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**

# D7.12 Architecture and Design Specifications of S&R Platform, V2

| | |
|---|---|
| **Workpackage:** | WP7 – S&R Platform Design, Development and Service Integration |
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# Search and Rescue Project Profile

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| **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/ |
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# Document History

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# List of abbreviations

| Abbreviation | Explanation |
|---|---|
| API | Application Programming Interface |
| AR/VR/MR | Augmented/Virtual/Mixed Reality |
| C&C | Command and Control |
| CBRN | Chemical, biological, radiological and nuclear |
| COTS | Commercial off-the-shelf |
| ESB | Enterprise Service Buss |
| FCH | Fuel Cells and Hydrogen |
| FR | First Responders |
| GUI | Graphical User Interface |
| PKI | Public Key Infrastructure |
| RPAs | Remotely Piloted Aircraft Systems |
| SOA | Service Oriented Architecture |
| SSL | Secure Sockets Layer |
| UAV | Unmanned aerial vehicles |
| USAR | Urban Search and Rescue |
| WUI | Wildland Urban Interface |

# Executive Summary

This deliverable, which was produced as a part of the task 7.2 (Architecture and Design Specifications of S&R) in WP7 (S&R Platform Design, Development and Service Integration) presents the initial reference architecture for Search and Rescue system. The scope of this reports represents the starting point for future project activities, which are mainly aimed for technical and technological tasks, but also for other task types.

In this task, the conceptual architecture and detailed specifications of the integrated S&R platform will be derived and documented. The architecture of the S&R platform will describe in detail the integration logic and interfaces between the involved tools and services produced by WP3: *Situation Awareness, WP4: Data aggregation, Analysis and Decision Support*, WP5: *Design and implementation of specialised equipment for first responder*s, WP6: *S&R Component Design & Development*. The design of the architecture will adopt a structured approach, which goes through the:

● Definition of the initial "reference model" of the S&R platform, which will identify the scope of the individual components and services and the context wherein they will operate.

● Design of the components' "functional architecture", which specifies the functions to be performed by the components, as well as defines the inter-relations between the functions and qualifies data sources and data flows;

● Design of S&R components' "information and communication architectures", which establishes how data flows and data exchange are actuated;

● Definition of the common reference architecture for the S&R platform, adopting a Service-oriented Architecture approach and also considering the interaction dynamics between components.

In this context, the architecture of the integrated S&R platform will be designed with the scope to facilitate interoperability and inter-connectivity with third parties to allow for extensibility whilst preserving a considerable degree of implementation-platform-independence. Key factors to this objective are the adoption of widely accepted as well as emerging standards as well as the use of Open Source Software in accordance with the Project's needs. Therefore, a wide range of standards and technologies will be considered and utilised in the implementation of the S&R Platform (RDF, OWL, Triple Stores, SQL, NoSQL, XML, JSON, HTML5, REST, SOAP, Web Services, WSDL, SOA, etc.) to achieve the desired objective. The design will take account the different system stakeholders and potential security issues.[1]

After description of the methodology, which is used in S&R project, including ArchiMate modelling language in the general context of Enterprise Architecture best practices, this deliverable will present first view of the reference architecture.

Reference architecture layers are:

- Field layer

[1] Annex 1 – Research and Innovation action, Number – 882897 – Search and Rescue, pg. 43

- Communication Layer
- Integration Platform
- Decision support and command and control layer
- GUI (Visualisation and security layer)

This view of the architectural layers is mainly based on the physical location of the devices and technologies, which at same time are enhanced with major functional building blocks.
Detail of initial reference architecture follow in last sections of the deliverable, main view are:

- Use case view
- Application layer
- Technology and physical view.

In this second version we added operational view and add some evolution on initial logical approach.

# 1 Introduction

## 1.1 Overview

One of the main objectives for the Search and Rescue (S&R) project is to design, implement and test through a series of large-scale pilot scenarios a highly interoperable, modular open architecture platform for first responders bycapitalising on expertise and technological infrastructure from both CONCORDE and IMPRESS FP7 projects.

As it is stated from the project DoA the aim is to create a governance model of S&R, which will enable the design and operation of a more effective architectural structure that allows the easy incorporation of next generation R&D and COTS solutions. These will make possible the adoption of future disaster management systems. Based on this approach the project will seek tocreate and expose the building blocks (logical, physical, domain concepts) that can be linked to create a state-of-the-art solution for Crisis Management.

In this deliverable we demonstrateour **Reference architecture** that will be the backbone for next technical and technological activities in the project.

Our architecture activities are mainly included in **WP7** - S&R Platform Design, Development and Service Integration, and will use detailed design results from other technical focused work packages. Detailed design will be delivered in following work packages:

- **WP1** - First responders Requirements and Governance model (mainly for Governance Model)
- **WP3** - Situation Awareness
- **WP4** - Data aggregation, Analysis and Decision Support
- **WP5** - Design and implementation of specialised equipment for first responders
- **WP6** - S&R ICT Component Design & Development
- **WP8** - S&R Validation and Demonstration

## 1.2 Relation to other deliverables

This report builds uponoutcomes from D1.1 and D1.2 and proposes an architectural framework that accommodates all tools, which were proposed by S&R technology providers. Business, application and technology layers are described in this version of the report

## 1.3 Structure of the deliverable

In the next section of this deliverable, we will present the methodology, which was used for realising this report, including associated standards and tools.

The business view is described in Section 3, followed by logical or application view in Section 4. Draft proposal for physical view is presented in Section 5.

The last section concludes the initial reference architecture presented in previous sections.

# 2 Approaches to S&R reference architectural design

The aim of this section is to provide information about the S&R reference architectural design alongside with details about the analytical framework.

Based on the outcomes from D1.1 and D1.2 and considering that emerging technologies are targeted as potential components of the S&R platform – a layered modular reference architecture is proposed. An Enterprise Architecture is applied as methodology to describe S&R architectural framework. The building blocks and concepts are represented using ArchiMate®- [2] a standard from Open Group, while the model representation was developed using Archi – Open source ArchiMate modelling tool version 4.6.0[3].

Moreover, the Open group standards are aligned with the TOGAF framework as depicted in **Error! Reference source not found.**. ArchiMate® proposed modelling language for Enterprise architecture, which most matches the needs and objectives of S&R platform:

- A multi-tier architecture of information processing
- Results accessible in a ubiquitous manner to actors involved
- Flexible and scalable architecture to easily allow accommodation of next generation R&D and COTS solutions

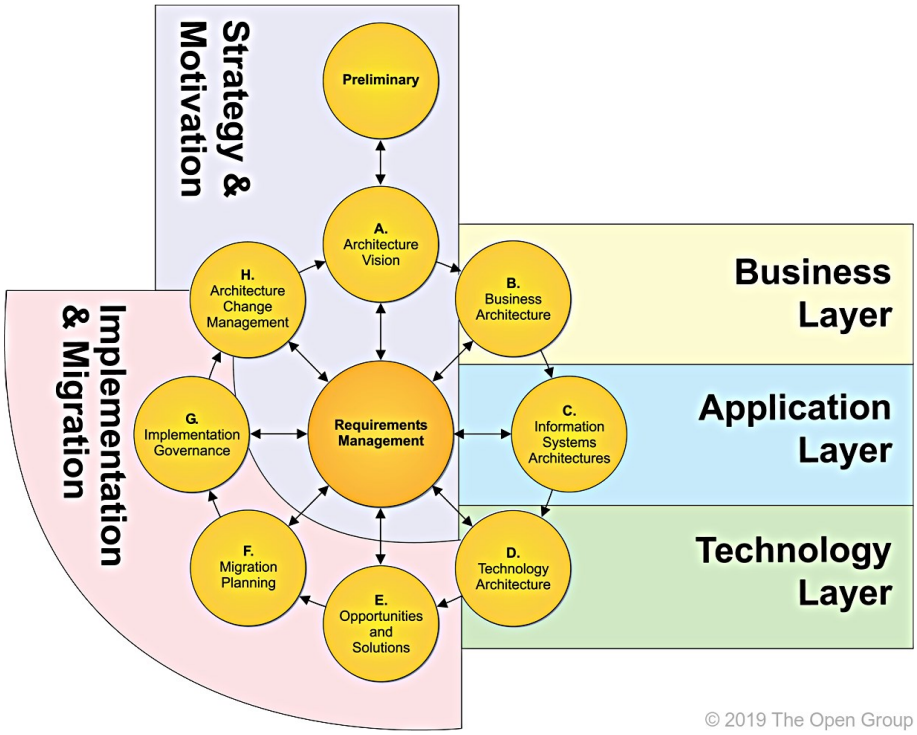


**Figure 2-1: ArchiMate 3.0. Layers**

[2] https://pubs.opengroup.org/architecture/archimate3-doc
[3] https://www.archimatetool.com/

The classification of concepts based on aspects and layers provides a global view, but the concepts cannot be clearly separated as they are interlinked.

**Business layer** identifies the concepts and relationships of the highest level of the architecture and ultimately defines the expected goals and requirements of an enterprise architecture framework.

**Application layer** is the concept used to model any structural entity in the application layer: software components software applications, or information systems.

**Technology layer** offers infrastructure services (e.g., processing, storage, and communication services), which arew needed to run applications.

In the next sections the above introduced concepts will be described in relationship with the tools, which are proposed within S&R.

In this second version we use Arcadia Systems Engineering method[4] in order to add operations view to the already presented logical view.

[4] https://www.eclipse.org/capella/arcadia.html

# 3 Search and Rescue reference architecture

The main objective of the Search and Rescue (S&R) is to establish an efficient synchronization framework managing the data, developed services and information flow between the different authorities, which are involved in emergency management operations, including the crisis managers (Rescue forces, Police, Fire department, etc.).
The underlying principle of S&R is that virtually any existing system and technology, could be employed by emergency responding organizations, if there is a need for this.
The proposed S&R platform can be split into the following three categories:

- **Front-End** equipment systems and collection tools, which are mainly based on technologies employed in the crisis scenarios will acquire relevant and sensible information in real time (e.g. sensors, drones, rescue robots, smart glasses smart uniforms, first aid for kids' device characterized by the usage of innovative textile materials, first aid devices, and masks). The platform will be equipped with heterogeneous autonomous assets and sensors that provide various sources of data, indoor positioning and extensions of communications efficiently by employing swarming behaviours.
- **Data Fusion and Mediation Systems** will fuse the information coming from those heterogeneous sources and provide a more detailed and accurate situational/context awareness to the decision makers and to the C&C centers. Within S&R the integrated version of CONCORDE EMS offers the particular functionality, but other systems may be also used. The S&R platform will contain all the features that end-users identified and classified as highly important during the piloting of CONCORDE and IMPRESS and enhance them with the latest developments in First Responders' related technologies.
- **Back-End applications**, services and portalswill provide decision support capabilities to crisis stakeholders. Adhoc web portals and additions to stakeholders' systems and back-offices will provide a common, uniform and ubiquitous platform for collecting, analysing and sharing real time data from the sensors, drones and rescue robots for supporting management decisions. Federated security will enable access by different stakeholders to services provided by different stakeholders.

Considering the complexity of the S&P system and the mix of various devices and sensors the only architecture that can accommodate such a complex scenario is a microservice architecture.

## 3.1 Microservice architecture

A microservice is an approach, which is applied to develop a single application as a suite of small services that run their own processes and communicate using lightweight mechanisms, often using API. These services should be easily and independently deployable using automated deployment machinery. A microservice can be compared with Robert C. Martin single responsibility principle, which states that all things that change for the same reason should be grouped together.
This architecture type has a lot of benefits, but the main ones are:

- A microservice can be built by small teams and are easy to maintain
- Services can be independently and automatically deployed.
- Very easy to debug because a micro-service offers fault isolation.
- Usage of technology stack that revolves on the business problem addressed.

Different technology stack can be chosen to solve a certain problem, as opposed to the one size fits all approach. For example: a specialized image analysis microservice can use MATLAB capabilities of image processing, whereas the rest of the application can be written in something else.
Using Microservices architecture at application level we can expose state-full and stateless services at system level services creating a state-of-the-art Service Oriented Architecture (SOA). Main Data Buss – Enterprise Service Buss (ESB) will act as gateway between system level exposed services, middleware processing and external systems.

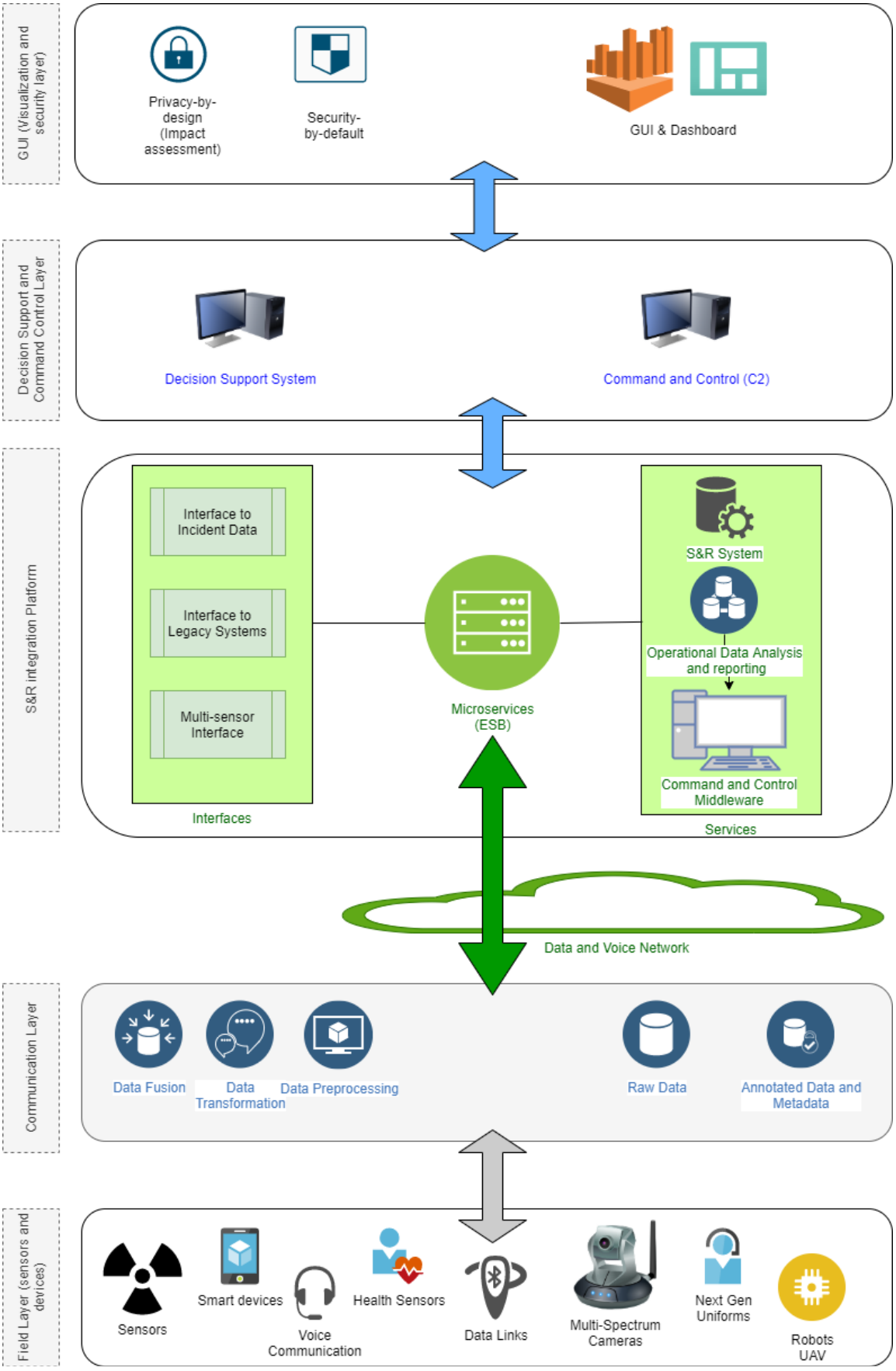


**Figure 3-1 : S&R Reference Architecture Layers**

For the S&R Reference Architecture we split components on five functional layers and one networking layer based on deployment location, functionalities and services provided.

