beAWARE

Enhancing decision support and management services in extreme weather climate events

700475

7.5

Integrated beAWARE platform 2nd version

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Abstract

This document describes the implementation of each component and the integration stage of the second version of the beAWARE platform. It provides an overview of the integration status of the different components the hosting infrastructure and the improvements that are performed since the first version (D7.4). The Second Prototype is the updated version of the platform that integrates improved features of the 1st Prototype combined with new services.

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at its sole risk and liability.

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Author list

Organisation	Name	Contact Information
CERTH	Ilias Koulalis	iliask@iti.gr
IBM	Benjamin Mandler	MANDLER@il.ibm.com
IOSB	Philipp Hertweck	philipp.hertweck@iosb.fraunhofer.de
IOSB	Tobias Hellmund	tobias.hellmund@iosb.fraunhofer.de
CERTH	Anastasios Karakostas	akarakos@iti.gr
CERTH	Stratos Kontopoulos	skontopo@iti.gr
CERTH	Stelios Andreadis	andreadisst@iti.gr
CERTH	Gerasimos Antzoulatos	gantzoulatos@iti.gr
CERTH	Panagiotis Giannakeris	giannakeris@iti.gr
CERTH	Emmanouil Michail	michem@iti.gr
UPF	Gerard Casamayor	gerard.casamayor@upf.edu
MSIL	Itay Koren	itay.koren@motorolasolutions.com

Executive Summary

The D7.5 of the beAWARE platform provides a technical overview of the development and integration of the second prototype, explains the second version improvements with respect to the first prototype and the new features, which took place during the development and the integration.

The objectives for this second prototype were:

- The integration of newly delivered and second version of existing beAWARE services,
- The optimisation of the platform to be aligned with the new functionalities and the updated user's requirements.

The deliverable summarises the status of all the services that are integrated in the second prototype for a video demonstrator.

Abbreviations and Acronyms

API	Application Programming Interface
ASR	Automatic Speech Recognition
CDR	Central Data Repository
CI	Continuous Integration
DA	Drones Analysis
DTr	dynamic texture recognition
DTstL	Dynamic Texture spatio-temporal localization
EFAS	European Flood Awareness System
FIFO	First In First Out
GPU	Graphics Processing Unit
GUI	Graphical User Interface
JSON	JavaScript Object Notation
KB	Knowledge Base
KBR	Knowledge Base Repository
KBS	Knowledge Base Service
K8s	Kubernetes
MS	Milestone
M2M	Machine-to-machine
MSB	Message Bus
MTA	Multilingual Text Analyser
MRG	Multilingual Report Generator
ObjD	Object detection
OWL	Web Ontology Language
PSAP	Public-safety answering point
P2	Prototype 2
REST	Representational State Transfer
SMA	Social Media Analysis
UC	Use Case
VRS	Visual River Sensing
WP	Work Package
XML	Extensible Mark-up Language

Glossary

Term	Meaning in beAWARE
A	
Audio Item	Audio recording.
B	
Building	A structure with walls and a roof and usually windows and often more than one level, used for any of variety of activities, as living, entertaining, or manufacturing (e.g. a house or factory).
C	
Crisis	Situation with high level of uncertainty that disrupts the core activities and/or credibility of an organization and requires urgent action.
Crisis Management	Management process that identifies potential impacts that threaten an organization and provides a framework for building resilience, with the capability for an effective response that safeguards the interests of the organization's key interested parties, reputation, brand and value creating activities, as well as effectively restoring operational capabilities. Crisis management also involves the management of preparedness, mitigation response, and continuity or recovery in the event of an incident, as well as management of the overall programe through training, rehearsals and reviews to ensure the preparedness, response and continuity.
Crisis Classification Component	In the content of beAWARE project, it is a component which integrates and deploys the necessary technological solutions enabling stakeholders (authorities, first responders, citizens) to (a) timely aware them for an upcoming extreme natural event by acting as an Early Warning System; (b) provide real-time monitoring of the ongoing crisis, facilitating the risk assessment and decision support processes via the PSAP (Public Safety Answering Points) component.
Classification	The action or process of classifying something.
Communication	Any type of (tele) communication infrastructure.
D	
Damage	Combination of exposure and vulnerability
Data Analysis	A type of a task involving data analysis.
Disaster	The occurrence of physical event who causes negative impact, such as a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.
Drone	an unmanned aircraft or ship guided by remote control or onboard computers
E	

