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

D3.7 Requirements to knowledge management and SA Model V2

Workpackage:	WP3 – Situation Awareness
Authors:	KT
Status:	Final
Due Date:	30/06/2021
Version:	1.00
Submission Date:	30/06/2021
Dissemination Level:	PU

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

Search and Rescue Project Profile

Grant Agreement No.:	882897
Acronym:	Search and Rescue
Title:	Emerging technologies for the Early location of Entrapped victims under Collapsed Structures & Advanced Wearables for risk assessment and First Responders Safety in SAR operations
URL:	https://search-and-rescue.eu/
Start Date:	01/07/2020
Duration:	36 months

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	ESCUELA ESPANOLA DE SALVAMENTO Y DETECCION CON PERROS (ESDP)	Spain

Document History

Version	Date	Author (Partner)	Remarks/Changes
0.10	17/05/2021	Iosif Sklavidis (KT)	Table of Contents
0.20	25/05/2021	Christos Angelidis, Giorgos Mimoglou, Kalliopi Angelaki (KT)	Initial version
0.30	25/05/2021	Christos Angelidis, Giorgos Mimoglou, Kalliopi Angelaki (KT)	Section Editor
0.40	30/05/2021	Iosif Sklavidis (KT)	Overall Editor
0.50	15/06/2021	Giorgos Vafeiadis, Iosif Angelidis (UBITECH)	Technical Reviewer (1)
0.60	18/06/2021	Katerina Margariti, Spyros Boletis (MAGGIOLI)	Quality Reviewer (2)
0.70	24/06/2021	Christos Angelidis, Giorgos Mimoglou, Kalliopi Angelaki, Iosif Sklavidis (KT)	Overall Editor
0.80	28/06/2021	Christodoulos Santorinaios (NTUA)	Quality Control
1.00	30/06/2021	Christos Ntanos (NTUA)	Final version to be submitted

Executive Summary

This deliverable is produced in the scope of WP3's D3.7 "Requirements to Situation Awareness and SA Model v.2". D3.7 describes methods for finding the necessary knowledge for first responders in order to achieve a level of situation awareness and to develop disaster emergencies. Situation Awareness (SA) is the accuracy with which people perceive, recognize and anticipate modifications in their environment that are relevant to achieving operational goals. Initially, in order to capture, develop, share and use organizational knowledge to finally enable SA, a Knowledge Management System is required. The Knowledge Management System requires components, both human and hardware, that must follow a variety of operational goals (time of response, time of deployment, rescue victims etc.).

The goal of the deliverable, is the further extension of requirements to D3.1, the definition of the requirements of the Knowledge Management functionality in order to enable the situation awareness, a more efficient context-aware data sharing and presentation to the emergency responding actors, and subsequently more efficient decision-making support. The requirements to be collected should address different aspects of the S&R system functionality such as:

a. knowledge models and information elements required to represent various types of resources used in S&R operations
b. the support required for various types of decision making and decision points during S&R operations
c. the requirements to the overall knowledge management infrastructure to support the achieving of situation awareness.

These needs will support the risk awareness in decision-making, related to both victims as well as staff on the field.

Moreover, WP3 will develop the requirements to SA domain with respect to the emergency domain standards such as EDXL (the Implementation of EDXL standards aims to improve the speed and quality of coordinated response activities by allowing the exchange of information in real time).

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1 Introduction

1.1 Objectives

The aim of the D3.7 is the analysis and the definition of the requirements for knowledge management functionality, in order to enable Situation Awareness to S&R operations. Consequently, knowledge models and information elements will make the sharing of information smooth for more effective decision-making.

A first attempt has been made in the D3.1 concerning the collection of data, information, and knowledge regarding the requirements to knowledge management functionality, the requirements to the management of various and heterogeneous types of resources and decision making, and the requirements to overall knowledge infrastructure.

The D3.7 "Requirements to knowledge managements and SA model v.2" includes updated requirements with technical specifications. The requirements are evaluated based on technical criteria of the feasibility of implementation and practical considerations on training pilots.

1.2 Scope

The scope of D3.7 "Requirements to Situation Awareness and SA model v.2" deliverable is to provide the logic (e.g., rules) and models for storing, sharing, notifying, and presenting information to various stakeholders, based on their roles of disaster response.

The definition of the technological requirements of the Knowledge Management functionality shall enable situation awareness, more efficient context-aware data sharing, and presentation to the emergency responding actors, and subsequently more efficient decision-making support. The requirements to be collected should address different aspects of the S&R system functionality such as:

a. knowledge models and information elements required to represent various types of resources used in S&R operations
b. the support required for various types of decision making and decision points during S&R operations
a. the requirements to the overall knowledge management infrastructure to support the achieving of situation awareness.

1.3 Relationship with Other Documents

The Deliverable D3.7 addresses the specification of the requirements to knowledge management and Situational Awareness. The deliverable offers inputs to other S&R components and tools; for example, the knowledge management types of data are useful for the DSS support while it will receive inputs from pre-large-scale incidents analysis conducted within WP 4 Task 4.1 and more. This deliverable is therefore linked to the following deliverables:

- D1.3 - Definition, evaluation and refinement of the S&R CM governance model
- D3.2 - Situation Awareness Model – specification
- D4.1 - Data aggregation

