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)

Search & Rescue

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

D7.2 Architecture and Design Specifications of SnR Platform

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Executive Summary

This deliverable, produced in task 7.2 (Architecture and Design Specifications of SnR) from WP7 (SnR Platform Design, Development and Service Integration) present initial reference architecture for Search and Rescue system. This deliverable scope is to be starting point for future project activities mainly for technical and technological tasks, but also for other task types.

After description of the methodology used in SnR project, Archimate modelling language in general context of Enterprise Architecture best practices, this deliverable present first view of reference architecture.

Reference architecture layers are:

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

This view of architectural layers is mainly based on physical location of devices and technologies at same time decorated 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.

The next version of this deliverable will present final architecture and design of Search and Rescue system.

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1 Introduction

1.1 Overview

One of the main objectives for the Search and Rescue (SnR) 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' capitalising on expertise and technological infrastructure from both CONCORDE and IMPRESS FP7 projects.

As it is stated from the project DoA the aim to create a governance model of SnR to design and operate more effectively and create an architectural structure that allow to easily incorporate next generation R&D and COTS solutions which will be possibly adopted in the future disaster management systems. Based on this our approach in this deliverable is to create 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 develop our "initial" **Reference architecture** that will be the backbone for next technical and technological activities in the project. A final version of the architecture and design will be delivered in **D7.12** - Architecture and Design Specifications of SnR platform, V2 in M22 of the project. Second version will present updated reference architecture and also system design of the solution.

Our architecture activities are mainly included in **WP7** - SNR 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** - ICT Component Design & Development
- **WP8** - SnR Validation and Demonstration

1.2 Relation to other deliverables

This report takes over the outcomes from D1.1 and D1.2 and proposes and architectural framework that accommodates all tools proposed by SnR technology providers. Business, application and technology layers are described in this version of the report

An updated version of this report will be submitted in M22 and will include details about processed and deployment.

1.3 Structure of the deliverable

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

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 SnR reference architectural design

The aim of this section is to provide information about the SnR 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 SnR platform – a layered modular reference architecture is proposed.

An Enterprise Architecture like methodology is applied to describe SnR architectural framework. The building blocks and concepts are represented using ArchiMate®- [1] a standard from Open Group, while the model representation was developed using Archi – Open source Archimate modelling tool version 4.6.0[2].

Moreover, the Open group standards are aligned with the TOGAF framework as depicted in **Error! Reference source not found.**.

ArchiMate® the proposed modelling language for Enterprise architecture is most matches the needs and objectives of SnR 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

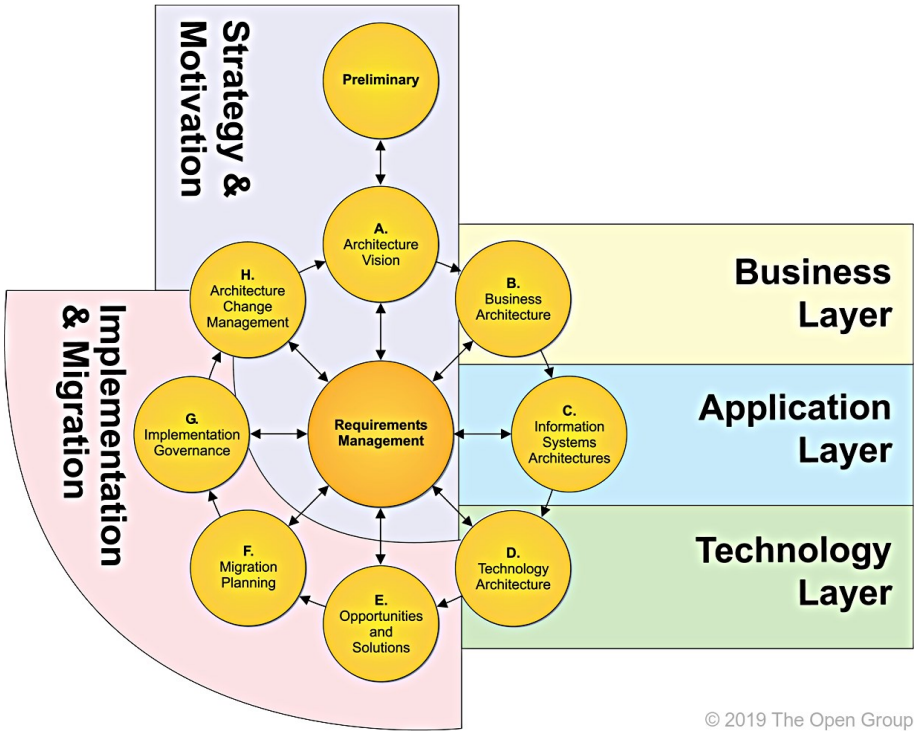

Figure 2-1: ArchiMate 3.0. Layers

[1] https://pubs.opengroup.org/architecture/archimate3-doc

[2] 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) needed to run applications.

In the next sections the above introduced concepts will be described in relationship with the tools proposed within SnR.

3 Search and Rescue reference architecture

The main objective of the Search and Rescue (SnR) is to establish an efficient synchronization framework managing the data, developed services and information flow between the different authorities involved in emergency management operations and the crisis managers (Rescue forces, Police, Fire- department, etc.).

The underlying principle of SnR is that virtually any existing system and technology, could be employed by emergency responding organizations, if there is a need for this.

The proposed SnR 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 in order to 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**: which will fuse the information coming from those heterogeneous sources and will provide a more detailed and accurate situational/context awareness to the decision makers and to the C&C centers. Within SnR the integrated version of CONCORDE EMS offers the particular functionality but other systems may be also used. The SnR 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 portals: which will 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 to develop a single application as a suite of small services that run their own processes that 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.