Term	Meaning in beAWARE
Early warning	The provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response.
Early warning system	The set of capacities needed to generate and disseminate timely early warnings.
Energy	Any type of energy-generating infrastructure.
Exposure	The presence of people, livelihoods, environmental service and resources, infrastructures, economic and social and cultural assets in areas or places that are subject to the occurrence of physical events and that thereby are subject to future potential negative impact
F	
Forecast	Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.
Forecasting model	Numeric representation of a physical phenomenon, which - starting from input data (other forecasts, measures, etc.) - solves by numerical techniques its internal equations and provides forecasts as output data.
Flood	An overflow of a large amount of water beyond its normal boundaries, involving an area usually dry, triggered by various events (rainfall, snowmelt, exceeding of a drainage network, ...)
Flood forecasting model	a forecasting model which provide estimation of hydraulic variables (such as water level, velocity, depth…) in a specific domain from meteorological forecasts or measure as (intensity of rain, humidity, temperature…) provided as input
Flood map	Hazard outcome in case if flood, expressing the spatial distribution of the intensity of the flood in terms of depth, persistence or velocity
H	
Hazard	The occurrence of a physical event with a certain probability and intensity. Unlike the disaster, hazard may not cause any negative impact
Heatwave	A period of abnormally and uncomfortably hot and usually humid weather
Human	Human beings in danger.
I	
Image Analysis	The task of extracting useful information from still images.
Image Item	Captured image.
Impact	The impact of natural disasters and incidents.
Impact Type	The various types of impacts, like human, economic, and environmental impacts (e.g. injuries, damage to properties etc.)
Incident	The various incidents taking place during a natural disaster.
Incident Type	The various types of incidents, like e.g. floods, blocked streets etc.
L	

Term	Meaning in beAWARE
Living Being	Any living being that is in danger during a natural disaster.
Location	A location (point or area), indicated by latitude, longitude, and radius.
M	
Mission	A mission assigned to a rescue unit during a crisis.
Monument	A structure or building that is built to honour a special person or event.
N	
Natural Disaster	The actual manifestation of a natural disaster type. An instance of a natural disaster has specific climate conditions with specific values (e.g. temperature = 45) plus some other properties (e.g. start/end time).
Natural Disaster Type	The various types of disasters, like e.g. floods, forest fires, storms or earthquakes etc.
P	
Police	Law enforcement infrastructure and services.
Preparedness	The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent or current disasters.
Prevention	The outright avoidance of adverse impacts of hazards and related disasters.
Priority	The condition of being regarded as more important than others are.
Property	Any type of private property.
Public awareness	The extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards.
Public information	Information, facts and knowledge provided or learned because of research or study, available to be disseminated to the public.
R	
Recovery	The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.
Relief Place	a position or the state of being covered and protected
Resilience	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.
Responder	A first responder unit (e.g. a firefighter, police officer or emergency medical physician).
Risk	The combination of the probability of certain hazard to occur and of its potential negative consequences.

Term	Meaning in beAWARE
Risk assessment	A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.
Risk management	The systematic approach and practice of managing uncertainty to minimize potential harm and loss.
Risk map	Spatial distribution of risk in a certain area, obtained by evaluation and combination of hazard, exposure and vulnerability in each point of spatial grid od a certain size
River Section	graphic representation of a river obtained by the intersection a river reach with a vertical plane usually orthogonal to the main direction of the flow
S	
Scenario or operational scenario	environmental and ecological context of the natural disaster and its impact of the elements at risk and stakeholder assets
Sensor	A Sensor is an instrument that observes a property or phenomenon with the goal of producing an estimate of the value of a parameter.
Severity	Measure of the possible consequences of a hazard, for example given by the comparison between a measurement or forecast of a weather variable (e.g. temperature, water level, rain …) and one or more predefined alert thresholds.
Stakeholder	Every subject (person or groups) who holds interest or concern regarding a certain action, objective, project and can be affected by it or can affect it.
Street	The road network infrastructure.
Subway	Subway infrastructure.
T	
Task	A task that has to do with analysing or processing items.
Text Analysis	The task of analysing textual corpora.
Text Item	A piece of text.
Transportation	Transportation services and infrastructure.
Technical requirement	formalization, standardization and elaboration of the user requirement specification and allocation in the beAWARE subsystems
U	
Use Case	conceptual description of intended or expected utilization of the beAWARE system to prepare for, respond to, or act upon the occurrence of the scenario
User Requirement	expectation, request, guidelines for functionalities, capabilities, conditionalities and features that would facilitate the successful completion of an use case