- D4.2 - Situational Analysis & Impact Assessment
- D4.3 - Design of SOT DSS components
- D4.4 - Design of PHYSIO DSS component
- D4.5 - Development of SOT DSS components
- D4.6 - Development of PHYSIO DSS component
- D5.2 - First responder prototype uniform and first aid for kids' device design
- T6.5[1] - Design of an aftermath knowledge capitalisation mechanism
- D6.6 - Report on legacy systems and their connection to the S&R related technical characteristics
- D7.2 - Architecture and Design Specifications of S&R platform
- D7.3 - Component interface specifications for interoperability within S&R
- D7.4 - Adapted S&R components and services
- D7.5 - Integrated S&R platform 1st version
- D8.1 - S&R Pilot guidelines and User's Handbook
- D8.2 - S&R Use Case 1: Victims trapped under rubble (Italy) - Pilot plan
- D8.3 - S&R Use Case 2: Plane crash, mountain rescue, non-urban (Greece) - Pilot plan
- 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
- D8.5 - S&R Use Case 4: Forest fire expanded and threat to industrial zone (Kineta, Agioi Theodoroi, Greece) - Pilot plan
- D8.6 - S&R Use Case 5: Victims trapped under rubbles (France) - Pilot plan
- D8.7 - S&R Use Case 6: Resilience Support for Critical Infrastructures through Standardized Training on CBRN (Romania)- Pilot plan
- D8.8 - S&R Use Case 7: Chemical substances spill (Spain) - Pilot plan
- D8.9 - S&R Evaluation Framework
- D8.10 - S&R Pilot Implementation and Evaluation Report 1st version

1.4 List of Abbreviations

Abbreviation	Explanation
APP	Application
CBRN	Chemical, Biological, Radiological, And Nuclear
CM	Crisis Management
D	Deliverable
DSS	Decision Support System
EDXL	Emergency Data Exchange Language

[1] It is referred to the Task 6.5

EMS	Emergency Management System
EU	European Union
GA	Grant Agreement
GM	Governance model
GIS	Geographic Information System
GPS	Global Positioning System
KT	Konnektable
WP	Work Package
PSAP	Public Safety Answering Point
RDF	Resource Description Framework
SA	Situation Awareness
S&R	Search and Rescue
SnR	Search and Rescue
UC	Use Case
Wi-Fi	Wireless Fidelity

Table 1-1: List of Abbreviations

2 Knowledge Sources in S&R

It is important to find approaches in terms of aligning Knowledge Management initiatives to the real processes. The role of effective knowledge retrieval and sharing in the process of crisis prevention is vital. The Knowledge sources provide this information. In these sources are included policies about the response in time of a crisis and the procedures must be followed. Moreover, these sources provided protocols to be followed in accordance with the legislation of a country.

In S&R project the sources that will provide this kind of information as described above will be the COncORDE, the existing Databases, the DSS, the Governance Model, the Domain Experts and the Training Framework. The information is produced from all the sources used from the actors in order to help them to deal with the crisis. In the next sections they will be presented in more detail.

2.1 Management Levels in S&R

The management involves quick decision-making in critical conditions. Crisis therefore leads decision-makers into an urgent decision-making situation, with the obligation to minimize the potential consequences for a wide range of high-stake elements. In management, there are varying levels of control: Strategic, Tactical, and Operational. [1]

The **Strategic level** defines "what to do" in an incident. In this level the involved actors have the overall command and responsibility for an incident. They determine the policy, the overall strategy, the resource deployment and the parameters within which commands will operate in lower levels. In this level, the decision making must be analytical and in-depth, make use of resources and be able to develop and maintain an operational picture, identify and access options in order to evaluate the progress. The actors in this level should avoid the involvement in the decisions of the other management levels. The information provided in this level is varied and related to tasking and situational awareness.

The **Tactical level** defines "How to do it" in an incident. The actors in Tactical level determine tactics in an incident within the strategy. The Decision Making in this level needs to identify and evaluate options which necessitates an analytical approach but pressure and changing of circumstances may force an instinctive approach. The information which will be provided in this level are task-specific and concerns the maintenance of situational awareness and the upward transfer of situational information that is of relevance to strategic level. The goals of the Tactical level should be clear and explicit.

The **Operational level** deals with "doing it" in an incident. The actors in this level work within a functional and a geographical area of responsibility to implement the tactical plan as defined in Tactical level. They must have a clear understanding of the tactical plan and have access to the information which is crucial for the execution of it. Decision making at this level may be characterized by an instinctive approach based on circumstances. The information required for actors in this level is related to the tasks. The goals in Operational level may be fewer than them in previous levels but must be clear and explicit.

2.2 COncORDE EMS features

COncORDE, as an effective emergency management system (EMS), contains a specific and comprehensive knowledge management system on which SnR can be based on, so as to aid first responders and actors to successfully complete SnR procedures by collecting data from several resources. In the beginning, the fundamental screen of COncORDE EMS provides access to all operational information bridging the gap between the operational and the strategic world. [2] As a cloud-based platform, divides the emergency response in five procedures as shown in the Figure 2-1.

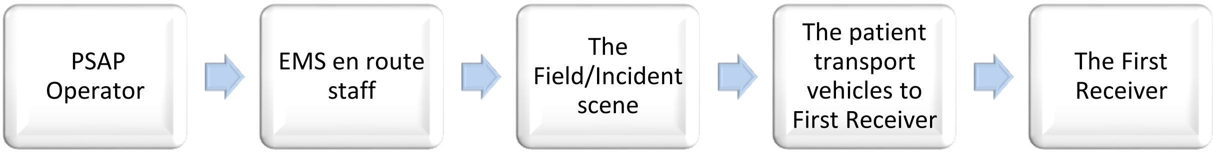

Figure 2-1: COncORDE Procedures

The platform achieves its purposes using an innovative set of tools integrated into a knowledge-enabled cluster of Decision Support Systems with integration to social networking facilities at a level not seen before. The COncORDE EMS consists of the following subsystems/tools and services:

<table>
<tr><th>Decision Support System</th><th>Patient MGT</th><th>Semantic Infrastructure</th></tr>
<tr><td>Incident MGT System
• Incident information tool
• Team MGT tool
• Hospital MGT tool</td><td>User MGT
• User Registration
• Secure Authentication and Authorization</td><td>Information & Notification
• Notification tools</td></tr>
<tr><td colspan="2">External Services
• PSAPs
• Nearby hospitals
• Weather data</td><td>Map Integration
• Google maps
• ArcGIS
• Open maps</td></tr>
</table>

Table 2-1: COncORDE EMS Services

The Decision Support System has been designed in order to make an effective real-time allocation of resources during an incident. For further upgrade of the real-time allocation, the Semantic knowledge of KT is used to match patients' injury profiles with the hospital specialties and expertise. The DSS offers four services from which the first three concerned the allocation of certain supplied resources to relevant demand and the last one concerned the estimation of required resources in a new emergency incident:

1. Recommended (optimal) allocation of available EMS units to incidents, depending on estimated needs.
2. Recommended (optimal) allocation of patients to transport vehicles and first receivers (hospitals), based on given order of evacuation and triage results for present injuries.
3. Recommended (optimal) allocation of tasks to available actors on the field, given demand pre-defined by the field commander.

4. Estimation of expected casualties and demanded resources (EMS units), given historical data on emergency incident recordings.

Each of the above Decision Support Services integrates with the semantic knowledge management module assisting the semantic mapping between patients and First Receivers informed capacity on medical specialties and beds.

Regarding the map services, the COncORDE platform has 3 different approaches. The first one is a map integrated in the creation of an incident and the registration of a hospital, the second is an overall map of an incident and the third is a full-screen map that offers all map functionalities available for all users. Furthermore, in the field, COncORDE app is able to alert medical first responders to a severe healthy situation by observing vital signs of various trauma patients.

2.3 Decision Support System in S&R

Another source of knowledge is the output of the SnR DSS. The vast amount of data that the S&R system receives, in a disaster situation, makes the decision making a time-consuming procedure. Such situations, when time is important for live saving, require fast resource allocation. The DSS components and services retrieve most of the field and operational data, in order to produce an efficient real-time resource allocation and help decision-makers to reduce potential errors and wastes. Its design addresses the following three levels of decision making in crisis situations.

- Strategic level (allocation of resources from different regional establishments, interoperability with different countries)
- Operational level (communication among organizations, planning and data warehousing, logistic models)
- Tactical level pertaining to field deployment (ambulance, field teams, EU modules, triage, communication protocols, transmission of medical patient data)

To achieve these objectives the DSS is divided into two components, PHYSIO and SOT DSS. The PHYSIO component has been designed and developed by CNR and is related with the physiological modelling of the individuals involved in the mass casualty incident. In other words, it monitors and describes the physiological state of the patients. More specifically, PHYSIO provides the following functionalities:

- Describe the evolution over time of physiological state variables (PSVs), representing some aspects of the patient's condition;
- Describe the effect on the victim health of different possible lesions;
- Determine the type of the needed treatment based on the evolution of the PSVs;
- Evaluate the effect of the treatments on the PSVs.
-

Furthermore, the SOT component, which is implemented by KT, is related to the effective resource and task allocation, during the incident operations. Exploiting linear programming (LP) and machine learning (ML) techniques, SOT DSS covers the four services as mentioned in section 2.2. Both components work in a cooperative way to provide the optimal solutions and cover the demands of every crisis management level.

The data comes in various forms from the field, but the S&R components, e.g., COncORDE, and the DSS must utilize it properly. Task 6.2 'Voice, data and services interoperability frameworks' will provide a S&R Data Model to address this issue of heterogeneity. Still, the data must be transformed to knowledge and delivered among the end-users. The SA model comes to fill this gap, providing a situational summary of the crisis. For example, in a case of a fire, a sensor receives the temperature values of the environment. This data passes through the data integration mechanism to the Data Lake, where the aggregation mechanism makes the data homogeneous (there are dependencies on other tasks too, such as T6.2 "Voice, data and services interoperability frameworks", T7.5 "Integrated S&R platform 1st version" and more, which are going to analysed in dedicated Deliverables). Then the SA transforms these values in a standard, well-defined model as mentioned in chapter 3.

Aggregating more field data into the system, the SA produces the current state as 'Fire'. After a while, another sensor receives a high value of a flammable gas. Following the same process, SA aggregates the current situation 'Fire' with the situation 'High Gas' and produces the next situation through its established associations, 'Possible Explosion'. Finally, the DSS receives the latter and recommends an optimal allocation of resources in order to minimize potential effects, e.g., allocating the EMS away from the fireplace or allocating more ambulances to the critical location.