**Field layer** contain all devices and technologies deployed on critical event field. As main data sources we have devices like:

- Sensors
- Smart devices
- Health sensors
- Wearable
- Multi-Spectrum Cameras
- Voice communication devices
- Data links devices

Also, robots and UAV are deployed on the field, being receptors of the command-and-control directives.

On the **communication layer** primary raw data is processed (annotated) in order to enable interpretation event and/or alerts triggers.

On this layer three data typologies are exchanged:

- Raw data
- Annotated data
- Metadata

**Data and voice network** is the exchange medium between event field and the central unit.

On the **integration platform** layer the middleware processing units are located.

Core information gateway is ESB/Microservices component that will link interfaces with functional services.

Major interfaces are:

- Incident data interface
- Legacy systems interface
- Multi-sensors interface

Core functional services are:

- S&R Core
- Operational Data Analysis
- Reporting
- Command and control (C2) middleware

**Decision support and command and control layer** host services for decision support modules and C2 middleware.

Decision support functionalities are:

- Strategy support
- Operational Support

- Tactical support

Command and control enable remote control for robots and UAV deployed on event field.

**GUI (Visualisation and security layer)** dedicated to central units will host thedashboards for user interaction.
At same layer security and privacy by design services are performed.

# 4 Use Case View

## 4.1 S&R Use Cases

At the current time following use cases are identified and will be used in pilots, in order to validate S&R platform.[5]

| | Equipment | Present TRL | End TRL | Partners in charge with technology development |
|---|---|---|---|---|
| **1.** | Smart Glasses & AR Helmets | 4 | 6 | SIMAVI |
| **2.** | Emergency communication app | 5 | 7 | KT |
| **3.** | Advanced Augmented Reality (AR) technologies | 3 | 5 | SIMAVI |
| **4.** | Wearable GPS Tracker | 4 | 6 | UniCa |
| **5.** | Wearable ECG, EMG (wearable) | 6 | 7 | UniCa |
| **6.** | Wearable Strain sensors (wearable) | 5 | 7 | UniCa |
| **7.** | Emergency response health condition monitoring device | 4 | 6 | CERTH/HIT |
| **8.** | Radiation sensors (wearable) | 5 | 7 | UniCa |
| **9.** | Rescue drones | 9 | 9 | UHasselt |
| **10.** | AI services on top of rescue drones | 6 | 7 | AIDEAS |
| **11.** | Rescue Robots & Autonomous vehicles | 6 | 7 | DFKI, THALIT |
| **12.** | Chemical sensors | 4 | 6 | NTUA |
| **13.** | COncORDE EMS & Associated module / services | 5 | 6 | KT |
| **14.** | Decision Support System (DSS) | 4 | 6 | KT, CNR, NTUA |
| **15.** | Training through AR/VR | 5 | 6 | KT, SIMAVI |
| **16.** | Smart textile professional uniform | 4 | 6 | UNIFI |
| **17.** | Rescue system for children | 4 | 6 | UNIFI |
| **18.** | 3D Mixed Reality Command Centre | 3 | 6 | CERTH/HIT |
| **19.** | Smartwatch | 3 | 5 | KT |
| **20.** | Volunteer registration and operationalization application | 4 | 6 | CERTH |

**Figure 4-1: Technologies for first responders**

### 4.1.1 Use Case 1: Victims trapped under rubble (Italy)

Poggioreale, a small town and commune in Sicily, Italy was selected to simulate an earthquake as this area has a history considering severe earthquakes and it is also has a high risk of future quakes.
The following ad-hoc situations will be simulated:

- people trapped under the rubble and / or in premises not reachable as a consequence to the earthquake;
- the release of gases and / or other toxic substances;
- blocked roads preventing traditional vehicles to reach the area.

[5] Grand Agreement Proiect S&R - Annex 1 – Description of Action (part B), pag. 19

The Poggioreale test scenario will allow the demonstration of the main features and advantages of the use of the S&R products and solution.

**Table 4-1: Use Case 1 - Victims trapped under rubble (Italy)[6]**

| Pilot leader | CNR, Italy |
|---|---|
| **Pilot area description** | The Use Case will take place in Poggioreale, a small town and commune in Sicily, Italy, set in the Belice valley, which administratively belongs to the province of Trapani. On the night of 15th January 1968, a terrible earthquake raked through the Valle del Belice in southwest Sicily. Around 900 people died and ten towns and villages were significantly damaged. |
| **Needs and opportunities** | The S&R solutions (first responder equipment, RPAs/drones, EMS) are expected to allow faster acquisition of information on the current and future situations, better patient management and more effective use of available material, infrastructural, and human resources. The Poggioreale test scenario will allow the demonstration of the main features and advantages of the use of the S&R products and solution. |
| **Use case overview** | Due to its current situation, the city is the perfect scenario to simulate an earthquake. A whole series of ad hoc situations will be simulated, in which the contribution of the tools/equipment developed within the project will be evident |
| **Technology providers & tools involved** | 1) Wearable GPS tracker (UniCA)<br>2) Situational Awareness Model (UBITECH)<br>3) Emergency communication App (KT)<br>4) Decision Support System (DSS)(KT, CNR, NTUA)<br>5) Rescue kits for children (UniFI)<br>6) Smart textile professional uniform (UniFI)<br>7) Wearable ECG, EMG (UniCA)<br>8) Wearable strain sensors (UniCA)<br>9) AI algorithms for recognizing objects from drone images (AIDEAS)<br><br>(See D8.2 S&R Use Case 1: Victims trapped under rubble (Italy) – Pilot plan) |
| **Roles in S&R architecture** | • Field Layer<br>• Communication Layer<br>• S&R Integration Platform<br>• Decision Support and C2 Layer<br>• GUI Layer |
| **End-users** | Regional Department of Civil Protection of Sicily (DRPC) and CNR |
| **Expected outcomes (operational KPIs)** | Time of initial notification call<br>Time until the first ill/injured victim has been triaged in the field<br>Time until the last ill/injured victim has been triaged in the field<br>Time until first treatment was performed<br>Time until victim is evacuated from scene<br>Time until victim arrives to emergency department ED<br>Time to notification of the first appropriate staff person, who assumes medical management coordination role<br>Time to arrival of the first EMS ambulance on scene<br>Time to transportation/evacuation of the last ill/injured survivor from the scene |

[6] D8.2 S&R Use Case 1: Victims trapped under rubble (Italy) – Pilot plan

| | |
|---|---|
| | Time until first triage assessment in emergency department<br>Time until last triage assessment in emergency department<br>Average time spent by victims on the scene<br>Average time spent by victims on ambulances and helicopters<br>Number of victims evacuated from the scene<br>Number of victims that receive first triage<br>Number of victims transported to the emergency department (first triage)<br>Number of victims transported to the emergency department (second triage)<br>Specific KPI s for the equipment/technologies, which are/were tested during the UC |

### 4.1.2 Use Case 2: Plane crash, mountain rescue, non-urban (Greece) - Plane crash in a mountainous region around Thessaloniki

For this use case an extended scenario will be created in order to involve first responders, civil protection organisations, individual climbers, mountaineer associations, established mountain shelters and possibly the public civil protection, the army, the fire brigade and the police.

**Table 4-2: Use Case 2 - Plane crash, mountain rescue, non-urban (Greece)[7]**

| Pilot leader | HRT, Italy |
|---|---|
| **Pilot area description** | The incident begins with a forced landing of a passenger propeller aircraft due to mechanical problems upon approaching the airport of Thessaloniki. Despite the efforts of the pilot, the aircraft crashes in a remote location of the mountainous area around the city, 30 minutes hiking distant from the nearest dirt road. A number of HRT first responders will be involved in the incident. Depending on their availability, public civil protection, the army, the fire department, and the police will participate at the pilot. An invitation will be sent to include civil protection organizations, individual climbers, mountaineer associations, and established mountain shelters.<br>According to the scenario, the weather condition is assumed to be extremely windy, a common phenomenon at that period of the year (October-November). No terrorist intention is assumed to be involved in the incident. |
| **Needs and opportunities** | The relevant actor that will participate in the demonstration exercise will be chosenduring the preparation phase of the pilot. |
| **Use case overview** | Forced airplane landing in a mountainous area that is isolated and there is no road access.<br>The relevant actor that will participate in the demonstration exercise will be chosenduring the preparation phase of the pilot. |
| **Technology providers & tools involved** | 1. Smartwatch (**KT**)<br>2. Emergency Communication App (**KT**)<br>3. Situational Awareness (**UBITECH**)<br>4. 3D Mixed Reality Command Centre (depending on the required hardware) (**CERTH**)<br>5. Volunteer application (**CERTH**)<br>6. Emergency Response Health Condition Monitoring Device (Test the device on the simulated victims) (**CERTH**)<br>7. e-learning based platform (to be used for training) (**CERTH**) (UC2 is foreseen to take place in Oct-Nov 2022, so I believe that we will be OK, timewise) |

[7] D8.3 S&R Use Case 2: Plane crash, mountain rescue, non-urban (Greece) - Pilot plan

| | |
|---|---|
| | 8. Smart Glasses (to be used for training and if possible, to display information through AR on the field) (**SIMAVI**)* CERTH will provide 2 Smart Glasses and SIMAVI will provide technical assistance<br><br>9. Artificial intelligence (We understand that this is a technology for image/video analysis. If so, we would like to test it with images from the drones) (**AIDEAS**) (See D8.3 S&R Use Case 2: Plane crash, mountain rescue, non-urban (Greece) - Pilot plan) |
| **Roles in S&R architecture** | • Field Layer<br>• Communication Layer<br>• S&R Integration Platform<br>• Decision Support and C2 Layer<br>• GUI Layer |
| **End-users** | Hellenic Rescue Team |
| **Expected outcomes (operational KPIs)** | • Support the exchange of information between first responders on the field and the Command and Control Centre<br>• How quick is the information flow<br>• How many users can have access to the same information and the same time<br>• Show only relative information to the end user<br>• Classification of information<br>• How a DSS can support media coverage<br>• How a DSS can support handling the relatives of the victims<br>• Offline access<br>• Local network to support dissemination of information among first responders on the field<br>• Other specific KPI s for the equipment/technologies tested during the UC |

### 4.1.3 Use Case 3: Earthquake / heavy storms between Vienna Rail Station & Kufstein railway station heavy damages in the rail station (Cross-border pilot, Austria-Germany) - Pilot plan

In this Use Case communication breaks down because of lack of power supplies. Insecure communication channels must be used.
Situation awareness system can be initiated by Vienna command centres. Data provided from the scenario in Lower Austria are used to create a situation report and control further operations in the field in real time.

**Table 4-3: Use Case 3 - Earthquake / heavy storms between Vienna Rail Station & Kufstein railway station heavy damages in the rail station (Cross-border pilot, Austria-Germany) - Pilot plan[8]**

| Pilot leader | JOAFG & JUH (Austria-Germany) |
|---|---|
| **Pilot area description** | The Use Case is organised by two medical first responder organisations from Germany and Austria including their respective disaster relief units. It |

[8] D8.4 S&R Use Case 3: Earthquake/ heavy storms between Vienna Rail Station & Kufstein railway station heavy damages in the rail station (Cross-border pilot, Austria-Germany) - Pilot plan

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| | will be organised as a field exercise focusing on the response phase of the disaster risk management cycle. The scenario and exercise is envisioned at regional scale.<br>A heavy storm is ongoing. An uprooted tree falls on the tracks, derailing a train that is approaching Kufstein railway station. Passengers that are unharmed are seeking shelter in a nearby building. Due to the storm, the regional command centre in Tyrol is experiencing a blackout and has lost communications. During the operation an unexpected gas explosion occurs at the building used as temporary shelter.<br>Trains in this region are frequent, carrying about 10-15.000 people a day between the eastern and western parts of Austria. Between the main train stations of Austria, impacts of different degrees at several points are known, most due to interruptions of the overhead wiring or the rail tracks caused by the storm. The train approaching Kufstein cannot brake in time, crashing into a tree that fell on the tracks, derailing a train waggon with approx. 40 people on board.<br>Communication infrastructure and electricity is collapsed in some of the municipalities. Communication is irregular and unstable. Because of the communication breakdown, the chaos will last longer. As soon as a public communication hub is launched, it breaks down again because of an overload. Data exchange/ transfer of patient information from one command centre to another is necessary due to a blackout in the region.<br>All of a sudden, a gas explosion occurs, which was triggered by a glowing cigarette that was improperly discarded next to a stack of gas barrels alongside a building nearby the train station, which as a consequence partially collapses. The building was used as a temporary shelter by train passengers that were involved in the recent train accident. The number of people in the building is unknown. Some ten people are found outside of the building remains, shocked and lightly injured. |
| **Needs and opportunities** | Communication breaks down because of lack of power supplies. Insecure communication channels have to be used. |
| **Use case overview** | Train patient routing system, triage structures, rebuild of communication infrastructure/ad hoc infrastructure to re-establish basic comm. Train to take over data management for different ambulance services from command center to command center (in Vienna there are 5 command centres that are able to switch between each other to completely take over the others fleet and run the logistics).<br>Situation awareness system can be initiated by Vienna command centers. Data provided from the scenario in Lower Austria are used to create a situation report and control further operations in the field in real time. |

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| **Technology providers & tools involved** | 1. Robot: SeekurJr (weight 80kg, max. payload 50kg, 3-5h operating time) (DFKI)<br>2. Obstacle avoidance system (THALIT)<br>3. CONCORDE Communication App (KT)<br>4. Smartwatches (KT)<br>5. Six Gas HazMat Monitor (UNICA) See D8.4 S&R Use Case 3: Earthquake/ heavy storms between Vienna Rail Station & Kufstein railway station heavy damages in the rail station (Cross-border pilot, Austria-Germany) - Pilot plan |
| **Roles in S&R architecture** | • Field Layer<br>• Communication Layer<br>• S&R Integration Platform<br>• GUI Layer |
| **End-users** | JOAFG & JUH (Austria-Germany) |
| **Expected outcomes (operational KPIs)** | • Establish communication link to the next full capable node<br>• Time to Re-establish communication<br>• Data transfer/Data Exchange digital-paper-digital<br>• Interoperability of patient routing system AUT/GER (exchange patient data via patient routing system)<br>• Time until all trapped victims are rescued<br>• Usability of technical equipment (gas detection, UGV, CONCORDE app)<br>• Interoperability of CONCORDE platform<br>• Connection with S&R platform |

### 4.1.4 Use Case 4: Forest fire expanded and threat to industrial zone (Kineta, Agioi Theodoroi, Greece)

In this Use Case: a wildfire is initiated by arson. Due to the strong winds and the dry forest fuel, the later caused by prolonged heat waves 10 days before the fire incident, the fire expands rapidly towards the residential area. Huge quantities of smoke are produced and hence, the nearby communities are requested by the relevant stakeholders to evacuate.