Term	Meaning in beAWARE
V	
Video Analysis	The task of extracting useful information from video sequences.
Video Item	A video recording.
Vulnerability	Susceptibility or predisposition for loss and damage to human being and their livelihoods, as well as their physical, social and economic system when affected by hazardous physical event.
W	
Water depth	the height of the water (in a river section, channel section, section of a pipe, specific point of flooded area) measured from the bottom or the ground
Water Level	The height of the water (in a river section, channel section, section of pipe, specific point of a flooded area…) measured from well-defined zero (i.e. the mean sea level)
Weather station	Q place equipped for measure weather, meteorological, hydrological or hydraulic data

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1 Introduction

In this document we provide a description of the second version of the integrated beAWARE platform (P2), due M24 (December, 2018). The presented platform state is a continuation of the plan defined in D7.3 “Integrated operational beAWARE platform “and D7.4 “Integrated beAWARE platform 1st version and technical evaluation report”. The Architectural Design, continued with the specification of the mechanisms described in D7.2 “System requirements and architecture”. The goal of revising the integration plan is to support the development by guiding the integration of the software components towards the final version of the beAWARE platform, with the agreement on identified interfaces.

The document is structured in 6 sections: Section 2 provides a high-level technical overview of the prototype. Section 3 details the integration status of the components. Section 4 details the technical infrastructure hosting the prototype. Section 5 contains video link and details about the demonstrator as well as the sequential steps followed for the interoperability assessment. Finally, Section 6 summarizes the conclusions and presents the future work.

Overall, during the development process, many challenges like integration between different technologies, component interconnection, shared usage for some functionalities, etc. were tackled. Many technical issues regarding dependencies between services and 3rd party libraries were addressed, in order to obtain a stable and coherent product.

1.1 Integration Overview and current status

In D7.1, a technological roadmap was established, which determined the main attributes and timelines for the development of the different components of the beAWARE platform and described an iterative approach from the initial operational prototype towards the final version of the beAWARE platform. The “walking skeleton” for this technical roadmap is presented below:

During the first year of the project the main goal was to provide an initial operational version of the prototype which could allow a fast and easy integration framework including dummy services and services with limited functionality.

In the second step of the implementation and according to the expected timeline for MS3, a first version of a functional prototype was successfully presented.

In this third step of the implementation and according to the expected timeline for MS4, an updated version of the prototype is presented, followed by further improvements and new implementations to cover the requirements set by the end users.

1.2 Integration approach

The system development, as already described in Deliverable 7.2, follows an iterative approach, from an initial dummy prototype to the final version, and follows the following cycle:

1. Integration Prototype: Dummy end-to-end architecture; most service dummies in place, operating on test/mock data. This is expected by the end of the first year of the project as a part of MS2.
2. First Prototype: Using real services from WP3-WP6; First Prototype milestone (MS3), expected at M18.
3. Second Prototype: Using real services from WP3-WP6; Second Prototype milestone (MS4), expected at M24.
4. Final System: Complete beAWARE platform; Final System milestone (MS5), expected by the end of the project (M36).

This approach promotes continuous iterations of development and testing throughout the software development cycle of the project. The objective is to combine gradually and test the interface between the key components and eventually to expand in order to test all the integrated components of the platform fulfilling a complete flow that describes a Pilot Use Case scenario.

According to the expected timeline for MS4, the second SW development cycle of the project. stands for the successful delivery of the second version of the platform integrating: advanced techniques for social event detection, extended data integration functionalities, full functionality of the Early Warning component, a 1st version of the drones platform, extended coverage of linguistic expressions in all supported languages the 1st version of the Operations and Incident manager etc.