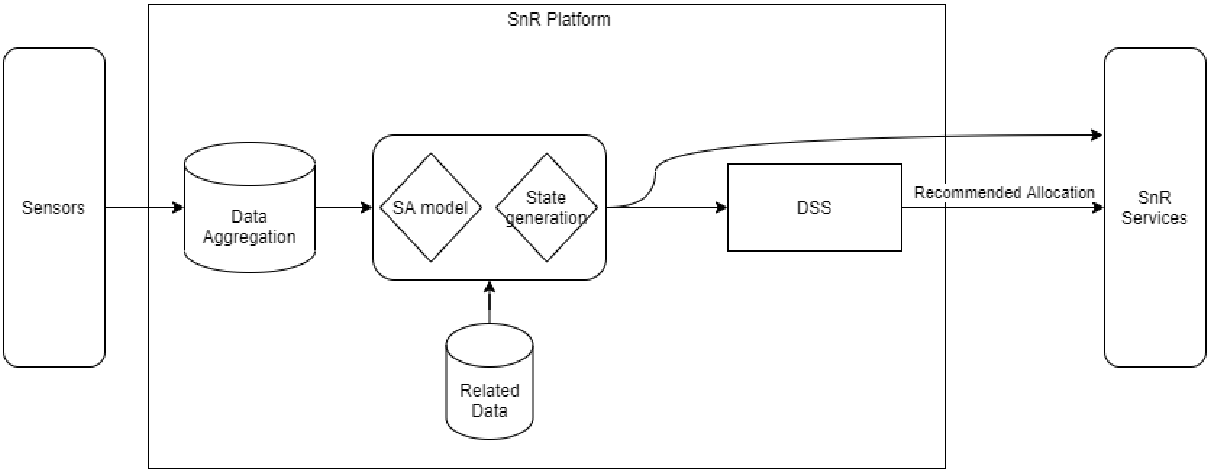

Figure 2-2: SA & DSS Connection

2.4 Governance model

The governance model (D1.3, D1.7, and D1.8) will be linked to existing databases to provide functionality for capturing Risk Assessment (e.g., comparable function for disaster type, location, radius, impact and threats). This component will be based on a library of terms, business rules and methods to support these types of analysis identified and implemented in T3.1 and T3.2. The content of the library reflects unified community definitions of risk and other parameters utilized to characterize a disaster or crisis event. This will allow for increased situational awareness and early warning of major disaster incidents. The S&R CM governance model will allow for a wider definition which includes the capability to collect:

a) static and dynamic data on the basis of standards and protocols and
b) all relevant static and dynamic data suppliers that are relevant to various disaster types.

The SA must model these guidelines and procedures, in order to represent them in a homogenous form, enabling quick process and response to any situation. The governance model must support the SA, in such way, that the following objectives can be achieved:

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

Thus, designing the SA ontology based on the D3.1 and the governance model information implies to a more robust and well-defined integrated system. Moreover, the governance model encapsulates the EU protocols enhancing the SA. Also, it reduces the effort of the other services to define the operational processes, such as the information representation and distribution among the levels of crisis management. Furthermore, this design approach results in an overall efficient and fast decision making for every situation. For example, having an incident-type model ontology and its well-defined and well-structured associations, the S&R platform can alert and notify the right organizations and people, retrieve pre-defined plans and procedures and, finally, represent the critical information as soon as possible.

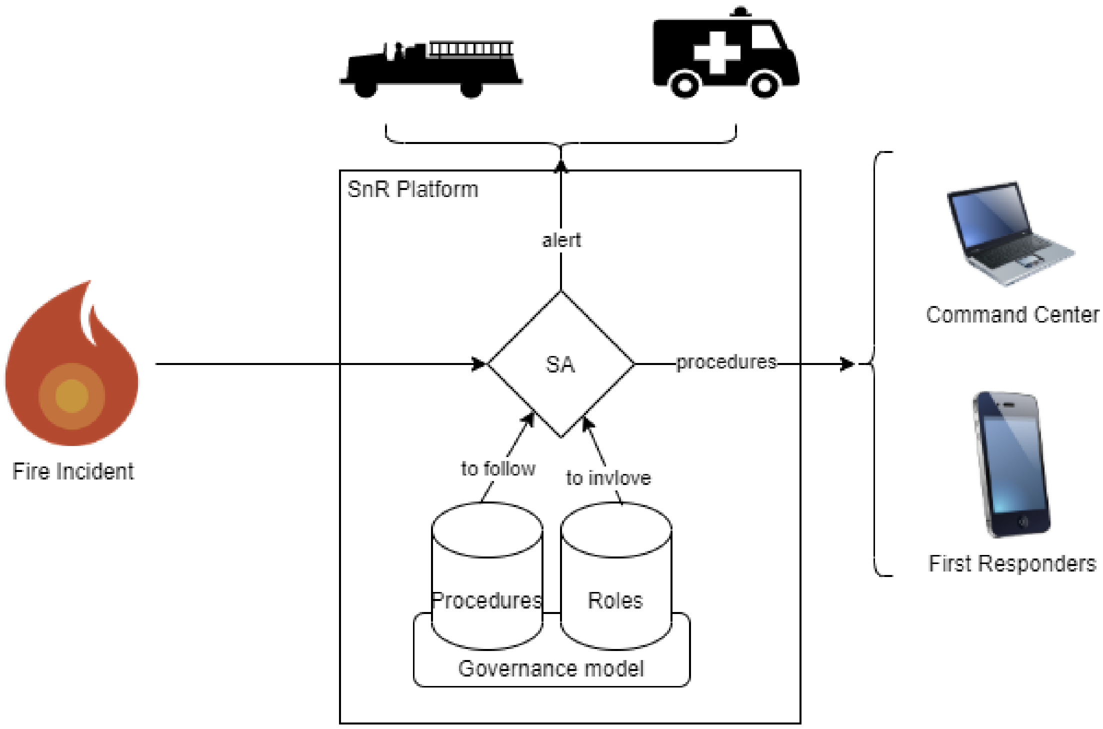

Figure 2-3: SA & GM connection

2.5 Domain Experts

Domain experts' contribution is also an essential factor for a smooth and immediate response regardless of the difficulty of the situation. As it has already been mentioned, the SA model is supported by the governance model in order to provide proper semantic correlations between field data and entities, so that the Data Lake processing mechanisms can process this information to generate a new state and/or decisions to take, effectively ensuring a more powerful and resourceful decision-making process. Therefore, in addition to the end-users' requirements, the SA model should take into account the knowledge of experts.

