beAWARE: Enhancing Decision Support and Management Services in Extreme Weather Climate Events

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1. Introduction

Climate conditions are expected to change worldwide. This includes an increase in intensity and frequency of (among others) extreme weather events. As a result, flooding, droughts, fires, etc. will become more common in the future. No matter the cause and kind, all major disasters require an immediate, comprehensive, and professional response. Major disasters create extreme stresses on every member of a community. As human population increases and the world's climate changes, we are seeing an increase in the intensity of disasters. Until now, a splintered structure dominated the emergency management landscape, leaving each community or county responsible for preparing for the disasters. This fragmented system often created significant risk exposures to communities, and limited resources resulted in significant loss of life and property. Disaster planners and responders should be able to use a wide variety of technologies and tools to assist them during an incident.

The overall context for beAWARE lies in the domain of situational awareness and command and control (C2). The first phase concerns the forecast of the extreme condition and the relevant preparations. Once a disaster occurs, an initial assessment needs to be conducted as soon as possible to determine the scope, geographical distribution, and scale of the incident. Situational awareness means being able to accurately determine what has happened, what is happening now, and what will come next, all in order to plan and coordinate the most effective response possible with the resources available. This observation phase will lead to an orientation phase suggesting both an individual as well as collective "cognition" orientation to data that is sensed and communicated. Once orientation to the data (or the lack of it) occurs then a decision is made, ultimately resulting is the final step, which is "act". The crisis management center is always striving or struggling to gain a sense of what is reality to be able to feel that he or she can

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make a decision that is the "best possible" given the circumstances. Then, a decision is made at the smallest deployable/operational unit or a higher level of the C2 function. Integral to the “act” step is the ability to communicate the action suggested and then monitor the action (feedback loop) in order to determine whether it resulted in the expected change to the situation. Getting the right people and resources to the right place at the right time will be the essence of the command and control aspect of the disaster response for our approach.

2. Context

Crises and disasters are unwelcome, but also unavoidable features of modern society. They can emerge within any domain, may be of human or of natural origin, and can last anywhere from hours, to days, to months and beyond. Weather-related disasters – such as droughts, floods, landslides, storms, fires and sometimes epidemics and pest outbreaks – far outstrip other types of disasters, and are affecting more communities than ever. When a hazard occurs, it exposes a large accumulation of risk, unleashing unexpected levels of impacts. While sometimes the crisis itself is the undoing of an organization or society, it is the way that we response to crises that often makes the difference between catastrophe and greater resilience. The emergency preparedness and response application challenge is mainly concerned with the interaction between humans and their environment under conditions thought to be hazardous to either life or habitat. This application challenge is not only multifaceted as its title implies but also covers a wide range of disasters, many with fundamentally different underlying processes (such as earthquakes, hurricanes, and wildfires). Even though the processes that generate the disaster might be fundamentally different, techniques to assess risk, evaluate preparedness, and assist response appear to have much in common and can share and benefit from advances in mobile technologies, communications, video analytics, geographic information science (such as data acquisition and integration; data ownership, access, and liability issues; and interoperability) and information technology in general. In order to assess and mitigate risk to human life and property, and in order to respond effectively, we must develop predictive and operational models that are embedded within command & control solutions. A post-disaster statement might conclude that if we knew then what we know now, we could prevent or at least reduce the risk, damage, and loss and shorten the recovery period. Since command and control and related technologies provide an operational forum for realizing this statement, deep understanding of the challenges for command & control solutions arising from disaster management.

3. beAWARE Objectives

In this context, we aim at developing a novel framework for crisis management that manages and support authorities and end users before and during a crisis. The overall research challenge in building effective command and control for emergency management can be viewed as one of delivering accurate, appropriate information to all the parties involved in a disaster at the proper stages of the disaster in a timely manner.

beAWARE is based on specific innovation objectives:

Obj.1 – Perform a research study on the requirements for emergency services given the current digital landscape (i.e. end user in emergency need, PSAP operator, first responder). The aim of this objective is to identify the needs for emergency services with the current accessible digital landscape. The research will be the base for targeting the gaps in e.g. the present warning technologies and make improvements with the aim of filling the gaps.

Obj.2 – Multilingual speech and written communication analysis in emergency calls The capability to grasp the content of the message transmitted by the caller during an emergency call is very crucial in the context of beAWARE.