**Table 4-4: Use Case 4 - Forest fire expanded and threat to industrial zone (Kineta, Agioi Theodoroi, Greece)[9]**

| Pilot leader | EPAYPS (Greece) |
|---|---|
| **Pilot area description** | The pilot will take place in an urban area mixed with forest that is situated nearby an industrial zone. Each year, wildfires result to high mortality rates and property losses, especially in the wildland urban interface (WUI), affecting millions of people and having devastating global consequences on the biodiversity and the ecosystems. It has to be considered that wildfire |

[9] D8.5 S&R Use Case 4: Forest fire expanded and threat to industrial zone (Kineta, Agioi Theodoroi, Greece) - Pilot plan

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| | disasters may rapidly change their nature into technological disasters, e.g. in the mixed areas of forest and residential, heavy industrial, or recycle zones. This pilot is based on a real scenario that took place in Industrial Zone, Attica, Greece were a refinery was indeed in danger during wildfires occurred on July 2018 in Greece. |
| **Needs and opportunities** | RPAS/drones,<br>Rescue robots to facilitate SAR operation. |
| **Use case overview** | A wildfire is initiated by arson. Due to the strong winds and the dry forest fuel, the later caused by prolonged heat waves 10 days before the fire incident, the fire expands rapidly towards the residential area. Huge quantities of smoke are produced and hence, the nearby communities are requested by the relevant stakeholders to evacuate. The use of aerial Fire-fighting means is restricted due to the strong winds, so all the forces are operating through the ground. Due to the specific morphology of the area and the extreme meteorological conditions the fire expands and approaches industrial/critical infrastructure facilities. Because of the dense smoke produced and the reduced visibility some of the workers are trapped inside smoke plume and cannot reach a safe place. The main objective of the pilot is to test the remote sensing technologies proposed in the S&R project for the safety of first responders; alarms for early warning of toxicity and radiation exposure and generally inspection of the hot zone area; use of RPAS/drones, such as rescue robots to facilitate SAR operation. |
| **Technology providers & tools involved** | 1) Smart Glasses (SIMAVI)<br>2) Smartwatch (KT)<br>3) Emergency response health condition monitoring device (CERTH/HRT)<br>4) Radiation sensors (wearable) (TBD)<br>5) Chemical sensors - Rescue MIMS (NTUA)<br>6) Drones (UHasselt)<br>7) Collaborative drones' platform (UHasselt)<br>8) Rescue Robots & Autonomous vehicles (DFKI)<br>9) Obstacle Detection and Avoidance System (ODAS) (THALIT)<br>10)Volunteer application, (Tech 3.1) (CERTH )<br>(See D8.5 S&R Use Case 4: Forest fire expanded and threat to industrial zone (Kineta, Agioi Theodoroi, Greece) - Pilot plan) |
| **Roles in S&R architecture** | • Field Layer<br>• Communication Layer<br>• S&R Integration Platform |
| **End-users** | Association of Officers and Sub-Officers of Hellenic Fire Corps (EPAYPS, GREECE) |
| **Expected outcomes (operational KPIs)** | • Nb of organisations and users involved<br>• Nb of new requirements recorded<br>• Level of realism of the exercise<br>• Level of effectiveness of the smart glasses<br>• Operation capability of chemical sensors on roving systems or robotic platforms<br>• Effectiveness of the S&R technologies (wearables etc.) |

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| | • Capability of the local network to support dissemination of information among first responders on the field<br>• Specific KPI s for the equipment/technologies tested during the UC |

### 4.1.5 Use Case 5: Victims trapped under rubbles (France)

This Use Case is based on International Emergency Firefighters' training facility, approved by INSARAG in 2015.
It meets the conditions of a real-life situation according to the United Nations INSARAG standards.
The facility is well located between various European countries and can be easily accessed.

**Table 4-5: Use Case 5 - Victims trapped under rubbles (France)[10]**

| Pilot leader | PUI (France) |
|---|---|
| **Pilot area description** | Built in La Souterraine, France (FRA) on a site of 3 ha/7.5 ac, International Emergency Firefighters' training facility was approved by INSARAG in 2015. It meets the conditions of a real-life situation according to the United Nations INSARAG standards.<br>The facility is well located between various European countries and can be easily accessed.<br>The site can be easily accessed using various means of transportation:<br>• by car: A20 motorway, exit 23.<br>• by train: a station is 200 m (0.1 mi) away —Paris-Toulouse rail-line.<br>• by airplane: the Limoges international airport is only 35 minutes away. |
| **Needs and opportunities** | Area dedicated to training, maintaining and increasing the specific skills of first responders<br>Two classrooms are now available in the humanitarian logistics base, 800 m/0.5 mi from the worksite. |
| **Use case overview** | **Exploitation.** Area dedicated to training, maintaining and increasing the specific skills of first responders. In this area, the first simulation/training activities will be carried out thanks to the first data acquired by the monitoring systems (vibrational - environmental - on images). A rubble area was also created for the use of searching and locating devices, drone overflights and the medicalisation of buried victims. Other layouts enable USAR teams to work in real-life, operational USAR conditions with designated<br>areas for a base of operations, a USAR coordination centre (OSOCC) and a medical centre. |
| **Technology providers & tools involved** | The components that will be tested are the rescue MIMS, drones, Situational Awareness Model, Emergency communication App, PHYSIO DSS, Wearable tracker and the connected uniforms. In the specific area, the first simulation/training activities will be carried out thanks to the first data acquired by the monitoring systems (vibrational - environmental - on images). A rubble area will be also created for the use of searching and locating devices, drone overflights and the medicalization of buried victims. Other layouts will enable USAR teams to work in real-life, operational USAR conditions with designated areas for a base of operations, a USAR coordination cell (UCC) and a medical centre.<br>(See D8.6 S&R Use Case 5: Victims trapped under rubbles (France) - Pilot plan) |
| **Roles in S&R architecture** | • Field Layer |

[10] D8.6 S&R Use Case 5: Victims trapped under rubbles (France) - Pilot plan

| | |
|---|---|
| | • Communication Layer<br>• S&R Integration Platform<br>• Decision Support and C2 Layer<br>• GUI Layer |
| **End-users** | Pompiers de l' Urgence Internationale (PUI France) – International Firefighters with the technical support of THALIT, KT, ATOS & NTUA. |
| **Expected outcomes (operational KPIs)** | • Notification and coordination time<br>• Time for crisis notification call issues by the Operations Centre to reach user's communication devices<br>• Time needed for a user's post (e.g. text, photo) to be transmitted in other user's mobiles<br>• Response Time<br>• Time for rescuer's arrival on scene<br>• Effectiveness in supporting the communication and coordination between first responders on the field and the Operations Centre provided by the tested devices/tools<br>• Effectiveness in monitoring the first responders/volunteers/victims' health vitals<br>• Specific KPI s for the equipment/technologies tested during the UC<br>• Average time until unaffected persons reach safe assembly points<br>• Total evacuation time for all actors<br>• Average time spent by victims on the scene<br>• Time for rescuers to reach the first/last affected/injured person on scene |

### 4.1.6 Use Case 6: Resilience Support for Critical Infrastructures through Standardised Training on CBRN (Romania)

The pilot shall take place at the Regional Air Services (International Airport Tuzla), located near the Black Sea at about 300 km from Bucharest, tentatively in September-October 2022. The pilot will consist of a practical simulation exercise at the airport, with the operators CBRN team belong to International Airport Tuzla and the medical staffs belong to Central Military Hospital "Dr. Carol Davila".
The facility is an important entity from the Transport Sector, which is defined as the Critical Infrastructure sector by the Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. The facility was chosen for the proof of concept regarding the resilience support through standardized training. No other aspect regarding the criticality of the facility will be used and therefore there will not be approached sensitive information.
In the training exercises will also participate The Central Military Emergency University Hospital "Dr. Carol Davila" is a multidisciplinary hospital unit with old traditions in Romanian medicine, which has the infrastructure (human and material) capable of providing qualified medical assistance, both for emergency situations and for those related to primary medical services, specialised or in ambulatory, offering the full range of quality diagnostic and medical treatment possibilities.

**Table 4-6: Use Case 6 - Resilience Support for Critical Infrastructures through Standardised Training on CBRN (Romania)[11]**

[11] D8.7 S&R Use Case 6: Resilience Support for Critical Infrastructures through Standardized Training on CBRN (Romania)- Pilot plan

| Pilot leader | PROECO-CBRNE (Romania) |
|---|---|
| **Pilot area description** | At Tuzla airport, activities are carried out normally, according to the daily schedule.<br>The intervention capacity of the private emergency service of Tuzla airport is fully available, both in terms of staff and search-and-rescue technique.<br>At the level of the airport security and protection company, no special events were reported. |
| **Needs and opportunities** | Romanian Cluster PROECO-CBRNE will provide all equipment for training exercise: tents, chemical and biological detection equipment, and protective equipment for all participants, Intervention Kit. |
| **Use case overview** | In the training exercises will also participate The Central Military Emergency University Hospital "Dr. Carol Davila "is a multidisciplinary hospital unit with old traditions in Romanian medicine, which has the infrastructure (human and material) capable of providing qualified medical assistance, both for emergency situations and for those related to primary medical services, specialized or in ambulatory, offering the full range of quality diagnostic and medical treatment possibilities. |
| **Technology providers & tools involved** | 1) Smart glasses (SIMAVI)<br>2) Communication system for rescue (KT)<br>3) Six Gas Hazmat Monitor (UniCa)<br>4) Wearable strain sensors (UniCa)<br>5) Rescue system for children (UNIFI)<br>6) Smart textile professional uniform (UNIFI)<br>7) E-learning based platform (to be used for training) (CERTH)<br>(See D8.7 S&R Use Case 6: Resilience Support for Critical Infrastructures through Standardized Training on CBRN (Romania)- Pilot plan) |
| **Roles in S&R architecture** | • Field Layer<br>• Communication Layer<br>• S&R Integration Platform<br>• Decision Support and C2 Layer<br>• GUI Layer |
| **End-users** | PROECO |
| **Expected outcomes (operational KPIs)** | • Notification and coordination time<br>o Time for crisis notification call issues by the Operations Centre to reach user's communication devices<br>o Time needed for a user's post (e.g. text, photo) to be transmitted in other user's mobiles<br>• Response time<br>o Time for rescuer's arrival on scene |

| | |
|---|---|
| | o Time for rescuers to reach the first/last affected/injured person on scene<br>• Effectiveness in supporting the communication and coordination between first responders on the field and the Operations Centre provided by the tested devices/tools<br>• Effectiveness in monitoring the first responders/volunteers/victims' health vitals<br>• Evacuation time<br>o Average time until unaffected persons reach safe assembly points<br>o Total evacuation time for all actors<br>• Average time spent by victims on the scene<br>• Specific KPI s for the equipment/technologies tested during the UC |

### 4.1.7 Use Case 7: Chemical substances spill (Spain)

In UC7, SUMMA 112 and ESDP will prepare a CBRN incident with two separate scenarios. The pilot will be allocated to The National School of Civil Protection, Rivas Vaciamadrid, between October-November 2022. This school is a specific place for the training of both intra community and national courses. It has several scenarios where first responders can perform a joint train ad hoc: aquatic rescue, collapsed structures, fire, explosions, CBRN incidents, transport of dangerous goods…
The main objective is to delimit the working zones according to the existing risks and toxicity levels, in order to guarantee the safety of the first responders and rescue dogs, and as well indirectly to the safety of the victims of the incident. These safety zones can change due to various circumstances, both environmental and accidental, and it is expected that these changes will be recognised by CONCORDE, and chemical sensors, which will send alerts to the first responders in the area warning of new dangers.

**Table 4-7: Use Case 7 - Chemical substances spill (Spain)[12]**

| Pilot leader | SERMAS – ESDP (Spain) |
|---|---|
| **Pilot area description** | An accident in a factory results in a chemical spill in a building, endangering the factory workers' health.The Use Case involves real life simulation of S&R of victims in chemical risk emergency situation. |
| **Needs and opportunities** | The area to validate the technology simulates a Collapsed Structure Building with pieces of rubble; near Madrid, in the middle of a cross country, with the facilities of the National School of Civil Protection and accessible from the road A3.<br>The training Camp has the following characteristics:<br>• Collapsed Structures Area: Two zones of 7.500 m2. More than 150 points of concealment. Underground galleries with a length<br>of 240 m. Vertical access. Constructions that simulate collapsed buildings. With structures of five levels and 100 square meters<br>per floor. Special area for shoring props movement of loads and breakage of plates. Landslide area of 4500 square meters<br>• Area of water<br>• Raft of 9.400 m3 with a Depth that in some areas reaches 7 meters<br>• Simulation Accident Area: Surface 12.500 m2<br>If required by the project's needs, standing building might be located for adding up to this testing site. |
| **Use case overview** | The technology will be tested in the below briefly described Spanish Civil protection School Training Camp |

[12] D8.8 S&R Use Case 7: Chemical substances spill (Spain) - Pilot plan

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|---|---|
| **Technology providers & tools involved** | 1) Concorde EMS & Associated module/services (KT). The S&R Emergency Management System (EMS) will be based on Concorde EMS. COncORDE is a state of the art software platform that supports and enhances the existing coordination and decision processes during small or large-scale crises and medical emergencies, at local, regional and cross-border level.<br><br>2) Emergency communication app (KT).<br><br>3) DSS (decision support system) (KT, CNR; NTUA). 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, and the allocation of available EMS units to incidents.<br><br>4) Wearable GPS tracker (UniCa): GPS tracking will run even when there is a loss of network connectivity and synchronizes GPS recorded data as soon as it is reconnected.<br><br>5) Six Gas Hazmat Monitor (UniCa). 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 expected gases to be detected are: Ammonia (NH3), Propane (C3H8), Carbon Monoxide (CO), Oxygen (O2), Chlorine (Cl2), Carbon Dioxide (CO2)<br><br>6) Smartwatches (KT): 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). (See D8.8 S&R Use Case 7: Chemical substances spill (Spain) - Pilot plan) |
| **Roles in S&R architecture** | • Field Layer<br>• Communication Layer<br>• S&R Integration Platform<br>• Decision Support and C2 Layer<br>• GUI Layer |
| **End-users** | SUMMA 112 (SERMAS) and ESDP (K9 teams) |

| | |
|---|---|
| **Expected outcomes (operational KPIs)** | • Notification and coordination time<br>• Time for crisis notification call issues by the Operations Centre to reach user's communication devices<br>• Time needed for a user's post (e.g. text, photo) to be transmitted in other user's mobiles<br>• Response time<br>• Time for rescuer's arrival on scene<br>• Effectiveness in supporting the communication and coordination between first responders on the field and the Operations Centre provided by the tested devices/tools<br>• Effectiveness in monitoring the first responders/volunteers/victims' health vitals<br>• Average time until unaffected persons reach safe assembly points<br>• Total evacuation time for all actors<br>• Average time spent by victims on the scene<br>• Time for rescuers to reach the first/last affected/injured person on scene<br>• Specific KPI s for the equipment/technologies tested during the UC |

## 4.2 Security Requirements

The security view presents the characteristics of the system in terms of confidentiality, integrity and availability. This is recognized as CIA[13] Triad in information security[14].

