carrying strap or belt clipping, powerful rechargeable battery, different microphones for paved and unpaved ground, wireless headphones, noise visualization, memory function<br>  <br>**Figure 2-3: Sewerin Aquaphon A100** | Not specifically developed for SEARCH AND RESCUE operations, ear protection function settings required for optimal use, battery for microphone needed, 1m recommended measurement distance |

| | | |
|---|---|---|
| Savox Searchcam 3000 | Excellent video quality and clarity, Versatile options: submersible, boom extension, rope drop head, Wide field of view, Piston grip provides convenient access to control buttons, Two-way communication, Quality headset, Carrying case: wheels, well-organized, Location of battery indicator<br>  <br>**Figure 2-4: Savox Searchcam 3000** | Heavy, Expensive, Reboot required for whole system when articulating head would "freeze up", Reboot required before use of audio system, Reboot required if contrast and brightness controls are engaged in the wrong sequence, Lengthy boot and shutdown time, Multiple power buttons, Inadequate spacing between controls and adjustment knob when using pistol grip with agloved hand, Poorly designed monitor mount/display yoke, obstruction of articulation button, Cables not long enough for the pole when extended, Carrying strap: not heavy-duty, not padded, too narrow, did not balance camera well, Powered by lithium ion batteries only (no AC or DC power source capabilities) |
| Uhasselt | Yacob: can be manoeuvred over a large area. Automated functions<br>Tythus: nearly limitless flight time, yet limited in range due to the cable. Easy in operation.<br>  <br>**Figure 2-5: Tythus** | Both systems are susceptible to weather conditions. As a rule of thumb: if birds cannot fly (heavy winds, rain, extreme temperatures...), the drone cannot fly either. |
| Coyote III | • robust but lightweight frame<br>• high mobility on difficult terrain | • legged wheels may become fragile on high loads |

| | | |
|---|---|---|
| | • can climb stairs and rocks<br>• modular mount for sensors and manipulator<br>• may be remote controlled<br>• possible cooperation with other robots<br>  <br>**Figure 2-6: Coyote III** | • limited power capacity, no long-term operation |
| EN (electronic noses) | • Simplicity<br>• Fast response times<br>• Portability<br>• Inexpensive | • Unstable results<br>• Specificity issues |
| MS (mass spectrometers) | • High sensitivity (low LODs)<br>• High specificity<br>• High mass range<br>• High resolution<br>• Real time measurements<br>• Measurements' stability<br>• Accuracy<br>• Portability<br>• Fast analysis times (s)<br>• Qualitative and quantitative analysis<br>• No sample preparation<br>• Ability for MS/MS or $MS^n$ (extra confirmation steps and elimination of false alarms) | • Relatively high costs (purchase and maintenance) |

| | | |
|---|---|---|
| IMS (ion mobility spectrometry) | • Instrumental simplicity<br>• Small size<br>• Light weight<br>• Robustness<br>• Low-power consumption<br>• Fast response times<br>• High sensitivity | • False positive alarms<br>• Potential compounds' adsorption onto the IMS surfaces<br>• Limited selectivity<br>• Lack of performance in highly contaminated environments<br>• Humidity, temperature, and composition of the sample may affect detector's response<br>• Bureaucracy due to the integrated radioactive sources |
| GC (gas chromatography) | • Accuracy<br>• Couples with other analytical techniques | 1. Long analysis times |
| IR (infrared spectroscopy) | • Reliable and repeatable results<br>• Qualitative analysis<br>• Quantitative analysis<br>• Non-invasive technique | 1. Lack of flexibility<br>2. Indoor use |
| CRDS (cavity ring-down spectroscopy) | • Real-time measurements<br>• High sensitivity | 1. Lack of selectivity |
| LIBS (laser-induced breakdown spectroscopy) | • Direct analysis<br>• Sensitivity<br>• Non-destructive real time analysis No sample preparation | • False positive alarms<br>• Plasma conditions vary with the environmental conditions |
| Raman (spectroscopy) | • No sample preparation requirements<br>• Sensitive to homo-nuclear molecular bonds<br>• Fully integrated threat libraries<br>• Portability<br>• Non-destructive<br>• Fast response times | • Cannot be used for metals or alloys<br>• Fluorescence of the sample background may lead to false negative alarms |

| | | |
|---|---|---|
| | • Analysis through glass and polymer packaging | |
| THz spectroscopy | • Penetrates though materials<br>• Non-destructive<br>• Many non-metallic or non-polar materials are transparent to THz | • Limited penetration in high-water content or metal objects<br>• Distance limitations |
| Fluorescence | • Excellent signal-to-noise ratio | • Limit due to linear intensity |
| Instruments based on various sensors (e.g. chemical, electrochemical, immunochemical, colorimetric, etc.) | • Portability<br>• Sensitivity<br>• Reliability<br>• Easy operation<br>• Low LODs<br>• Fast response times | |
| Flame spectrophotometry | • Sensitivity | • Small number of excited atoms<br>• Sample interferences<br>• Reproducibility |
| Nanotechnology | • Extreme sensitivity<br>• Rapid analysis<br>• Selectivity<br>• Small size<br>• Accuracy | |
| TLC (thin-layer chro matography) | • Simplicity<br>• Sensitivity (high)<br>• Low cost<br>• Fast separation | • Humidity and temperature effects on the sample |
| Enzyme based sensors | • Simplicity<br>• Specificity<br>• Sensitivity<br>• Low false positive or negative alarms<br>• Speed of analysis | • Lack of stand-off detection |

**Table 2-1: Benchmarking of existing state-of-the art technologies for entrapped victims and detecting chemicals[1]**

(NTUA courtesy)

| Supplier | Model | Mass analyzer | Mass range (m/z) | Power (W) | Weight (kg) |
|---|---|---|---|---|---|
| INFICON | HAPSITE® ER Chemical Identification System | Quadrupole | 41-300 | N/A | 34 |
| FLIR Systems Inc. | Griffin™ 824 | Cylindrical ion trap | N/A | N/A | 22.7 |
| FLIR Systems Inc. | Griffin™ 844 | Cylindrical ion trap | N/A | 110-240 VAC | 20 |
| Purdue University | Mini 12 | Rectilinear ion trap | N/A-900 | 50 | 15 |
| Torion Technologies (recently acquired by PerkinElmer) | TRIDION™-9 GC-MS | Toroidal ion trap | 45-500 | 80 | 14.5 |
| University of Liverpool | SNIFFLES pre-prototype | Non-scanning linear ion trap | 50-500 | 34 | 14 |
| Torion Technologies (recently acquired by PerkinElmer) | GUARDION™-7 GC-MS | Toroidal ion trap | 50-500 | 75 | 13 |
| Purdue University | Mini S | Rectilinear ion trap | N/A-925 | 65 | 12 |
| Purdue University | Mini 10 | Rectilinear ion trap | N/A-550 | 70 | 10 |
| BaySpec Inc. | Portability™ | Linear ion trap | 40-650 | 65 | 9.9 |
| 1st Detect | MMS-100™ | Cylindrical ion trap | 15-625 | N/A | 8 |
| Purdue University | Mini 11 | Rectilinear ion trap | N/A-2000 | 30 | 5 |
| 908devices | M908 ™ | Microscale ion traps | 55-400 | N/A | 2 |
| Samyang Chemical Corp | Palm portable (without pump) | Quadrupole ion trap | 45-300 | 5 | 1.5 |

**Table 2-2: Benchmarking of mass spectrometry based portable instruments[2]**

[2] NTUA courtesy

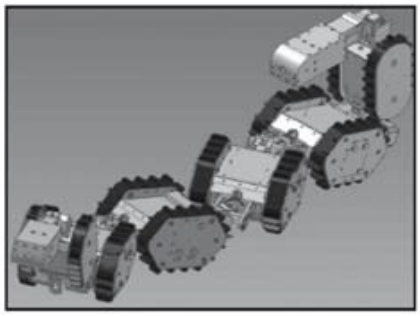
| UAV | Size | Weight | Sensitivity to environmental conditions | Operating time | Mode of operation | Reference |
|---|---|---|---|---|---|---|
| 3DR Solo Quadcopter | 46 cm, height 25 cm | 1.5 kg | -Payload: 500g with gimbal, camera and other accessories.<br>-Max wind: 40km/h<br>-Operating temperature: 0° C - 45° C<br>GoPro HERO3+ or HERO4 camera | - From 20 to 25 min<br>- Max Speed: 55 mph / 88.5 km/h<br>- Require Wifi | APM flight control software | (Dawdi et al., 2020) |
| Aibot X6 hexacopter | Length/ Width/ Heigth 1.05 x 1.05 x 0.45 m | 3.4 kg | -Payload: 2.0 kg<br>- Max wind:36km/h<br>-Operating temperature: -20° C - 40° C<br>No camera<br>Ultra-sonic sensors may not work in a proper way under certain conditions like above water, snow, high grass or trees.<br>If there are obstacles above the Aibot X6 V2 or when flying indoor, it is preferred to use Manual Mode. | - Max 20 min<br>- Max Speed: 40 km/h | Manual Mode or Assisted Mode | (INACHUS project) |
| DJI M100 quadrotor<br>Price: around $3000 | Diagonal Wheelbase 65 cm | From 2.355kg to 2.431kg | - Payload: 1 kg<br>- Max wind 36 km/h<br>- Operating Temperature -10°C - 40°C<br>- Obstacle avoidance: 0.2 m to 20 m<br>- No camera | - From 13 to 40 min<br>- Max Speed: 79.2 km/h (no payload, no wind) | Master-and-Slave control<br>Long-range remote controller: 5Km | (Mittal et al., 2019)<br>(built in obstacle avoidance)<br>(Ruiz-Espitia et al., 2018) |

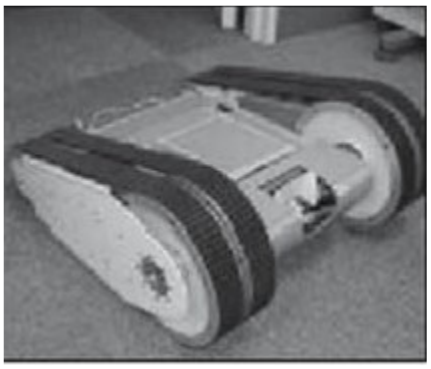
| | | | | | | |
|---|---|---|---|---|---|---|
| DJI Matrice 210 Price: 9250$ | Diagonal Wheelbase 65 cm 643 mm | 4.8kg | - Payload 1.34 KG<br>- Max Wind: 12 m/s<br>- Operating Temperature: -20° - 50° C<br>- Obstacle sensing range: 0.7-30 m | - From 24min to 34min<br>- Max Speed: From 61 to 81 k/h | Dual Remote Controller Mode | (Forssén et al., 2020) |
| DJI Inspire 1 Price: 3620$ | Length/ Width/ Heigth 43.7 x 30.2 x 45.3 cm | 2.845 kg (without gimbal and camera) | - Payload: 600g with gimbal and camera.<br>- Wind: 36 km/h<br>- Operating Temperature: -10° - 40° C<br>- Ultrasonic Sensor Operating Range: (5-500 cm) (Non-absorbing material)<br>- Camera: Zenmuse X3 optical camera<br>- Max Transmitting Distance: 5 km | - Approx: 18 min<br>- Max Speed: 79 k/h | - Dual remote Controller mode | (Middleton et al., 2018) |
| DJI Matrice 600 Pro UAV $5,699 | Diagonal Wheelbase: 1133 mm | 10 kg | - Payload: 5.5 kg<br>- Max Wind: 28.8 km/h<br>- Operating Temperature: -10° C to 40° C<br>- Supported different DJI Gimbals | - From 16 to 32 min.<br>- Max Speed: 65 kph (no wind) | - Dual remote Controller mode | (Albanese et al., 2020) |

**Table 2-3: Benchmarking of UAVs[3]**

**From the diversity of search and rescue robots that are used in areas where buildings have been damaged or collapsed, we will mention the most representative ones (see Table 2-4[4]).**

**It should be noted that the achievements in this area are different, comprehensive and diversified because of the difference in the level of skills, geographic and political factors, disaster types, types of debris.**

| Number | Name of terrestrial search-rescue robot | Remarks |
|---|---|---|
| 1 |  **Figure 2-7: SOURYU-I** | **Tokyo Institute of Technology** |
| 2 |  **Figure 2-8: SOURYU-II** | |
| 3 |  **Figure 2-9: Multi-unit rescue robot** | |
| 4 |  **Figure 2-10: Rescue mobile robot "RESDOG"** | **Okayama University** |
| | | |

| | | |
|---|---|---|
| 5 |  <br>**Figure 2-11: UMRS (Utility Mobile Robot for Search)-V-S2** | **Kobe University** |
| 6 |  <br>**Figure 2-12: UMRS (Utility Mobile Robot for Search-V-M3** | |
| 7 |  <br>**Figure 2-13: Micro Traces** | **Inuktun (USA)** |
| 8 |  <br>**Figure 2-14: Micro VGTV** | |

| | | |
|---|---|---|
| 9 |  <br>**Figure 2-15: Bujold** | **Center for Robotic Assisted Search and Rescue (CRASAR), Florida University** |
| 10 |  <br>**Figure 2-16: Urbie Hybrid5T** | **JPL's Machine Vision Group (DARPA Advanced Technology Office)** |
| 11 |  <br>**Figure 2-17: AMOEBA-I** | **Shenyang Institute of Automation (SIA), Chinese Academy of Sciences (CAS)** |

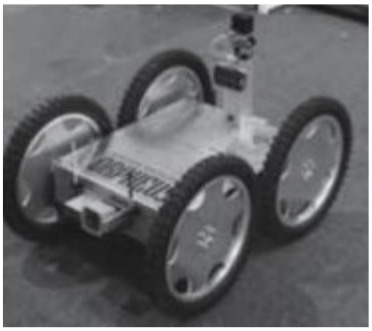
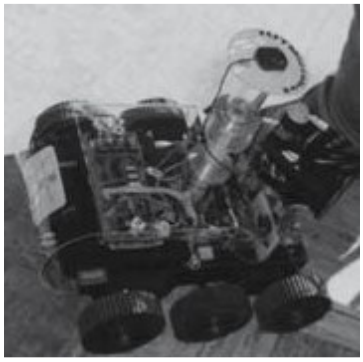
| | | |
|---|---|---|
| 12 |  <br>**Figure 2-18: ROBRNO** | **Brno University of Technology, Czech Republic** |
| 13 |  <br>**Figure 2-19: IUTMicrobot** | **Isfahan University of Technology, Iran** |
| 14 |  <br>**Figure 2-20: Coyote III micro rover** | **German Research Center for Artificial Intelligence (DFKI)** |
| 15 |  <br>**Figure 2-21: Seerkur Jr** | |

**Table 2-4: Terrestrial Search and Rescue Robots**

The proposed work has highlighted the following seven factors that can inspire developments in USAR operations in tools and technology; best practices and lessons learned, rescue technology, community involvement, information systems, technology integration, crisis management and budgets available. The selected factors can serve as a basis for practical developments.

Advancing all these factors is the key for getting faster decisions and improving reaction times.

## 2.2 End-users' requirements

The operational requirements input from D1.2, combined with the results of T1.1 will be used for the design and development of the RESCUE MIMS prototype; the S&R artificial sniffing tool will be developed, capable of measuring critical volatiles in the field, either for the early detection of toxic environments or for the localization of entrapped victims and for ensuring the chemical protection of the First Responder.

Through an analysis of the case studies several challenges were identified, as well as advantages and lessons learned. This report breaks down these broad categories into sub-categories and explores the main issues in disaster management and provides examples to clarify these issues. The good practices of S&R referred mostly to cooperation as well as sharing and combining resources. Among the main advantages of cooperating with volunteers was their local knowledge. As members of local communities' volunteers could provide valuable information on the environmental characteristics, available resources and community needs. The challenges, on the other hand, were on the levels of technology, organization, communication, procedures, legislation, training, and coordination.

One of the main issues during S&R missions was the lack of specific training which applied to volunteers but also, in some cases, to S&R professionals. Another challenge that many respondents identified was the incompatibility of communication technologies used by different stakeholders, both volunteers and professionals.

This seems to be an issue even when a common protocol, such as INSARAG, is used, or when different actors share the same physical space. Another important challenge that some participants discussed was the difficulty in applying advanced technologies when basic infrastructure was destroyed.

The end-user requirements regarding the technologies and equipment proposed to be used in the S&R project must contribute to the achievement of the following objectives:

a) Increasing the degree of ensuring the physical protection of First Responders and volunteers who intervene in the area affected by the disaster for the rescue of people trapped under rubble;

b) Increasing the capacity of the degree of information (in real time, correct and complete) of the First Responders and of the volunteers regarding the evolution of the operative situation in the intervention area during all its development;

c) Ensuring the obtaining of information, by using chemical sensors, to identify the location of persons trapped under the rubble.


**Figure 2-22: S&R project vision on first response equipment**

Analyzing the offer of technologies and equipment that will meet the fulfillment of objective a), within the S&R project will be designed, tested and validated a series of solutions (see Figure 2-1), as follows:

- **Professional Uniforms**: an innovative uniform for fire brigades' operators to protect critical parts of the body in case of fire rescue or first aid activities sand at the same time monitoring the state of user's health.
- **HAZMAT six-gas monitor with VOC detection**: The HAZMAT monitor, embedded on wearable of First Responder, consists of several chemical sensors that allow greater detection of threats such as toxic gases and VOCs derived from manmade activities such as industrial processes. This type of monitor, use hands freely, is the optimal solution for monitoring a maximum of 6 gases at the same time, for personal protection (including entering semi-enclosed or closed spaces) and for detecting possible gas leaks in the intervention area.