2.6 Training

Training constitutes a key task to prepare for a crisis. Most emergency response agencies have dedicated structures for constant training of their staff. In many emergency response units, training exercises are an important daily activity. Training and exercising for crisis preparedness can have different purposes: training units and individuals, testing equipment and the ability of staff to deploy and use it, controlling stocks of supplies, and testing all components of contingency plans from the knowledge of the detailed protocols and procedures by the staff to the plan itself. In S&R project the training of involved parties is a fundamental factor for an emergency crisis situation. Educational activities will help emergency responders reduce risk, assess a hazard situation, and respond directly in a new crisis. The main goal of Training in the project is to test all the technologies which will be developed and used within the project in order to see the efficiency of them in a crisis. The simulated environment in which the training will take place is fully interactive and simulate all the possible scenarios as an output of T4.3 3D model. In addition, it will give the ability for the technologies within the project to be tested. All the functionalities of the training framework will be available also in the real time situation. Such training does not test only the knowledge of protocols but also the ability to innovate in a stressful environment and when "the fear factor" is present. Such strategic crisis management exercises require in-depth preparation to provide a sense of reality and focus mainly on the human elements. The scope of training is not to test the people and their ability to cope with the different situations, but to adapt, lead and function to the current threat.

3 Requirements to Knowledge Management System in S&R

3.1 Existing Databases and Aggregation Mechanisms

The existing databases will provide information about natural disasters in the S&R ecosystem. The information of the existing Databases (T4.1 output) will be gathered in a data point (Data Lake) and it will be transformed using aggregation mechanisms in order to be homogeneous. The aggregation mechanisms will provide a way to process the data and extract useful knowledge. Data aggregation and visualization are usually the most helpful components for decision making. However, the real success for the management of emergency situations comes from the beginning with well-organized planning. As it was mentioned earlier, the definition of great knowledge comes from:

- Collecting and organizing Data
- Summarizing and analysing Information
- Synthesizing and Decision-making Knowledge.

In the Strategic Level, the knowledge provided by the existing Databases and the processing in it helps to better understand the situation and provides solutions regarding the definition of a plan.

S&R will support the coordination and decision making in the emergency management domain. In addition, there are partners in S&R who have developed algorithms in order to empower the DSS with their capabilities and functionalities. The information technology infrastructure in S&R includes data processing, storage, and communication technologies and systems that will be used to aggregate, transfer and transform the information. The transformation will give useful knowledge to actors (e.g., First Responders, etc.). The mechanism behind the SA model is an ontology which will use an RDF schema as analysed in the D3.2 and will be further extended in D3.8. This schema will provide a way to search for specific information. As a result, SA model can provide to S&R through COncORDE the metadata in order to:

- Classify incidents and their characteristics
- Represent technical information such as actors, resources, location
- Represent incident domain-specific information such as the type of the incident, resources and the status of infrastructure.

3.2 Trade off between expressivity and practicality in the design of knowledge representation formalism

In emergency situations, decision makers must be aware of the whole status of the crisis, in order to coordinate the first responders safely and efficiently. This means, that an operation will not put any first responder in danger, as well as it will be completed quickly and successfully. The problem lies behind the way that the SA keeps feeding the crisis management levels with proper information format and knowledge. For example, a notification like "Fire in a building, at Vasilissis Sofias Avenue, with 3 tons of rumble, flames at 800°C near gas station, 50 civilians nearby" it captures a big part situation (expressivity), but it is not useful for a First Responder (practicality). The information must be delivered to the users depending on their needs. The S&R components are responsible to require the proper information needed from the SA Model, which is a passive module providing that information. The information flows (what, who, when) must fulfil these requirements of every crisis management level, considering the Governance Model.

The ontology of SA should capture the right information and deliver it to the right person using the associations between the information and the user model. To be more specific, SA has to collect the metadata of the homogeneous data from the COncORDE database. Then the semantics will be obtained by the rules and associations between the models. Finally, the information for each end user will be formalized, in order to become practical for him and pass it to the COncORDE, which is responsible to deliver it to the clients through notifications and alerts. Furthermore, the semantics and the summarization of the situation will be utilized by the DSS.

3.3 Situational Analysis

The Situational Analysis following a crisis typically looks at key crisis drivers, affected areas, the number and type of affected people, the ways in which people are affected, the most urgent needs and available capacities. It is an in-depth look at the aspects related to the inputs, the processes and the outputs of an incident. This information is extremely relevant and useful to compare and contrast with existing data and information, and monitor progress. If existing data and information are sparse, a situation analysis can serve as a baseline to inform future monitoring and evaluation rounds. In an incident characterized by time pressure, complexity and uncertainty, the main challenge for a response team is to obtain as quickly as possible "situation awareness", i.e., an assessment of the extent of the crisis they respond to. The Situational Analysis is responsible to provide the suitable information as understandable and easy as possible. For this reason, Situational Analysis gathers the information which is often "raw" and unprocessed: typically, information is collected by individual team members who focus on their specific discipline or expertise (e.g., fire fighters, police, and medical care) and provides targeted knowledge to the actors. [3]

In S&R project the Situational Analysis prepares CM decision-making and plans effective response. The Situational Analysis uses the available knowledge and analyses all the factors to identify potential hazards, allowing all involved to undertake the necessary planning to ensure a timely and adequate response. The outputs of Situational Analysis are:

- A contingency plan outlining proposed interventions / responses.
- A clear agreement on which agencies and individuals are responsible for different interventions or actions.
- A plan of action for carrying out the interventions, including timelines.
- Identified lead time (start-up time) and action for each activity, including negotiation on the practicalities and logistics involved in carrying out the recommended activities with third parties.

These outputs need to be clear and explicit in order to be used from the involved actors. This will happen as an output of T4.3 in the 3D Mixed Reality Command Center.