The CIA Triad is part of recognised industry standard ISO/IEC 27001:2018 that describes best practice for an information security management system.

Bellow we detail how the application will address the three pillars:

- **Confidentiality –** states that the information in a computer system should be accessed only by the people that should view it. There are many methods used to assure confidentiality we're mentioning the most important ones:
    - **Authentication-** all users will be authenticated using a username and a password. All the accounts will be unique and traceable – meaning that one account will be linked to a user. We will limit the use of generic system accounts like root, admin, because these accounts are anonymous. A user can be authenticated in system based on:

      o What the user knows – a password

      o What the user has – a token or a key card

      o What the user is – biometrics (fingerprint, iris, etc.)
    - **Authorisation –** all users will be authorised to perform certain tasks, using the least privilege principle. The authorisation will be done using access rights.

[13] Confidentiality, integrity and availability

[14] Matt Walker. 2011. CEH Certified Ethical Hacker All-in-One Exam Guide (1st. ed.). McGraw-Hill Osborne Media.

  - **Encryption –** all data will be encrypted. Encryption is a mathematical two-way function that makes the data unreadable unless you have the decryption key. We're referring to both data at rest and data in transit. Data at rest will be encrypted using encrypted volumes and data in transit using HTTPs and SSL. The methods mentioned above will used together. For example: when authenticating a user, the password must be encrypted when sent over the internet.

- **Integrity –** states that data in a computer system should be only modified. In case of integrity users must be sure the data they are viewing, and modifying is the actual data from the system. The same system applies in reverse, the data sent by the server shouldn't be modified by an internal data. There are many methods used to assure integrity. In the following, we are mentioning the most important ones:
  - **Encryption –** data, which are transmitted over the internet are encrypted and cannot be read or modified by other people.
  - **Hashing** - this method assures the integrity of data per se but cannot work without other methods presented here. Hashing is a mathematical collusion resistant one-way function that presents a digest of a message. If the message is altered, that digest is changed. A property of a hash algorithm is that any small change in the initial message will produce a major change in the hash. Integrity is an innate property of Public Key Infrastructure (PKI) that we'll be used throughout the project, SSL.
  - **Authentication and authorisation** are also used here, because only an authenticated user should be able to access the system, and the system should be accessed based on the user rights.
- **Availability** – states that the system is accessible for the people that need access to it for as much time as possible. It doesn't matter how secure a system is if you can't have access to it, the application won't work. Availability is achieved by using some of the methods mentioned here:
  - Capacity – assuring that the right number of concurrent users can use the system-of-systems
  - Backups – system backups are very important because if a breach occurs and all the historic data is deleted/encrypted by ransomware the system becomes unavailable.
  - Logs – logs are applicable for the system as whole, not only in the availability part. We mention it here because it's an integral part of business continuity. Logs allow system administrators to monitor what's happening in real time or what has happened at a point in time[15].

[15] Shon Harris. 2009. CISA Certified Information Systems Auditor All-in-One Exam Guide (1st. ed.). McGraw-Hill, Inc., USA.

## 4.3 First Responders Technological Context

A benchmarking of the main technologies used within different European projects for first responders has been outlined in order to give an accurate overview of the first responders' technologies state of the art. The main objective of this benchmarking is twofold: the first goal is to maximise the technologic effort within S&R project, avoiding losing developmental resources by exploiting already available technologies; (ii) creating new feasible synergies among different EU projects, which could be useful also for S&R dissemination.

We firstly presented the main European projects focused on first responders, highlighting main scopes, the duration and developed technologies per each. They were selected through research conducted through the main search engines (specifically Cordis Europa: https://cordis.europa.eu/it) using the following keywords: (European project, AND First responders, AND Technology).

The first table (Table 4-8) presents a classification of the European project focused on first responders and emergency personnel, starting from the ongoing ones to the oldest.

The second sets of tables aims to detail the available specific technologies developed within each project, categorising them for their type (i.e. Wearable devices; AR/VR/MR applications; Platforms; Drones; Mobile phone & Applications; Robots; Chemical Sensors; Information, Communication & Localisation Systems) and specifying per each the device's name, scope and key functionalities (i.e. what the technology does) and sensors (how the technology is built).

### 4.3.1 European Projects for First Responders

**Table 4-8: European Projects for First Responders**

| Project | Year | Purpose | Technology |
|---|---|---|---|
| iProcureSecurity PCP Pre-Commercial Procurement of Innovative Triage Management Systems Strengthening Resilience and Interoperability of Emergency Medical Services<br><br>https://pcp.iprocuresecurity.eu/ | 2021-2024<br>Ongoing project | - iProcureSecurity PCP project will develop an innovative triage management system that provides quick and accurate overview of victims, as well as improved interoperability with other first responders and relevant actors. | - Triage management system<br>- 5G<br>- Wearables<br>- Telemedicine<br>- AI<br>- Big data analytics |
| SIXTHSENSE- Smart integrated extreme environment health monitor with sensory feedback for enhanced situation awareness<br><br>https://sixthsenseproject.eu/about/ | 2020-2023<br>Ongoing project | - Improve the efficiency and safety of first responders' engagement in difficult environments<br>- Optimise on-site team coordination and mission implementation | - Innovative wearable health monitoring system |

| | | | |
|---|---|---|---|
| RESPOND-A - Next-generation equipment tools and mission-critical strategies for First Responders<br><br>https://respond-a-project.eu/ | 2020-2023<br>Ongoing project | Leverage First Responders efficiency and safety by introducing a joint technological and conceptual framework for maximal Situational Awareness in terms of boosting capabilities of<br>- Early Assessment<br>- Safety Assessment<br>- Risk Mitigation | - 5G wireless communications<br>- Augmented and virtual reality or autonomous robots |
| INTREPID - Intelligent Toolkit for Reconnaissance and Assessment in Perilous Incidents<br><br>https://cordis.europa.eu/project/id/883345 | 2020-2023<br>Ongoing project | - Help first responders by providing a platform that will improve the 3D exploration and analysis of disaster zones.<br>- First responders will be able to immediately start operations without having to wait for specialised teams or for the zone to be fully secured. | - INTREPID platform |
| PATHOCERTH - Pathogen Contamination Emergency Response Technologies<br><br>https://cordis.europa.eu/project/id/883484 | 2020-2023<br>Ongoing project | - Strengthen the coordination capability of first responders if they work in places where the risk of contamination via water is high<br>- Produce pathogen contamination emergency response technologies, tools and guidelines to be validated by first responders<br>- Detect pathogens quickly and to better control emergency situations | |
| ASSISTANCE - Adapted Situation Awareness tools and tailored training scenarios for increasing Capabilities and Enhancing the Protection of First Responders<br><br>https://assistance-project.eu/ | 2019-2022<br>Ongoing project | - Help and protect different kind of first responders' (FR) organisations that work together during the mitigation of large disasters (natural or man-made)<br>- Enhance their capabilities and skills for facing complex situations related to different types of incidents | - UAVs<br>- Smart wearable sensors<br>- Robots and drones' swarms equipped with specific sensors<br>- SA platform<br>- Virtual Reality (VR)<br>- Mixed Reality (MR) |

| | | | |
|---|---|---|---|
| | | | - Augmented Reality (AR) |
| FASTER project<br><br>https://www.faster-project.eu/ | 2019-2022<br>Ongoing project | - Protect first responders in hazardous environments<br>- Enhance their capabilities in terms of situational awareness and communication | - Augmented Reality (AR) supplied both through mobile phones and AR glasses (e.g. HoloLens)<br>- Lightweight and camera-equipped UAVs<br>- Mobile application<br>- Wearable sensors and smart textiles<br>- Wearable device for K9s<br>- UxV<br>- Robotic Platform |
| ResponDrone<br><br>https://respondroneproject.com/ | 2019-2022<br>Ongoing project | - Develop and apply a situational awareness system in emergency situations, providing critical information and communication services to first responders<br>- Develop an integrated solution for first responders to easily operate several drones with multiple synchronised missions<br>- Enhance their situation assessment capacity and own protection<br>- | - ResponDrone<br>- |

| | | | |
|---|---|---|---|
| CURSOR - Coordinated Use of miniaturised Robotic equipment and advanced Sensors for search and rescue Operations<br><br>https://www.cursor-project.eu/ | 2019-2022<br>Ongoing project | - Develop new and innovative ways of detecting victims under debris<br>- Achieve significant improvements in search and rescue operations through the coordinated use of miniaturised robotic equipment and advanced sensors | - CURSOR Search and Rescue Kit |
| TERRIFFIC – Tools for early and Effective Reconnaissance in CBRNe Incidents providing First responders Faster Information and enabling better management of the Control zone<br><br>https://www.terriffic.eu/ | 2018-2021<br>Ongoing project | - Develop a comprehensive system of complementary, interconnected and modular software and hardware components<br>- Enrich the European response to CBRNe events<br>- Enable a step-change to the response in the initial hours | - Information Management and Decision Support System<br>- Atmospheric dispersion modelling software<br>- Augmented/ mixed reality environment<br>- A mobile van equipped with improved radiation detection technologies and enabling the integration of tactical information systems.<br>- UAV Q800X<br>- Unmanned ground vehicle, allowing for integration of various detectors, piloted automated exploration and manipulation tasks.<br>- Handheld detector<br>- Gamma camera<br>- SiPR detector |

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| | | | - Portable neutron detector |
| IN-PREP - An Integrated next generation Preparedness programme for improving effective inter-organisational response capacity in complex environments of disasters and causes of crises<br><br>https://www.in-prep.eu/ | 2017-2021<br>Ongoing project | - Prepare responders better – so more lives can be saved during natural disasters and crises.<br>- Improve collaborative response planning<br>- Agencies using in-prep will be able to plan, train and collaborate better than ever before. | - Handbook of Transboundary Preparedness and Response Operations that synthesises the lessons learnt, recommendations, check-lists from past incidents)<br>- Training platform (Mixed Reality Preparedness Platform a novel IT-based tool, which holistically integrates<br>- Information Systems (IS) and Situational Awareness (SA) modules |
| I-REACT - Improving Resilience to Emergencies through Advanced Cyber Technologies<br><br>https://www.i-react.eu/ | 2016-2019 | - Integrate emergency management data coming from multiple sources, including that provided by citizens through social media and crowdsourcing.<br>- Produce information faster | - Mobile app<br>- Wearable device<br>- Augmented reality<br>- innovative cyber technologies and ICT systems, |

| | | | |
|---|---|---|---|
| | | - Allow citizens, civil protection services and policymakers to effectively prevent and/or react against disasters | - Copernicus Emergency Management Service<br>- European Flood Awareness System (EFAS)<br>- European Forest Fire Information System (EFFIS)<br>- European Global Navigation Satellite Systems (E-GNSS) |
| INACHUS - Technological and Methodological Solutions for Integrated Wide Area Situation Awareness and Survivor Localisation to Support Search and Rescue Teams<br><br>https://www.inachus.eu/ | 2015-2018 | - Achieve a significant time reduction related to Urban Search and Rescue (USARUSAR) phase<br>- Provide a wide-area situation awareness solution for improved detection and localisation of the trapped victims assisted by simulation tools for predicting structural failures and a holistic decision support mechanism incorporating operational procedures and resources of relevant actors | - Ground-Based Seismic Sensor system (GBSS)<br>- SurfaceRadar<br>- StickRadar<br>- Mobile Phone Detector<br>- Bullet Constraints Builder (BCB)<br>- Extreme Loading® for Structures Software (ELS)<br>- Mapping tool for the priorisation of USAR operations in urban surroundings<br>- Multi-source Information<br>- Fusion Engine<br>- Unmanned Aerial |

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|---|---|---|---|
| | | | Vehicles (UAVs)<br>- Communication System and Infrared Camera<br>- INACHUS Robot<br>- Electronic Nose-Gas Detector (E-nose)<br>- Real-Time Locating System (RTLS)<br>- Portal & mobile application for search & rescue operations<br>- (S&R-ESS)<br>- Common Operational Picture (COP) with Environment Services |
| DRIVER - Driving Innovation in crisis management for European Resilience<br><br>https://www.driver-project.eu/ | 2014-2020 | - Develop a pan-European Test-bed for crisis management capability<br>- Development<br>- Develop a well-balanced comprehensive portfolio of crisis management solutions<br>- Facilitate a shared understanding of crisis management across Europe. | |
| C2-SENSE - Interoperability Profiles for Command/Control Systems and Sensor Systems in Emergency Management<br><br>https://c2-sense.eu/ | 2014-2017 | - Develop a profile-based Emergency Interoperability Framework by the use of existing standards and semantically enriched Web services<br>- Expose the functionalities of C2<br>- Systems, Sensor Systems and other | - C2-SENSE profile |

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|---|---|---|---|
| | | emergency/crisis management systems<br>- Assess its outcomes in a realistic "Flood Scenario in Italy" pilot to ensure that the developed technologies are generic and applicable in a real-life setting. | |
| SAFESENS - Sensor technologies enhanced safety and security of buildings and its occupants<br><br>http://eniac-safesens.eu/ | 2014-2017 | - Develop co-integration of gas sensor and presence detection technologies<br>- Enhance safety and security of buildings and its occupants<br>- Develop different technological building blocks<br>- Exceed the performance of state-of-the-art devices at the level of form factor, power consumption and reliability (specificity in case of gas detection). | - Gas sensor<br>- Presence detection technologies<br>- New gas detectors that are wearable and localisable |
| EXPEDIA - Explosives Precursor Defeat by Inhibitor Additives<br><br>https://cordis.europa.eu/project/id/604987 | 2014- 2018 | - Create a European guide for first responders with basic instructions on how to interpret findings on a crime scene when suspected bomb factories have been encountered. | - Mobile application |
| HYRESPONSE - European Hydrogen Emergency Response training programme for First Responders<br><br>https://hydrogeneurope.eu/project/hyresponse | 2013-2016 | - Establish the World's first comprehensive training programme for first responders<br>- Facilitate safer deployment of FCH systems and infrastructure. | |
| IF REACT - Improved First Responder Ensembles Against CBRN Terrorism<br><br>https://www.prometech.eu/projects/if-react/ | 2012-2014 | - Develop a tool that allows end users and procurement staff to select the best PPE system for the mission of the first responder and the expected threat<br>- Provide added functionality regarding | - Heads-up-display (HUD)<br>- Novel gas mask<br>- One-size-fits-all over-pressured hood with a |

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| | | the C4I needs of the typical wearer<br>- Typical First Responder tactical needs as communication, (indoor) localisation & situational awareness, will be enabled by affordable, robust and easy to use technology. | head cooling system<br>- Skin protection with air permeable Saratoga technology<br>- 3G bubble<br>- A suit-integrated camera system |
| DITSEF - Digital and Innovative Technologies for Security and Efficiency of First Responders operation<br><br>https://cordis.europa.eu/project/id/225404 | 2010-2013 | - Increase the effectiveness and safety of First Responders by optimal information gathering and sharing with their higher command levels | - Network of sensors, localisation and communication systems<br>- Indoor localisation, wireless communication, human interfaces, sensor equipment<br>- All these technologies were integrated into an easy-to-use wearable system for every FR |
| NMFRDISASTER - Identifying the Needs of Medical First Responder in Disasters<br><br>https://cordis.europa.eu/project/id/218057 | 2008-2009 | Identify need for further research in<br>- Training methodology and technology used to train medical first responders for disasters<br>- Understanding the human impact of disaster on first responders<br>- Ethical and legal issues influencing the medical response to disasters<br>- Personal Protective equipment used in Chemical and Biological incidents<br>- Use of blood and blood products in disasters | - |

### 4.3.2 Technologies Developed within European Projects for First Responders

#### *4.3.2.1 Augmented Reality/ Virtual reality/ Mixed Reality Applications*

These technologies are used within many projects: Augmented Reality, Virtual Reality and Mixed Reality are integrated with the developed systems and platforms.