**The possibility of wireless connection offers real-time access to the instrument's indications, the alarm status in any location and a faster incident response time.**

The necessary basic characteristics of the HAZMAT six-gas monitor with VOC detection of the end users (power supply, size, payload, user interface characteristics, durability, cost, etc.) were mentioned in the deliverable D1.2.

- **Smartwatch**: has a built-in emergency communication application via Bluetooth that offers messaging, heart rate monitoring and alert functions (Android Wear compatible smart watches with the same features can also be used.
- **Wearable monitoring systems** embedded in the uniform of the first responder:

- ECG, EMG, respiration by means of fully textile electrodes (fully embedded in the garment).
- Strain sensors by means of fully plastic devices (wearable as they can be applied onto a textile substrate).
- Radiation sensors (mainly X rays) by means of fully plastic devices (wearable as they can be applied onto a textile substrate).

- **Special Glasses and Helmets using Advanced Augmented Reality (AR) technologies**: The AR helmet will be mainly used in situations where visibility is limited due to smoke, rabble or other obstacles. The S&R project responds to the needs of end users by making two prototypes:

1. ***Rescuer AR helmet***: The AR helmet will feature an impressive list of sensors and electronics. A front-facing Camera (480 x 360 resolutions at 60fps) provides real-time depth information in the 0.4 to 4m range. This is complemented by a wide-angle AR tracking camera (640 x 480 running at 100fps behind a 166° diagonal fisheye lens) and an RGB 1080p HD camera running a 30fps for taking snapshots or sharing a live video-feed of what the wearer sees.

2. ***Smoke-diver AR helmet***: aiding fire-divers through their smoke diving search and rescue missions.

- **RESCUE-MIMS mounted on a Coyote III micro rover** (see Figure 2-2) **or robotic platform Seekur Jr** (see Figure 2-3): a RESCUE MIMS (Membrane Inlet Mass Spectrometer) can be mounted on a Coyote III micro rover or a robotic platform SeekurJr to identify VOCs emitted from manmade activities such as industrial processes, warning First Responders of their presence in the area, in order to adopt individual protection measures in case of entry into the contaminated area.

**Figure 2-23: RESCUE-MIMS on-board DFKI robotic platform Seekur Jr**

**Figure 2-24: Coyote III micro rover**

b)

- **GPS Tracker**: GPS tracking will run even when there is a loss of network connectivity and synchronizes GPS recorded data as soon as it is reconnected.
- **Emergency communication app**: An Android Application that can alert first responders to life-threatening conditions by monitoring vital signs of multiple trauma patients.
- **End user mobile application (victim side)**: an android application for the routing of end-users. The application will connect people's smart phones with the Operations Centre to inform on the fastest/safest route to assembly points and/or health facilities and provide navigation without causing further confusion or panic. Another module will operate the automatic and immediate communication with civil protection services, such as the police, the ambulance and/or other rescue vehicle reporting the position of victims, their evacuation trajectory or escape route, while also indicating candidate meeting points for assembly, treatment and rescue.
- **Volunteer mobile application**: an application for volunteers that will provide information about the emergency event such as meeting points for mission and resource planning, requirements for volunteer deployment (insurance, food, accommodation, responsibilities).
- **UAV** (**Unmanned aerial vehicle**): the unmanned aerial vehicle will allow for monitoring the events on the field environment in order to guide and protect physical equipment (e.g. protect robot from fire). Also, the drone will transmit the data collected (video, images) to the ground station to locate victims. The streamed data video/images from the drone will be communicated to the CONCORDE platform; the advantage of drone is the higher view respect to the robot.

  Also, in the opinion of end users, the unmanned aerial vehicle can be used as a data relay obtained by a RESCUE MIMS mounted on the platform of a robot (for example Coyote III or Seekur Jr).

  The necessary basic characteristics of UAV of the end users (power supply, size, payload, user interface characteristics, durability, cost, etc.) were mentioned in the deliverable D1.6.

- **Coyote III micro rover or** robotic platform Seekur Jr**:** The use of robots as a platform for search-rescue is still viewed by end users with caution, due to distrust in the accuracy of information received in harsh weather conditions, their ability to traverse an area with debris resulting from a natural or technological disaster, the accuracy of the transmitted data - especially on video images-.

  The necessary basic characteristics of this robotic platform of the end users (power supply, size, payload, user interface characteristics, durability, cost, etc.) were mentioned in the deliverable D1.2.

  A novelty specific to the S&R project is the creation of equipment entitled" First **aid device for kids**". The rescue device has the characteristic to protect and reassure children involved giving a very first aid situation during emergency situations.

c) **RESCUE-MIMS (Portable Membrane Inlet Mass Spectrometer)**: the operational usefulness of a Portable RESCUE-MIMS (see Figure 2-4) in the search for people trapped in the event of a disaster is absolutely necessary, because it helps to achieve 2 basic objectives of S&R actions:

- increasing the chances of identifying people trapped under the rubble by overcoming the limitations generated by the action of K-9 dogs or other technologies used in this case;
- ensuring increased protection for First Responder to VOCs action generated by industrially produced materials.

The necessary basic characteristics of Portable RESCUE MIMS of the end users (power supply, size, payload, user interface characteristics, durability, cost, etc.) were mentioned in the deliverable D1.2.

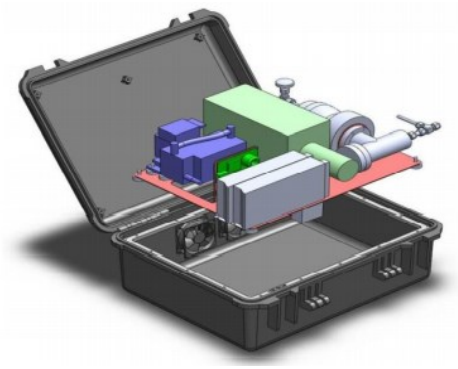


**Figure 2-25: Portable RESCUE MIMS (Peli case)**

Summarizing the above (see Table 2-1), in order to integrate the use by end users of technologies that make their work more efficient, the S&R project will provide them with a CONCORDE EMS platform with associated modules / services, a 3D Mixed Reality Command Center and a Training through AR / VR module.

| Module / Service | Before | After |
|---|---|---|
| Smart Glasses & AR Helmets | 4 | 6 |
| Emergency communication app | 5 | 7 |
| Six Gas HAZMAT monitor | 5 | 7 |
| Advanced Augmented Reality (AR) technologies | 3 | 5 |
| Wearable GPS Tracker (wearable) | 4 | 6 |
| Wearable ECG, EMG (wearable) | 6 | 7 |
| Wearable Strain sensors (wearable) | 5 | 7 |
| Emergency response health condition monitoring device | 4 | 6 |
| Radiation sensors (wearable) | 5 | 7 |
| Rescue drones | 9 | 9 |
| AI services on top of rescue drones | 6 | 7 |
| Rescue Robots & Autonomous vehicles | 6 | 7 |
| Chemical sensors | 4 | 6 |
| CONCORDE EMS & Associated module / services | 5 | 6-7 |
| Decision Support System (DSS) | 4 | 6 |
| Training through AR/VR | 5 | 6 |
| Smart textile professional uniform | 4 | 6 |
| Rescue system for children | 4 | 6 |
| 3D Mixed Reality Command Centre | 3 | 6 |

**Table 2-5: Technologies for first responders**

Another novelty in the project is the significant large number of equipment (with related technologies) that during the entire process of design, testing (drilling and field exercises) and validation pass, for the whole S&R project, from a TRL level (Technological Maturity Level) of minimum 3 (Demonstration of the concept regarding the critical functionalities or characteristics at analytical or experimental level) up to the maximum level of 9 (Systems whose functionality has been demonstrated in the operational environment).

Of all the steps taken to validate equipment in terms of technological maturity, in the opinion of end users, an important role is played by testing technologies in field exercises.

The S&R project offers seven Use Cases for this purpose, where not only the efficiency of the promoted technologies is tested, but also a framework is created that allows interoperability not only between technologies but also between First Responders teams from different partner countries in the project.

In this regard, we consider that the use of standardized operational procedures (SOPs) developed by INSARAG for search and rescue teams participating in a field exercise organized by a project partner country is a useful basis for improving this type of procedure compared to the growing

## 2.3 Gap analysis

Continuing in the requirements of the first responders in WP1 of S&R project, we reach the Gap analysis for Community Resilience which is a method that inquires on the current and desired state of the issue at stake and allows for indicating prioritization and suggest possible remedial measures. This analysis is very important in the S&R project which will provide valuable feedback on the resource management and assessment of management efforts, comparing to actual with desired performance.

In particular with respect to providing high-level guidance for the development of the S&R technologies / wearables and the operationalization of the Use Cases (UCs). The GAP analysis was performed through the relevant T1.3 (GAP analysis for Community Resilience) works of WP1 (First responders Requirements and Governance model). In terms of timing, the work was split in two distinct Phases: A and B, as explained below.

The Gap analysis has been built on the related work performed during M1 – M4 of the S&R project (**PHASE A**, documented in detail in D1.2) on the GAP analysis for community resilience. In PHASE A, the scope was to produce a preliminary structure of the GAP analysis survey that would then be further modified and refined in PHASE B (see below), by reaching a common understanding and agreement on important definitions concerning 'resilience', 'community' and 'community resilience' for the purposes and scope of the S&R project.

In **PHASE B** (M5 – M12), the aim was to refine the work that was performed in PHASE A so that the feedback obtained and the resulting recommendations would be of **practical value and applicability** as much as possible to the S&R technology/wearable developers and to the operationalization of the proposed 7 UCs that will take place during S&R project as possible (2/Greece, France, Romania, Spain, Austria-Germany, Italy). The scope was thus limited and targeted on how to best combine the identified 'community resilience' attributes/capacities with the involved parties (i.e. technology/wearable developers and UCs participants and end-users) key requirements for the aforementioned aim.

The PHASE B methodology relied on a participatory approach which combined several methods. These methods are presented below with a brief elaboration on how these were applied in the project:

- PHASE A structured literature review and case study findings (documented in detail in D1.2) and
- Brainstorming S&R partner online meetings that have been organized during the first year of the project's lifetime were several conclusions have been derived:
    a. **What is the purpose of the refinement for the GAP survey?**
    b. **Who will the survey be addressed to?**
    c. **Who will benefit from the survey answers?**
    d. **How to proceed with the refinement?**
- Surveys and meetings with the S&R consortium partners. In particular:
    a. A poll addressed to S&R consortium partners for relating key user needs with resilience attributes/capacities.
    b. A Focus Group meeting with S&R first/early responders and technology developers.
    c. The final GAP survey that was administered to all the S&R consortium partners
    d. A refinement / validation Workshop with the participation of external experts where the feedback obtained from the GAP analysis and the aforementioned methodology where presented and discussed.

The administered GAP survey, it included 21 questions answered mainly by first and early responders (e.g. Fire and rescue brigade, Emergency medical services, Civil protection, police-law enforcement personnel, Coast guard / Border security, by-stander individuals) and technology developers (e.g. Emergency Coordination Centres, Critical infrastructures and infrastructure operators; hospitals, registered national and international voluntary organizations active in disaster & spontaneous volunteers; utility companies, primary care organizations, public authorities, UAV/robots/vehicle manufacturers, infrastructure manufacturers, support aid manufacturers) and other partners (including Legal & Ethical Partner, Universities, Dissemination & Exploitation experts) of course who completed the specific questionnaires.

Most of the questions focused on the community resilience and crisis management procedures implemented and needed within the organization of the responders. Additionally, the survey included some questions investigating the technical challenges faced during operations within the organizations of the responders and the importance of each features and procedures. Also, the survey provided to the responders the ability to include additional options and suggestions for each feature/procedure.

Figure 2-5 shows the reported normalized scores of importance attributed by each category of responder to each feature.

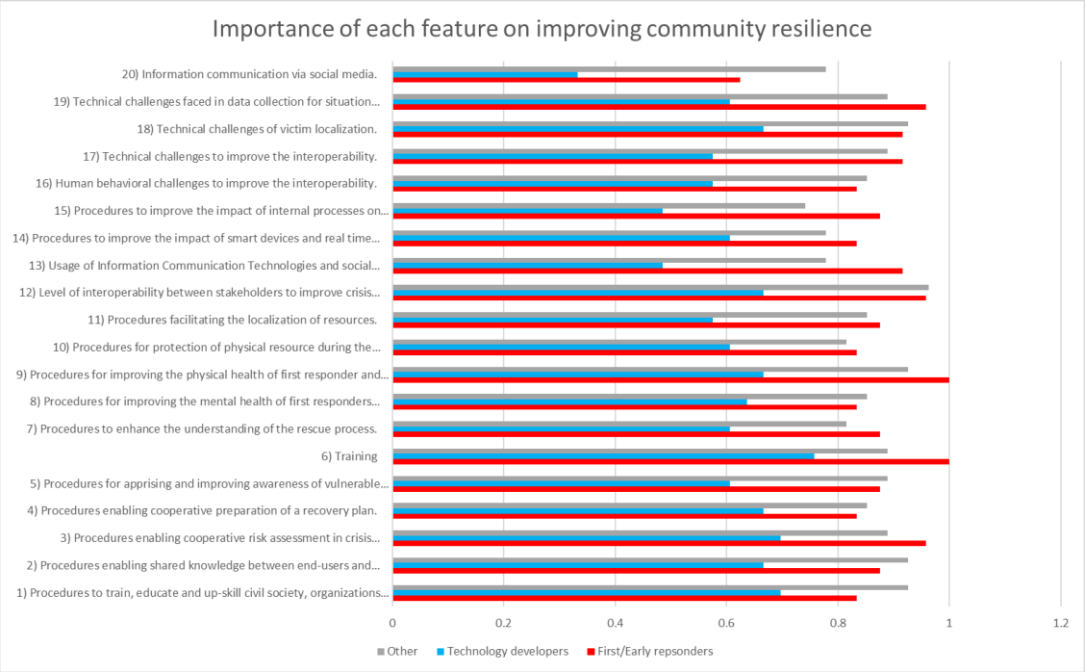



**Figure 2-26: The normalized importance score of each studied feature on improving community resilience**

The **top 5 important features for first and early responders** were:

1) Procedures for improving the physical health of first responder and victims.
2) Training.
3) Procedures enabling cooperative risk assessment in crisis management.

4) Level of interoperability between stakeholders to improve crisis management operation.
5) Technical challenges faced in data collection for situation awareness and risk assessment.

The **top 5 more important features for the technology developers** were respectively:

1) Training.
2) Procedures to train, educate and up-skill civil society, organizations and local communities about the rescue process.
3) Procedures enabling cooperative risk assessment in crisis management.
4) Procedures for improving the physical health of first responder and victims.
5) Procedures enabling shared knowledge between end-users and civil society, organizations and local communities.

The **top 5 more important features for the other partners** were:

1) Level of interoperability between stakeholders to improve crisis management operation.
2) Technical challenges of victim localization.
3) Procedures to train, educate and up-skill civil society, organizations and local communities about the rescue process.
4) Procedures enabling shared knowledge between end-users and civil society, organizations and local communities.
5) Procedures for improving the physical health of first responder and victims.

From the above-mentioned, the list of the five most important features for the three categories of responders have common features. Table 7, shows the similarities and difference on the raking of different category of responders. The identification of the similarities and dissimilarities of the features appearing of the list of the different responders allowed to focus on the shared important features and on the differences.

| Order | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **First and early responder** | Procedures for improving the physical health of first responder and victims. | Training | Procedures enabling cooperative risk assessment in crisis management. | Level of interoperability between stakeholders to improve crisis management operation. | Technical challenges faced in data collection for situation awareness and risk assessment. |
| **Technology developer** | Training | Procedures to train, educate and | Procedures enabling cooperative | Procedures for improving the physical health | Procedures enabling shared |

| | | | | | |
|---|---|---|---|---|---|
| | | up-skill civil society, organizations and local communities about the rescue process. | risk assessment in crisis management. | of first responder and victims. | knowledge between end-users and civil society, organizations and local communities. |
| **Others** | Level of interoperability between stakeholders to improve crisis management operation. | Technical challenges of victim localization. | Procedures to train, educate and up-skill civil society, organizations and local communities about the rescue process. | Procedures enabling shared knowledge between end-users and civil society, organizations and local communities. | Procedures for improving the physical health of first responder and victims. |

**Table 2-6: Five most important feature for different category of responders**

The detailed results and the analysis for the aforementioned are summarized in D1.6, Section 3 where the reader is encouraged to refer and for avoiding replication, as the aim of this section is to provide a brief overview of the approach and the responder's top priorities. As suggested in D1.6, guidance in relation to the development of technology/wearables and/or the operationalization of the UCs should be obtained by following the suggested approach depicted in Figure 2-27.