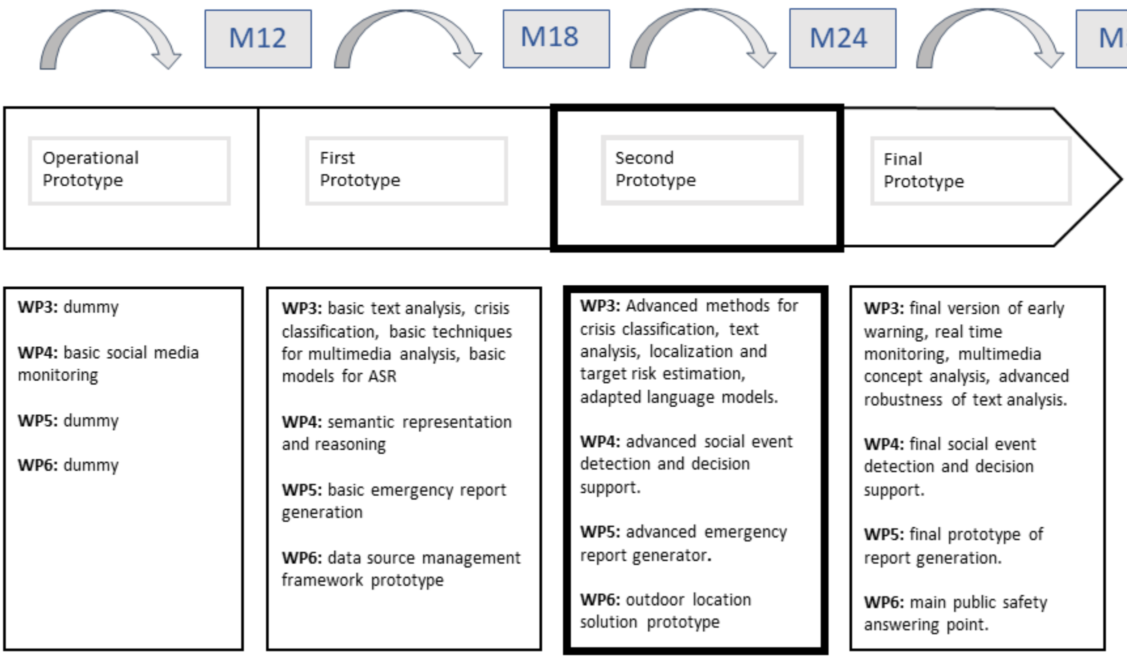


Figure 1: beAWARE walking skeleton

2 Second Prototype Architecture

In this section a high-level overview of the beAWARE platform architecture, explaining the components forming the system from a functional standpoint, is provided.

The global architecture of the beAWARE platform has been discussed at length in D7.1, D7.2, D7.3 and D7.4.

During work on the Second Prototype, the focus was on improving established services, developing and performance optimisation. Significant improvements in platforms' modules were made in comparison to the First Prototype, by advancing technologies previously presented in their basic form. Furthermore, new services are introduced such as the drones platform and the analysis module to analyse the input of this platform.

An overview of all the components, in this second version of the platform, with a functional description the improvements carried out as well as their dependencies is given in the following subsections.