- Augmented Reality (AR) combines virtual reality with reality.
- Virtual Reality (VR) is a computer-generated environment with scenes and objects that appear to be real, making the user feel they are immersed in their surroundings.
- Mixed Reality (MR) refers to the merging of real and virtual worlds to produce new environments and visualisations, where physical and digital objects co-exist and interact in real time.

**Table 4-9: AR/VR/MR Applications**

| Device | Scope & Key functionalities | Sensor type |
|---|---|---|
| K9 Behaviour Recognition- explained in FASTER<br><br>https://www.faster-project.eu/tech/ | - Capture and transmit in real time motion signals and situational status of K9s<br>- Extract valuable information about K9 behaviour and translate it to specific messages that can be transmitted wirelessly through IoT communication protocols to first responders | - 3-axis accelerometer<br>- Gyroscope |
| I-REACT Wearable<br><br>https://www.i-react.eu/ | - Coordinate missions and avoid accidents due to imprecise information<br>- Warn when levels of oxygen are low | - EGNOS/EDAS positioning system connected to Galileo satellite<br>- Oxigen sensor |
| Head-Up Display for First Responders<br><br>https://www.prometech.eu/products/head-up-display-for-first-responders/ | - Aimed at CBRN specialists operating in and around the hotzone | - Radiological sensor |

| | | |
|---|---|---|
| AR Glasses- I-REACT<br><br>https://www.i-react.eu/ | - Easily fit into different kinds of helmets<br>- Grant a direct connection with the control room<br>- Visualises real<br>- time maps, reports or pictures taken from drones<br>- Sens reports and communicate with the control room without using hands | - Not available |
| Hololens<br><br>https://www.microsoft.com/it-it/hololens<br><br>https://docs.microsoft.com/en-us/hololens/hololens1-hardware<br>**not specific for a project, but usually employed in many projects* | - Redefines personal computing through holographic experiences to empower you in new ways<br>- Blends cutting-edge optics and sensors to deliver 3D holograms pinned to the real world | - Inertial measurement unit (IMU)<br>- Environment understanding cameras<br>- depth camera<br>- 2MP photo / HD video camera<br>- Mixed reality capture<br>- Microphones<br>- Ambient light sensor |

#### *4.3.2.2 Platforms*

**Table 4-10: Platforms for FR**

| Device | Scope & Key functionalities | Characteristics |
|---|---|---|
| IN-PREP Platform<br><br>https://www.in-prep.eu/ | - Enhance collaboration between first responders, crisis managers and civil protection agencies through the development of a novel IT training platform, the Mixed Reality Preparedness Platform (MRPP)<br>- Enable interagency training for the entire chain of command.<br>- In a training session, a simulated crisis is created and merged into the real world. | - Decision support capabilities with built-in situational awareness<br>- Resource allocation in real time<br>- Rapid remote sensing for quicker response actions<br>- Large scale evacuation simulation<br>- Coordinated C2/C3 systems<br>- Vulnerability and Risk assessment<br>- |
| INACHUS Communication Platform<br><br>https://i-sense.iccs.gr/<br><br>https://www.inachus.eu/ | - Manage the seamless interoperation, the interconnection between other networks (cellular, etc.) abd | - Real-Time Localisation System (RTLS)<br>- mobile gateways<br>- wireless communication<br>- Delay Tolerant Network (DTN) |

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|---|---|---|
| | provides redundancy and recovery functionality<br>- The gateways support the functionality of any other mobile USAR center as an alternative and cost-effective solution in an integrated ad-hoc manner but with redundancy, extendibility, and security capabilities to assure robustness, flexibility and reliability | - LWIR camera |
| Intrepid Platform<br><br>https://cordis.europa.eu/project/id/883345 | - 3D exploration<br>- Analysis of disaster zones<br>- Intelligence amplification<br>- Extended reality concepts<br>- Smart cybernetic assistants<br>- Deep indoor networking<br>- Positioning capabilities | - Developing |

*4.3.2.3 Drones*

**Table 4-11: Drones**

| Device | Scope & Key functionalities | Sensor type |
|---|---|---|
| UAV- Type<br><br>**UAV Drone are usually employed in many projects. In this box its main general characteristics are reported*<br><br>Cost variable according to brand and characteristics | - Military aircraft operated without a pilot that can be reused | - Inertial Measurement Units (IMUs)<br>- GPS/GNSS<br>- Light Detection and Ranging (LiDAR) |
| UAV by ONERA- INACHUS<br><br>https://www.onera.fr/fr<br><br>https://www.inachus.eu/ | - 3D mapping system on UAV is its ability to accurately capture geometry in poorly lit areas, through narrow passages or through vegetation where the performance of image-based techniques is lower.<br>- The embedded LIDAR can also collect high-resolution 3D data even in low visibility or bad weather conditions (haze, fog, rain or snow) | - 3D laser scanners<br>- 3D data |
| Alpha 800 UAV<br><br>https://alphaunmannedsystems.com/alpha-800-uav/ | - 2.5 hours endurance<br>- 3 Kg of payload capacity<br>- Up to 30 Km range<br>- On-board alternator/generator<br>- Redundant power supply<br>- High variety of payloads available and integrated<br>- All on board electronics are IP64 or higher rated<br>- Patent pending technologies<br>- | - IMU (inertial measurement unit)<br>- ADS (air data system<br>- IAS<br>- GPS<br>- PFD (Primary Flight Display) |

| | | |
|---|---|---|
| UVA Q800X<br><br>https://www.aeraccess-group.com/product/outdoor/hawker-q800x.html | - Provide first responders quick assessment of the situation | - EOIR payloads<br>- IMSI Catcher<br>- loud speakers<br>- Laser illuminators<br>- MIRION Spir Explorer |
| Mothership Drone- CURSOR<br>https://www.youtube.com/watch?v=6LF4eg_rl3Q&feature=emb_logo<br>https://www.cursor-project.eu/ | - Central drone of CURSOR system<br>- Provide communication between Robot (SMURF), Drone System and FRs | - Zoom videocamera |
| Transport Drone- CURSOR<br>https://www.youtube.com/watch?v=6LF4eg_rl3Q&feature=emb_logo<br>https://www.cursor-project.eu/ | - Transport Robot (SMURF) to the disaster center<br>- Increase the safety of FRs | - Not available |
| Ground Penetrating Radar Drone- CURSOR<br>https://www.youtube.com/watch?v=6LF4eg_rl3Q&feature=emb_logo<br>https://www.cursor-project.eu/ | - Scan the disaster site to detect any track of victims | - GPA sensor |
| 3D Modelling Drones<br>https://www.youtube.com/watch?v=6LF4eg_rl3Q&feature=emb_logo<br>https://www.cursor-project.eu/ | - The swarm takes pictures and provides with3D model of the area | - Not available |

#### *4.3.2.4 Mobile Phones and Applications*

**Table 4-12: Mobile Phones and Applications**

| Device | Scope & Key functionalities | Characteristics |
|---|---|---|
| I-REACT mobile app<br>Android-iOS<br>https://www.i-react.eu/ | - Allow both citizens and professionals to report emergencies | - Take a pic of the situation<br>- Select the type of hazard<br>- Add information<br>- Send the report<br>- All the reports will be gathered to generate real-time risk maps |
| EXPEDIA App<br><br>https://cordis.europa.eu/project/id/604987 | - European guide for first responders with basic instructions on how to interpret findings on a crime scene when suspected bomb factories have been encountered | - Not available |
| GO Phones- CURSOR<br>https://www.cursor-project.eu/ | - Inn/ovative wireless phones producing noises when tracking and rescuing people | - Not available |

#### *4.3.2.5 Robots*

**Table 4-13: Robots**

| Device | Scope & Key functionalities | Sensor type |
|---|---|---|
| INACHUS robot<br>https://www.sintef.no/<br>https://www.inachus.eu/ | - Snake-like robot prototype designed and manufactured to help USAR teams finding and communicating with victims under a collapsed building<br>- The robot is remotely controlled by a rugged tablet PC and an operator can drive the robot under the rubble by entering through small holes (20cm x 20cm of cross-section)<br>- The robot is able to estimate its position based on a real-time locating system<br>- A two-way audio communication system is available to allow the rescuers to communicate with the victims under the rubble RTLS determine the absolute (GPS coordinates) and relative (local coordinates relative to a defined reference system) location of the INACHUS robot head module under the rubble | - Two video cameras<br>- Radar<br>- electronic nose<br>- infrared camera<br>- Real-Time Locating System (RTLS) by IK4-Tekniker<br>- |
| SMURF- Soft Miniaturised Underground Robotic Founder- CURSOR<br>https://www.cursor-project.eu/ | - Detect the location of victims<br>- Communicate with victims | - Sensor to detect humans<br>- |
| StickRadar<br>https://cinside.se/<br>https://www.foi.se/<br>https://www.inachus.eu/ | - Crawl into the rubble and get closer to the trapped victims, increasing the chance to find deeply buried humans and save more lives. The robot radar detects movements in five directions around the robot body. This gives a good direction estimation to the detected movement. | - Not available |

#### *4.3.2.6 Chemical Sensors*

**Table 4-14: Chemical Sensors**

| Device | Scope & Key functionalities | Sensor type |
|---|---|---|
| INACHUS robot<br>https://www.sintef.no/<br>https://www.inachus.eu/ | - Snake-like robot prototype designed and manufactured to help USAR teams finding and communicating with victims under a collapsed building<br>- The robot is remotely controlled by a rugged tablet PC and an operator can drive the robot under the rubble by entering | - Two video cameras<br>- Radar<br>- electronic nose<br>- infrared camera<br>- Real-Time Locating System (RTLS) by IK4-Tekniker<br>- |

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|---|---|---|
| | through small holes (20cm x 20cm of cross-section)<br>- The robot is able to estimate its position based on a real-time locating system<br>- A two-way audio communication system is available to allow the rescuers to communicate with the victims under the rubble RTLS determine the absolute (GPS coordinates) and relative (local coordinates relative to a defined reference system) location of the INACHUS robot head module under the rubble | |
| SMURF- Soft Miniaturised Underground Robotic Founder- CURSOR<br>https://www.cursor-project.eu/ | - Detect the location of victims<br>- Communicate with victims | - Sensor to detect humans<br>- |
| StickRadar<br>https://cinside.se/<br>https://www.foi.se/<br>https://www.inachus.eu/ | - Crawl into the rubble and get closer to the trapped victims, increasing the chance to find deeply buried humans and save more lives. The robot radar detects movements in five directions around the robot body. This gives a good direction estimation to the detected movement. | - Not available |

#### *4.3.2.7 Information, Communication and Localisation Systems*

**Table 4-15: Information, Communication and Localisation Systems**

| Device | Scope & Key functionalities | Characteristics |
|---|---|---|
| 5G wireless communication | - Files can be downloaded (even movies) within seconds.<br>- Pages will upload almost instantly<br>- Can play easily online games.<br>- Finest Quality of Service (QoS).<br>- All Networks can be gathered on a platform.<br>- Easily support previous generations.<br>- No limitation as user demands.<br>- | - 5G devices are comparatively less expensive than 3G and 4G devices<br>- Using 5G the battery runs out very fast.<br>- New deployments of 5G can be connected directly with The Mastercore by 5G -IU (5G Interfacing Unit) without All IP concept.<br>- Ability to support the new services<br>- |

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|---|---|---|
| Ground-Based Seismic Sensor system (GBSS)<br>https://www.foi.se/<br>https://www.inachus.eu/ | - Detect and locate knocking signals from victims trapped in debris heaps<br>- Detect and locate knocking signals even in noisy environments<br>- Detected signals are visualised on a map to help the USAR team quickly and accurately understand where the signal is coming from and to share information with other teams | - Vibration-sensitive sensors connected to a signal processing unit |
| SurfaceRadar<br>https://cinside.se/<br>https://www.foi.se/<br>https://www.inachus.eu/ | - Search for survivors from disaster<br>- Enhance the high range resolution of an impulse UWB radar, with beamforming to get better location information of the target | - UWB beam steering radar |
| Mobile Phone Detector<br>https://www.diginext.fr/en/<br>https://www.inachus.eu/ | - Find trapped victims is debris heaps<br>- Survey the local environment for mobile devices to help determine possible victim locations | - Not available |
| C2-Sense Profile<br>https://c2-sense.eu/ | - Make the organisations cooperate through interoperability<br>- Acquisition and sharing of information<br>- Simplicity and immediacy<br>- Availability of communication technologies<br>- Useful support for the human operator | - Not available |
| Prometech Tag & Trace system<br>https://www.prometech.eu/projects/if-react/ | - track persons and objects for use in a wide range of security related applications<br>- Specifically designed for use by the first | - NFC technology |

| | | |
|---|---|---|
| | responders community and emergency management personnel. | |
| Incident Management System<br>https://www.prometech.eu/products/incident-management-system/ | - The main purpose of the REACT platform is to improve situational awareness by, firstly, using innovative techniques to visualise information and, secondly, providing the necessary tools and functionality to introduce relevant data from a range of different sources into the system | - Geographical information system (GIS) |

# 5 Application Layer

## 5.1 Components

Building block for S&R solution are presented in this section

### 5.1.1 Multisensory Interface

This component will act as main interface to all sensors data. It is an abstraction to all sensors raw and structured data. At same time this is the main input for all sensors data, trying to abstract different data formats that came for different sensors types.
This component is the main feeder to Data lake ecosystem.