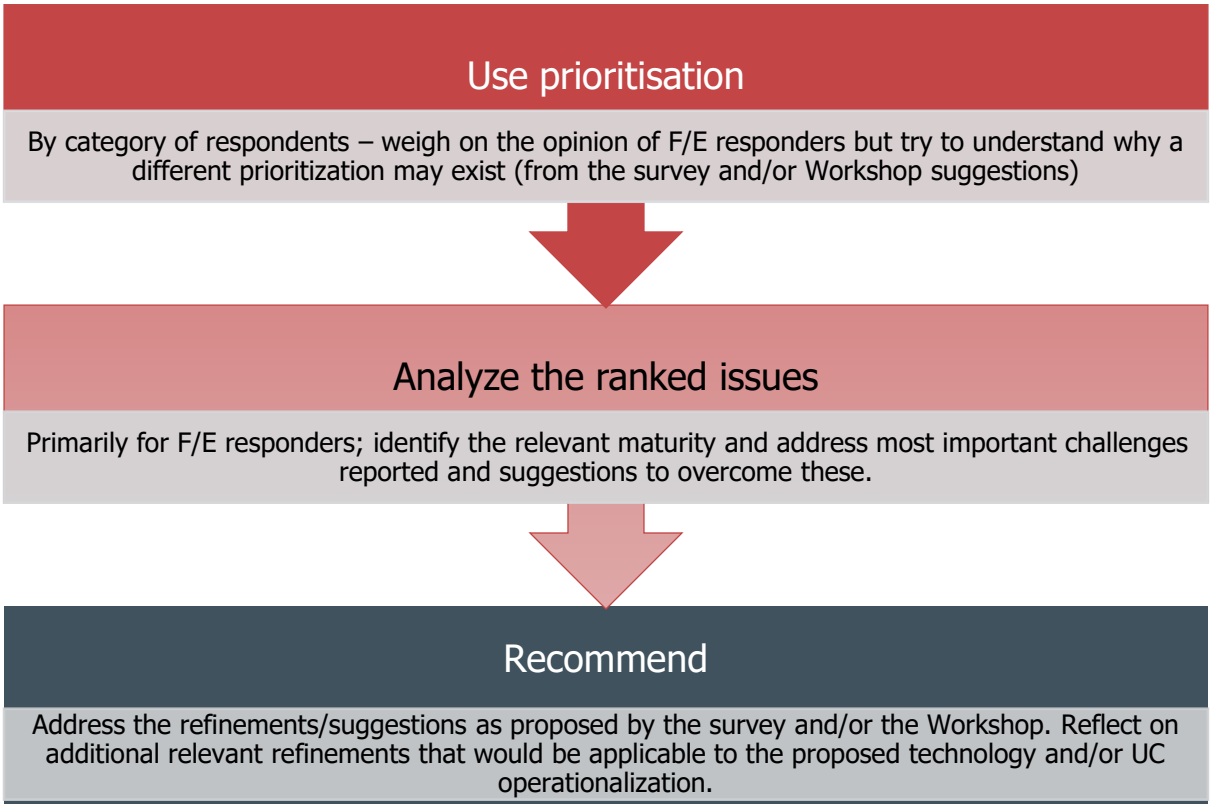



**Figure 2-27: Schematic recommendation on how to proceed and best use the findings**

# 3 Specifications of S&R Governance Model

## 3.1 S&R Operational Model

The specifications of S&R Operational Model are the core concepts to be developed within task 1.4 of S&R project. In order to clearly describe the S&R model, we will first present CRISYS (Critical Response In Security and Safety emergencies FP7-SEC-2010.4.1-1) operational model as its architectural structure will allow to easily incorporate next generation R&D and COTS solutions. The Model will also support a unified vision of the EU role and will provide a common framework to assess needs and integrate responses. The framework will enable a pro-active approach using a wider range of decisional support features and monitoring systems and will also give to crisis responders an effective and unified vision of (a) the dynamic changes going on during event's lifetime and (b) the capabilities and resources currently deployed in the field.

The CRISYS project aimed to assist the population, environment, economy and, in general, the whole society by helping to achieve better protection and a more rapid return to a reasonable quality of life in the aftermath of a crisis. During CRISYS there were gaps that will be addressed within S&R, as identified in COM (2010)600 - Towards a stronger European disaster response: the role of civil protection and humanitarian assistance:

1) **In CRISYS project, the citizen was not fully introduced in response process, there was lack of education. During S&R, we will introduce the citizen and local communities at the centre of the crisis management process.**

Training and education are utmost importance in crisis management involving both citizens and first responders. The citizens must be aware of the risks of the disasters, act and assist when necessary. The first responders have to be trained on a regular base in order to be able to respond immediately in every type of disaster. A two-way process must be ensured whereby citizens also have the opportunity to contribute and integrate their local knowledge into the disaster management cycle. The core idea behind each training module is the simulation of the situation that will present itself and, depending on each scenario that will take place during the project, how it evolves and what decisions need to be made. The aim of S&R project is the well-trained citizens which is a fundamental requirement for a high-quality disaster response. The closer involvement of citizens in information and preparedness activities could reduce significantly the defect level in cases of emergency and at the same time improve the quality of disaster response measures. For that reason, volunteering groups will be involved in the pilots, citizens as well as young people. Before the pilots, training courses, joint simulation exercises and an exchange programme will take place, where experts can learn first-hand about similar responsibilities under different national systems. It has to be mentioned that VR first responder training modules will be integrated in S&R. Additionally, special Glasses and Helmets using Advanced Augmented Reality technologies will be developed for training and operational purpose.

There are many advantages for the citizens to integrate into the crisis management:

- Develop a risk-awareness culture in order to raise public awareness and invest more for their own safety.
- Promote cooperation between the citizens and first responders in order to be more efficient and reduce the delays in emergency response.
- Train the citizens in rescue management in order to be involved in their own safety, because during a major disaster, the rescue teams will not be able to face all the requests of the citizens who will have to carry out an initial rescue phase by themselves for their families, their neighbors and other citizens.
- Ensure a two-way learning process whereby citizens and local communities also contribute and integrate their local knowledge into the disaster management cycle.
- Understand the value of crisis management and then contributing to avoid disaster emergency caused by human errors.

The new AR/VR technologies will allow for the development of interactive and distance training modules; these scenarios are also fun, which allows for an easier diffusion between the citizens.

**2) CRISYS included a Re-active and ad-hoc response system. In S&R, we will promote a holistic framework, where prevention and preparedness are linked to response, thus moving into a proactive system.**

Disaster preparedness consists of a set of measures undertaken by governments, organisations, communities or individuals to better respond and cope with the immediate aftermath of a disaster, whether it be human-made or caused by natural hazards. The objective is to reduce loss of life and livelihoods. Simple initiatives can go a long way, for instance in training for search and rescue, establishing early warning systems, developing contingency plans, or stockpiling equipment and supplies. In the case of early warning systems, both warning systems present among local communities, for example through repeated experiences in disaster-prone areas, and professional warning systems can be coordinated to ensure higher levels of effectiveness in disaster preparedness. Disaster preparedness plays an important role in building the resilience of communities.

The training activities that will take place within S&R project will raise people' preparedness and their response capacities. Emergency Management is about managing risks to communities and the environment. It is the core business of Emergency Services but every individual and organisation have a part to play.

Emergency Management, as formulated within the United Nations' Yokohama Strategy (1994), includes the following four phases:

- Prevention/Mitigation

- Preparedness
- Response and
- Recovery.

Leaders in organisations need to know their roles and responsibilities in each phase of the emergency management cycle and lead their organisation through them.

**Prevention/Mitigation**: any action or sustained effort aimed at reducing risk, undertaken in advance. Prevention or mitigation can be structural or non-structural. Examples of structural mitigation include resistant construction, structural modification and creation of barriers among others. Non-structural mitigation includes regulatory measures, design of education programmes and non-structural physical modification. Examples can range from back-burning or constructing sea walls to protect from tidal waves, to having alternative sources of electricity or alternative communication systems in place. Prevention activities should be happening all the time.

**Preparedness**: making arrangements, creating and testing plans, conducting training, educating and sharing information to prepare communities should an emergency eventuate. These are also ACTIONS and they are happening all the time.

**Response**: the assistance and intervention during or immediately after an emergency. Focus is on saving lives and protecting community assets (buildings, roads, animals, crops, infrastructure). Usually measured in hours, days or weeks.

**Recovery**: the coordinated process of supporting emergency-affected communities in reconstruction of physical infrastructure and restoration of emotional, social, economic and physical wellbeing. Usually measured in months and/or years.

### 3) In CRISYS there were Diverse structures, SOP, equipment, Inoperability within intra & inter-agency. Now we have the S&R governance model.

The investigation regarding the Standard operating procedures of the end-users made us understand the differences and the commons methods that are used within the various teams. The S&R governance model will give the emergency organisations to work in common structures, use a common equipment and cover the gap which exists especially in the methodology used by the EU end-users. The S&R platform that will be developed during this project, will provide easy integration connectors with other command and control software solutions. The Model is built on the existing SOP investigated and, on the accountabilities, and responsibilities of all the organisations involved in the crisis management domain. Its architectural structure adopted will make it operate more effectively in the future disaster management systems.

Today, the rescue teams do not have all the same standards; Therefore, it is important and necessary to suggest a common doctrine in order to make the work and the interoperability easier of the different teams in the following sectors:

- Engagement procedure (preparedness, mobilisation, deployment...),
- SOP,
- Logistics and materials,
- Operations management platform,
- S&R project will allow for the development and suggestion of operational standards which the rescue teams will manage to adapt. This common basis will allow for a better collaboration and exchange of information in the intervention field.

Additionally, S&R provides:

- New technology tools shared between the teams: by adapting identical tools for the teams, the interoperability has been reinforced, the principle of subsidiarity has been strengthened, allowing the team to share its equipment and communicate it to other stakeholders. The efficiency in finding victims and the safety of rescuers will be more important.
- New operational platform to coordinate the operations: The communication and the share of information are prioritised during the rescue operations. By adopting a common platform, the exchange of information between the teams and on the field will permit to anticipate the evolution of complex situations. The radio communications will be shared in order to assure a direct communication between the teams on site with the structure of the management (EMS).

A deployment procedure will be equally be adopted by the teams: the SOP will be able to guide the teams in the use of INSARAG guidelines [1] or European modules on civil protection. These two systems are relatively close and compatible with the deployment of the rescue team.

**4) In CRISYS there was Lack in training: In S&R, we will use Advanced mixed reality (AR & VR), simulation engines, curricula.**

As it has already been indicated above, training and education are very important in crisis management. The lack of training and education leads to the loss of human lives. Education in emergencies provides immediate physical and psychosocial protection, as well as life-saving knowledge and skills (for example, with respect to disease prevention, self-protection and awareness of rights) (Education in emergencies - UNHCR|Emergency Handbook). If children and youth receive safe education of good quality during and after an emergency, they will be exposed less frequently to activities that put them at risk. They will also acquire knowledge and mental resources that increase their resilience and help them to protect themselves. Inclusion in national education systems enhances these protection benefits. VR first responder training modules will be integrated in S&R. New innovative methods of training will be applied into the project in order to attract the first responders and citizens, offering them an easy and security training curriculum based upon agreed training material and practical exercises built on the five complimentary methodical approaches:

- Modern, didactically refined lectures and seminars, emphasising interactive learning and including self-tutoring possibilities.

- Documented in open-structured, user friendly, based on state-of-the-art software tools in data and knowledge management.
- Computer-based interactive models and virtual reality with biofeedback, simulating threat scenarios and the resulting consequences without and with appropriate countermeasures.
- Realistic field exercises.
- Evaluation of 3D computer-models during the practical field exercises.

The model will be based on the principles of 're-use, before buy, before make' and in this way, seeks a maximal reuse of existing legacy systems and solutions and beyond state-of-science, R&D and COTS tools and technologies.

For the training of the citizens, it is necessary to provide learning tools which will be compatible with people with disabilities (deaf, blind, paralysed...). These «fun» learning tools would give the chance to the children to receive more easily the message of training.

**5) In CRISYS: Fragmented security market: in S&R there will be Access to end-users, certification, harmonization and standardization**

The S&R platform contains a wealth of existing mature / near mature technological solutions, which have been developed by partners COTS products or fully demonstrated in FP7 and H2020 projects. They are summarised in the following Table. The S&R solutions which will be employed throughout the field demonstrations' will be also tested by the legacy systems of the responders' organisations which will participate in the demonstrations. All technologies, will be fully operational during S&R duration.

- Smart Glasses & AR Helmets
- Emergency communication app
- Six Gas HAZMAT monitor
- Advanced Augmented Reality (AR) technologies
- Wearable GPS Tracker (wearable)
- Wearable ECG, EMG (wearable)
- Wearable Strain sensors (wearable)
- Emergency response health condition monitoring device
- Radiation sensors (wearable)
- Rescue drones
- AI services on top of rescue drones
- Rescue Robots & Autonomous vehicles with Obstacle Detection System
- Chemical sensors
- CONCORDE EMS & Associated module / services
- Decision Support System (DSS)
- Training through AR/VR

- Smart textile professional uniform
- Rescue system for children
- 3D Mixed Reality Command Centre

These different tools of new technology will make easier the work of the rescue teams who have as a priority to save lives. However, we must not forget that this equipment includes field tools and this includes many advantages:

- They are robust, resistant, with a good autonomy, usable in unfavorable weather conditions (rain, cold, heat, etc...),
- Their cost is adapted to the teams in order to be easy to buy it in big quantity.

**6) In CRISYS Technology providers have difficulties to access the stakeholders and demonstrate technologies: In S&R Test-bed and open the final two demonstrations to technology provides outside the consortium**

Seven pilots will take place during the S&R project including end-users, first responders, volunteers, training centers and relevant stakeholders. Seven relevant scenarios have already been developed which will give the opportunity to the relevant parties to test the system under real conditions and provide their feedback for further improvements. The preparation of the pilots has started from month 6 of the project and lasted for 6 months. During this time, the pilot environments have been identified for each responsible pilot partner. The pilot requirements have already been specified by the end-users with the aid of the technical partners who will be involved in the relevant pilots as well. The specific pilots will run from month 13 of the project start until month 33. During this time, S&R platform will be developed and the actual execution of the pilots will take place under realistic conditions and data through a series of trials with end-users who will evaluate the demonstrators and apps and assess the quality and usability of the S&R Platform in collaboration with technical partners who will closely monitor throughout the pilot the operation.

## 3.2 S&R Emergency Management System (EMS) integrated solutions

The S&R Emergency Management System (EMS) will be based on Concorde EMS (FP7-SEC-2013-1). The main screen of CONCORDE EMS comprises the central part of the UI. It is set up as a dashboard, from which all operational information can be accessed with one step click.

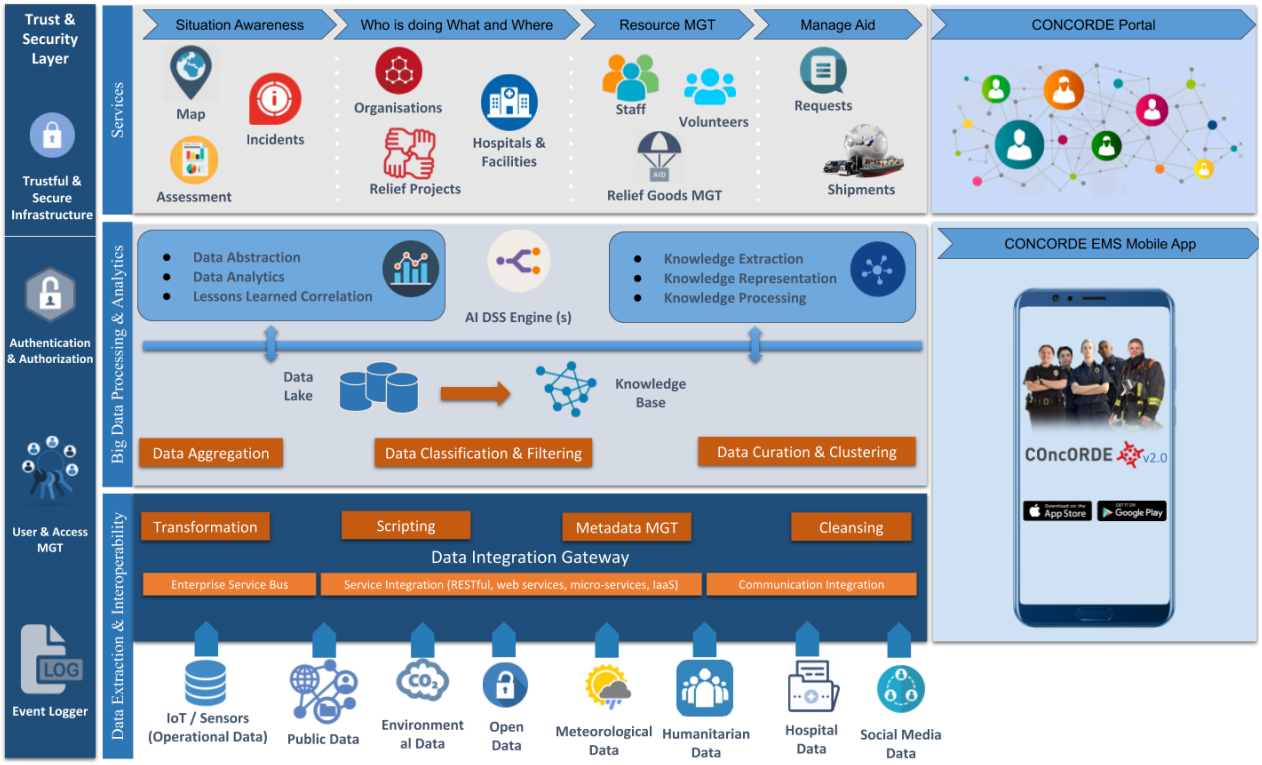



**Figure 3-1: CONCORDE**

It is a cloud-based platform which divides the emergency response in 5 spaces of work:

1. The PSAP/112 centre managing the initial alert phase
2. The emergency medical vehicles on their way to the incident scene
3. The Field/Incident scene
4. The patient transport vehicles

to First Receiver

5. The First Receiver

The platform has an open source / community version which will be offered by KT and will be evolved further through S&R to bridge the gap between the operational world (first responders, rescuers etc.) and the strategic one (dispatching centre, hospitals etc.). The incident window in the dashboard allows access to the entire information related to incident management – PSAP info, Sitreps and Team table. The current version of CONCORDE EMS features the following subsystems / tools and services:

| | | |
|---|---|---|
| **Incident MGT System**<br>• Incident information tool<br>• Team MGT tool<br>• Hospital MGT tool | **User MGT**<br>• User registration<br>• Secure Authentication and Authorisation<br>• Event log and reply<br>• Bystander service | **Information & Notification**<br>• Notification tools<br>• Rescue and field applications<br>• Tracking tools |
| Decision Support System | **Patient MGT** | **Semantic Infrastructure** |
| External Services<br>• PSAPs<br>• Nearby hospitals<br>• Weather data<br>• Social Media Data | | **Map integration**<br>• Google maps<br>• ArcGIS<br>• Open maps |

**Table 3-1: CONCORDE EMS features**

**Command Centre Mixed Reality (MR) Conference Table:** In regard to the aforementioned EMS, a Command Centre Mixed Reality conference table (using CERTH / HIT's past experience from **VERITAS, Mixed Reality lab** and vehicle simulators) will be **developed in T4.3 in WP4** and added. This exclusive module will allow for interactive, rescue team and multi-user support, direct communication and commandment with 3D Mixed Reality Visualisation capabilities, commandment and communication with emergency response services and the following capabilities:

**Figure 3-2: Command Centre Mixed Reality (MR) Conference Table**

- Stereoscopic 3D, interactive with multi-user support
- Image registration for presentation heterogeneous data sources of information (e.g. GIS, Satellite imagery, live camera and thermal camera feed from drones and rescuers.)
- Fire development information from survey drones and helicopters.
- Rescue units and rescued people position and condition presentation.
- Distress call position and information presentation.
- Real time traffic information.
- Crowd sourcing from social media.