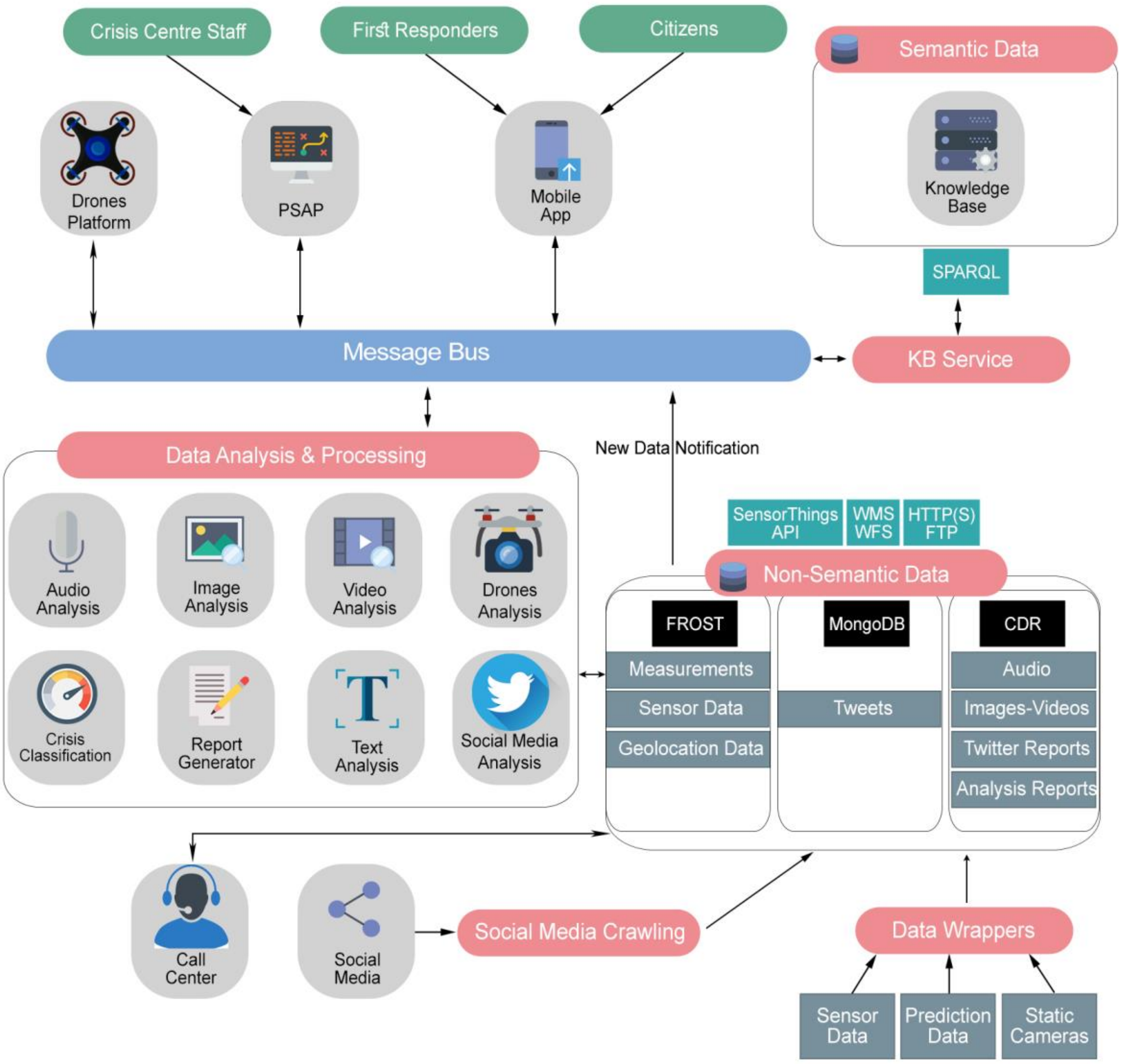


Figure 2: Architectural high-level view

2.1 Global view

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).

The complete set of functional dependencies between all the implemented components and their technical description can be consulted in the corresponding Deliverables.

2.2 Ingestion Layer

This layer serves as the input mechanism into the platform. The mechanism has been described in detail in D7.4. Ingestion layer consists of two modules: The Social Media Monitoring and the Monitoring machine sourcing information.

2.3 Business Layer

This layer encompasses the components that provide the actual platform specific capabilities. Improvements were made to the modules to meet the requirements of the second prototype.

2.3.1 Knowledge Base (KB)

The Knowledge Base (KB) constitutes the core means for semantically representing the pertinent knowledge and for supporting decision-making. It is based on the beAWARE ontology (see D4.2), which uses a well-defined formalism (OWL – Web Ontology Language). The beAWARE ontology encompasses, amongst others, information regarding domain knowledge (types of crises, risks and impacts), analysis results of multimodal input (image, video, text and speech) and contextual information, climate and environmental conditions, geolocations, as well as aspects relevant to events and time.

For more details about the beAWARE ontology, we refer to D4.2 Semantic representation and reasoning where it is described in detail. To host the ontology the WebGenesis content management system (CMS), developed by the beAWARE partner IOSB is used. Unlike other CMS, WebGenesis is able to host and manage ontologies. For information retrieval, a standardized SPARQL-interface is available. For manipulation or storage of semantic data, a REST interface is offered. Both interfaces are described in more detail in the just mentioned

D4.2. Like shown in the architecture picture, these are accessed through the Knowledge Base Service (KBS) enabling interaction with other components using the message bus.
Besides these APIs used by other components, the Knowledge Base offers a user interface to visualize and navigate through the whole ontology, including the available concepts as well as the information represented by the instances.