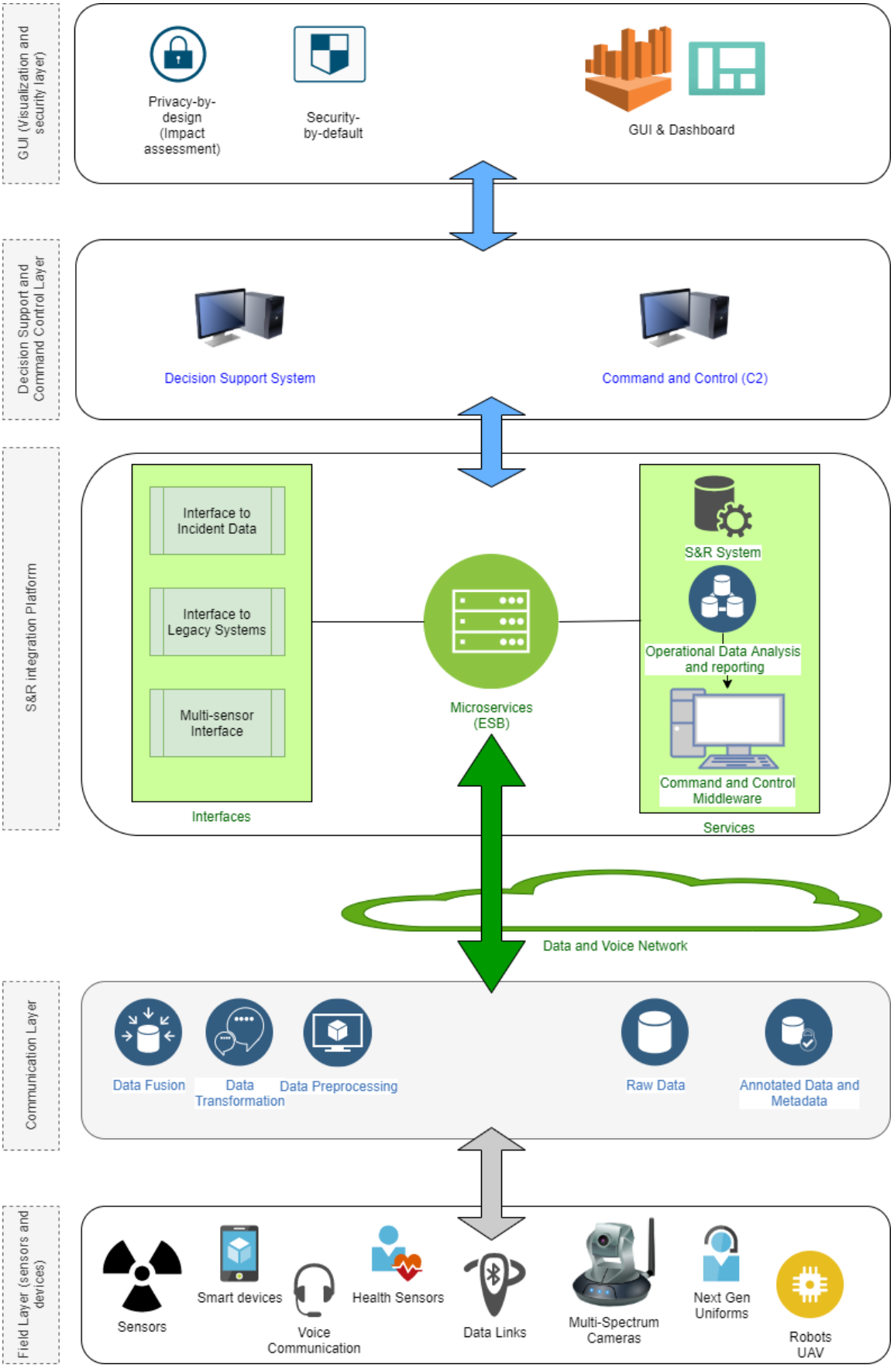

Figure 3-1: SnR Reference Architecture Layers

For the SnR 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:

- SnR 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 GUI and dashboards for user interaction.

At same layer security and privacy by design services are performed.

4 Use Case View

4.1 SnR Use Cases

At the current time following use cases are identified and will be used in pilots, in order to validate SnR platform.

'able 2: S&R underpinning technologies

Module / Service	Before	After	Partner(s) Involved

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'echnologies for first responders SU-DRS02-2019

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

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.

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

Table 4-1: Use Case 1 - Victims trapped under rubble (Italy)

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 SnR solutions (first responder equipment, RPAs/drones, EMS) are expected to allow faster acquisition of the current and future situation, 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 SnR 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	MAG, UniCa, UNIFI, THALIT (See D7.1 Extensive Service Catalogue)
Roles in SnR architecture	• Field Layer • Communication Layer • SnR Integration Platform • Decision Support and C2 Layer • GUI Layer
End-users	CNR
Expected outcomes (operational KPIs)	Time of initial notification call Time until the first ill/injured victim has been triaged in the field Time until the last ill/injured victim has been triaged in the field Time until first treatment was performed Time until victim is evacuated from scene Time until victim arrives to emergency department ED Time to notification of the first appropriate staff person who assumes medical management coordination role Time to arrival of the first EMS ambulance on scene Time to transportation/evacuation of the last ill/injured survivor from the scene Time until first triage assessment in Time until last triage assessment in emergency department Average time spent by victims on the scene Average time spent by victims on ambulances and helicopters Number of victims evacuated from scene Number of victims that receive first triage Number of victims transported to emergency department (first triage)

	Number of victims transported to emergency department

4.1.2 Use Case 2: Plane crash, mountain rescue, non-urban (Greece)

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)

Pilot leader	HRT, Italy
Pilot area description	The pilot will be done in order to test the strategy and tools developed for a specific natural or man-made disaster using the vast experience of the Mountain Rescue department of HRT and by setting the pilot based on previous real cases that have taken place in the past.
Needs and opportunities	The relevant actor that will participate in the demonstration exercise will be decided during 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. The relevant actor that will participate in the demonstration exercise will be decided during the preparation phase of the pilot.
Technology providers & tools involved	NTUA CERTH, UBI (See D7.1 Extensive Service Catalogue)
Roles in SnR architecture	• Field Layer • Communication Layer • SnR Integration Platform • Decision Support and C2 Layer • GUI Layer
End-users	HRT
Expected outcomes (operational KPIs)	• Support the exchange of information between first responders on the field and the Command and Control Centre • How quick is the information flow • How many users can have access to the same information and the same time • Show only relative information to the end user • Classification of information • How a DSS can support media coverage • How a DSS can support handling the relatives of the victims • Off line access • Local network to support dissemination of information among first responders on the field