Direct communication and commandment of: Drones with cameras and sensors; Drones with ER equipment defibrillator, first aid kit; Emergency support teams and Individual units & requests.

**CONCORDE Incident MGT system**

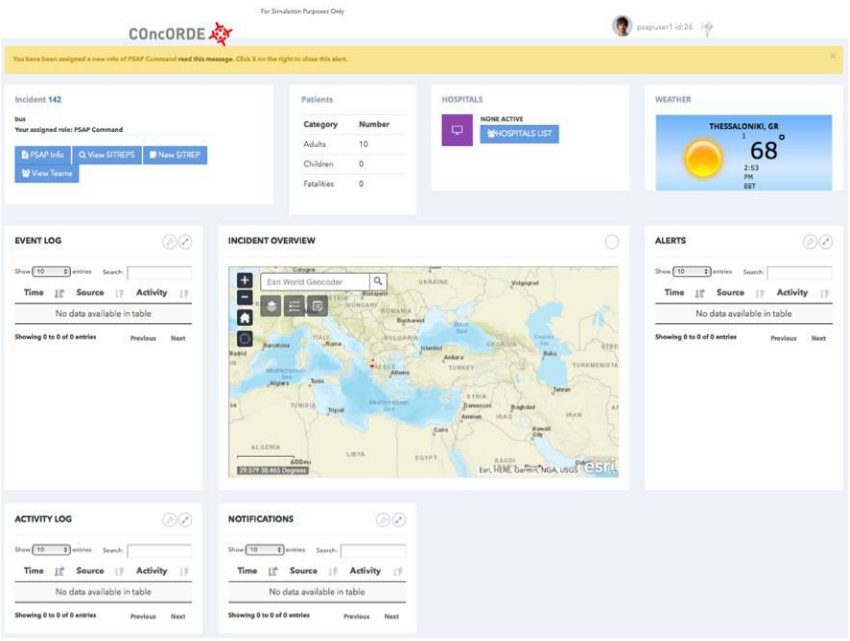



**Figure 3-3: CONCORDE Incident MGT system**

**Decision Support Service**: **S&R** partner **KT** [2] designed and developed a decision support tool that can be used for efficient real-time resource allocation. Machine learning algorithms were implemented to estimate the number of expected victims/patients in an earthquake/flood emergency incident, as well as the estimated number of ambulance units demanded. A network model is also derived to capture the resource flow. Then, a mathematical programme is formulated to optimise the allocation of the resources and an implementation is provided through a web service for real-time execution. **KT's** Semantic knowledge is exploited to further improve the allocation, matching patients' injury profiles to expertise and specialties of hospitals. The **Decision Support Services Module** implemented four algorithms and offers them as services.

Three of the services exploit optimisation techniques to recommend allocation of certain supplied resources to relevant demand, while the fourth one exploits machine learning techniques to learn from data and predict/estimate required resources in a new emergency incident. For convenience, these services are listed below:

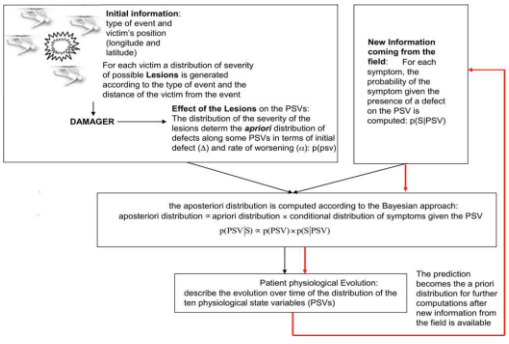



**Figure 3-4: DSS Algorithm example**

- Recommended (optimal) allocation of available EMS units to incidents, depending on estimated needs
- Recommended (optimal) allocation of patients to transport vehicles and first receivers (hospitals), based on given order of evacuation and triage results for present injuries
- Recommended (optimal) allocation of tasks to available actors on the field, given demand pre-defined by the field commander.
- Estimation of expected casualties and demanded resources (EMS units), given historical data on emergency incident recordings.

The Decision Support Services integrate with the semantic knowledge management module.

This integration facilitates the semantic mapping between patients (considering their status and injuries being the output of the medical treatment on the field) and First Receivers' (Hospitals) reported capacity on medical specialities and beds.

The current version of COncORDE's DSS will be significantly enhanced by CNR with the addition of the forecasting services on the evolution of the vital physiological functions of the victims (individuals involved in the mass casualties' incident) of the crisis, determining the time-curve of each Physiological State Variable (PSV), on the basis of a modelling analysis through which both the effect of injuries and the effect of delivered treatments. The goal in this case is to provide a stand-alone simulation platform focused on the patient physiological status, able to follow the victim from the very beginning of the crisis event to the end of the patient's observation period (due to death, discharge, assignment to definitive care or conclusion of the simulation). To achieve this, we will need to develop a series of different sub-modules, interconnected with each other, in order to provide the following features for each individual patient:

● Describe the evolution over time of the physiological stare variables (PSVs), representing the patient's condition;

● Describe the effect of different possible lesions on the PSVs: lesions determ a defect along some PSVs in terms of initial defect and rate of worsening;

● Determine the type of the needed treatment based on the values of the PSVs;

● Evaluate the effect of the treatments along the PSVs in term of modification of the instantaneous damage and the rate of worsening.

Moreover, the module will provide a prediction, in terms of distributions, of the physiological state of the victims, starting from the initial information provided by first responders (for example the type of event, victim's position). This prediction becomes in turn a priori information for recurrent computations after new information is available from the field (new recorded symptoms and signs), obtained from rescuers and/or directly acquired from the instrumentation/equipment. The module will be embedded into the **S&R** DSS component with the aim of proving a mean for an efficient decision making in emergency health operations, giving suggestions and improving the quality of the services provided to citizens.

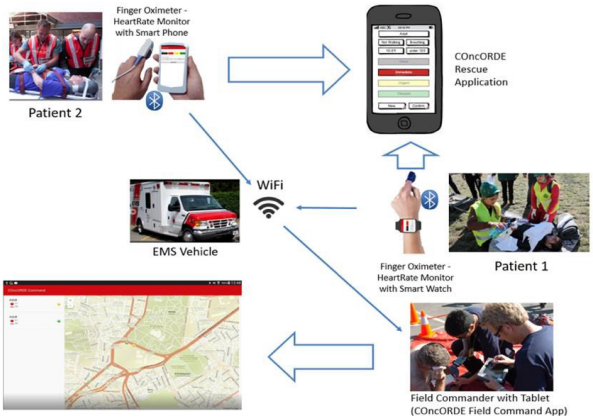



**Figure 3-5: Map Services and Android Application**

**Map services**: CONCORDE platform has 3 different approaches of the map, **KT** used Open maps and Google maps:

- One is the map embedded in the creation/update of an incident and in the registration of a hospital (an organisation);
- The second is the overview map in the dashboard of an incident;
- And the third, that we can consider as the truly map module, is a full-screen map that turns all map functionalities available for all users (like directions, edit function, proximity analysis).

**On the Field Applications**: The CONCORDE Android Applications on the field can alert medical first responders to life-threatening conditions by monitoring vital signs of multiple trauma patients.

## 3.3 Actual existing Standard Operating Procedures (EU MS & International Organisations)

In this chapter, we are going to introduce the standard operating procedures in EU and International Organisations.

### 3.3.1 European Standard Operating Procedures

The **European Civil Protection Pool (ECPP)**[5] forms part of the EUCPM for enhanced European disaster response, with a focus on increased coordination and efficiency. When the EUCPM is activated, member states and participating states offer their assistance to the requesting country. This assistance may be provided in the form of qualified personnel (rescue or medical teams, experts) or equipment, which all represent resources made available through the ECPP. The common pool enables better planned and organised, more predictable, coherent EU operations. Capacities committed to the pool need to meet common high standards, validated through an EC certification and registration process. Such certification includes participation of registered capacities in disaster simulation exercises to train emergency response jointly with peers and other teams, further preparing the European response capacities to reliably operate during international deployments, in close coordination with authorities of the host nation and other deployed capacities. In case the EUCPM and its related ECPP get activated, the Emergency Response Coordination Centre (ERCC) will coordinate the deployment of relevant

[5] https://ec.europa.eu/echo/what/civil-protection/european-civil-protection-pool_en

capacities. The resources of the ECPP should generally be self-sufficient for several days as well as interoperable in terms of procedures and technical infrastructure.[6] It should be noted, however, that criteria on interoperability are not clearly specified. In the guidelines on the 'Certification and Registration of Response Capacities in the ECPP' interoperability is broadly defined as 'i.e. in how far the response capacity is interoperable with other deployed capacities' (EC, 2019, p.6). Interoperability is referenced as a key criteria in the certification process, further elaborating that

*'the capacity should be capable to work efficiently with other mobilised response capacities and contribute smoothly to common operations. This implies a common understanding of basic principles in disaster response operations, flows of communication and communication equipment, technical complementarity of equipment, etc.' (EC, 2019, p.14)*

As briefly mentioned, participation in the ECPP requires prior certification by the European Commission, ensuring compliance with the quality requirements for each of the modules. One of the points in getting certified is for a module to participate in an international field exercise. Among other things, this is supposed to enhance the capability of interoperability between modules from all over Europe, as their only chance to train and work with other modules from all over Europe is during these exercises.

One example for exercises of this scale is **EU MODEX**. EU MODEX, short for European Union Module Exercises, are exercises conducted for the European Commission. As the name implies, these are table top exercises as well as full-scale field exercises for all the module types registered in the ECPP. Their goal is to "enhance the coordination of civil protection assistance interventions by ensuring improved compatibility and interoperability between the intervention teams and other intervention support as well as by developing the competence of the experts involved" [7]. During an exercise, modules from all over Europe come together, as they would in a real disaster, and not only have to work as a team themselves, but also with the other modules in order to work as efficient as possible and therefore being able to safe as many lives as possible. Having this in mind, they are not only useful for working on interoperability, but also they are a good example for a way to strengthen the EUCPM and therefore whole Europe.

### 3.3.2 International Standard Operating Procedures – International USAR Response Cycle

An international USAR response has the following phases:

[6] https://erccportal.jrc.ec.europa.eu/CP-Pool#/
[7] https://etendering.ted.europa.eu/cft/cft-documents.html?cftId=4618 – Tender specifications


**Figure 3-6: The International USAR Response Cycle**

*3.3.2.1 Preparedness*

The preparedness phase is the period between disaster responses. In this phase USAR Teams undertake preparatory measures to ensure that they are at the highest level of readiness for deployment as possible. Teams will conduct training and exercises, review lessons-learnt from previous experiences, update Standard Operating Procedures (SOPs) as required, and plan future responses.

**a) Management Team:**

- Responsible for the staffing, training and deployment of the USAR Team over the entire USAR response cycle.
- Responsible for following and training to INSARAG minimum standards.
- Ensure proper identification of USAR Team functions.
- Ensure all personnel are trained in safety and security.
- Ensure that safety and security function is assigned to (a) team member(s).
- Responsible for maintaining coordination with national (team's governing body) and international stakeholders (i.e. INSARAG) and being active on the VOSOCC.
- Ensure the readiness of the USAR Team all the times, and that a mobilisation organisation maintains an up-to-date immediate call-up system.
- Responsible for the registration of the USAR Team in the INSARAG USAR Directory

b) **USAR Team Search**

- Responsible for having in place physical search, canine and/or technical search structures and methods, and their regular training and constant readiness.

- Responsible for canine handlers having the possibility to train with the other members of the USAR Team (e.g. technical search, rescue and medical).
- Responsible for ensuring that all appropriate documentation for border-crossing for canine (e.g. microchip, vaccination) is ready.

**c) USAR Team Rescue**

- Responsible for rescue structures and methods being in place, regularly trained and in constant readiness.
- Responsible for ensuring that rescue teams have the possibility to train with the other members of the USAR Team (e.g. canine and technical search and medical).
- Responsible for ensuring industry best practices are maintained and implementing new rescue methods, standards and technical equipment accordingly.

**d) USAR Team Medical**

- Maintain a constant state of mission readiness and comply with all other general requirements as determined by USAR Team policy.
- Develop and maintain an appropriate immunisations/vaccination/inoculation for working in the affected country recommended by the USAR Team's national health authorities.
- Maintain the medical cache stored in clearly labelled containers with attached inventory list for deployment and border-crossing.
- Prepare processes to efficiently medically screen all personnel at the time of international deployment.

e) **USAR Team Logistics**

- Maintain logistical readiness for training and international deployment and equipment/staff to set up and maintain a BoO (technical equipment and supplies for entire deployment).
- Have appropriate documentation for border-crossing for the USAR Team staff and equipment (i.e. passport, visa, certificate of vaccination, labelling of equipment, cargo manifest, shippers' declaration of dangerous goods).
- Maintain up-to-date transportation arrangements for international deployment.
- Maintain communications equipment always ready for deployment (interoperable).
- Maintain a system to be self-sufficient (food, water, fuel) for the duration of deployment.

*3.3.2.2 Mobilisation*

**a) USAR Team Management**

- Ensure departure within ten hours after the request for assistance.
- The USAR Team Leader has the overall responsibility of personnel, equipment, and operations from the team's activation until its return home.

- Collect and analyse information about the disaster and the actual situation in the affected country (i.e. the VOSOCC and/or ICMS).
- Await the request for international assistance by the affected country or offer assistance via diplomatic channels.
- Through the designated channels in the home country, collect the relevant disaster and affected country information to formulate (additional) recommendations for the deployment of the USAR Team.
- Through the designated channels in the home country collect relevant disaster and affected country information from the affected country authorities to be able to plan USAR Team deployment according to the needs and requirements of the affected country.
- Obtain log on information for the ICMS from the VOSOCC.
- Provide and update planning and deployment details and team capacity and exchange information with the international community through VOSOCC and ICMS (coordination with the LEMA and other teams).
- For planning, have Ministry of Foreign Affairs liaise from the beginning on with the affected country if and what support is required.
- Prepare meetings with RDC/UCC and the LEMA (information about the teams' capabilities and the needed support by local authorities).
- Brief the USAR Team on the disaster, the engagement and the affected country's cultural and political sensitivities and reinforce the ethics considerations.
- Prepare to establish and to run an initial RDC and UCC and to support UNDAC, if needed.

**b) USAR Team Search**

- Ensure that the readiness of physical search, technical and/or canines (health, fitness, hygiene, diet, etc.) for travel, including all specialised gear and equipment (including microchips), are ready for USAR operation (respect international standards and procedures).

**c) USAR Team Rescue**

- Ensure readiness of equipment cache and necessary documentations for restricted items

**d) USAR Team Medical**

- Conduct remote information gathering to include the receiving country specific hygienic, health and medical risks.
- Through the designated channels in the home country, verify that medical personnel with licensure have appropriate permission to practice their discipline within the scope of USAR operations in the affected country.
- Assess the local medical system to determine if it can effectively cope with the impact of the situation or if the system is extended beyond its capabilities.

- Conduct the medical screening process for USAR Team personnel and search dogs as well as a review of the required international documentation.
- Coordinate with safety and hazardous materials (hazmat) functions to clarify overlapping concerns.
- Determine medical plan for in-transit phase and be prepared to adjust en route.

**e) USAR Team Logistics**

- Ensure availability of transportation (air or ground; to/within country).
- Provide team members' lists and equipment manifest and shippers' declaration for dangerous goods and prepare for international border control processes.
- Ensure self-sufficiency for the duration of deployment (pre-packed dedicated equipment cache so as not to deplete domestic capacity).
- Check compatibility of VHF and UHF radio equipment with local systems.
- Identify local support needs required by the team and forward these through the management to the UCC.