3.4 Situational Awareness model

In the frame of S&R project, the SA Model will provide a common way to represent the information of the processed and aggregated data. SA model is responsible to correlate the messages with the actors and incident.

As mentioned in D3.2 the SA Model uses an Ontology schema to represent the data flow. In addition, it correlates the data and the users within the S&R project to extract more enriched knowledge and to achieve Situational Awareness. As mentioned in the D3.2 the Ontology Model is compose of:

- **Classes**, which represent the core entities of the model.
- **Object properties**, which conceptually link the model's classes, aiming to represent correlations.
- **Data properties**, which conceptually link the model's classes with literal properties (both numerical and alphabetical).

The SA Model will represent all the information as described in D3.2 "Situation Awareness Model - specification". Moreover, all this information will be expanded for the needs of the S&R project. The expanded version will be represented in second version of in the D3.8 Situation Awareness Model – specification, V2. From the implementation point of view, the SA Model will be used from DSS in order to have a way to ask for data from COncORDE.

The SA Model will be fed also from the governance model. The governance model (D1.3, D1.7, D1.8) as described earlier (in the chapter of Governance model), will be linked to existing databases (this will be found through the next version of governance model as an outcome of the specific task) to provide functionality for capturing Risk Assessment (e.g., comparable function for disaster type, location, radius, impact and threats). The SA model is responsible for enabling quick process and response to any situation. The governance model supports the SA model, in such way, that the following objectives can be achieved (As it shown in Figure 2-3 "SA & GM connection"):

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

Thus, the SA model will be enriched with the information of the governance model and the result will be a more well-defined integrated information for the end users. Moreover, the definition of operational processes will reduce the effort among the management levels. Finally, this design approach results in an overall efficient and fast decision making for every situation.

3.5 COncORDE

As it was described in "D3.1 Requirements to knowledge management and SA Model ", COncORDE is an Emergency Management system capable to provide a holistic solution regarding the procedures and action that should be done in a crisis [2]. This chapter must be involved in D3.7 too, due to the fact it is a basic requirement which is repeatedly mentioned in D3.7 chapters. However, the overall requirements are both work of D3.1 and D3.7. In order to highlight the identified actors, this chapter (coming from D3.1) is mentioned again.

COncORDE is a successful emergency management system with an accurate knowledge management system that S&R can be based on, in order to collect data from resources and as a result help the first responders and the other actors proceed with the S&R operations. The COncORDE platform consists of a sequence of interactions between the system and a set of external actor(s), one of the actors actually being an end-user of the system. As mentioned in "D3.1 Requirements to knowledge management and SA Model ", a variety of actors which will be participate in S&R operation can easily be identified from COncORDE. In Table 3-1 are listed the identified actors of COncORDE:

Actors	Description
High Commanders	These are people responsible for the higher-level decision making and communication at regional, national, international levels, that may not use the system for operational needs, however, they are called to make higher-level decisions during large-scale incidents that, e.g., require upscale for resource allocation as well as to provide the link to the higher level and wider boundaries
PSAP Operators	PSAP is the space, which takes the initial call for an alert. The person who takes the call may be referred to as the call handler/operator. PSAP also hosts the dispatch operators who are responsible for making the initial decision for the dispatch of EMS units to the incident field (incident field stands for the disaster's location)
EMS en route staff	After an alert for an emergency incident, EMS vehicles are dispatched to the field via road, water or air. The vehicles have a task to provide emergency medical care to the victims/patients. The people who attend the scene are first responders e.g., firefighters, ambulance personnel, doctors, nurses etc.
Field Staff - Field/Incident Commander	It is the first arriving EMS en route staff on the field who becomes physically involved in control and command. The incident field commander will have higher commanders, usually in control rooms (not on the field).
Field staff - Triage Runner	It is the responsible person for running towards the victims on the field and tagging them according to severity of injuries, in order to prioritize the most serious cases.
Field Staff - Retrieval Runner	It is the person on the field who is assigned an area or specific patients and retrieves them to transfer them to the medical area setup of the field.

Field Staff - Field medics	They are the medical and para-medical staff of the temporary field treatment, usually they are medical staff performing the tasks and communicating with the incident commander.
Transport Crew	It is the crew of any vehicle, which takes patients from the incident field to the first receiver
First Receiver Staff	It is the staff at the place the patients are transferred for hospital care after being triaged and treated on the field. Usually, a first receiver is a hospital, appropriate to the situation. In disasters where infrastructure is damaged, a first receiver can be an adapted environment, such as a field/tent hospital, a school etc.
Bystander	They are people close to the incident field, who do not require emergency medical help and want to assist in the emergency management. They can support the EMS units by providing information, by undertaking some tasks depending on the needs of the incident commander. Usually, a bystander acts like a Caller, but he/she can be also a victim.
System administrator	Usually, a super user who can access all parts of the system and offer operational support to the actors.
System	This is the CONCORDE platform itself. It is considered as an actor, responding appropriately to user actions and requests and performing pre-scheduled tasks.
Victim/Patient	These are actors of the incident not of the system who require emergency medical help, usually for the treatment of injuries.

Table 3-1: Identified Actors from COncORDE

The above actors undertake different tasks in an emergency response incident, according to their role. COncORDE will store data that the actors insert in its database in order to have the whole information about the incidents. In addition to the information that will be given by the actors directly through the COncORDE interface, the database of COncORDE will store the processed data from the field that will be given from the sensors (e.g., Drones, robots etc.) and processed data from existing Databases which will be stored in Data Lake. All the knowledge will be stored in a suitable format for the needs of the DSS and S&R operation.