4.1.3 Use Case 3: Earthquake / heavy storms between Vienna Rail Station & Kufstein railway station heavy damages

In this Use Case communication breaks down because of lack of power supplies. Insecure communication channels have to 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

Pilot leader	JOAFG & JUH (Austria-Germany)
Pilot area description	**Pilot Site 1**: Vienna command centres **Pilot Site 2**: Lower Austria, Tritolwerk (exercising ground)
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 centers that are able to switch between each other to completely take over the others fleet and run the logistics). 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.
Technology providers & tools involved	SYNYO, DFKI, THALIT (See D7.1 Extensive Service Catalogue)
Roles in SnR architecture	• Field Layer • Communication Layer • SnR Integration Platform • GUI Layer
End-users	JOAFG & JUH (Austria-Germany)
Expected outcomes (operational KPIs)	• Establish communication link to the next full capable node train semi-digital handover of data (digital (out)-paper-digital(reading)) • Exchange patient data via patient routine system • Connection with SnR platform

4.1.4 Use Case 4: Forest fire expanded and threat to industrial zone (Attica Region, 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 (Attica Region, Greece)

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 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, 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 SnR 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	NTUA, CERTH, UBI (See D7.1 Extensive Service Catalogue)
Roles in SnR	• Field Layer • Communication Layer

architecture	• SnR Integration Platform
End-users	EPAYPS (Greece)
Expected outcomes (operational KPIs)	• Nb of organisations and users involved • Nb of new requirements recorded • Level of realism of the exercise • Level of effectiveness of the smart glasses • Operation capability of chemical sensors on roving systems or robotic platforms • Effectiveness of the SnR technologies (wearables etc.) • Capability of the local network to support dissemination of information among first responders on the field

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)

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. The facility is well located between various European countries and can be easily accessed. The site can be easily accessed using various means of transportation: • by car: A20 motorway, exit 23. • by train: a station is 200 m (0.1 mi) away —Paris-Toulouse rail-line. • 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 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 areas for a base of operations, a USAR coordination centre (OSOCC) and a medical centre.
Technology providers & tools involved	KT, THALIT, ATOS (See D7.1 Extensive Service Catalogue)
Roles in SnR architecture	• Field Layer • Communication Layer • SnR Integration Platform • Decision Support and C2 Layer • GUI Layer
End-users	PUI France
Expected outcomes (operational KPIs)	• Notification and coordination time • Time for crisis notification call issues by the Operations Centre to reach user's communication devices • Time needed for a user's post (e.g. text, photo) to be transmitted in other user's mobiles • Response Time • Time for rescuer's arrival on scene • Effectiveness in supporting the communication and coordination between first responders on the field and the Operations Centre provided by the tested devices/tools • Effectiveness in monitoring the first responders/volunteers/victims' health vitals • Average time until unaffected persons reach safe assembly points • Total evacuation time for all actors • Average time spent by victims on the scene • 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)

In Romania, the project foresees the involvement of the General Inspectorate for Emergency Situations (IGSU) under which works the National Center for Training for Emergency Management (CNPPMSU) responsible for CBRNe specific training activities in its facilities close to Bucharest (20Km), which are equipped with equipment and qualified personnel for the preparation of the personnel involved in removing the causes and in the planning of post-disaster recovery activities, and establishing the required efforts to recover the effects of man-made and natural threats to be restored as soon as possible.

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)

Pilot leader	PROECO-CBRNE (Romania)
Pilot area description	the involvement of the General Inspectorate for Emergency Situations (IGSU) under which works the National Center for Training for Emergency Management (CNPPMSU) responsible for CBRNe specific training activities in its facilities close to Bucharest (20Km), which are equipped with equipment and qualified personnel for the preparation of the personnel involved in removing the causes and in the planning of post-disaster recovery activities, and establishing the required efforts to recover the effects of man-made and natural threats to be restored as soon as possible.
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	SIMAVI, KT, ATOS (See D7.1 Extensive Service Catalogue)
Roles in SnR architecture	• Field Layer • Communication Layer • SnR Integration Platform • Decision Support and C2 Layer • GUI Layer
End-users	PROECO
Expected outcomes (operational KPIs)	• Notification and coordination time o Time for crisis notification call issues by the Operations Centre to reach user's communication devices o Time needed for a user's post (e.g. text, photo) to be transmitted in other user's mobiles

	• Response time o Time for rescuer's arrival on scene o Time for rescuers to reach the first/last affected/injured person on scene • Effectiveness in supporting the communication and coordination between first responders on the field and the Operations Centre provided by the tested devices/tools • Effectiveness in monitoring the first responders/volunteers/victims' health vitals • Evacuation time o Average time until unaffected persons reach safe assembly points o Total evacuation time for all actors • Average time spent by victims on the scene

4.1.7 Use Case 7: Chemical substances spill (Spain)

This Use Case involves real life simulation of SnR of victims in chemical risk emergency situation.

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.

Table 4-7: Use Case 7 - Chemical substances spill (Spain)

Pilot leader	SERMAS – ESDP (Spain)
Pilot area description	After an accident in a factory derives in chemical spill in a building, threatening the health of the workers of the factory. The Use Case involves real life simulation of SnR 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. The training Camp has the following characteristics: • Collapsed Structures Area: Two zones of 7.500 m2. More than 150 points of concealment. Underground galleries with a length of 240 m. Vertical access. Constructions that simulate collapsed buildings. With structures of five levels and 100 square meters per floor. Special area for shoring props movement of loads and breakage of plates. Landslide area of 4500 square meters • Area of water • Raft of 9.400 m3 with a Depth that in some areas reaches 7 meters • Simulation Accident Area: Surface 12.500 m2 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
Technology providers & tools involved	ATOS, KT (See D7.1 Extensive Service Catalogue)
Roles in SnR architecture	• Field Layer • Communication Layer • SnR Integration Platform • Decision Support and C2 Layer • GUI Layer
End-users	SERMAS – ESDP
Expected outcomes (operational KPIs)	• Notification and coordination time • Time for crisis notification call issues by the Operations Centre to reach user's communication devices • Time needed for a user's post (e.g. text, photo) to be transmitted in other user's mobiles • Response time • Time for rescuer's arrival on scene • Effectiveness in supporting the communication and coordination between first responders on the field and the Operations Centre provided by the tested devices/tools • Effectiveness in monitoring the first responders/volunteers/victims' health vitals • Average time until unaffected persons reach safe assembly points • Total evacuation time for all actors • Average time spent by victims on the scene • Time for rescuers to reach the first/last affected/injured person on scene

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 Triad in information security[3].