*3.3.2.3 Operation*

**a) USAR Team Management**

- The LEMA of the affected country is the overall responsible authority for the disaster response: USAR Teams must adhere with the policies and procedures of the affected country regarding incident operations.
- Team management is responsible for managing all aspects of team operations and ensuring all functional areas within the team coordinate operations. They are also responsible to assess the progress of operations. Team management must ensure ongoing coordination and communication between other response entities.
- Coordinate with the LEMA, RDC and UCC during the entire operation: all planning must be done in close cooperation and information exchange with UCC and the LEMA.
- Ensure that all ICMS and paper-based documents are processed and shared according to INSARAG USAR coordination.
- Monitor and approve ICMS and paper-based information from field staff to external parties for quality control.
- Ensure that the USAR Team efforts are integrated into local operations.
- If first USAR Team in place, and RDC and UCC are not in place, establish and operate provisional RDC and UCC.
- Ensure that operations can start with priority (assignments) and set up the BoO simultaneously.
- Organise reconnaissance missions to identify worksites, based on INSARAG triage method.

- Establish a work cycle to ensure a sustainable work at worksite(s) and rest periods (maintain a reserve).
- Establish an information cycle to brief home base, USAR Team members, UCC and the LEMA.
- Keep a detailed operations log.
- Assess and respect permanently the safety and security situation and procedures.
- Establish and enforce rules and regulations for safety and security on worksite(s) and BoO.
- Managing and coordinating the media together with the LEMA/UCC. A guide to managing relationships with the media can be found in the Guidance Notes.
- Conduct contingency planning from beginning of the operation (safety/security, medical evacuation (medevac), demobilisation etc).

**b) USAR Team Search**

- Perform physical, technical and/or canine search in collapsed or failed structures of heavy wood/reinforced masonry with structural steel in close coordination with the USAR Team Rescue.
- Continually conduct a risk/hazard analysis of the assigned work area for USAR Team members and canine and take appropriate mitigation action.
- Assess and respect permanently the safety and security situation and procedures.

**c) USAR Team Rescue**

- Perform rescue (breaching, extrication and transport) in collapsed or failed structures of concrete, heavy wood/reinforced masonry with structural steel (rigging and lifting) in close operation with USAR Team Search and USAR Team Medical.
- Assess the collapsed structure and local failures to identify void size, location and configuration for potential live victims, and for determining access possibilities.
- Interview the public for information on victims, building lay-out and use.
- Decide access points, escape routes, safe havens and assembly points.
- Set up of a staff accounting system, building monitoring system and safety and security system.
- Perform cutting, breaching, lifting, lowering, moving, shoring, rigging and other rescue operations.
- Continually conduct a risk/hazard analysis of the assigned work area for USAR Team members and take appropriate mitigation action.
- Assess and respect permanently the safety and security situation and procedures.
- Establish worksite perimeter control procedures.

**d) USAR Team Medical**

- Coordinate with the LEMA/OSOCC/Health Cluster:
  - Availability of local and international medical resources.
  - Local medical procedures such as; casualty handover, casualty transport, fatality management, and medical waste disposal.
  - Methods of regular communications with local health authorities.
- Provide medical input into USAR Team decision making/planning process.
- Coordinate with Safety, hazmat, and Logistics functions to promote safe health and hygiene practices (BoO and work sites).
- Provide continuous health monitoring and medical care to USAR Team members (to include canines).
- Evaluation, care, and stabilisation of individuals entrapped in rubble (in some instances providing advanced medical care for many hours as other USAR disciplines work to free the patient).
- Initial evaluation, care, transport or referral of individuals with medical conditions encountered while the USAR Team is on reconnaissance missions.
- Assistance with medical care during transportation of patients from field to a care facility, if required.
- Assistance with recovery of deceased in the collapsed structure environment with attention to cultural sensitivities and to retrieving remains without further trauma and with managing risk for workers, if necessary.
- Advice as part of multi-disciplinary input through the UCC into the LEMA decision making on when emergency response to the collapsed structure incident transitions to a recovery effort (i.e. when the potential for survivability for those still entrapped).

**e) USAR Team Logistics**

- Establish BoO. The BoO serves as the USAR Teams' site for headquarters, communications hub, sleeping/resting/eating/health areas, equipment stock set-up and refuge from the elements while operational in a disaster-affected country.
- Run and organise the BoO over all of the operation, including perimeter control procedures.
- Support the work on the worksites (e.g. transportation, food, equipment).
- Ensure that all team personnel have reliable means of communications.
- Coordinate transportation requirements.
- Perform contingency planning for relocation of BoO and the demobilisation phase.
- Support the management on the contingency planning (e.g. transportation for medevac).

#### *3.3.2.4 Demobilisation*

**a) USAR Team Management**

- Demobilisation must be planned and coordinated from the beginning of the operation. All players, including the UCC and the LEMA must be involved in the planning from the beginning.
- Ensure proper hand-over is conducted to USAR Teams that take over the tasks of the departing team.
- Teams are required to update their Team Fact Sheet in ICMS and notify the UCC, who - based on the team's request - should provide the team with an estimated stand-down date and time.
- Teams are required to complete and submit the documentation to the UCC.
- Plan and communicate possible donations to the LEMA and/or affected community.
- Prior to leaving the area, the USAR Team Leader is expected to meet with the UCC, the LEMA, and political leaders of the community, as appropriate, to complete the team's participation.
- If appropriate: communicate to the media the finishing of their work and the departure (in coordination with the LEMA and UCC).

**b) USAR Team Search**

- Cease work and prepare handover to the organisation taking over the tasks.
- Prepare canines and equipment for return transportation.

**c) USAR Team Rescue**

- Cease work and prepare handover to the organisation taking over the tasks.
- Prepare and pack equipment for demobilisation and departure.

**d) USAR Team Medical**

Coordinate demobilisation with local relevant health authorities (i.e. through UCC/Health Cluster) Healthcare infrastructure assessments (USAR is often in country early in the post-impact phase and/or may have more mobility to assess remote outlying locations. An additional benefit may be found in structural engineering personnel who may accompany the USAR medical personnel on the assessment), if required.

- Health needs assessments (for same reasons as above), if requires.
- Provide advice on or facilitate health and medical donations.
- Provide handover to relevant medical organisations.
- Identify appropriate medical cache donations through UCC/Health Cluster.
- Assess potential exposures and need for follow on medical care.
- Maintain in-transit medical care for team to home base.

**e) USAR Team Logistics**

- The BoO site should be restored to its original state in so far as possible.
- Prepare the BoO equipment for return transportation.

- Ensure that the dangerous goods are prepared, packed and labelled according the International Air Transport Association regulations.
- Provide resources for logistics requirements during demobilisation (preparing of manifests, packing and loading, shippers' declaration of dangerous goods etc.)
- Plan and ensure the required transportation.

*3.3.2.5 Post-Mission*

**a) USAR Team Management**

- The after-action process includes compiling a Post Mission Report documenting administrative issues and operational concerns which should be forwarded to OCHA within 45 days of returning home.
- Lessons-learnt must be included in planning and training.

**b) USAR Team Search**

- The canine group prepares and delivers a report on the mission to their USAR Team.

**c) USAR Team Rescue**

- Provide inputs to the team report and identify lessons-learnt.

**d) USAR Team Medical**

- Coordinate immediate and long-term medical follow-up with USAR Team Management (including mental health).
- Restore USAR medical cache within timeline prescribed by USAR Team policy.
- Provide input into USAR Team post mission operations report.

**e) USAR Team Logistics**

- Safety equipment and supplies must be restored and restocked for next deployment.

### 3.3.3 Standard Operating Procedures (SOP) within S&R

*3.3.3.1 Preparedness: planning for major emergencies including training exercises*

The preparedness phase is the period between disaster responses. In this phase USAR Teams undertake preparatory measures to ensure that they are at the highest level of readiness for deployment as possible. Teams will conduct training and exercises, review lessons-learnt from previous experiences, update Standard Operating Procedures (SOPs) as required, and plan future responses.

All the Search and Rescue end users participated in the completion of the SOP **questionnaire have a training plan for their team**. The only exception is PROECO, whose members are used as trainers for other administrative entities (eg the National Institute for Administration). More specifically, HRT recruits attend the first level/basic training program and after joining the department of their choice (mountain rescue, water rescue or USAR), they follow a more expertised training, divided in two levels.

Additionally, whenever there is an opportunity, members of HRT participate in exercises abroad. PUI training conform to the INSARAG procedure of deployment. The regular training working with dogs for ESDP is mandatory in order to make sure that K9 teams are ready to act in case of disaster.

All the end users **organize simulation exercises** except for PROECO. HRT frequently organises internal simulation exercises for practicing mountain, water and urban search and rescue procedures, which in some cases are joint between our departments. These are not conducted, however, under an existing plan. Each department organizes an average of two or three exercises annually. The organization of simulation exercises for EPAYPS is a frequent procedure which is conducted in properly selected locations in proportion to the existing risk. At least 5 major exercises per year for Natural, Technological and NaTech Disasters. JUH organizes simulation exercises 1-2 year focus on medical and logistics for Emergency Medical Team (EMT). JOAFG organizes approximately 5 exercises of different sizes (internal or with other organisations) - EMS focus, SnR rescue dogs. For PUI, there is 1 simulation every 2 months, management (command-post, ICMS, UCC), medical, search and rescue and logistics. PUI also participates in 1 or 2 international exercises during the year. SUMMA within the Summa112 [3] training program there are: 1.- mandatory practical courses on multi-victim incidents with a final simulation. 2.- Periodical but continuous training (on/off doing PPE practice two hour every 15 days in total, which means each group attends a practice every 2 months, because we are 4 groups) for the professionals that integrate the Biological Risk Transportation Group (which is volunteer). 3.- Periodical training for assembly and disassembly of the SUMMA 112 Sanitary Decontamination Station. 4.- ERICAM (USAR Team) training and reviewing the material monthly.

It is worth mentioning that all the end users **organize special sessions – debriefing** in order to analyse the lessons learnt. Most of the end users **use the social network** for their exercises and other public information such as websites, conferences, press releases, newsletters and communication departments inside the teams. HRT's **Operational Manager** is handling and monitoring the whole operational procedure followed by our team members. In that frame, he's strongly collaborating with our telecommunications experts and the head of each department, who initially activate and, then, contact our members in the field. The operational management of EPAYPS follows every exercise's handbook. The field operational manager, which controls the activities, communicates with the team supervisors for every new progress. The management team members of PUI are members of the fire department and experienced in management of special operation. The operational management of the team members is based on the IMV protocol of the Community of Madrid, which is based on the PLATERCAM law.

All the end users are well informed for the safety and security of their teams. More specifically, all HRT members are intensively and strictly trained in self-protection and properly equipped for each incident. In case they don't have the necessary equipment, they do not participate to all the emergencies. Of course, all their volunteers are insured by the organization for body injuries that may occur during trainings or rescue missions. CNR is conformed to the Decree of Chief of the National Department of Civil Protection of January 12th, 2012 and decree of November 25th, 2013. All the

team members of PUI have the training "BSAFE" from UN and during simulation they are working different scenario about the security and safety issues. The information received inside SUMMA is by the coordinating center. Firefighters secure the area and remove the victims from the hot zone. The safety elements used by the team is the individual PPE without being monitored or communicated between us, only through the coordinating center.

**The end users collaborate mainly with their National Authorities** (Fire Service, Coastguard, local civil protection offices). JUH is working closely with the German EMT National Focal Point, WHO Regional Office Europe & EMT Secretariat, EMT classification processes in different countries. PUI collaborates with International Authorities (INSARAG, WHO, International Office for Migration, CARITAS etc). The actions of the national authorities and SUMMA are contemplated in PLATERCAM (Madrid Civil Protection Plan). More information can be found in https://www.comunidad.madrid/transparencia/sites/default/files/plan/document/acuerdo_de_30_de_abril_de_2019.pdf. They algo belong to ESP USAR Team ERICAM, so they are updated with the circumstances of international catastrophe on behalf of Global Disaster and Coordination System GDACS https://vosocc.unocha.org/. ESDP works with the National School of Civil Protection and they are members of ERICAM as well working under INSARAG guidelines [1]. All the end **users use K9 research activities** and techniques except for JUH and PROECO which is not part of their team. All dogs are trained for searching in open air and debris, using the air scenting technique completed with electronics devices (scanner, sensors). Additionally, the K9 teams **share information with the other members of the team**. Health certificates and dogs' passports and all the **transport documentations for the dogs** are updated. The teams have **various methods in case of disasters**. In cases of large scale disasters, HRT organization is alarmed and invited to support the search and rescue operation by the General Secretariat for Civil Protection or by the local civil protection offices. Their operational manager, in collaboration with the board and the head of the USAR department, examines their operational capacity in accordance with the severity of the disaster, the available rescue equipment and their human resources. At the same time, there is a call for support to all HRT rescue stations in Greece. The respective authorities are relatively informed and the on-field focal points from their side are indicated.

During the operation our volunteers work under the command of the indicated state representative. EPAYPS aims at: 1) Performing rescue (breaching, extrication and transport) in collapsed or failed structures of concrete, heavy wood/reinforced masonry with structural steel (rigging and lifting) and 2) assessing the collapsed structure and local failures to identify void size, location and configuration for potential live victims, and for determining access possibilities. JOAFG uses Manchester and Triage. The rescue efforts are usually executed by the fire brigade. After the assessment phase of the structures, PUI has the process to decide the priorities of search: the K9 team is deploying on the field, always 2 K9 teams for the security. If the result is positive with 1 dog, the second dog confirm or not. The rescue method inside SUMMA is the one established by the IMV protocol of the Community

of Madrid. It determines the functions of each resource on a first-come, first-served basis, and also depends of the circumstances of the catastrophe, for example, we have a biologycal unit for transport patients with this type of risk, and we use PPE adapted to it, also the type of incident influent into the type of rescue. They have available babesafe tool, Fernokit, Pelvic belt, spinal board, blade stretcher, hip aligner for femoral head fractures, stifnech for adults and babies (cervical collars of Laerdal), and immobiliser of head called dama de elche.

**The training of the rescue teams are mostly common with the other parts of the teams to all the end users**. In HRT, the members are initially and basically trained commonly. This training program is held internally, however, they also join external training sessions, held by the Fire Service, the Coastguard, the Hellenic Airforce and the National Emergency Service or by corporations. When joining a specific department, their volunteers follow a more specialized training, though they are all trained commonly in First Aid. Regular exercises with K9 and medical teams take place in JOAFG and also with other organisations. The basic response team training is common and each unit has specialization training (e.g. communications, EMS etc.) except for the rescue dog unit, which is separate. The personnel of SUMMA who belongs to ERICAM make trainings together K9 and firefighters. They also receive the accreditation by UNOCHA together as well.

Not all of the **end users have a monitoring system for the vaccination of their team**. All the team members of PUI have a connected card ID1 to register all the information medical or not; they also follow a process for the vaccinations. Regarding SUMMA, there is a control system for the vaccination of ERICAM rescue teams that are candidates for international sorties. The unit for international trips of HIGH LEVEL Carlos III is in charge of this issue for all the professionals of ERICAM. All team members and dogs in ESDP have vaccination documentation. There are some differences between staff who work in national or international level. For national teams, hepatitis and tetanus vaccine. For International typhus fever and more diseases in addition.

**Only some end users have a medical system.** Most of them follow their National Health System. All the end users have a **list of the necessary medical equipment for the transportation** and a list of medicines with the signature of the medical team leader except CNR who, during the COVID-19 pandemic they had a close link with the National Health Service. All the end users have **a way of maintenance of their equipment**. There are volunteers in each HRT department appointed for the equipment status, who are responsible for the maintenance and keeping track of it. Their equipment is maintained either by their members or by professionals, who collaborate with HRT. EPAYPS uses the Outsourcing (mainly). They have technicians only for basic support of the systems. JUH uses a software-based quality management system. JOAFG follows the Medical product law (Medizinproduktegesetz). PUI disposes a complete list of equipment, limit date of use for medicines, dates of control of the batteries. PROECO uses individual first aid kits. Within SUMMA, the expiry dates and defects in equipment are checked monthly by the ERICAM team and the teams of the mobile uvis carrying the disaster backpack. ESDP has all equipment stored and they do maintenance work. Staff on call checks the equipment, but some kind of equipment needs in depth review.

Equipment used in high interventions as safety harnesses and roped need an special maintenance (its use is registered with data as resistance and time of use) in order to determinate the equipment useful life. This is done for security reasons. Veterinary Material. Registration and expiry control too. All the teams of the **end users are autonomous enough to go for a mission** except for JOAFG who can take part only in national missions. The **greatest gap** for HRT is the absence of a logistics software, that could facilitate the whole operational procedure and provide an overview about our equipment. For EPAYPS, the gaps depend on the size of the incident and the number of the units that participate. JOAFG does not have international logistics experts available. The declaration of IATA, the control of the inventory, the charge of the battery and the control of the date of the medicines are some of the gaps faced by PUI. ESDP faces Budget issues in some cases and take some days off from their own companies. Their team are volunteers and it is not always easy to take some days without previous notice in the case that they have to move to international operations. For SUMMA, it is sometimes difficult get the adequate transport when all the infrastructure has down. The bureaucracy of Governments sometimes is another difficulty. There are possibilities to meet hazard circumstances with special or specific resolution. CNR and JUH do not have any gaps in their teams in relation to the logistics. The **most usual procedure of transport for an immediate deployment** is vehicles (ambulances, trucks), air transport (airplanes, helicopters) and sea transport.