### 5.1.2 External Data Interface

In order to access external data S&R system must create a common interface for accessing incident data or other legacy system

### 5.1.3 Data Buss ESB

This is the main integration component for S&R system. On this data buss all kind of entities are passed between different components or storage.

### 5.1.4 Interface to Incidents Database

This component play abstraction role for interfacing with different incidents databases. In order to have a common path for information from different incidents databases this component define a standard interface implementing in same time gateways to incidents databases that have different data structures.

### 5.1.5 Incidents Data

Storage for common incident data structures

### 5.1.6 Interface to Legacy Systems

This component play abstraction role for interfacing with legacy systems. In order to have a common path for information from different legacy data this component defines a standard interface by implementing in same time gateways to legacy databases that have different data structures.

### 5.1.7 Legacy Data

Storage for common legacy data structures

### 5.1.8 S&R Operational Data

This component play abstraction role for creating a common interface to S&R operational data. This interface is used by all S&R components as gateway to operational data structures.

### 5.1.9 Operational Database

In this component we will store all required data that will be used in S&R system.

### 5.1.10 Annotated Data

In annotated data component S&R store and retrieve annotated data that came from different sensors or other sources. Annotated data is the result of interpreting and transform raw sensor data in structured text (i.e. image interpretation and decomposed in text describing objects, interpreted medical data from wearable)

### 5.1.11 S&R Metadata

S&R metadata component is used for storage and retrieval of metadata, i.e. information that add contextual information (time, position, altitude, etc) to raw sensors data and annotated data.

### 5.1.12 Reporting Service

Reporting Service module will offer user on-demand and predefined reports (After-Action, Situational) from available operational data.

### 5.1.13 Decision Support System (DSS module)

Using different sets of data, metadata and annotated data this module will provide users specific information that will help decision making process in crisis situations, helping command and control operators to understand situation context and providing solutions for different tactical activities based not only on real time data, but also on historical information available from incidents databases and legacy systems.

### 5.1.14 Situational Analysis & Impact Assessment

The 3D Mixed Reality Command Centre will support decision makers and propose tactical actions. The 3D MR CC based on line S&R data will help end users with impact assessment in order to plan effective response with the support of the DSS. This component will visualise damages and needs through mobile applications, UAV and robot cameras, sensors, social media and crowd-sourcing and by integrating information from different agencies and dimensions in the same spatial coordinate system.

### 5.1.15 Data Lake Ecosystem

This virtual component is a set of all other data storage components:

- Incidents data
- Legacy data
- S&R operational data
- Annotated data
- Metadata

## 5.2 System Collaboration

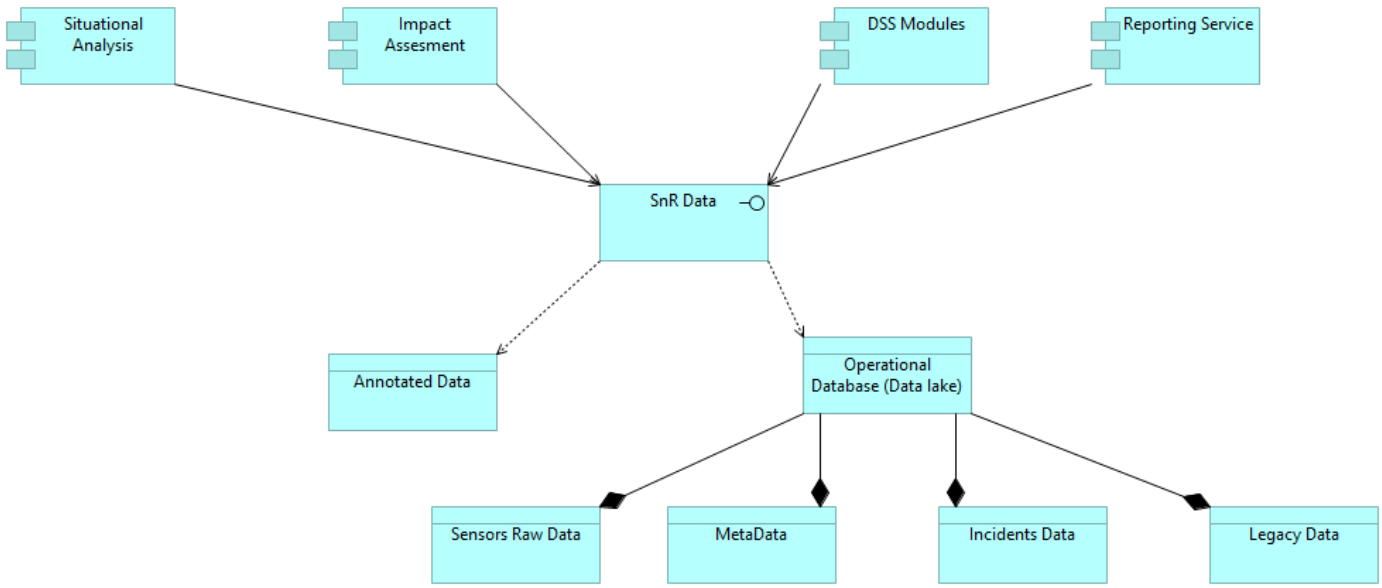


**Figure 5-1: S&R Data Interface**

In Figure 5-1: S&R Data Interface we represent the main data interface to operational database and interaction with major functional components, the core of S&R Analysis and Decision Support services.

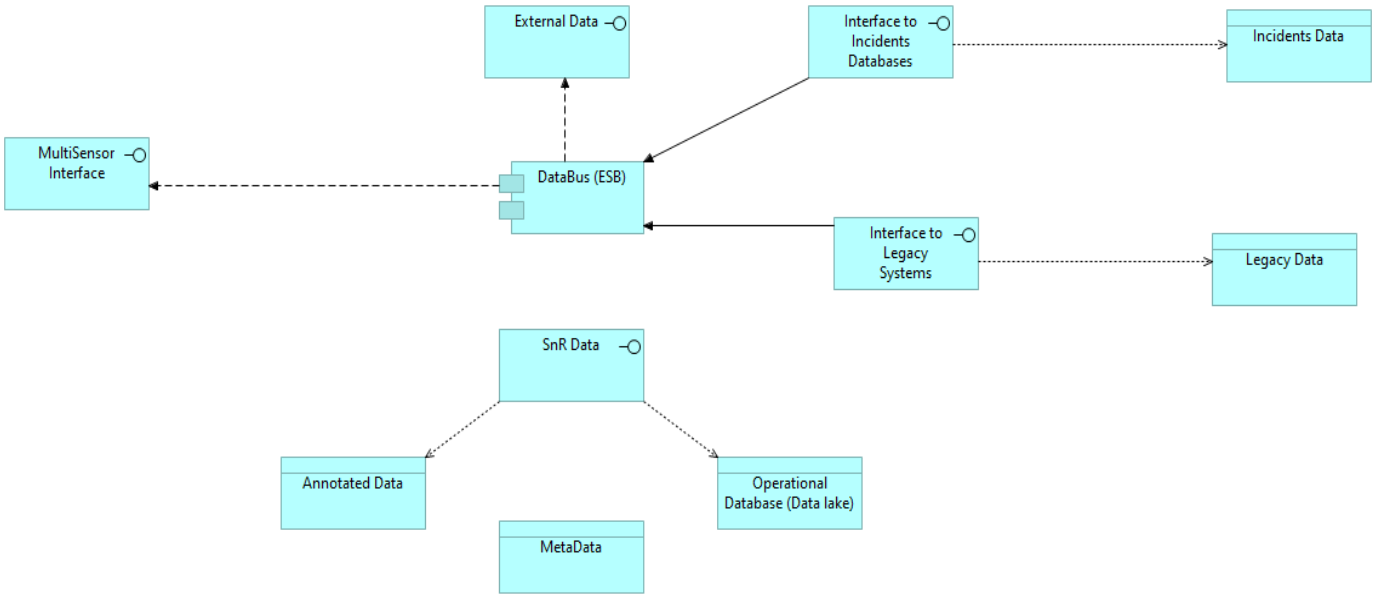


**Figure 5-2: S&R Interface to External Systems**

S&R System will be interfaced with external incidents databases and legacy systems already in place at end users.
In order to have a coherent interface S&R design will abstract different data structures and will define a common external data interface for interactions with own components.

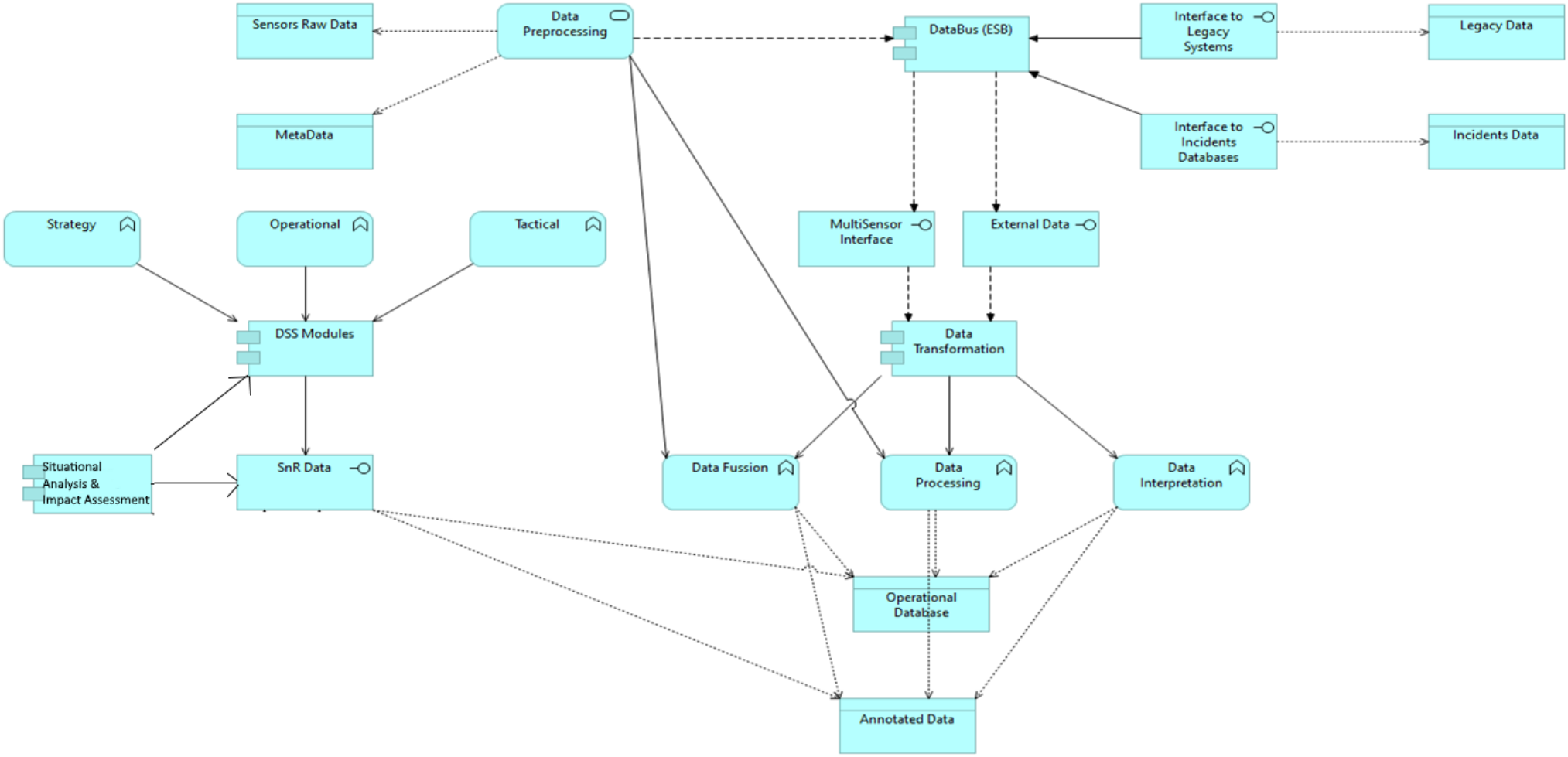


**Figure 5-3: Main S&R Module Interactions**

In the Figure 5-3 is shown a summary of module interaction between major S&R system components. Main data sources are sensors with their raw data, end-users legacy systems available and incident database information. Data Buss (ESB) will provide a common path for informational feeding of S&R. Standard abstraction interfaces for raw sensor data and external data will provide a common approach for data acquisition.
Data services – fusion, transformation and processing – interpret and prepare information for all core analysis and decision support components (Strategy, Operational, Tactical, Impact Assessment, and Situational Analysis).

## 5.3 Data Flows

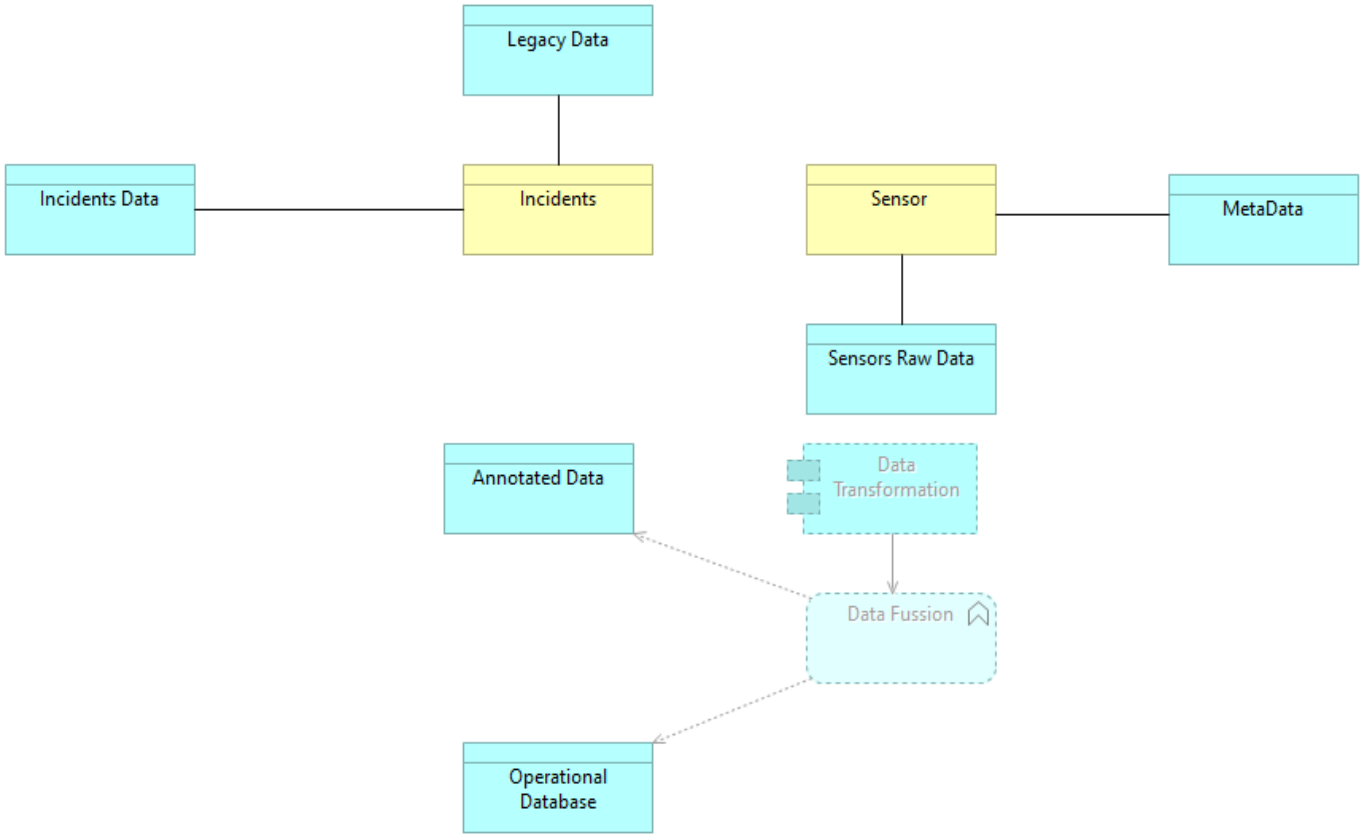


**Figure 5-4: S&R Major Entities (Data Lake Ecosystem)**

In the Figure 5-4 we try to represent the main informational entities sources and S&R storage – Data lake ecosystem and data plus service interoperability frameworks.