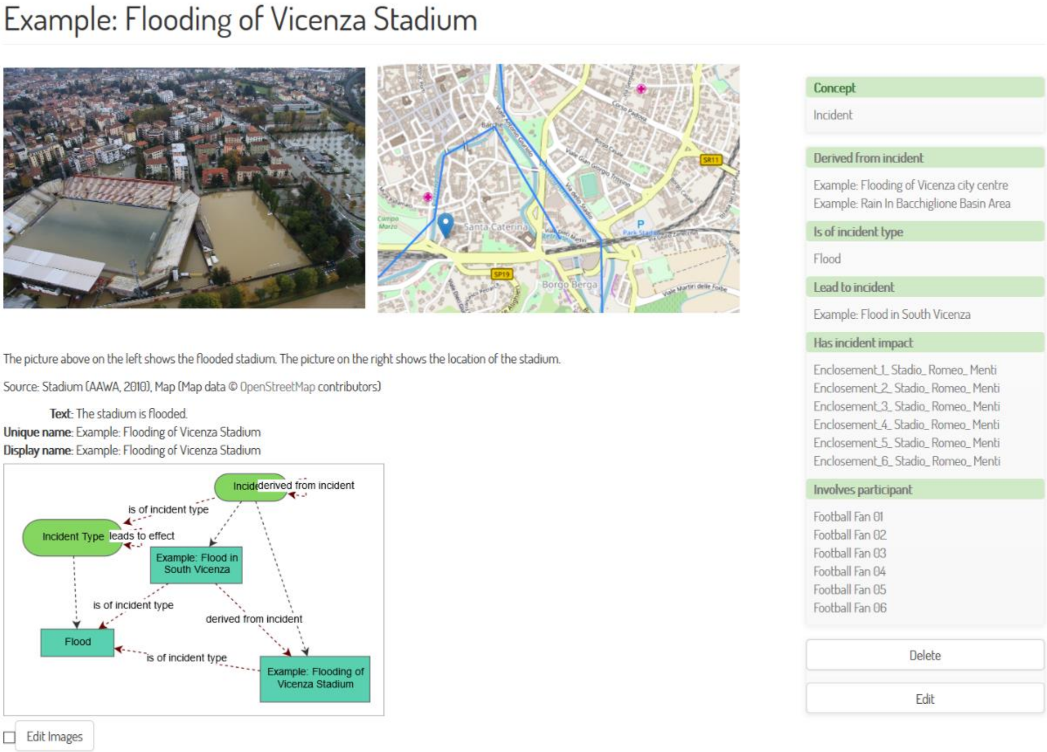


Figure 3 shows the information available for an incident. On the one hand, there is the data describing the incident itself, for example the available text. On the other hand, the semantic relations are displayed on the right side and can be used to navigate through the data. In addition, a visualization of the semantic relationships is offered (see

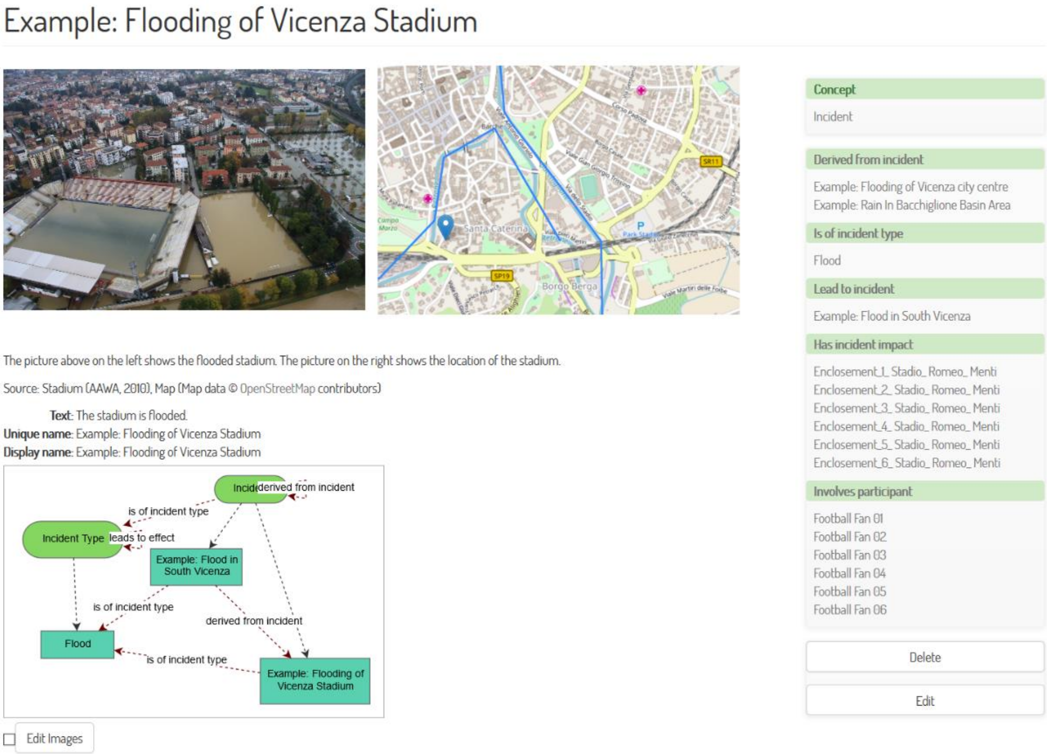


Figure 3, lower left side).