#### *3.3.3.2 Mobilisation: response and travel, coordination with national and international authorities, transport and logistics*

The mobilisation phase is the period immediately following the occurrence of a disaster. International USAR Teams prepare to respond and travel to assist the affected country.

The end users **have a real-time monitoring system for disasters** either national or international. For example, PUI, SUMMA & ESDP as INSARAG members, they use GDACS system to receive alarm and other applications on smartphone. HRT uses seismographer network of the Greek organization of antiseismic planning and protection. They also use a privately owned meteorology radar. JUH has internal operations centre and collaboration with Johanniter Alert and Information Centre and German Joint Information and Situation Centre (GMLZ). All the teams **organise a briefing for the team before the deployment**, one is about the disaster situation and the organisation of the mobilisation, before the medical screening and the loading of the equipment, and one about the security, safety, the deployment and the presentation of the country (culture, religion etc...) just before the travel to the airport. The end users with K9 have various ways to **ensure that their K9 team is ready for the deployment (health, hygiene...) and the whole trip.** HRT volunteers who are responsible for the rescue dogs, take care of such matters. JOAFG K9 is a unit for national actions. PUI has a veterinarian to check the capability of the K9 team for a deployment (veterinarian screening). All the end users follow **procedures to check the documentation concerning the materials to be transported**. The documentation is prepared by HRT secretariat and checked by the board and the

operations manager. JOAFG has inventory lists. The team leaders of PUI & ESDP have all the documents about the material on paper and on a stick. All the end users **have official documents related to the practices of the medicine** except for HRT who provide only First Aid. EMAK teams of EPAYPS have the related documents. JOAFG disposes official documentation of education and training of EMTs and paramedics. PUI has all the attestation for the doctor, nurses and veterinarian. PROECO uses instructions regarding the intervention of professional emergency services in search - rescue actions – ISU 02.

HRT team does not **check the medical status of the personnel and dogs participating in the mission**, but it is their family doctors who check it. CNR neither. All the other teams do this check. More specifically, before a deployment, just after the first briefing, PUI's medical team organizes a medical screening to be sure all the members should go on mission (temperature, blood pressure, sticker in case of accident, and COVID test PCR if necessary). In SUMMA, there is an annual checking for all personnel, furthermore, the professionals receive a medical check focus on the medical status, previously to participating in a mission, and after it. The medical team which **follow up on hazardous materials** are JUH, CNR, PROECO, SUMMA & ESDP. PUI team has HAZMAT specialist in the USAR team. All the end users are **able to prepare their own transportation plan** by organising their equipment to be transported by each one, but is needed to value the type of catastrophe and mission to reply adequately to this question. There is specific **preparation by the teams regarding the transport of passengers and hazardous materials including the equipment**. Especially when there is air transportation, HRT secretariat makes all the arrangements. With regard to hazardous materials, HRT does not use any. JOAFG uses transport of Power Generator and transport of field kitchen. PUI has to prepare the IATA declaration for the flight, the logistics team leader has is trained in IATA procedure. PROECO follows the instructions related to the intervention of professional emergency services in search - rescue actions – ISU 02. Last month, for example, SUMMA did a simulation to work inside a Covid+ environment. Thee organised the preparation of the component, and the movement of the professionals and the work inside the camo with specific PPE against this hazard.

#### *3.3.3.3 Operations: in the country, K9, medical, management, coordination, reporting*

The operations phase is the period when international USAR Teams are performing USAR operations in the affected country. It starts with arrival of a USAR Team at the Reception/Departure Centre (RDC) in the affected country, registration with the UCC/OSOCC, reporting to the Local Emergency Management Agency (LEMA) (or National Disaster Management Authority (NDMA)), and performing of USAR operations. The phase ends when the USAR Team is instructed to cease operations.

**The management teams coordinate with the local authorities in the disaster area**, depending of course on the operational plans. Before a deployment takes place, in PUI, they have to wait the international call for assistance from the country affected, and when PUI is the first team

arrived in the disaster area, they have to coordinate with the LEMA (local emergency management authority).

For all the teams, **there is a pace of work in the area**. They work in rotation scheme, depending on the operation, their physical condition and their level of experience and training. The mission duration is normally below 12h for standard duty. In disaster response, 6h shifts with rotation to next 6h shift (role change) total again 12h. Actually, it is mandatory for the maintenance of the team. The **safety and security conditions** for most of the teams are part of the National Civil Protection Authorities or local emergency management authorities. In PUI, in the Base of operation and on the field, there is a "security officer" to control the Personal Protective Equipment, the security area, covid process, use of equipment in security etc. More specifically, PUI & SUMMA use the INSARAG procedures. The teams have to do the ASR 2, which is the Assessment Search and Rescue level 2, victim confirm yes or not, time of work 12 hours or more 12 hours, the site will be in category A, B, C or D and after the priorities, the USAR team is deployed on the work site with the priority A, and the K9 team is deployed to search trapped victims; we use 1 dog, and minimum 1 more to confirm. In the case of an assessment of the situation for a SAR operation, HRT uses the ICAR/IMRF/INSARAG guidelines [1], depending on the situation and the competencies of their volunteers.

The **risk assessment carried out for the teams during the research** is done by the team leader or a security officer. SUMMA, nowadays has added a drones' group to Fire fighters of Madrid Community for this issue. Regarding **the evaluation of the situation in order to locate the victims**, most of the teams need only to evaluate whether dogs can take part (division of responsibilities with other rescue organisations). To complete the localization of the victim with K9, the teams can use electronic devices and scanner (extended wifi). There **is a security perimeter established during the site operation** for all of the teams. The **capacities of the teams are mostly satisfied to cut, pierce and extract a victim** except for JOAFG. Additionally, ESDP may localize the victim but not extract him.

JUH does not have a procedure to follow regarding **the assessment of the work site in order to define priorities**. HRT will take into consideration factors like amount of work needed to be carried out, number of volunteers, equipment, building material and structural hazards in the case a rescue takes place in a building, weather conditions (especially in the case of mountain and sea rescue) are that needs to be covered. For EPAPYS the steps to follow are: 1) Determine the scope and magnitude of the incident, 2) Identify scope, location and types of damage. 3) Estimate the urgent resource needs 4) Develop a sectorisation plan 5) Establish priorities, 6) Identify general hazards, 7) Identify infrastructure issues,. All steps are usually accomplished by; vehicle, helicopter, waterborne craft, uas, on foot or from reports from others. Teams carrying out this level of assessment must remain mobile, not engage in rescue operations and report the results as quickly as possible. JOAFG will identify the safety issues, secure own position, check personal safety, check team safety, move forward, redo. For CNR, this procedure is under the responsibility of the Fire Department. PUI, PROECO, SUMMA and

ESDP follow the INSARAG procedures. All the **teams have an evacuation and regrouping point set up for the team safety during the search** except JUH.

**The medical teams permanently monitor the USAR team at work** except for HRT. Regarding the **role of the medical team in taking care of the victims**, HRT provides only first aid treatment. Specialized medical care is provided by the authorities. The medical team of JUH offers basic health care but is not involved in rescue operations. EPAYPS, JOAFG, CNR, PUI, PROECO, SUMMA & ESDP provide triage/assessment and the role of their medical teams is to go into the victim in the confined space to do the first medical assessment and to supervize the extrication and evacuation. The **medical teams of HRT, JUH, PUI and ESDP do not advice the USAR teams in the area of chemical hazards**. All **the teams have a base of operations installed**.

**USAR operations are monitored by the logistics teams** (equipment, food, water, etc.) in various ways. More specifically, for HRT, the person who is in charge of logictics monitors the operation, in relation to equipment and supplies. Food, water and equipment are listed beforehand, weighted and placed into boxes. Food and water is provided to team members, according to the alimentation plan. EPAYS has set up a base of operations. Logistics team of JUH monitors EMT operation according to SOPs. JOAFG logistics are based on the use of material and equipment. Basic set is layed out for support of 24h operations self sustainable. Logistic team is always present during operations for CNR. PUI has 1 logistics team is in the BoO to monitor the equipment and the Base of operation and 1 part of the logistics team on the field, in a "Advance logistics". SUMMA by controlling the stock of material, anticipating the needs that may arise.

#### *3.3.3.4 Demobilisation: process with local and international authorities, travel, logistics*

The demobilisation phase is the period when international USAR Teams have ceased operations, commence withdrawal, coordinating their departure through the UCC/OSOCC, depart from the affected country through the RDC, and travel to their home country.

All **the teams organize a meeting with the local authorities and the teams in charge of the coordination, before leaving the area**. Whenever the teams participate in an operation, they always communicate beforehand with authorities to define our role and level of involvement. For PUI, there is a meeting organized by UCC (Usar Coordination Cell) with the LEMA before the end of the operation, and the LEMA decide to continue or stop the operation. For the teams which participate **in international missions, there is no donation of equipment made to local teams**. There is also donation of equipment by authorities.

In most of the cases, **there is a communication plan organised with the media before the disengagement**. In case of emergencies there is a plan being the communication with the media. Especially for SUMMA, if the mission is international, the government is informed and is responsible for communicating with the media. If the incident is in the Community of Madrid, SUMMA has a press department that is in charge of informing the media. All the teams **organize a transport operation**

**for the K9 teams and equipment** by the dog unit who is in charge regarding both and search and rescue units. All the medical teams ensure an assessment of the local needs of medical structures before disengaging, except for HRT, JOAFG and ESDP who are not involved in medical activities. For the other teams, it is an ongoing process during the whole mission. Sometimes, during the phase "beyond the rubbles", the medical team could do an assessment of the local needs in hospital or dispensary for a next project or program.

Most of the **teams usually donate medical equipment before the return**, such as medical drags and supplies. Regarding to the COVID risk, all the teams have taken the appropriate measures whenever participating in a mission, use the rapid tests, there are protocols regarding COVID 19, use of mask, collaboration with WHO, EODDY (Greece), German Robert Kock Institut (Germany). PUI who participated in the explosion in Beirut last August, used FFP2 and hydroalcoholic solution during the transport and all the mission, change every 4 hours, PCR test or vaccination in France before deployment, the results are sent to the country, PCR test in the affected country if necessary at the arrival, PCR test in France for the go back, the medical team continue to monitor the team until the result of the PCR test - on the field, mask FFP2, disinfection of the equipment after using, in the BoO, disinfection of the dog and the team members before entry in the BoO.

Mostly, all of the **teams take into account the transport of hazardous materials for the return**, except for those who do not handle hazardous material, such as HRT and JOAFG. PUI follows IATA procedure and PROECO goes according to the ORDER of the Minister of Interior No. 1184 of February 6, 2006 for the approval of the Norms regarding the organization and assurance of evacuation activities in emergency situations. All the **teams have a transport plan**.

#### *3.3.3.5 Post-missions: actions taken after a disaster to restore services and reconstruct communities, after action, review, lessons to learn*

The post-mission phase is the period immediately after a USAR Team has returned home. In this phase the USAR Team is required to complete and submit a post-mission report and conduct a lessons-learnt review to improve the overall effectiveness and efficiency for response to future disasters. The post-mission phase continuously merges into the preparedness phase.

The **teams prepare a mission report** except for the Greek teams, HRT and EPAYPS who prepare a debriefing session after the mission. HRT, EPAYPS and ESDP do not **have a «lessons to learn» document prepared** as these lessons are identified during the debriefing. JOAFG neither even though it is considered to be very important. The other teams use a «lessons to learn» document whose synthesis includes:

- conclusions regarding the evolution of the emergency situation, its consequences on the institutions, population and assets and their influence on the development of the mission;
- the executed actions and the ones being executed, by categories and localities;
- planned and unexecuted actions: causes and measures;

- other data requested by the upper echelon.

Each part of the teams CNR, PUI, PROECO, SUMMA & ESDP prepare a mission report from USAR, management, medical, K9, logistics and drones (PUI). The above-mentioned related to the **«lessons to learn» document prepared in Search are valid for the «lessons to learn» document prepared in Rescue**. HRT, EPAYPS and PROECO do not **have a medical and psychological monitoring system for team members**. JUH provides psycho-social support and after-care, incl. defusing + debriefing. Expert for psycho-social support is part of the team. JOAFG uses the PEER system. There is debriefing and possibility for psychological follow-up upon request. There is a team particularly dedicated to emergencies (emergency psychologists) in CNR. The medical team monitor all the team members in PUI during the mission every time, every day, and if necessary, we can have assistance by phone with a psychologist specialist in France during the mission and after. SUMMA has an occupational risk prevention department for the medical follow-up of SUMMA workers. At the psychological level, it also has a department of psychologists who monitor SUMMA workers. In ESDP, SUMMA checks. Regarding psychologist team, it is not mandatory a check, however, team member can decide to ask for an appointment.

The leader **team must complete a mission report** describing the intervention and finally outlining the points for improvement. PUI has to prepare a complete report of the mission and send it to INSARAG secretariat in Geneva. HRT and EPAYPS do not prepare such a report but is it included in the main report. All the teams have **a plan for restoring equipment and preparing for a new mission**, only for EPAYPS it is not obligatory. But there is a procedure of restoring the equipment through the typical procedures of everyday preparedness for the team at the Base. The logistics team leader of PUI organizes the cleaning, charge of battery, control etc. Each PROECO volunteer is responsible for restoring equipment and preparing for a new mission. On arrival at the base (Las Rozas Fire Station, Madrid) the material used is checked. The material is duplicated in case there is a new departure or mission. There is a Equipment Manifesto and a Vet Manifesto too for EDSP. All **the teams prepare a mission report**.

# 4 Interoperability Framework

## 4.1 Interoperability concepts

### 4.1.1 Situation Awareness Model

Due to the dependencies of the components in the project, the SA ontology is in direct communication with the Emergency Communication System. More specifically, the Emergency Communication System will be responsible for all data transformations that will be needed, before it calls the SA ontology RESTful API to either store or modify data. The SA service will be responsible for processing the transformed data in order to convert them into RDF triples, before eventually storing them to the triple store. This means that, apart from the Emergency Communication System, no other component will be storing data directly to the SA ontology endpoint. However, it is possible to directly call the SA ontology endpoint in order to obtain existing data that have already been stored, since they will have already been processed and can be returned in a proper format. If there are more specific format requirements in terms of the response, then the requester should call the Emergency Communication System, so that it can get the data in an agreed upon format and then do the requested transformation.

This chapter will contribute to overall objective of the deliverable from Interoperability perspective, as set in GA.

Among several definitions of **Interoperability**, for present project we propose to use definition of [ISO 22300:2018, 3.128]: "ability of diverse systems and organizations to work together", as this is more comprehensive in what regards entities participating, which are of various origins: technical, human, organizations, social, political and others. Also, we will consider relevant to support proper configuration of interoperability relations among entities participating on operations, the provision of [4]: "interoperability involves the task of building coherent services for users when the individual components are technically different and managed by different organizations".

**Integration**: Interoperability and integration are often used interchangeably, but they mean different things. With interoperability, systems work together, even if they were not specifically designed to work together, because standard communication protocol techniques are applied. Two (or more) systems that were not designed to be interoperable require integration.

### 4.1.2 Situation Awareness Model Utilization

In the context of S&R project, specific objectives need to be fulfilled by the Situation Awareness (SA) ontology, which will represent the SA model in the frame of T3.2 Situation Awareness Model. More specifically, the model aims to:

- Define the decisions that first responders (and other actors) make during the course of S&R operation;
- Represent the types of critical information required in order to support the various actors with their tasks;
- Represent the important information flows that potentially exist between involved actors, mediated by a knowledge management system in the form of notifications, alerts and timely information supply.

In order for the SA ontology to be provided as a service, a robust technological stack will be utilized, both for offering the required REST functionality and for storing the data in an efficient database. The latter is particularly important due to the nature of Search and Rescue, where performance and immediate data processing can be a determining factor between failure and success in operations. To this end, SA model web services will be utilized through the Emergency Communication System (EMS) in order for the SA ontology to be fed with the proper data. Additionally, the SA model should be able to provide the Emergency Communication System with the necessary data in a timely fashion.

In Figure 4-1, the overall model as a service is illustrated, provided as an endpoint.

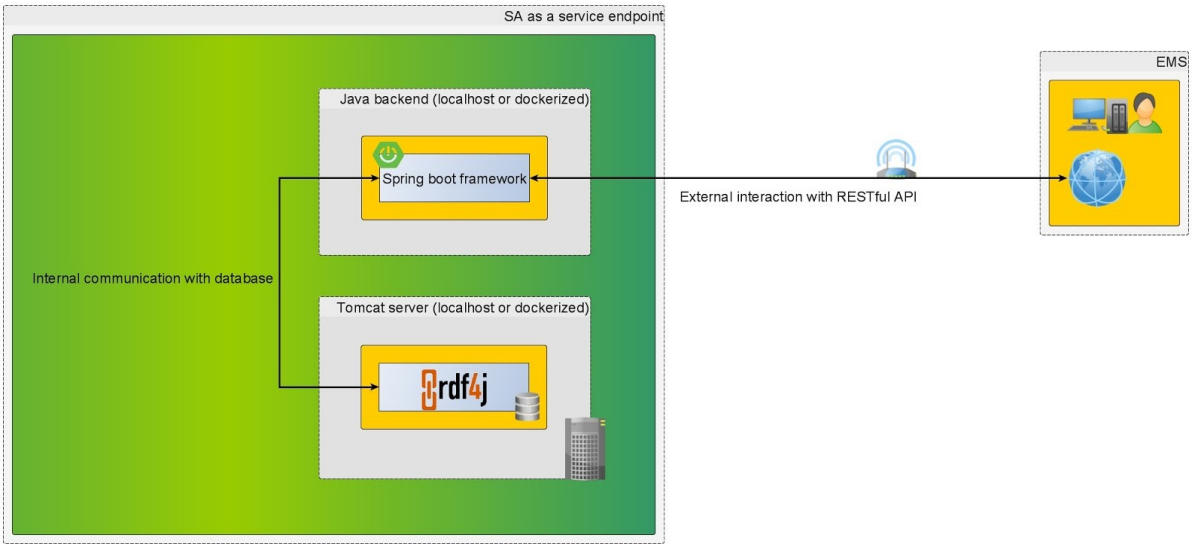



**Figure 4-1: SA Service Endpoint**

As shown in Figure 4-1, the SA ontology will be offered as a service via Spring REST, which the Spring Boot REST layer will be communicating with a Tomcat server hosting the RDF4J repository, where all RDF triples will be stored. All requests will be handled by Spring REST and actions such as data preprocessing/postprocessing will take place there, before any interactions with the triple store.