3.6 Lessons Learnt

The lessons learnt tool must retrieve the data of an incident. The properties of the SA ontology make the information retrieval an easy procedure since the model collects all the metadata of the incident and returns them to the tool. With this approach, the analyst will be able to explore the decisions and the operations that were made at that incident, i.e., High Commander's decision, First Responders' trajectories etc. For example, an Analyst would like to explore all the information about the incident. The lesson learnt tool uses the SA Ontology to retrieve all the correlated data about that incident. A possible approach on the interactions is illustrated in the following figure. More details on this will be released as an outcome of T6.5 "Design of an aftermath knowledge capitalisation mechanism" in M16.

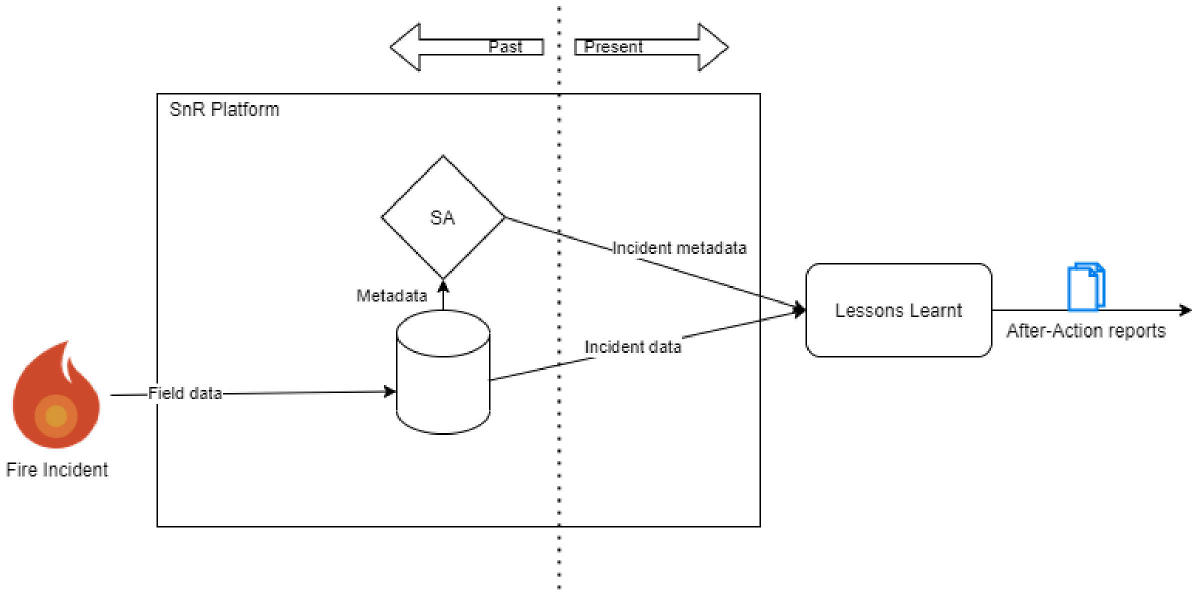

Figure 3-1: SA & Lessons Learnt Data flow connection

4 Requirement to SA in Use Cases

4.1 Situational Awareness model in Use Cases

The SA model has a critical role in real-time crises since it provides important information and representations about the overall situation. That role is to summarize the vast amount of data that the S&R systems are fed with, produce semantically enhanced information and deliver it, with a proper representation format to the different levels of crisis management. The best way to understand this role and functionality is to describe it through a use case scenario instance.

4.2 Phase A – Event initialization

Taking the UC1, as an example, victims trapped under rubble, without loss of generality, it is assumed that this situation came from an earthquake. The caller informs the High Commander and the latter fills the Incident Details form in COncORDE with the event type, location and the first estimation of the number of injured information, among others. Then, the DSS services will be triggered and will produce a first estimation of victims and a recommendation of resource allocation. The High Commander dispatches the required First Responders and the PSAP is settled at the crisis location, along with the field devices and sensors.

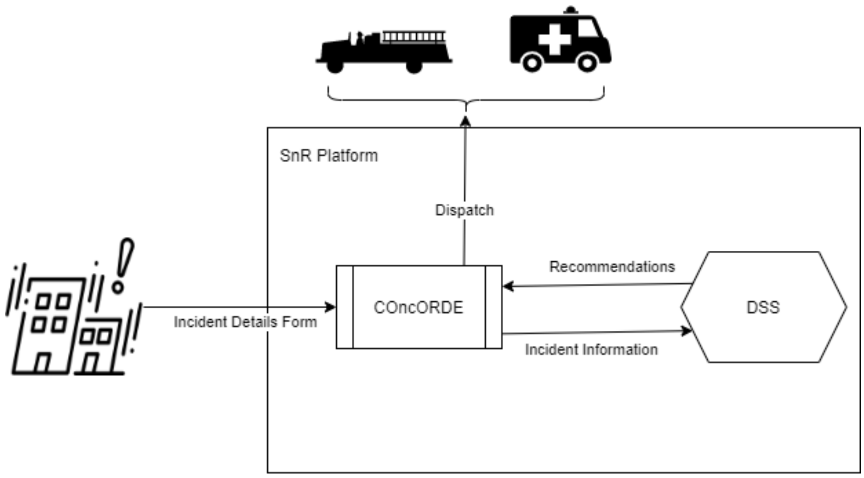

Figure 4-1: Event initialization

4.3 Phase B – Data field to semantics to notifications and decisions

The first responders report that they have freed two victims from the rumbles. In the meantime, a nearby sensor receives a high value of a dangerous gas from a broken gas tube. The data passes through the S&R Data Aggregation mechanisms in order to be homogeneous. Then, the SA utilizes this data and creates an output situation "Possible explosion at location A". Then, considering the governance model's rules, this information is converted into 3 messages to notify the three levels of crisis management:

- "Possible explosion at location A, dispatch fire trucks" to High Commander
- "Possible explosion at location A, define tasks accordingly" to Field Commander
- "Possible explosion at location A, evacuate the area" to First Responders

Alongside, the DSS receives the potential situation, triggers its services with the updated and:

- estimates the number of victims (considering the explosion and the nearby people)
- recommends a new allocation of EMS (extra ambulances and fire trucks)
- recommends a halt to the allocation of patients, with minor injuries to ambulances, since the system estimates that there will be patients with major traumas soon
- recommends a new allocation of tasks based on Field Commander's orders

After a while, the drones' human detection algorithm identifies 5 more people, trapped under rumbles. It is worth noting that UC1 does not include drone technologies, but it is mentioned here for the sake of the example. This information will be combined as follows, with the location of the drone, i.e., location B, through the ontologies' associations, producing a situation "People found from drone". Following the same procedure as above, three messages are created:

- "People found under rumbles" to High Commander
- "5 people found under rumbles, send rescue team" to Field Commander
- "5 people found under rumbles at location B, proceed to rescue" to First Responders

The DSS is updated with the new information and it executes its services, producing the recommendations, accordingly, in order to make decisions. During those procedures, the SA stores the information flow, the final decisions and procedures that the users made i.e., High Commander's decision, First Responders' trajectories etc. It is important to mention here that the previous messages and procedures are a simple example and do not comply with the official rules and procedures.

4.4 Phase C – Lessons Learnt

When the emergency has finished, the lessons learnt tool must retrieve and present all the procedures and decision made during the crisis. The Situational Awareness exploits its ontology methods to obtain the incident related metadata, from the Data Lake, along with the situational chain i.e., "Earthquake"->" Possible Explosion"->" People found" etc. The Situational Awareness is key component to lessons learnt tool, because it summarizes the situation and concentrates the data in order to represent the important information at the post-action report.

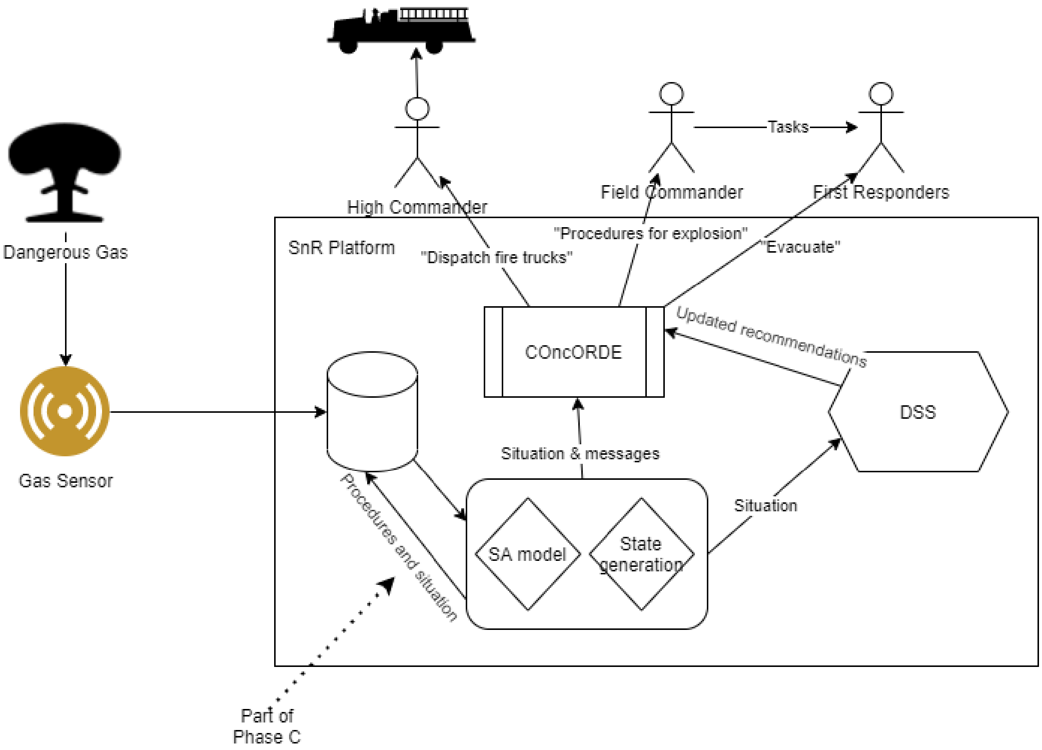

Figure 4-2: SA during event & Lessons learnt

5 Conclusion

In the current deliverable, the requirements to the knowledge management in the S&R and the SA model were presented thoroughly. The management of knowledge in the SnR project needs to keep access to a variety of data and information items, in order to support the emergency response and the decision-making process of the project. A key piece of knowledge required is the actual resources of the project. All this knowledge will be enriched with the information of the final governance model in order to have a complete and reliable system given to actors in the incident for better planning and decision making.

Annex I: References

[1] Azadehdel, R., Ahmadi, K. D., Azadehdel, M., & Enami, N. (2012). Effective model based on the role of leadership structure and information system in the field of crisis management. African Journal of Business Management, 6(5), 1967-1983.

[2] KT's Technical Documentation CONCORDE v0.2 https://alfresco.epu.ntua.gr/share/page/site/search-rescue/document-details?nodeRef=workspace://SpacesStore/bf0c1995-674c-4102-89be-e2f05b8a78d0

[3] Van de Walle, B., Brugghemans, B., & Comes, T. (2016). Improving situation awareness in crisis response teams: An experimental analysis of enriched information and centralized coordination. International Journal of Human-Computer Studies, 95, 66-79.