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:

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

- **Authentication-** all users will be authenticated using a user name 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:
  - What the user knows – a password
  - What the user has – a token or a key card
  - 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.
- **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 modify. 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 we're mentioning the most important ones:
  - **Encryption -** data is transmitted over the internet is encrypted and can't be read or modified by other people.
  - **Hashing** - this method assures the integrity of data per se, but can't 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 changed 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[4].

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 SnR 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 SnR 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 a 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 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 Firs Responders

Table 4-8: European Projects for First Responders

Project	Year	Purpose	Technology
SIXTHSENSE- Smart integrated extreme environment health monitor with sensory feedback for enhanced situation awareness https://sixthsenseproject.eu/about/	2020-2023 Ongoing project	- Improve the efficiency and safety of first responders' engagement in difficult environments - Optimise on-site team coordination and mission implementation	- Innovative wearable health monitoring system

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

RESPOND-A - Next-generation equipment tools and mission-critical strategies for First Responders https://respond-a-project.eu/	2020-2023 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 - Early Assessment - Safety Assessment - Risk Mitigation	- 5G wireless communications - Augmented and virtual reality or autonomous robots
INTREPID - Intelligent Toolkit for Reconnaissance and assessmEnt in Perilous Incidents https://cordis.europa.eu/project/id/883345	2020-2023 Ongoing project	- Help first responders by providing a platform that will improve the 3D exploration and analysis of disaster zones. - 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 https://cordis.europa.eu/project/id/883484	2020-2023 Ongoing project	- Strengthen the coordination capability of first responders if they work in places where the risk of contamination via water is high - Produce pathogen contamination emergency response technologies, tools and guidelines to be validated by first responders - 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 https://assistance-project.eu/	2019-2022 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) - Enhance their capabilities and skills for facing complex situations related to different types of incidents	- UAVs - Smart wearable sensors - Robots and drones' swarms equipped with specific sensors - SA platform - Virtual Reality (VR) - Mixed Reality (MR) - Augmented Reality (AR)
FASTER project https://www.faster-project.eu/	2019-2022 Ongoing project	- Protect first responders in hazardous environments - Enhance their capabilities in terms of situational awareness and communication	- Augmented Reality (AR) supplied both through mobile phones and AR glasses (e.g. HoloLens)

			- Lightweight and camera-equipped UAVs - Mobile application - Wearable sensors and smart textiles - Wearable device for K9s - UxV - Robotic Platform
ResponDrone https://respondroneproject.com/	2019-2022 Ongoing project	- Develop and apply a situational awareness system in emergency situations, providing critical information and communication services to first responders - Develop an integrated solution for first responders to easily operate several drones with multiple synchronised missions - Enhance their situation assessment capacity and own protection -	- ResponDrone -
CURSOR - Coordinated Use of miniaturised Robotic equipment and advanced Sensors for search and rescue OpeRations https://www.cursor-project.eu/	2019-2022 Ongoing project	- Develop new and innovative ways of detecting victims under debris - 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 https://www.terriffic.eu/	2018-2021 Ongoing project	- Develop a comprehensive system of complementary, interconnected and modular software and hardware components - Enrich the European response to CBRNe events - Enable a step-change to the response in the initial hours	- Information Management and Decision Support System - Atmospheric dispersion modelling software - Augmented/mixed reality environment - A mobile van equipped with improved radiation detection technologies and enabling the integration of tactical information systems. - UAV Q800X - Unmanned ground

			vehicle, allowing for integration of various detectors, piloted automated exploration and manipulation tasks. - Handheld detector - Gamma camera - SiPR detector - 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 https://www.in-prep.eu/	2017-2021 Ongoing project	- Prepare responders better – so more lives can be saved during natural disasters and crises. - Improve collaborative response planning - 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) - Training platform (Mixed Reality Preparedness Platform a novel IT-based tool, which holistically integrates - Information Systems (IS) and Situational Awareness (SA) modules
I-REACT - Improving Resilience to Emergencies through Advanced Cyber Technologies 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. - Produce information faster - Allow citizens, civil protection services and policymakers to effectively prevent and/or react against disasters	- Mobile app - Wearable device - Augmented reality - innovative cyber technologies and ICT systems, - Copernicus Emergency Management Service - European Flood Awareness System (EFAS) - European Forest Fire Information System (EFFIS) - 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 https://www.inachus.eu/	2015-2018	- Achieve a significant time reduction related to Urban Search and Rescue (USaR) phase - 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) - SurfaceRadar - StickRadar - Mobile Phone Detector - Bullet Constraints Builder (BCB) - Extreme Loading® for Structures Software (ELS) - Mapping tool for the priorisation of USaR operations in urban surroundings - Multi-source Information - Fusion Engine - Unmanned Aerial Vehicles (UAVs) - Communication System and Infrared Camera - INACHUS Robot - Electronic Nose-Gas Detector (E-nose) - Real-Time Locating System (RTLS) - Portal & mobile application for search & rescue operations - (SaR-ESS) - Common Operational Picture (COP) with Environment Services
DRIVER - DRiving InnoVation in crisis management for European Resilience https://www.driver-project.eu/	2014-2020	- Develop a pan-European Test-bed for crisis management capability - Development - Develop a well-balanced comprehensive portfolio of crisis management solutions - Facilitate a shared understanding of crisis management across Europe.	