## 4.2 Technological Framework – architecture

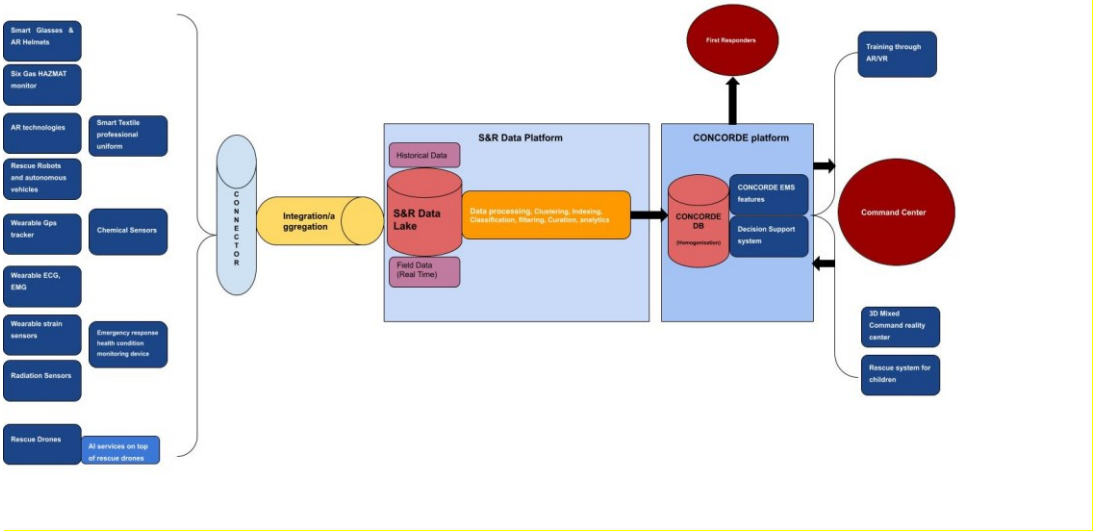



**Figure 4-2: Technological Level [1]**

### 4.3.1 Operational sensors and support equipment

**I. Sensors**

- Six gas hazmat monitor
- AR technologies
- Wearable strain sensors
- Wearable ECG, EMG
- Radiation sensors
- Chemical sensors

**II. Support equiment**

- Smart glasses and AR helmets
- Smart textile professional uniform
- Wearable GPS tracker
- Rescue Robots and autonomous vehicles
- Rescue drones
- Emergency response health monitoring equipment

### 4.3.2 Operational context

The operational S&R space is characterized by a mixture of technical and human resources with different roles and work areas. The technical elements are used almost everywhere, from sensors in direct contact with place of disaster to SW/HW systems met in the command and coordination centers.

Obviously efficient use of technical resources require that technology involvement in actions is necessary to comply with technical standards and protocols, to provide to the human factors a clear picture of operational field and to be an enabler of overall S&R activities. Humans acting as First Responders, support personnel and decision makers and their successful cooperation is obtained mainly by means of relevant and intensive training.

Actions in operational space are governed by a set of rules gathered in Standard Operational Procedures, specific to each kind of disaster, such as fire, flood, earthquake or chemical spill, among others. At the same time, activities in operations have to comply with legal provisions of either national or international organizations of participating players.

Search and Rescue operational environment is complex and highly dynamic. In most situations new actors and new technology need to intervene and cooperate with entities already in operations. This changing situation must not put to risk the consistency and effectiveness of interventions, so a high degree of interoperability is desired to exist between new actors and those already in operation.

Entities participating to an S&R running mission relating among them in a full interoperability framework will be considered in what follows as "Interoperable" while entities potentially to be involved in operations at a next phase will be considered "Candidate interoperable".

### 4.3.3 Interoperability relations in S&R missions

The concepts and considerations of 4.2.1 are summarized graphically in Figure … including the main technologies and role of humans, together with different kinds of interoperability relationships established to define an interoperability framework. Candidate interoperable entities, either technical or human are supposed to intervene after the basic interoperable context is established, with the role to contribute either for a more effective reach of the mission primary objectives or in case the objectives have been multiplied or changed in some way from the initial definition. The interoperability context has been integrated in the S&R technological framework of [1] and different categories of interoperability have been considered as mandatory to achieve between operating and new entities. Legal context was added as a cross domain to cooperation relations, contributing to defining the operational procedures associated with interoperability framework.

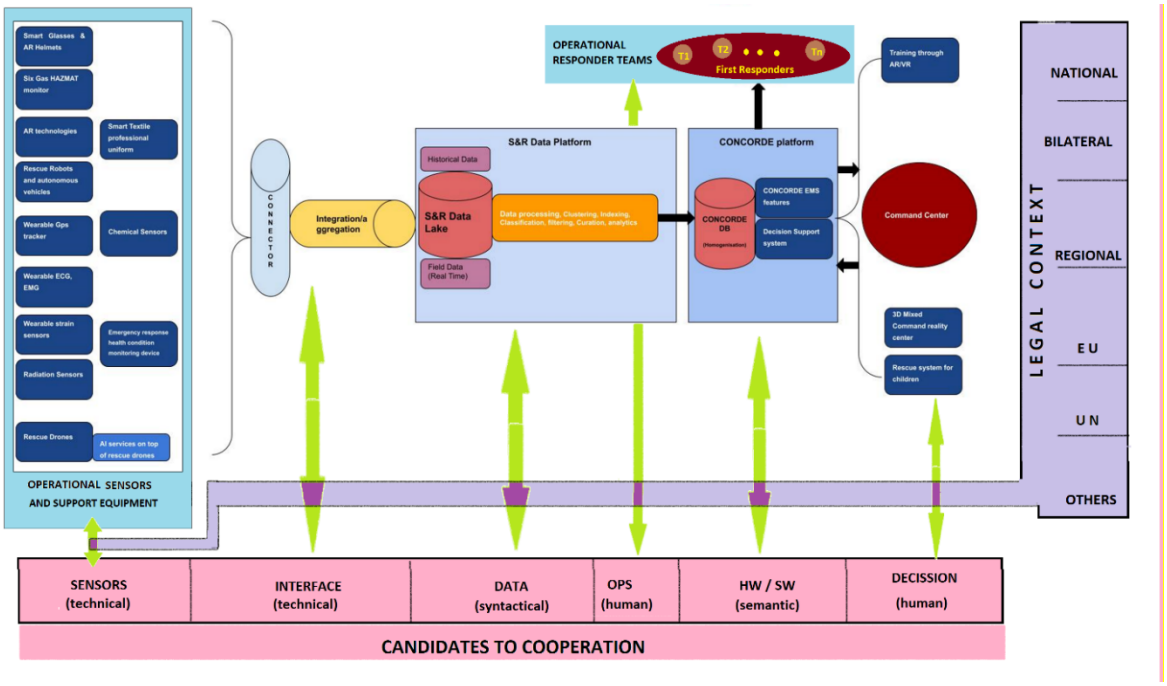



**Figure 4-3: Key entities acting in an S&R operation and interoperability relations**

According to research outcomes of present project, structure of entities participating in S&R actions lead to identification of four interoperability types.

*Technical interoperability* is defined in present S&R context as determined by wireless **communications interoperability,** which "specifically refers to the ability of emergency response officials to share information via voice and data signals on demand, in real time, when needed, and as authorized." [4]

*Syntactic interoperability* in present project will use definition provided in [ISO 22300:2018, 3.253]: ability of two or more systems or services to exchange structured data.

*Semantic interoperability* in present project will use definition provided in [ISO 22300:2018, 3.253]: ability of two or more systems or services to automatically interpret and use information that has been exchanged accurately

*Human interoperability* defined as in [5] [6]"the interrelationship between the social system network and the technological system that would provide interoperability across diverse organizational domains to establish sustainable human networks that are reliable, effective, and trusted".

### 4.3.4 Human interoperability in S&R operations

Human Interoperability is more challenging to be quantified because it is more complex than other interoperability types of previous sections. It is not subject of standards and depends on several social and economic components. References [5] identifies three components of human interoperability: elements of human system referred as "Human View" ( [5] [7]), relations between these elements,

and the contribution of relationships to human interoperability. Also, [5] summarizes a wide class of works and authors dealing with subject of Human View, focusing on elements of the human system. For the purpose of present project, we estimate as useful a brief analysis of elements of the human system and the way these elements are encountered in S&R operational context. Analysis of these elements is useful to understand what kind of relations / agreements and their content, need to be set among entities of an S&R operational context. According to [5] citing [7], there is a set of seven static products (human system elements) that compose the Human View.

*Concept* – is a conceptual, high-level representation of the human component in the enterprise architecture

*Constraints* — sets of characteristics that are used to adjust the expected roles and tasks based on the capabilities and limitations of the human in the system; constraints can be focused on personnel issues, such as availability, and/or on task related issues, such as priorities

*Tasks* — descriptions of the human-specific activities in the system

*Roles* — descriptions of the roles that have been defined for the humans interacting with other elements of the system

*Human Network* — the human-to-human communication patterns that occur as a result of ad hoc or deliberate team formation, especially teams distributed across space and time

*Training* — a detailed accounting of how training requirements, strategy, and implementation will affect the human

*Metrics*—a repository for human-related values, priorities, and performance criteria, that maps human factors metrics to any other Human View elements

One of the major challenges to be taken account is the interoperability between systems and between organisations.

It is important to underline that, in many cases, the FR organisations are NGOs formed by volunteers and with limited resources. This means that not all organisations have access to technology due to costs or system updates. On the other hand, a common technology framework does not exist, so that systems used by organisations in Europe may not be compatible with those used by others.

- DIRECTIVE 2007/2/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) [8] [9]
- European Civil Protection and Humanitarian Aid Operations. [10]

### 4.3.5 The conceptual model for the integrated delivery of public services

The European interoperability framework:

- Inspires European public administrations in their efforts to design and deliver seamless European public services to other public administration, citizens and business. If possible they may be: digital by default (providing data and services via digital channels), cross-border by default (all citizens in the EU) and open by default (transparency).
- Provides guidance to public administrations on the design and update of national interoperability frameworks or strategies promoting interoperability.
- Contributes to the establishment of the digital single market by fostering cross border and cross-sectorial interoperability for the delivery of European public services.

### 4.3.6 Security and privacy

Security and privacy [11] are major concerns in the provision of public services. Public administrations must ensure that they:

- Follow the privacy by design and security by design approach to ensure their entire infrastructure and building blocks; services are not vulnerable to attacks that could disrupt their operation and cause data theft or data damage; and comply with legal requirements and obligations relating to data protection and privacy, recognising the privacy risks of advanced data processing and analytics.
- They must also ensure that controllers comply with data protection legislation, covering the following points.
- Risk management plans' to identify risks, assess their potential impact and plan responses with appropriate technical and organisational measures. Based on the latest technological developments, these measures should ensure that the level of security is proportionate to the degree of risk;
    - "Business continuity plans' and 'back-up and recovery plans' to establish the necessary procedures for functions to operate after a disastrous event and for all functions to return to normal as soon as possible;
    - A "data access and authorisation plan" that determines who has access to what data and under what conditions, to ensure privacy. Unauthorised access and security breaches must be monitored and appropriate measures taken to prevent recurrence of breaches;
- Use of qualified trust services in accordance with the eIDAS regulation [12] to ensure data integrity, authenticity, confidentiality and non-repudiation.

When public administrations and other entities exchange official information, the information should be transferred, subject to security requirements, over a secure, harmonised, managed and controlled network. The transfer mechanisms should facilitate exchanges of information between administrations, businesses and citizens that are:

- Recorded and verified, so that both the sender and the receiver have been identified and authenticated through agreed procedures and mechanisms;
- Encrypted,so that the confidentiality of the data exchanged is guaranteed;
- Time-stamped, to maintain the exact time of transfer and access of electronic records;
- Recorded, so that electronic records are archived, thus ensuring a legal audit trail.

Appropriate mechanisms should allow for the secure exchange of messages, records, forms and other electronically verified information between different systems; should handle specific security requirements and electronic identification and trust services, such as the creation and verification of electronic signatures/seals; and should monitor traffic for intrusions, data changes and other attacks.

Information must also be adequately protected during transmission, processing and storage through different security processes, such as:

- defining and implementing security policies
- security awareness and training;
- physical security (including access control);
- security in development;
- operations security (including security monitoring, incident handling, vulnerability management);
- security reviews (including audits and technical checks).

As data from different Member States may be subject to different data protection enforcement approaches, common data protection requirements should be agreed before providing aggregated services.

The provision of secure data exchange also requires a number of management functions, among them:

service management to oversee all communications on identification, authentication, authorisation, data transport, etc., including access authorisations, revocation and auditing; service registration to provide, upon authorisation, access to available services by pre-tracing and verifying that the service is trusted;

service logging to ensure that all data exchanges are recorded for future reference and archived where necessary.

# 5 Common Vision

The new **European Interoperability Framework (EIF)** that was adopted on 23 March 2017, aims to the creation of a single digital market [13] in Europe for public sector, businesses and citizens[8]. Before attempting to provide an analysis on the EU Common Vision on Interoperability and how it can affect Search and Rescue missions, we need to provide a definition of the term "interoperability" and the EIF.

According to EIF, **Interoperability** is "*the ability of organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems".* Additionally, The **European interoperability framework** [14] is "*a commonly agreed approach to the delivery of European public services in an interoperable manner. It defines basic interoperability guidelines in the form of common principles, models and recommendations*"[9].

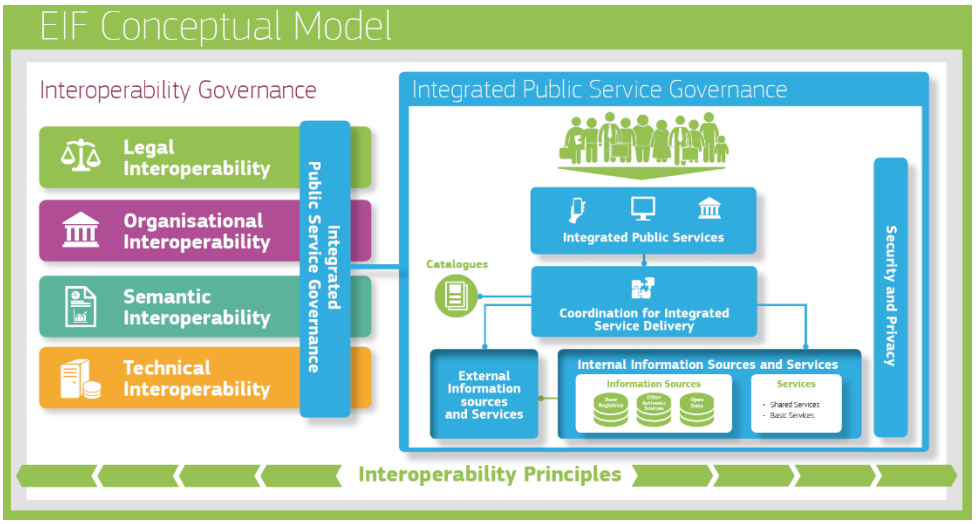



**Figure 5-1: : EIF Conceptual Model [10]**

Moreover, the overall goal of EIF can be summarized as follows:

- To remove barriers between services, IT systems and data
- To support the development of open and commons standards in order to create meaningful connections

Furthermore, the SnR project aims to develop a highly interoperable platform for first responders and to support the unified vision of EU role. In terms of search and rescue operations, the EU role is expressed through the EU Civil Protection Mechanism (EU CPM) and the creation of the RescuEU

[8] https://ec.europa.eu/isa2/eif_en
[9] https://ec.europa.eu/isa2/sites/default/files/eif_brochure_final.pdf
[10] https://ec.europa.eu/isa2/eif_en

reserve. Thus, the SnR platform will potentially require to be operated in the framework of the EU CPM and the interoperability framework of the platform will be required to support the interconnection across EU and the RescEU mechanism. Therefore, we also need to provide a short presentation of the EU CPM and the RescEU mechanism explaining the importance of the interoperability of the SnR platform in such an environment and how it can function towards a common EU vision.

According to the EU CPM website, "*the overall objective of the **EU Civil Protection Mechanism (EU CPM)** is to strengthen cooperation between the EU Member States and 6 Participating States in the field of civil protection, with a view to improve prevention, preparedness and response to disasters*"[11]. In simpler terms, it is an EU mechanism that supports a country in need to request for assistance when the scale of an emergency exceeds its response capabilities.