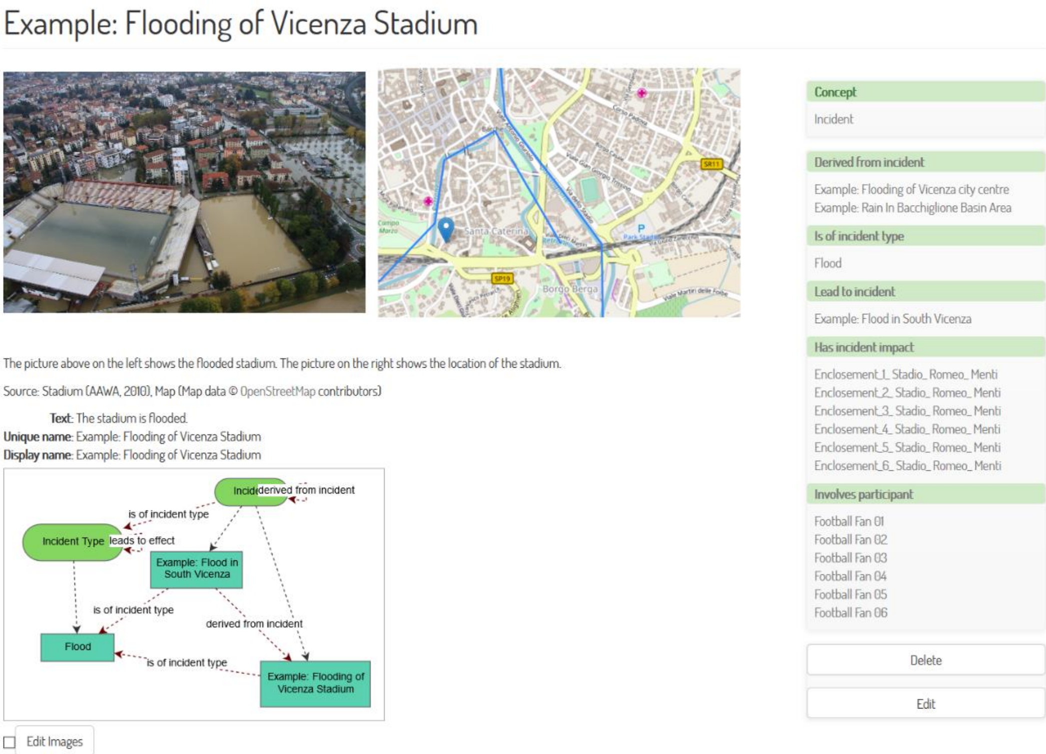


Figure 3 Visualization of an incident in the Knowldge Base

Geospatial information can be visualized on the map (**Error! Reference source not found.**). his includes semantic data containing location information, for example incidents as well as time series data coming from the FROST-Server (see section 2.4.2). On the map shown in Figure 4 the weather stations and river sections in the Vicenza region are visible. By clicking on those, an interactive graph (**Error! Reference source not found.**) is prompted which can e used to browse through the sensor data.