C2-SENSE - Interoperability Profiles for Command/Control Systems and Sensor Systems in Emergency Management https://c2-sense.eu/	2014-2017	- Develop a profile based Emergency Interoperability Framework by the use of existing standards and semantically enriched Web services - Expose the functionalities of C2 - Systems, Sensor Systems and other emergency/crisis management systems - 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.	- C2-SENSE profile
SAFESENS - Sensor technologies enhanced safety and security of buildings and its occupants http://eniac-safesens.eu/	2014-2017	- Develop co-integration of gas sensor and presence detection technologies - Enhance safety and security of buildings and its occupants - Develop different technological building blocks - 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 - Presence detection technologies - New gas detectors that are wearable and localisable
EXPEDIA - EXplosives PrEcursor Defeat by Inhibitor Additives 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 https://hydrogeneurope.eu/project/hyresponse	2013-2016	- Establish the World's first comprehensive training programme for first responders - Facilitate safer deployment of FCH systems and infrastructure.	
IF REACT - Improved First Responder Ensembles Against CBRN Terrorism	2012-2014	- Develop a tool that allows end users and procurement staff to select the best PPE system for the mission of the first	- Heads-up-display (HUD) - Novel gas mask - One-size-fits-all over-pressured hood

https://www.prometech.eu/projects/if-react/		responder and the expected threat - Provide added functionality regarding the C4I needs of the typical wearer - Typical First Responder tactical needs as communication, (indoor) localisation & situational awareness, will be enabled by affordable, robust and easy to use technology.	with a head cooling system - Skin protection with air permeable Saratoga technology - 3G bubble - A suit-integrated camera system
DITSEF - Digital and Innovative Technologies for Security and Efficiency of First Responders operation 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 - Indoor localisation, wireless communication, human interfaces, sensor equipment - 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 https://cordis.europa.eu/project/id/218057	2008-2009	Identify need for further research in - Training methodology and technology used to train medical first responders for disasters - Understanding the human impact of disaster on first responders - Ethical and legal issues influencing the medical response to disasters - Personal Protective equipment used in Chemical and Biological incidents - 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 https://www.faster-project.eu/tech/	- Capture and transmit in real time motion signals and situational status of K9s - 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 - Gyroscope
I-REACT Wearable https://www.i-react.eu/	- Coordinate missions and avoid accidents due to imprecise information - Warn when levels of oxygen are low	- EGNOS/EDAS positioning system connected to Galileo satellite - Oxigen sensor
Head-Up Display for First Responders 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 https://www.i-react.eu/	- Easily fit into different kinds of helmets - Grant a direct connection with the control room - Visualises real - time maps, reports or pictures taken from drones - Sens reports and communicate with the control room without using hands	- Not available
Hololens https://www.microsoft.com/it-it/hololens	- Redefines personal computing through holographic experiences to empower you in new ways	- Inertial measurement unit (IMU) - Environment understanding cameras - depth camera

https://docs.microsoft.com/en-us/hololens/hololens1-hardware **not specific for a project, but usually employed in many projects*	- Blends cutting-edge optics and sensors to deliver 3D holograms pinned to the real world	- 2MP photo / HD video camera - Mixed reality capture - Microphones - Ambient light sensor

4.3.2.2 Platforms

Table 4-10: Platforms for FR

Device	Scope & Key functionalities	Characteristics
IN-PREP Platform 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) - Enable interagency training for the entire chain of command. - In a training session, a simulated crisis is created and merged into the real world.	- Decision support capabilities with built-in situational awareness - Resource allocation in real time - Rapid remote sensing for quicker response actions - Large scale evacuation simulation - Coordinated C2/C3 systems - Vulnerability and Risk assessment -
INACHUS Communication Platform https://i-sense.iccs.gr/ https://www.inachus.eu/	- Manage the seamless interoperation, the interconnection between other networks (cellular, etc.) abd provides redundancy and recovery functionality - 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	- Real-Time Localisation System (RTLS) - mobile gateways - wireless communication - Delay Tolerant Network (DTN) - LWIR camera
Intrepid Platform https://cordis.europa.eu/project/id/883345	- 3D exploration - Analysis of disaster zones - Intelligence amplification - Extended reality concepts - Smart cybernetic assistants - Deep indoor networking - Positioning capabilities	- Developing

4.3.2.3 Drones

Table 4-11: Drones

Device	Scope & Key functionalities	Sensor type
UAV- Type	- Military aircraft operated without a pilot that can be reused	- Inertial Measurement Units (IMUs) - GPS/GNSS - Light Detection and Ranging

**UAV Drone are usually employed in many projects. In this box its main general characteristics are reported* Cost variable according to brand and characteristics		(LiDAR)
UAV by ONERA- INACHUS https://www.onera.fr/fr 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. - 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 - 3D data
Alpha 800 UAV https://alphaunmannedsystems.com/alpha-800-uav/	- 2.5 hours endurance - 3 Kg of payload capacity - Up to 30 Km range - On-board alternator/generator - Redundant power supply - High variety of payloads available and integrated - All on board electronics are IP64 or higher rated - Patent pending technologies -	- IMU (inertial measurement unit) - ADS (air data system - IAS - GPS - PFD (Primary Flight Display)
UVA Q800X https://www.aeraccess-group.com/product/outdoor/hawker-q800x.html	- Provide first responders quick assessment of the situation	- EOIR payloads - IMSI Catcher - loud speakers - Laser illuminators - MIRION Spir Explorer
Mothership Drone- CURSOR https://www.youtube.com/watch?v=6LF4eg_rl3Q&feature=emb_logo https://www.cursor-project.eu/	- Central drone of CURSOR system - Provide communication between Robot (SMURF), Drone System and FRs	- Zoom videocamera
Transport Drone- CURSOR https://www.youtube.com/watch?v=6LF4eg_rl3Q&feature=emb_logo	- Transport Robot (SMURF) to the disaster center - Increase the safety of FRs	- Not available

https://www.cursor-project.eu/		
Ground Penetrating Radar Drone- CURSOR https://www.youtube.com/watch?v=6LF4eg_rl3Q&feature=emb_logo https://www.cursor-project.eu/	- Scan the disaster site to detect any track of victims	- GPA sensor
3D Modeling Drones https://www.youtube.com/watch?v=6LF4eg_rl3Q&feature=emb_logo 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 Android-iOS https://www.i-react.eu/	- Allow both citizens and professionals to report emergencies	- Take a pic of the situation - Select the type of hazard - Add information - Send the report - All the reports will be gathered to generate real-time risk maps
EXPEDIA App 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 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 https://www.sintef.no/ https://www.inachus.eu/	- Snake-like robot prototype designed and manufactured to help USaR teams finding and communicating with victims under a collapsed building - The robot is remotely controlled by a rugged tablet PC and an operator can drive the robot	- Two video cameras - Radar - electronic nose - infrared camera - Real-Time Locating System (RTLS) by IK4-