Disaster sees no borders and there are cases where the capabilities of a single country cannot meet the challenges of a crisis. This is the reason behond the importance of EU CPM, which promotes the collective action during a major crisis and allows all members states to have support when managing a major event and have access to expertise from various countries, to provide an more efficient and coherent response. Furthermore, the mechanism supports the exchange of lessons learned among experts, promoting at the same time a common approach and understanding when managing a major crisis.

In the figure below, there is a representation of how the EU CPM works.

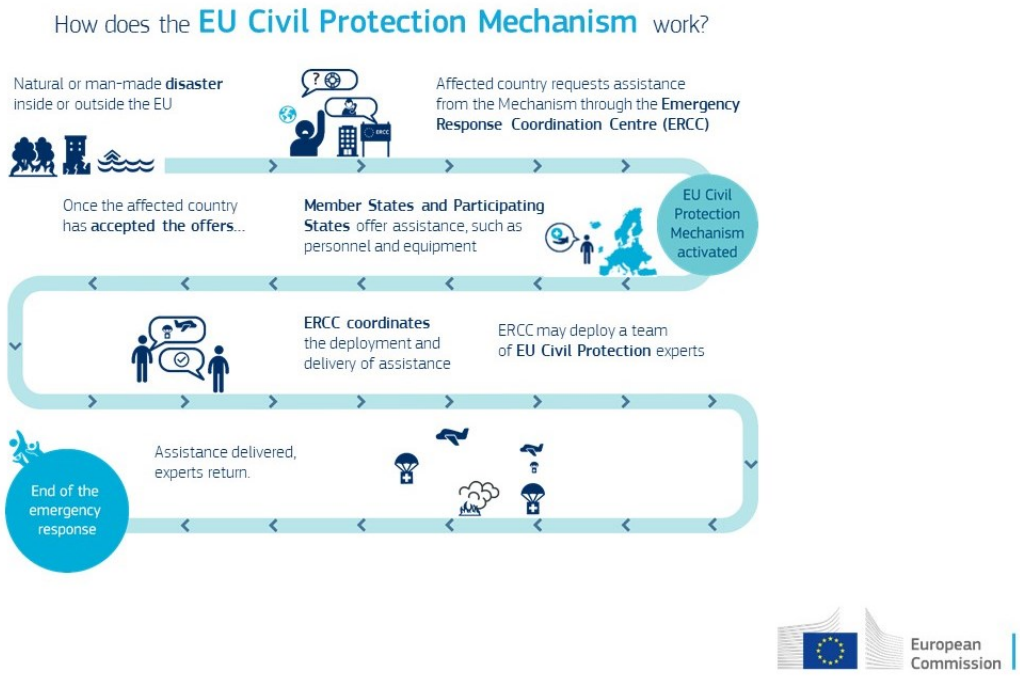



**Figure 5-2: How EU CMP works[12]**

[11] https://ec.europa.eu/echo/what/civil-protection/mechanism_en#
[12] https://ec.europa.eu/echo/what/civil-protection/mechanism_en#

As shown in the figure, in order for the EU CPM to be activated, the affected country needs to request assistance through the **Emergency Response Coordination Centre (ERCC)**.

Moreover, in March 2019, EU upgraded and enhanced its Civil Protection Mechanism by creating the **rescEU reserve** (DECISION (EU) 2019/420)[13], which initially was a fleet of airplanes and helicopters to support fighting forest fires, but in time it transformed to address other threats as well[14].

It is worth mentioning that in 2018, President of EC at the time, Jean-Claude Juncker said, *"A Europe that protects citizens has to be there in times of need. When there is a dangerous forest fire or a flood overwhelming national response, our citizens want action not words. rescEU will ensure concrete solidarity with our Member States hit by disasters."* [15].

It is easily to understand from the above, that the importance of interoperability in Crisis Management systems is very high. Since the view and the intent of EU is for member states to be able to support each other, especially though the EU CPM and RescEU mechanism, for that to be feasible and productive, different organisation from different states that work with different systems need to communicate and to exchange and combine various kinds information. The Technical Interoperability, as shown in figure X, is the key to that, since it will allow different systems to interconnect, supporting at the same time different first responder organisations to work together, increasing the level of efficiency when managing a major crisis, promoting at the same time the overall vision of EU for a unified community.

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019D0420&from=EN
[14] https://ec.europa.eu/echo/what/civil-protection/resceu_en
[15] https://ec.europa.eu/commission/news/resceu-2018-dec-12_en

# Annex I: References

[1] "INSARAG GUIDELINES 2020 - INSARAG," [Online]. Available: https://www.insarag.org/methodology/insarag-guidelines/. [Accessed 14 06 2021].

[2] Iosif Sklavidis, *Presentation to the Workshop "SnR end-user requirements and Beyond",* konnektable Technologies ltd., 2021.

[3] *Technical Internal Instruction SUMMA112 Itser 16.v7 Transmission of information between the Coordinating Centre and Mobile Care Resources and resolution of the demand for assistance..*

[4] "Interoperability - Wikipedia," [Online]. Available: https://en.wikipedia.org/wiki/Interoperability. [Accessed 11 06 2021].

[5] Holly Handley, "A Network Model for Human Interoperability," *The Journal of the Human Factors and Ergonomics Society,* March 2014.

[6] Brown, A., Human interoperability and building partnership capacities: Introduction to human interoperability. Human interoperability and net-centric series, Washington, DC: National Defense University, 2010.

[7] Handley, H., & Smillie, R., "Architecture framework human view: The NATO approach. Systems Engineering," pp. 156 -164.

[8] "Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)," [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32007L0002. [Accessed 11 06 2021].

[9] "Report from the Commission to the Council and the European Parliament on the implementation of Directive 2007/2/EC of March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) in accordance with Article 23 2016," [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016SC0273. [Accessed 11 06 2021].

[10] European Commission, "Guidelines "Certification and Registration" of response capacities in the European Civil Protection Pool (ECPP)," 2019. [Online]. Available: https://erccportal.jrc.ec.europa.eu/DesktopModules/ResponseCapacity/Documents/Certification%20Guidelines%20-%20October%202019.pdf.

[11] "Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data. Directive (EU) 2016/680 of the European Parl," [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32016L0680. [Accessed 11 06 2021].

[12] "Regulation (EU) 910/2014 on electronic identification and trust services for electronic transactions in the internal market," [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.257.01.0073.01.ENG. [Accessed 11 06 2021].

[13] "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - A Digital Single Market Strategy for Europe, Brussels," 06 05 2015. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015SC0100.

[14] "The European Interoperability Framework in detail | Joinup," [Online]. Available: https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/european-interoperability-framework-detail. [Accessed 11 06 2021].

# Annex II: Standard Operating Procedures Questionnaires

| Standard Operating Procedures (SOP) | |
|---|---|
| **Column Requested Information** | **Explanation/Fill in Guidance** |
| **Organization:** | **Please include your organization's name** |
| **Website:** | **Please include your organization's web address** |
| **Disaster expertise:** | **Please indicate as many as relevant** |
| **Country:** | **Please indicate your country of origin** |
| **Current State:** | **Please briefly reply if you have standard operating procedures** |
| **Do you have a SOP? If yes, please indicate the start date:** | **Please indicate your Standard Operating Procedures and the start date** |
| **Compliance/Condition Status:** | **Please indicate the status** |
| **Identified Gaps:** | **Please briefly list the major identified gaps** |
| | |
| **A. PREPAREDNESS** | |
| A1. Training / Exercices | 1) Do you have a training plan for your team? |
| | 2) Do you organise simulation exercices? If yes, how many and under which topics? |

| | |
|---|---|
| | 3) Are there any sessions organised in order to analyse the lessons learnt? |
| | 4) Is there any public information from you side? |
| A2. Management | 1) Do you have any particular information about the operational management of the team members? |
| | 2) Do you have any particular information for safety and security of the team? |
| | 3) Is there any collaboration between your team and the National, European or International Authorities? |
| A3. Search | 1) Do you use K9 research activities and/or techniques? |
| | 2) Does the K9 team share information with the other members of the team? |
| | 3) Are all the transport documentations for the dogs updated? |
| A4. Rescue | 1) What is your rescue method in case of a disaster? |
| | 2) Is the training of your rescue team common with the other parts (medical, USAR, K9)? |
| A5. Medical | 1) Do you use a monitoring system for the vaccination of your team? |
| | 2) What is your medical system? |
| | 3) Do you have a list of the necessary medical equipment for the transportation? |
| A6. Logistics | 1) What is the way of maintenance of your equipment? |
| | 2) Is your team autonomous enough to go for a mission? |
| | 3) What are the gaps of your team in relation to the logistics? |
| | 4) What is the usual procedure of transport for an immediate deployment? |
| **B. MOBILISATION** | |
| B1. Management | 1) Do you have a real-time monitoring system for disasters? |

| | |
|---|---|
| | 2) Do you organise a briefing for the team before the deployment? |
| B2. Search | 1) How can you ensure that your K9 team is ready for the deployment (health, hygiene…) and the whole trip? |
| B3. Rescue | 1) Do you have a procedure to check the documentation concerning the materials to be transported? |
| B4. Medical | 1) Do you have official documents related to the practices of the medecine? |
| | 2) Do you check the medical status of the personnel and dogs participating in the mission? |
| | 3) Does the medical team follow up on hazardous materials? |
| B5. Logistics | 1) Is the team able to prepare its own transportation plan (road, air ..)? |
| | 2) Is there any preparation by the team regarding the transport of passengers and hazardous materials including the equipment? |
| **C. OPERATIONS** | |
| C1. Management | 1) Does the management team coordinate with the local authorities in the disaster area? |
| | 2) Is there a pace of work in the area (team rotation)? |
| | 3) How does the team monitor the safety and security conditions? |
| C2. Search | 1) In what procedures does the team assess the situation to locate the victims ? |
| | 2) How is the risk assessment carried out for the team during the research ? |
| C3. Rescue | 1) What is the procedure followed by the team for the evaluation of the situation in order to locate the victims? |
| | 2) Is there a security perimeter established during the site operation? |
| | 3) What are the capacities of the team to cut, pierce and extract a victim? |

| | |
|---|---|
| | 4) How does the team conduct an assessment of the work site to define priorities? |
| | 5) Is there any evacuation and regrouping point set up for the team safety during the search? |
| C4. Medical | 1) Does the medical team permanently monitor the USAR team at work? |
| | 2) What is the role of the medical team in taking care of the victims? |
| | 3) Does the medical team advice the USAR team in the area of chemical hazards? |
| C5. Logistics | 1) Is there a base of operations installed? |
| | 2) How do USAR operations are monitored by the logistics team (equipment, food, water, etc.) ? |
| **D. DEMOBILISATION** | |
| D1. Management | 1) Is there a meeting organized by the team with the local authorities and the teams in charge of the coordination, before leaving the area? |
| | 2) In international missions, is there a donation of equipment made to local teams? |
| | 3) Is there a communication plan organised with the media before the disengagement? |
| D2. Search | 1) Is there a transport preparation organised for the for K9 teams and equipment? |
| D3. Rescue | 1) Is there a transport preparation organised for the for K9 teams and equipment? |
| D4. Medical | 1) Does the medical team ensure an assessment of the local needs of medical structures before disengaging? |
| | 2) Is there a donation of medical equipment made before the return? |
| | 3) What monitoring has taken place in relation to the COVID risk? |
| D5. Logistics | 1) Does the team take into account the transport of hazardous materials for the return? |

| | |
|---|---|
| | 2) Is there a trasport plan for the return of the team? |
| **E. POST-MISSION** | |
| E1. Management | 1) Does each part of the team prepare a mission report? |
| | 2) Is there a document «lessons to learn» prepared? |
| E2. Search | 1) Does each part of the team prepare a mission report? |
| | 2) Is there a document «lessons to learn» prepared? |
| E3. Rescue | 1) Does each part of the team prepare a mission report? |
| | 2) Is there a document «lessons to learn» prepared? |
| E4. Medical | 1) What medical and psychological monitoring system for team members is being used? |
| | 2) Does the team prepare a mission report? |
| E5. Logistics | 1) Is there a plan for restoring equipment and preparing for a new mission? |
| | 2) Does the team prepare a mission report? |

# Standard Operating Procedures (SOP)

| Column Requested Information | Explanation/Fill in Guidance |
|---|---|
| **Organization:** | **Please include your organization's name** |
| **Website:** | **Please include your organization's web address** |
| **Disaster expertise:** | **Please indicate as many as relevant** |
| **Country:** | **Please indicate your country of origin** |

| | |
|---|---|
| **Current State:** | **Please briefly reply if you have standard operating procedures** |
| **Do you have a SOP? If yes, please indicate the start date:** | **Please indicate your Standard Operating Procedures and the start date** |
| **Compliance/Condition Status:** | **Please indicate the status** |
| **Identified Gaps:** | **Please briefly list the major identified gaps** |
| | |
| **A. PREPAREDNESS** | |
| A1. Training / Exercices | 1) Do you have a training plan for your team? |
| | 2) Do you organise simulation exercices? If yes, how many and under which topics? |
| | 3) Are there any sessions organised in order to analyse the lessons learnt? |
| | 4) Is there any public information from you side? |
| A2. Management | 1) Do you have any particular information about the operational management of the team members? |
| | 2) Do you have any particular information for safety and security of the team? |
| | 3) Is there any collaboration between your team and the National, European or International Authorities? |
| A3. Search | 1) Do you use K9 research activities and/or techniques? |
| | 2) Does the K9 team share information with the other members of the team? |
| | 3) Are all the transport documentations for the dogs updated? |

| | |
|---|---|
| A4. Rescue | 1) What is your rescue method in case of a disaster? |
| | 2) Is the training of your rescue team common with the other parts (medical, USAR, K9)? |
| A5. Medical | 1) Do you use a monitoring system for the vaccination of your team? |
| | 2) What is your medical system? |
| | 3) Do you have a list of the necessary medical equipment for the transportation? |
| A6. Logistics | 1) What is the way of maintenance of your equipment? |
| | 2) Is your team autonomous enough to go for a mission? |
| | 3) What are the gaps of your team in relation to the logistics? |
| | 4) What is the usual procedure of transport for an immediate deployment? |
| **B. MOBILISATION** | |
| B1. Management | 1) Do you have a real-time monitoring system for disasters? |
| | 2) Do you organise a briefing for the team before the deployment? |
| B2. Search | 1) How can you ensure that your K9 team is ready for the deployment (health, hygiene…) and the whole trip? |
| B3. Rescue | 1) Do you have a procedure to check the documentation concerning the materials to be transported? |
| B4. Medical | 1) Do you have official documents related to the practices of the medecine? |
| | 2) Do you check the medical status of the personnel and dogs participating in the mission? |
| | 3) Does the medical team follow up on hazardous materials? |

| | |
|---|---|
| B5. Logistics | 1) Is the team able to prepare its own transportation plan (road, air ..)? |
| | 2) Is there any preparation by the team regarding the transport of passengers and hazardous materials including the equipment? |
| **C. OPERATIONS** | |
| C1. Management | 1) Does the management team coordinate with the local authorities in the disaster area? |
| | 2) Is there a pace of work in the area (team rotation)? |
| | 3) How does the team monitor the safety and security conditions? |
| C2. Search | 1) In what procedures does the team assess the situation to locate the victims ? |
| | 2) How is the risk assessment carried out for the team during the research ? |
| C3. Rescue | 1) What is the procedure followed by the team for the evaluation of the situation in order to locate the victims? |
| | 2) Is there a security perimeter established during the site operation? |
| | 3) What are the capacities of the team to cut, pierce and extract a victim? |
| | 4) How does the team conduct an assessment of the work site to define priorities? |
| | 5) Is there any evacuation and regrouping point set up for the team safety during the search? |
| C4. Medical | 1) Does the medical team permanently monitor the USAR team at work? |
| | 2) What is the role of the medical team in taking care of the victims? |

| | |
|---|---|
| | 3) Does the medical team advice the USAR team in the area of chemical hazards? |
| C5. Logistics | 1) Is there a base of operations installed? |
| | 2) How do USAR operations are monitored by the logistics team (equipment, food, water, etc.) ? |
| **D. DEMOBILISATION** | |
| D1. Management | 1) Is there a meeting organized by the team with the local authorities and the teams in charge of the coordination, before leaving the area? |
| | 2) In international missions, is there a donation of equipment made to local teams? |
| | 3) Is there a communication plan organised with the media before the disengagement? |
| D2. Search | 1) Is there a transport preparation organised for the for K9 teams and equipment? |
| D3. Rescue | 1) Is there a transport preparation organised for the for K9 teams and equipment? |
| D4. Medical | 1) Does the medical team ensure an assessment of the local needs of medical structures before disengaging? |
| | 2) Is there a donation of medical equipment made before the return? |
| | 3) What monitoring has taken place in relation to the COVID risk? |
| D5. Logistics | 1) Does the team take into account the transport of hazardous materials for the return? |
| | 2) Is there a trasport plan for the return of the team? |
| **E. POST-MISSION** | |
| E1. Management | 1) Does each part of the team prepare a mission report? |

| | |
|---|---|
| | 2) Is there a document «lessons to learn» prepared? |
| E2. Search | 1) Does each part of the team prepare a mission report? |
| | 2) Is there a document «lessons to learn» prepared? |
| E3. Rescue | 1) Does each part of the team prepare a mission report? |
| | 2) Is there a document «lessons to learn» prepared? |
| E4. Medical | 1) What medical and psychological monitoring system for team members is being used? |
| | 2) Does the team prepare a mission report? |
| E5. Logistics | 1) Is there a plan for restoring equipment and preparing for a new mission? |
| | 2) Does the team prepare a mission report? |