Obj.3 – Aggregate multimodal information from sensor networks, meteorological stations, etc. and social media for decision support and validation purposes and issue early warnings. Machine-to-Machine and Internet-Of-Things platforms are resources for collecting real-time participatory and opportunistic sensing information that can be utilize to detect an emergency or enhance the contextual information of dedicated physical vicinity. Information distributed over several Web resources, including forums, blogs, and social networks will be gathered, and content pertinent to specific topics related to emergency events will be crawled and extracted.

Obj.4 – Visual context analysis during emergency calls. This objective aims at understanding the visual context of the person calling in an emergency. This includes the global understanding of the situation based on visual data such as images and transmitted video.

Obj.5 – Semantic integration of multimodal information from the emergency calls, M2M/IoT platforms and social media for decision support and generation of early warnings. The key direction of this objective will be to research and develop technologies for semantic integration of the diverse multimodal content from social networks and blogs to enable reasoning for decision support in the PSAP, as well as for the generation of early warnings.

Obj.6 - Multilingual report generation from aggregated emergency data. In the scope of this objective, beAWARE will research and develop techniques for generation of multilingual written information of different kinds from ontological representations.

Obj.7 – Research & development of Main Public Safety Answering Point (PSAP) for emergency multimedia enriched calls Develop a PSAP. This objective will deal with the research and development of the main public safety answering point (MAIN-PSAP) that will provide a platform for integration of multiple unconnected security applications and devices and control them through one unified user interface.

4. The concept of beAWARE

Instead of focusing on a specific part of the crisis management problem (e.g. information routing), beAWARE proposes a holistic approach (Fig. 4) to the realization of crisis management framework that it will support all the phases in an emergency call sequence. The overall objective of beAWARE is to provide an integrated solution for new decision support services based on aggregated analysis of multimodal data and previous crisis management records. beAWARE will address the needs of the main sectors of the security emergency procedure, namely first responder and PSAP. Moreover, beAWARE aims to bring first responders, PSAP centres and forecast services to collaborate together in order to

explore new ways of working and delivering more effective outcomes. The beAWARE will perform a research study on the requirements for emergency services given the current digital landscape and the special needs of the people in danger during a crisis. These requirements will be the base for all the forthcoming implementations and methods.

beAWARE approach for integrating the disabled back into workforce

5. beAWARE system architecture

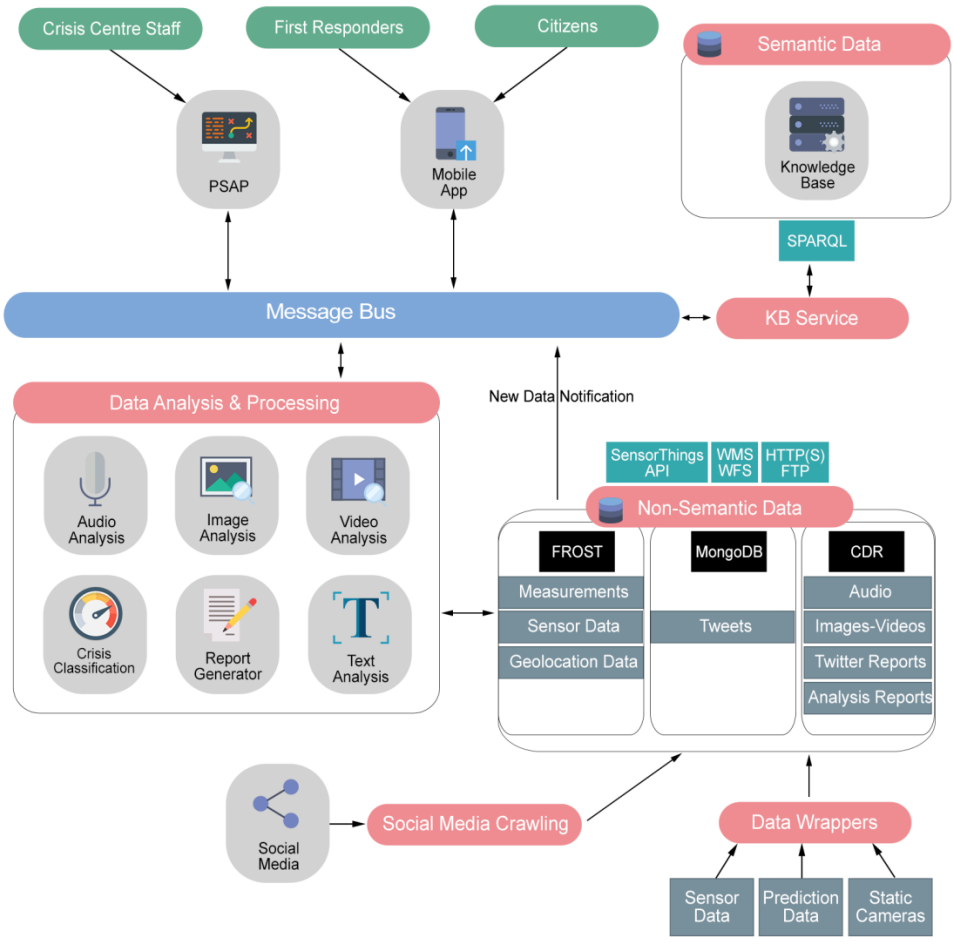
In this section we present the initial system architecture of our proposed crisis management system. The proposed architecture aims at satisfying the user needs and the objectives set in the previous sections. In addition, beAWARE architecture is formulated with the goal of providing accuracy and functionality for decision support systems to be able to respond well to weather related disaster scenarios.