	under the rubble by entering through small holes (20cm x 20cm of cross-section) - The robot is able to estimate its position based on a real-time locating system - 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	Tekniker -
SMURF- Soft Miniaturised Underground Robotic Founder- CURSOR https://www.cursor-project.eu/	- Detect the location of victims - Communicate with victims	- Sensor to detect humans -
StickRadar https://cinside.se/ https://www.foi.se/ 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 https://www.sintef.no/ https://www.inachus.eu/	- Snake-like robot prototype designed and manufactured to help USaR teams finding and communicating with victims under a collapsed building - 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) - The robot is able to estimate its position based on a real-time locating system - 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 - Radar - electronic nose - infrared camera - Real-Time Locating System (RTLS) by IK4-Tekniker -
SMURF- Soft Miniaturised Underground Robotic Founder- CURSOR https://www.cursor-project.eu/	- Detect the location of victims - Communicate with victims	- Sensor to detect humans -

StickRadar https://cinside.se/ https://www.foi.se/ 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. - Pages will upload almost instantly - Can play easily online games. - Finest Quality of Service (QoS). - All Networks can be gathered on a platform. - Easily support previous generations. - No limitation as user demands. -	- 5G devices are comparatively less expensive than 3G and 4G devices - Using 5G the battery runs out very fast. - New deployments of 5G can be connected directly with The Mastercore by 5G -IU (5G Interfacing Unit) without All IP concept. - Ability to support the new services -
Ground-Based Seismic Sensor system (GBSS) https://www.foi.se/ https://www.inachus.eu/	- Detect and locate knocking signals from victims trapped in debris heaps - Detect and locate knocking signals even in noisy environments - 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 https://cinside.se/ https://www.foi.se/ https://www.inachus.eu/	- Search for survivors from disaster - 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 https://www.diginext.fr/en/ https://www.inachus.eu/	- Find trapped victims is debris heaps - Survey the local environment for mobile devices to help determine	- Not available

	possible victim locations	
C2-Sense Profile https://c2-sense.eu/	- Make the organisations cooperate through interoperability - Acquisition and sharing of information - Simplicity and immediacy - Availability of communication technologies - Useful support for the human operator	- Not available
Prometech Tag & Trace system https://www.prometech.eu/projects/if-react/	- track persons and objects for use in a wide range of security related applications - Specifically designed for use by the first responders community and emergency management personnel.	- NFC technology
Incident Management System 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 SnR 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.

5.1.2 External Data Interface

In order to access external data SnR 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 SnR 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 define a standard interface 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 SnR Operational Data

This component play abstraction role for creating a common interface to SnR operational data. This interface is used by all SnR 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 SnR system.

5.1.10 Annotated Data

In annotated data component SnR 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 SnR Metadata

SnR metatdata 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 Assesment

The 3D Mixed Reality Command Centre will support decision makers and propose tactical actions. The 3D MR CC based on line SnR 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.