# 6 Operational View

In this section we will detail operational view of the architecture from the field activities point of view. Main views on this chapter are:

- Operational data flows
- Operational activities
-

## 6.1 Operational Data Flows

In the monitoring of the field operations, main data came from:

- Incident information
- Field sensors
- Voice communications

Next, Figure 6-1 presents the main data flows in the operational context.

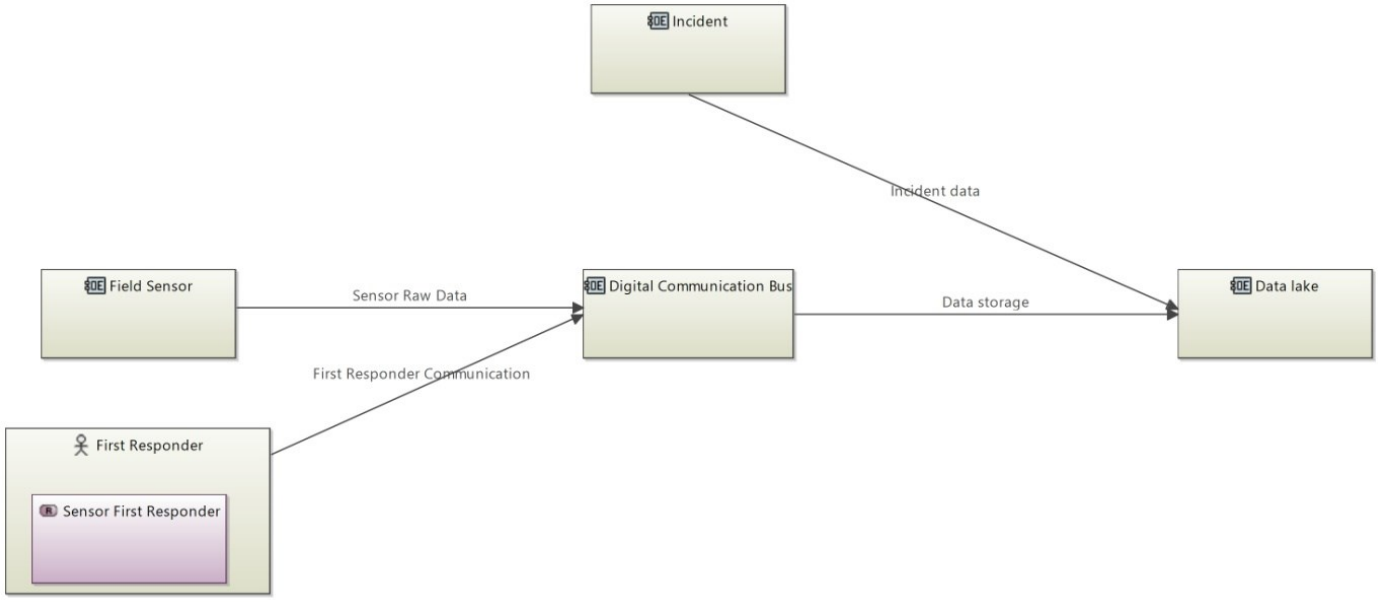


**Figure 6-1: Operational Data Main Flow**

As separate data flows, which are not processed in real time by S&R system, we have:

- Incidents historical data
- Interfaces with external related entities
- Communication channels
    - External (Hospitals, Urgency)
    - Mission

Next, Figure 6-2 shows "static" operational data flows.

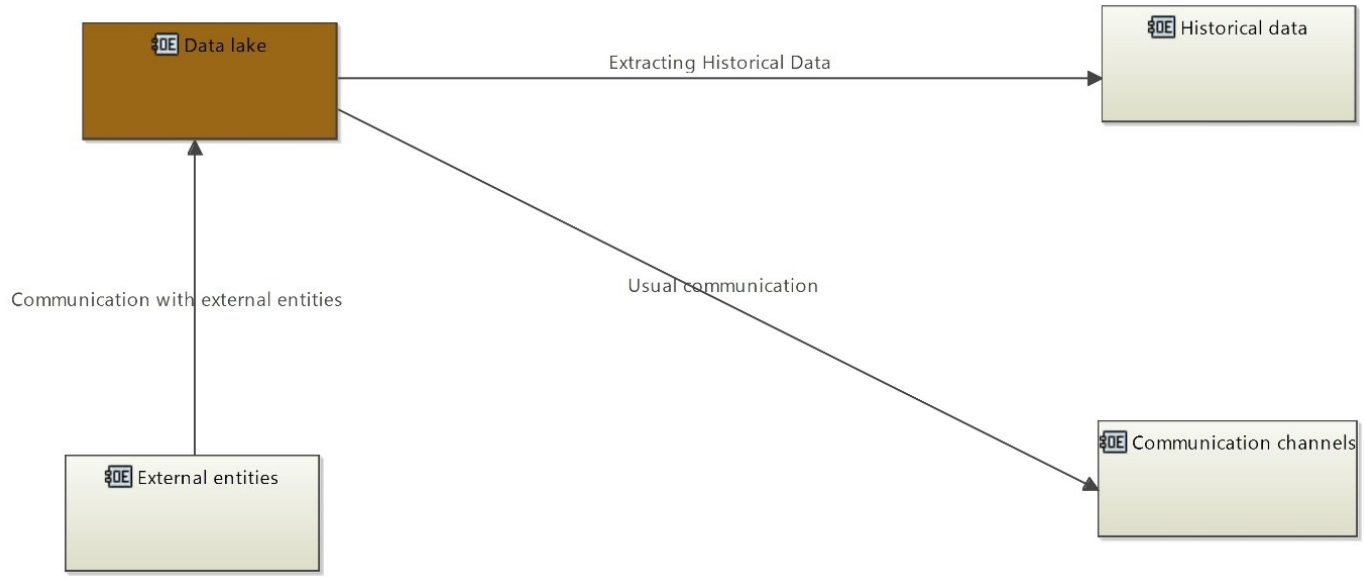


**Figure 6-2: Secondary Data Flows**

## 6.2 Operational Activities

On the field activities, from operational point of view, S&R system is dedicated to first responders' support – the real time reaction – having at same time support for some auxiliary and logistic processes.
Next, Figure 6-3 shows the main operational activities in the S&R context.

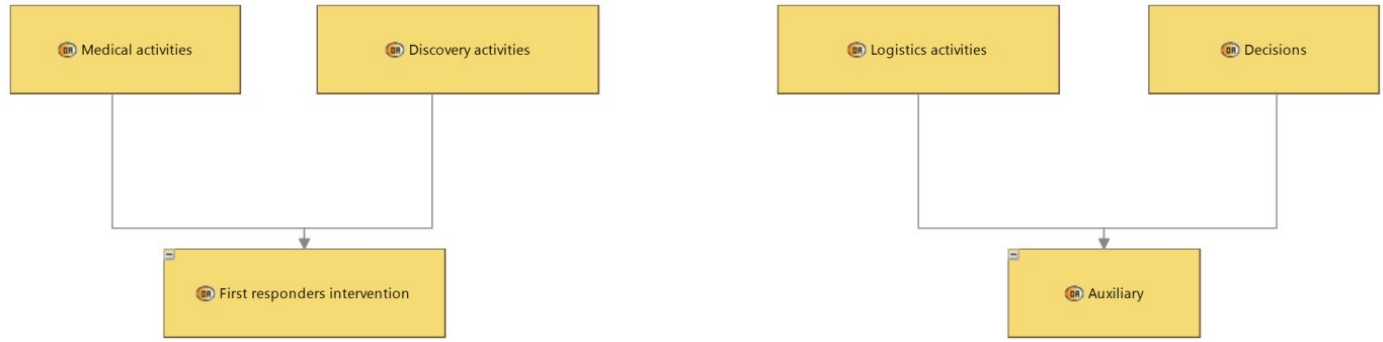


**Figure 6-3: Main Operational Activities**

As a summary in S&R context the main operational activities context are on:

- On emergency field
- Command and control
- Decision support

In the Figure 6-4, relations between these activities and related components of these building blocks are presented.

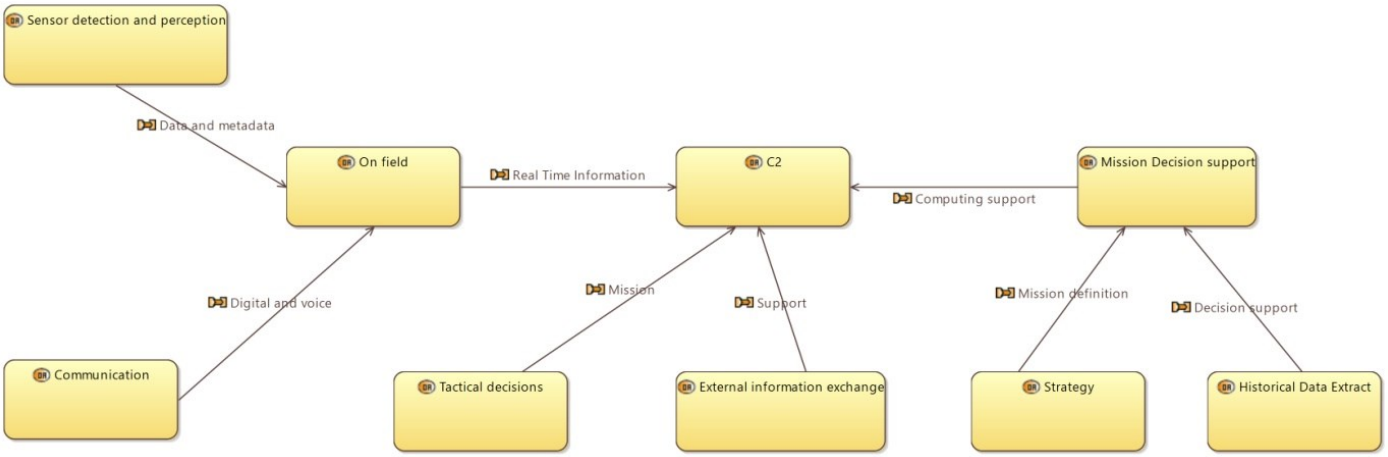


**Figure 6-4: Operational Activities Context**

## 6.3 S&R System View

The main system components of the S&R are:

- Field entities – sensors
  - Human/canine first responders
  - Autonomous devices
- S&R integration platform
- S&R interoperability frameworks
- Data lake
- External systems

Figure 6-5 shows main collaborations between these components.

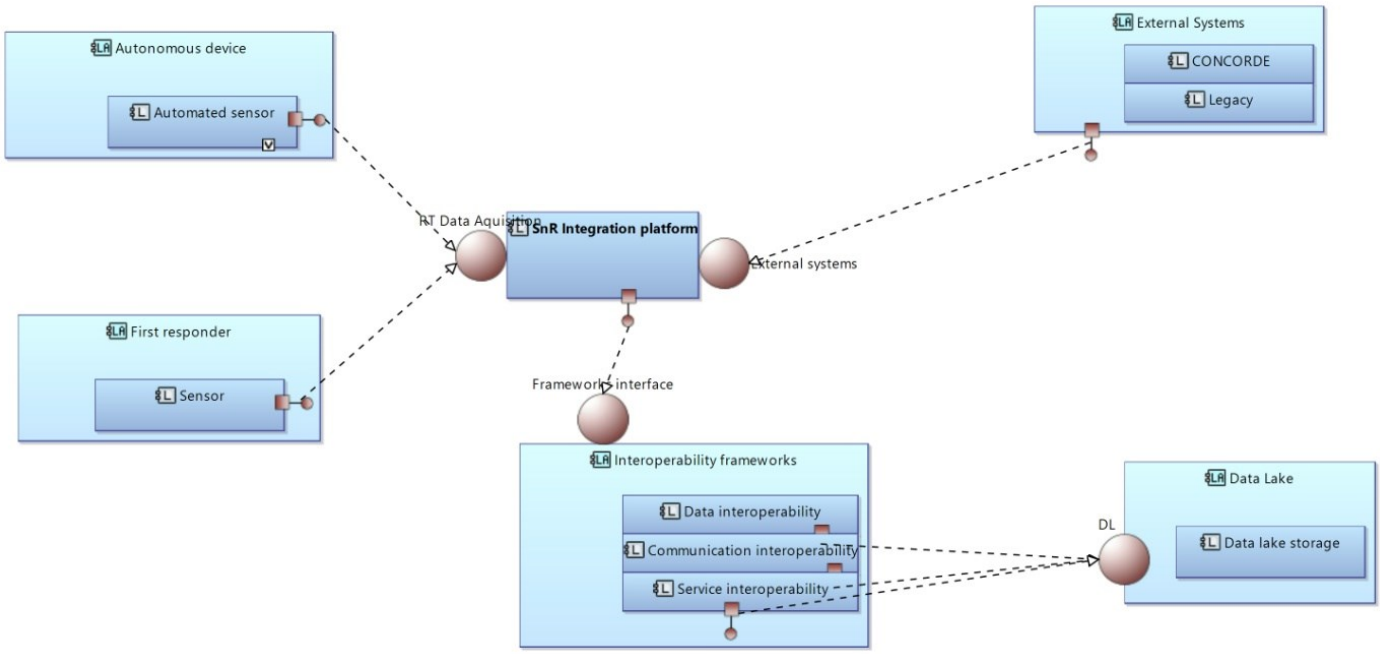


**Figure 6-5: S&R System Components**

For the interoperability framework following diagram shows the high-level design.