The architecture is roughly made up of the following layers:

1. Ingestion layer, containing mechanisms and channels through which data is brought into the platform;
2. Internal services layer, is comprised of a set of technical capabilities which are consumed by different system components. This layer includes services such as generic data repositories and communication services being used by the different components;
3. Business layer, containing the components that perform the actual platform-specific capabilities;
4. External facing layer, including the end-users' applications and PSAP (Public-safety answering point) modules, interacting with people and entities outside the platform (end-users of the platform).

6. Pilots

beAWARE testing and validation will be based on three pilots. The aim of the pilots is to better use the weather forecast and other technical aspects in preparing for floods, fires and heat waves. The better we are at preparing, the better the response will be. Furthermore, the purpose of the pilot is to test the preliminary results and findings, to correct any shortcomings and thereby deliver a thoroughly tested result. During the implementation of the project, 3 large scale pilots will take place, covering different



Architectural high-level view

scenarios. The scenarios will cover various aspects of the framework's goals and will be developed using the extensive experience of end users. All aspects and procedures of the proposed scenarios will be developed with the participation of various end users, each providing feedback based on its expertise.

The three proposed scenarios will have the following outline:

1st large scale pilot exercise – Flood (Italy): To support decision makers in the Italian Eastern Alps region during unplanned events (emergencies), in particular floods and flash floods, beAWARE will develop an environment capable of creating analysis and exploration tool that allows decision makers to track and understand events, behaviours and trends at the micro (i.e. user) or macro (crowd dynamics) scale.

2nd large scale pilot exercise - Fires (Spain): pose a threat to humans, animals and infrastructure and can in a short time create a lot of damage and heavy negative economic consequences. The fires can be influenced by the weather as periods of dry weather increases the risk of fires in the nature, and heavy

winds can cause a wide spreading in a given direction. It is also important to use forecast and warning systems in the handling of the public and influence on their behaviour to minimize risk of fire. beAWARE technologies will help in the early stages of the development of fires and support decision makers in the emergency management system.

Flood in Vicenza, Italy

3rd large scale pilot exercise – Heatwave (Greece): A strong heatwave occurred during summer in a region in northern Greece. During the relative period, very high temperatures (over 40ºC) occurred throughout northern Greece. beAWARE system will offer an early warning regarding the upcoming phenomenon, as well as assist all relative engaged organizations in taking the necessary measures in order to avoid past problems and address the heatwave more efficiently. Furthermore, it will assist fire department with real time local data in assessing the level of threat regarding the possibility of a forest fire.

7. Conclusion

beAWARE is tackling ambitious objectives in order to address the challenge of rapid response during a crisis. The consortium is well balanced with partners coming from the domains of ICT, text analysis, domain experts and emergency responders. beAWARE deals with the whole lifecycle of emergency call management from mobile devices, where issues such as data analysis, forwarding to first responders have been addressed by the partners and efficient solutions have been proposed. This paper presents the framework of a novel crisis management system. Future work includes realization of the components, development of an integrated platform and testing with realistic pilots.

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