5.2 System collaboration

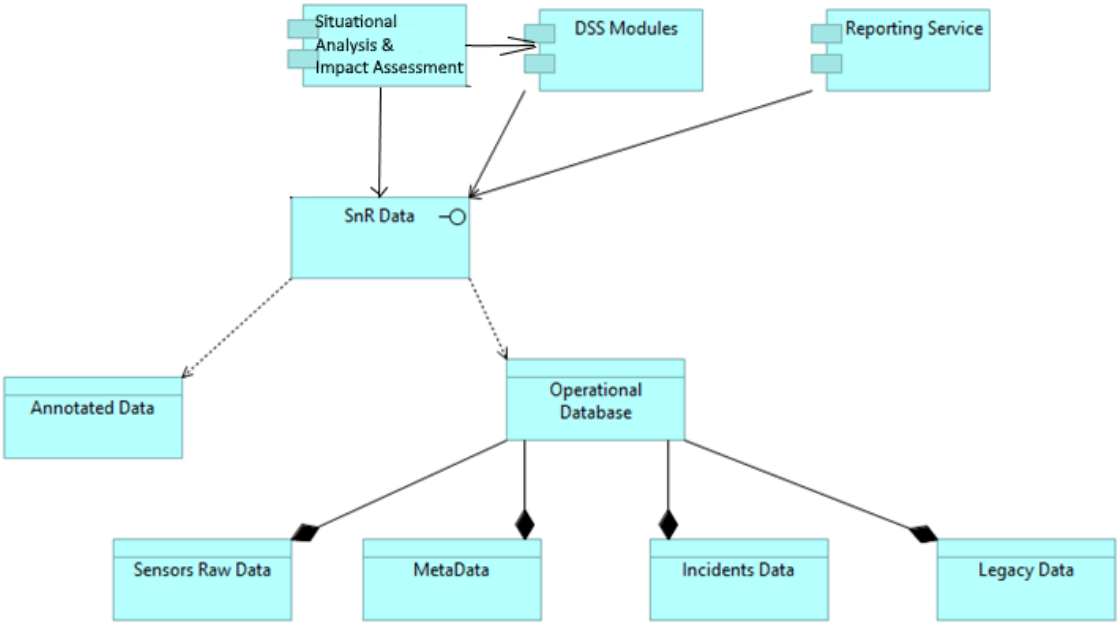

Figure 5-1: SnR Data Interface

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

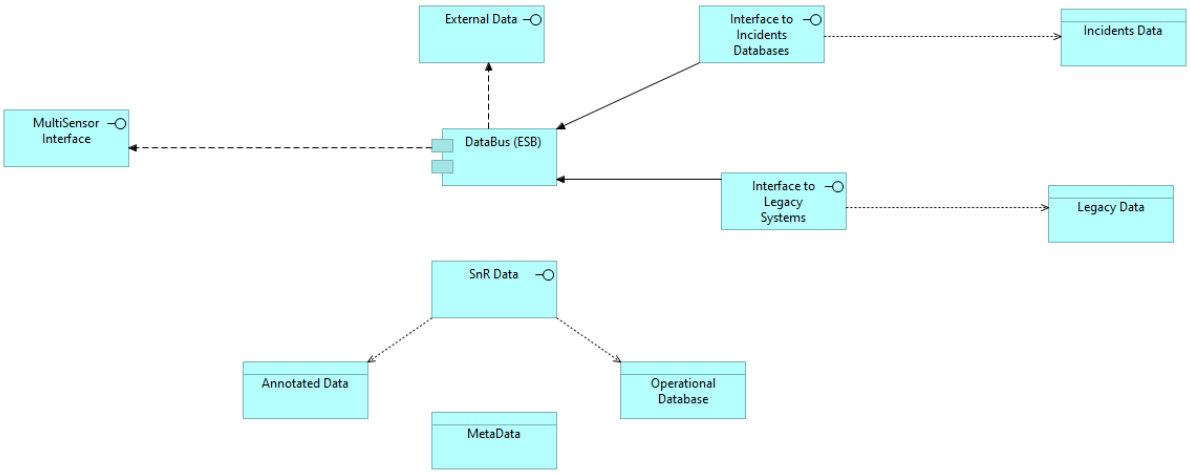

Figure 5-2: SnR Interface to external systems

SnR System will be interfaced with external incidents databases and legacy systems already in place at end users.

In order to have a coherent interface SnR design will abstract different data structures and will define a common external data interface for interactions with own components.

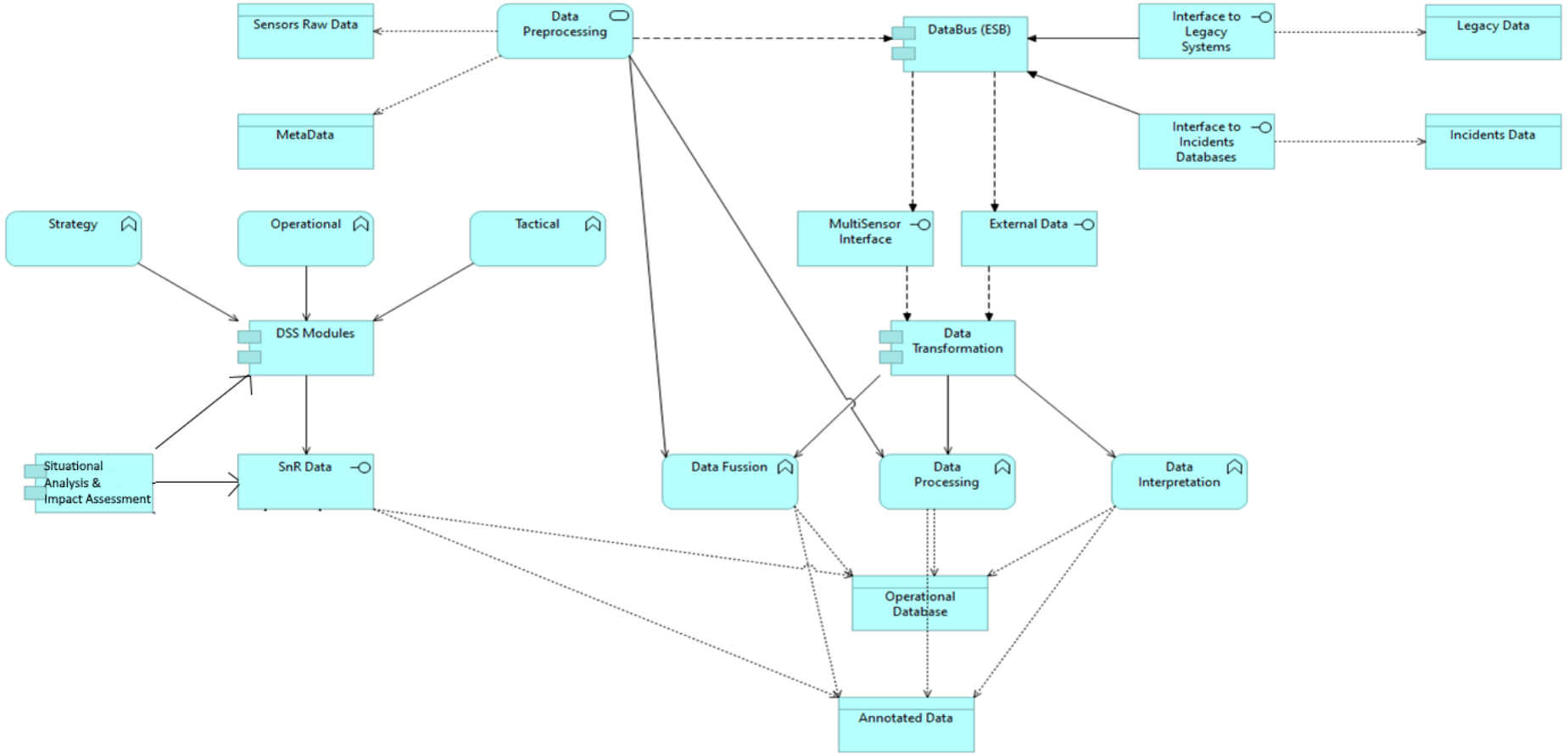

Figure 5-3: Main SnR Module Interactions

The previous diagram is a summary of module interaction between major SnR 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 SnR.