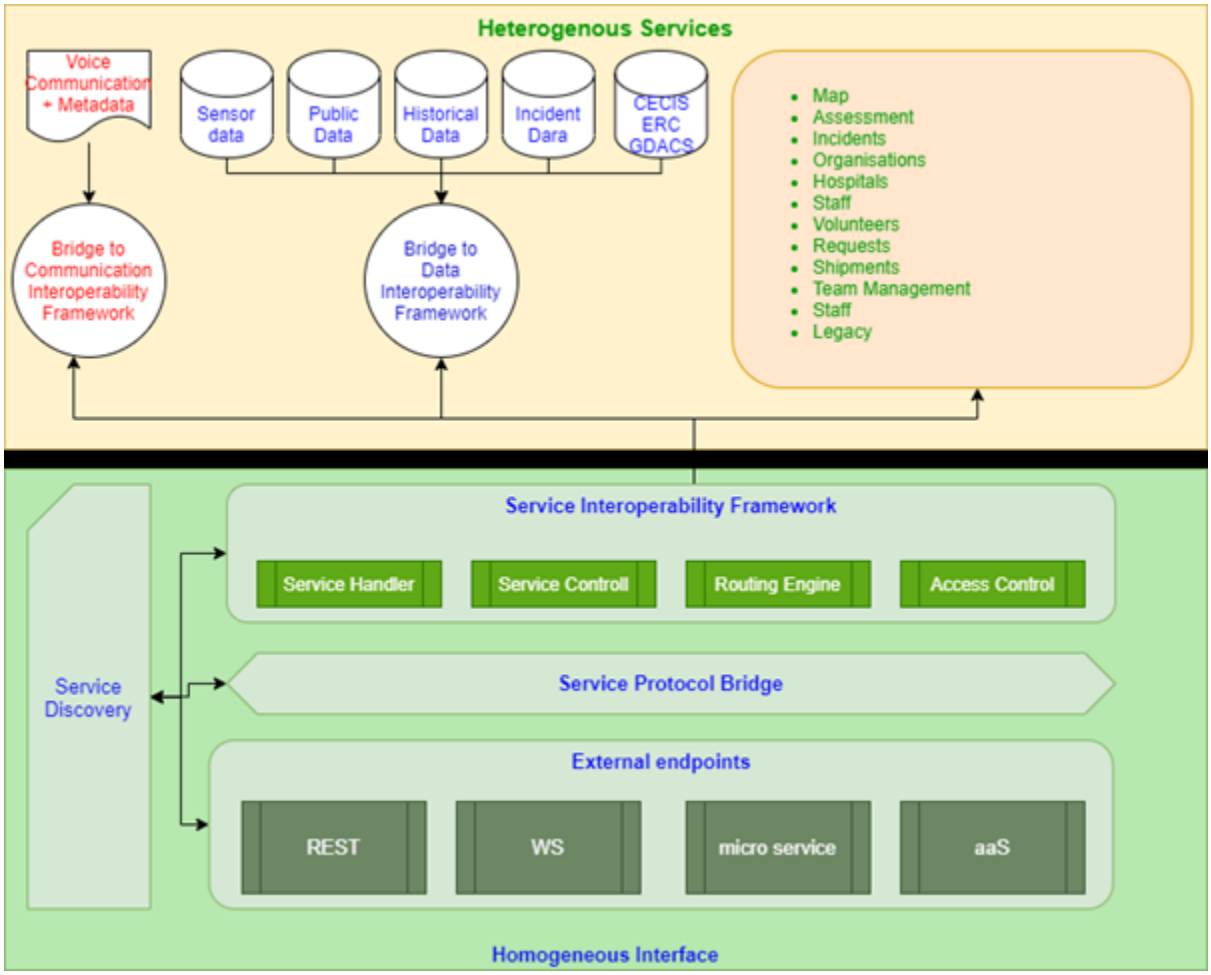


**Figure 6-6: S&R Service Interoperability Framework**

# 7 Technology and Physical View

## 7.1 Physical Nodes and Devices

In next subsections we will present major components from technological and physical view.

### 7.1.1 Sensors/Devices

All sensors (including chemical, nuclear, video, ...) and devices for first responders are represented by this component, at same time being the major source of raw data.

#### *7.1.1.1 Mobile devices*

The smart phones for the volunteers, which will host the volunteer application. This mobile application will be responsible to assign volunteers to regular staff and relief units according to their registration data, personal detail and abilities. Furthermore, this application will track the volunteer's position periodically while he/she is participated in an operation.

### 7.1.2 Data Processing Service

On this module, different operations on data structures are performed:

- Data collection
- Data preparation
- Data input
- Data processing
- Data interpretation
- Data storage

### 7.1.3 Data Fusion

Data fusion will provide functionality for integration of multiple data sources to produce more consistent, accurate, and useful information than provided by any individual data source

### 7.1.4 Data Transformation

Data transformation is the process of converting data from one format to another, typically from the format of a source system into the required format of a destination system.

### 7.1.5 Robot

Architecture representation for robotic platform provided by DFKI, the obstacle avoidance and enhanced situation awareness solution provided by THALIT and drones provided by UHasselt together with the field chemical tool provided by the NTUA

### 7.1.6 UAV

Representation for unmanned aerial vehicles (UAV) mainly having architectural significance as receptor for operator commands.

### 7.1.7 Command and Control (C2) Interface

Using this interface the command and control middleware will send commands to robots and UAV's. Commands source came from Command and control GUI.

### 7.1.8 Network

This component represents data network a mixture of modules for data exchange (video, text, image, location) on each separate level of crisis management (strategic, tactical, operational) and between the different levels, for the proper coordination of actions.

On a strategic level, S&R will provide interfaces to connect to European Civil Protection initiatives, such as the Common Emergency Communication and Information System (CECIS), the European Emergency Response Centre (ERC) and the GDCAS service from the JRC (GDACS XMLv2).

### 7.1.9 Voice Communication Network

Component voice network will be developed taking into account multiple levels of operations (from tactical to strategic level), various administrative levels (from local to EU and International), multiple communications technologies (TETRA, TETRAPOL, VHF, UHF, WiMAX, LTE, Wi-Fi, ad-hoc networks etc.) and various technical solutions developed within past or on-going European projects (DITSEF, HITGATE, ARGOS, ISITEP, PPDR-TC, E-SPONDER, etc.).

### 7.1.10 Data Bus Interface

This component will create a interoperable framework integrating various types of services within a single information router solution will be defined. ESB (Enterprise Service Bus) capabilities will be exploited with respect to Service Oriented Architecture (SOA) and Micro services concepts for event handling and management in crisis situations.

### 7.1.11 Central Processing Units

This a placeholder for S&R system operational hardware that will host major functional components (Situational Analysis, Impact Assessment, Decision Support – Strategy Operational and Tactical, and Reporting) middleware and GUI.

### 7.1.12 Command and Control (C2) Backend Service

Middleware component acting as interpreter and gateway for commands that base operator will send for driving robots and UAV.

### 7.1.13 C2 GUI

Command and control graphical user interface (GUI) is the component that facilitates "driving" of UAV or Robots by central system operators.

## 7.2 Physical Operational Components

Major physical components from S&R ecosystem are:

- Integration Platform
- Data Lake
- External Systems
- Field Sensors

Following diagram show relations between these components.

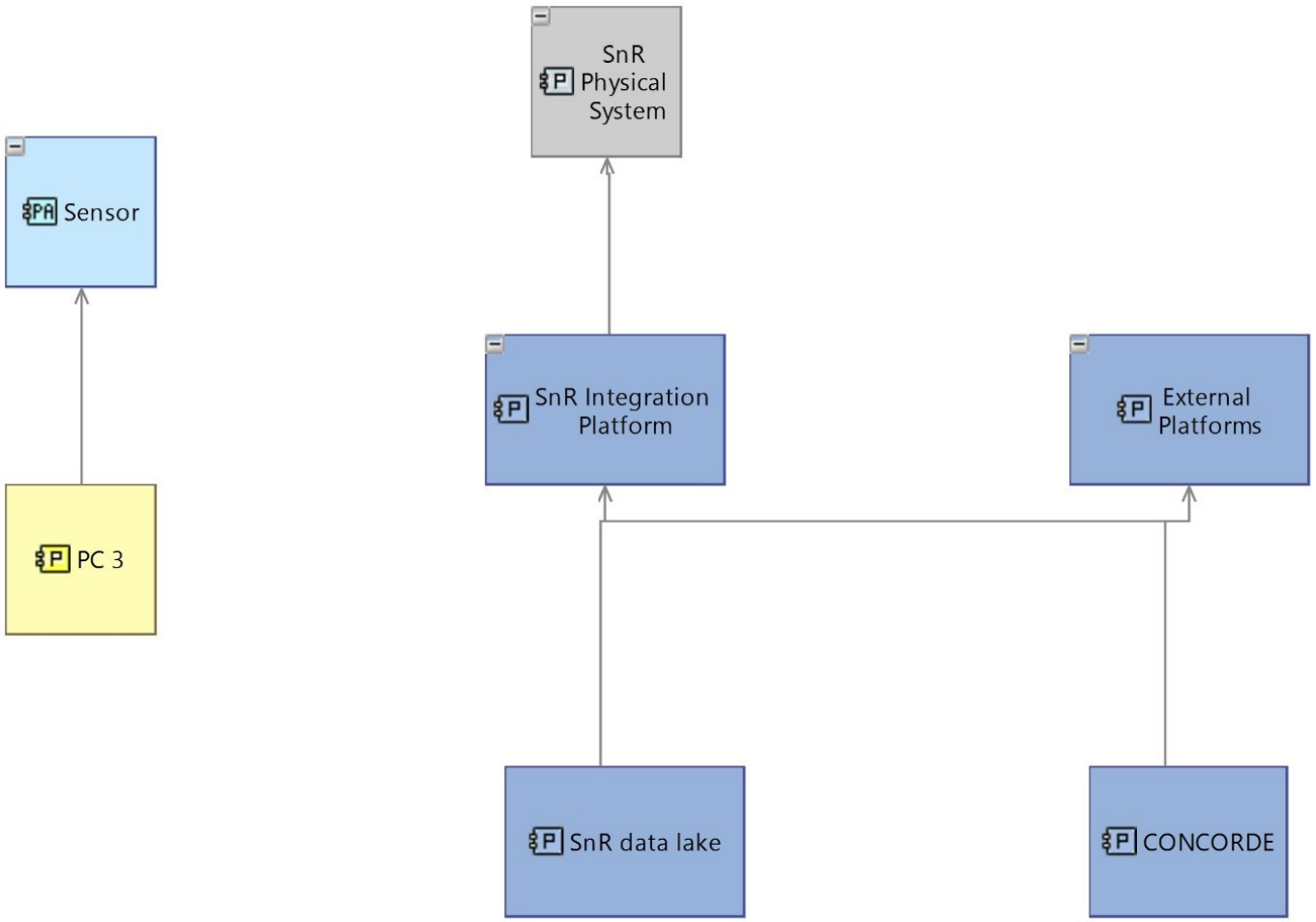


**Figure 7-1: S&R Major Physical Components**

## 7.3 Interactions

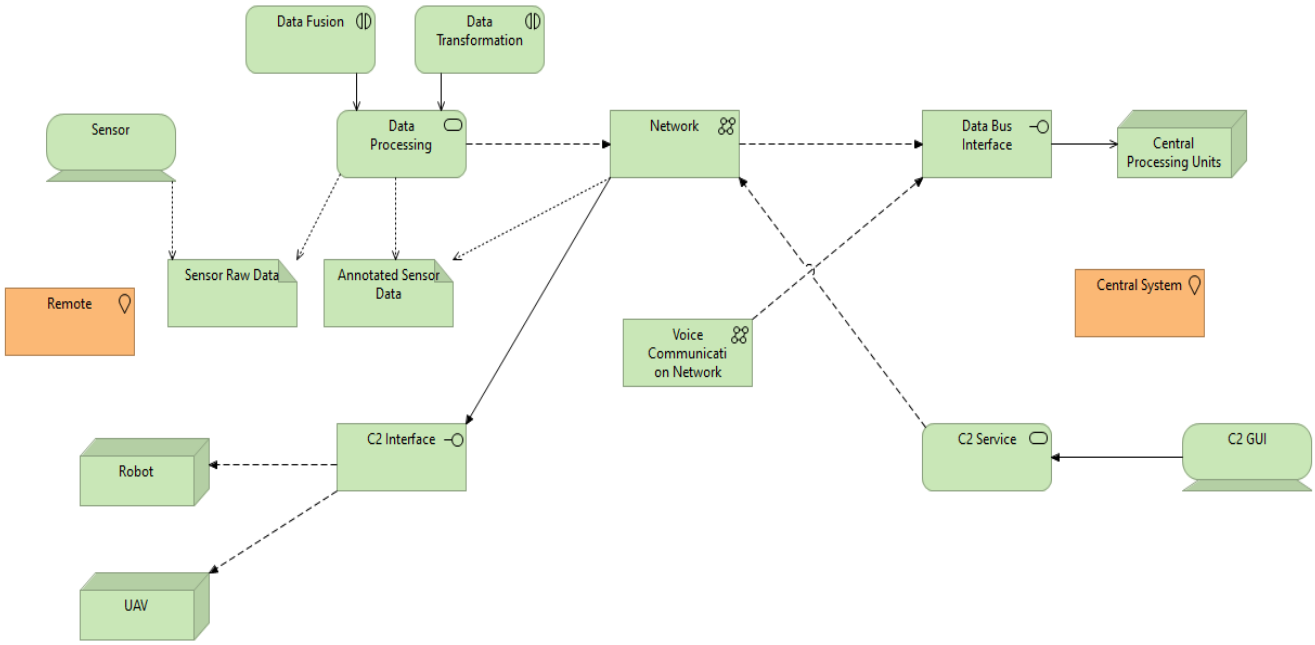

**Figure 7-2: S&R Technology Interactions**

In Figure 7-2, we present technology interactions.
On the left side, field devices and technologies through sensors collect raw data. Some of these sensors are located on robots or UAVs controlled by operators from central system.
Raw sensor data is processed on field devices for interpretation in order to enable special alerts or event triggering.
Data network and voice communication network are the main communication link between field operations and central system.
On central system side, major middleware components that perform functional services and also GUI, security and privacy processes are located.

# 8 Conclusion

## 8.1 Summary

The aim of this deliverable was to support the S&R architecture design and specifications of the integrated platform.

The design architecture of the integrated S&R platform had the aim to facilitate interoperability and interconnectivity with third parties to allow for extensibility whilst preserving a considerable degree of implementation platform independence. Key factors to this objective were the adoption of widely accepted as well as emerging standards, using Open-Source Software in accordance with the Project's needs.

The design has taken account for the different system stakeholders and potential security issues, adopting a structured approach going through the definition of the following steps:

(i) initial "reference model" of the S&R platform;

(ii) design of the components' "functional architecture";

(iii) design of S&R components' "information and communication architectures";

(iv) definition of a common reference architecture for the S&R platform.

## 8.2 Evaluation

Search & Rescue is part of a complex and articulated context: many European projects have dealt with the development of new technologies and solutions for first responders and emergency personnel, and many of them are still ongoing. Having a general but complete overview of the main projects focusing on this issue, with their respective technologies, could be useful to maximise developmental efforts, as well as to create new opportunities for networking and synergies with other projects, which could also be helpful for S&R dissemination.

Knowing the technologies already available within the marketplace could be enriching also for the architecture design and for the implementation of S&R platform. For this reason, an overview of the interested European projects and their technologies will be presented in the following paragraphs.