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

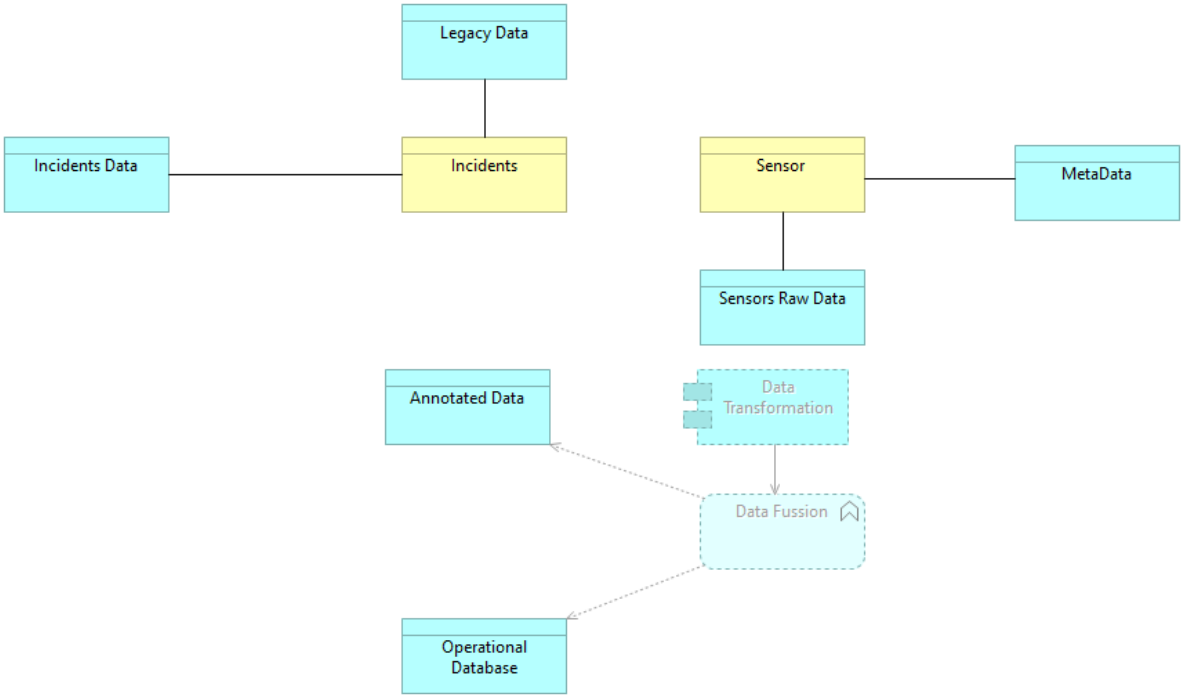

Figure 5-4: SnR Major Entities

In the previous diagram we try to represent the main informational entities sources and SnR storage.

6 Technology and Physical View

6.1 Physical Nodes and Devices

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

6.1.1 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.

6.1.1.1 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.

6.1.2 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

6.1.3 Data Fusion

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

6.1.4 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.

6.1.5 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

6.1.6 UAV

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

6.1.7 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.

6.1.8 Network

This component represent 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, SnR 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).

6.1.9 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, WiFi, 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.).

6.1.10 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.

6.1.11 Central Processing Units

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

6.1.12 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.

6.1.13 C2 GUI

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

6.2 Interactions

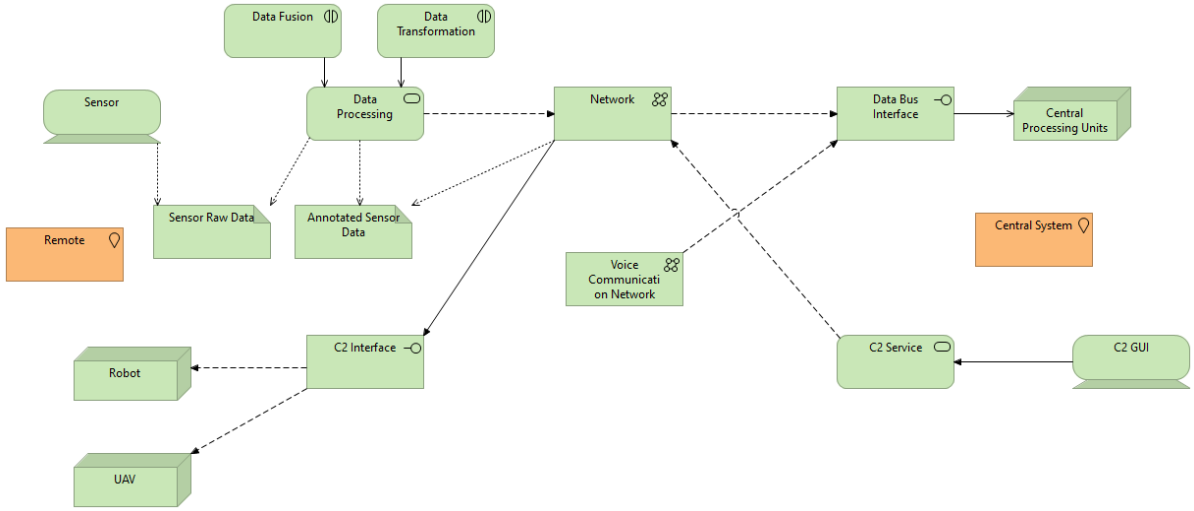

Figure 6-1: SnR Technology Interactions

In this diagram, we represent 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.

7 Conclusion

7.1 Summary

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

The design architecture of the integrated SnR 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 SnR platform; (ii) design of the components' "functional architecture"; (iii) design of SnR components' "information and communication architectures"; (iv) definition of common reference architecture for the SnR platform.

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

7.3 Future Work

As a second version of the architecture and design will came in M22, the major additions will be:
Transformation of use cases in system usage scenarios, having following table as template.

Table 7-1: Usage scenario template

ID	
Name	
Storyline	
Goal(s)	
Actors	
Preconditions	

Postconditions	
Trigger events	

Addition views – strategy, motivation, implementation and migration/deployment will be developed based on our methodology that use Archimate.

Also, detailed design for all components would be included in next version.

Annex I: Glossary and Acronyms

No.	Acronym	Details
1	COTS	Commercial off-the-shelf
2	C&C	Command and Control
3	API	Application Programming Interface
4	SOA	Service Oriented Architecture
5	ESB	Enterprise Service Buss
6	UAV	Unmanned aerial vehicles
7	GUI	Graphical User Interface
8	RPAs	Remotely Piloted Aircraft Systems
9	WUI	Wildland Urban Interface
10	USAR	Urban Search and Rescue
11	SSL	Secure Sockets Layer
12	PKI	Public Key Infrastructure
13	AR/VR/MR	Augmented/Virtual/Mixed Reality
14	CBRN	Chemical, biological, radiological and nuclear
15	FCH	Fuel Cells and Hydrogen
16	FR	First Responders