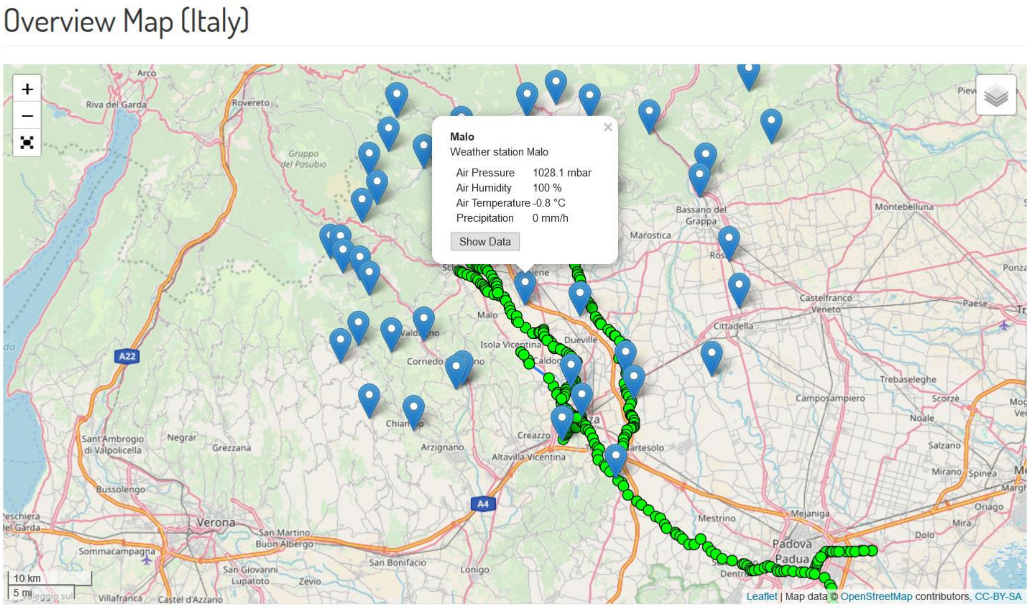


Figure 4: Visualization of geospatial information

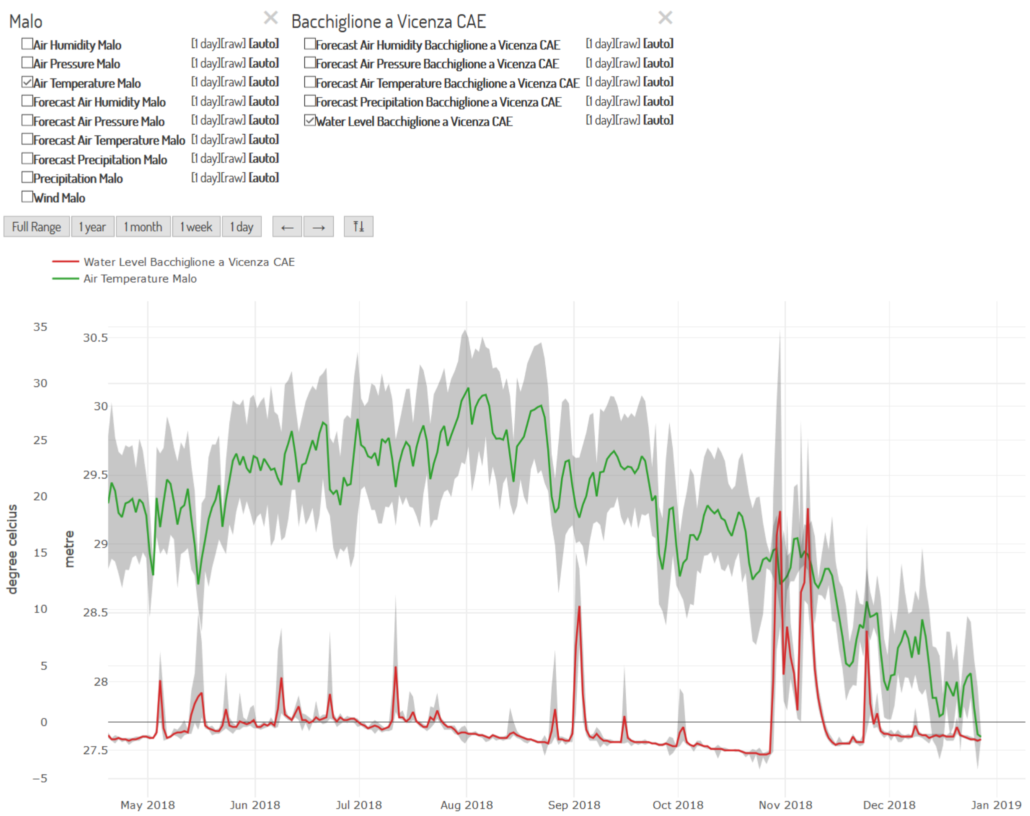


Figure 5: Visualization of the available sensor data

Through an external Ontology endpoint, knowledge stored in other KBs (such as WikiData) can easily be integrated into the beAWARE Knowledge Base and be visualized on the map

The KB also provides facilities for the retrieval of multipurpose, heterogeneous information, supporting this way a large set of the beAWARE system features, such as the visualization of diverse geospatial data on maps and dashboards. The KB can also accommodate external knowledge stored in other KBs (such as WikiData), which is publicly available under the principles of Linked Open Data.

2.3.2 Knowledge Base Service (KBS.

The Knowledge Base Service (KBS) is a sophisticated middleware that handles storage, processing and retrieval of system data from the KB. In a nutshell, it acts as a communication proxy, receiving inputs from various components and informing other components.

Besides monitoring the message bus and storing/exchanging information, the KBS incorporates a semantic reasoning mechanism for semantically enriching the beAWARE KB with incoming information, and for inferring underlying knowledge and discovering interlinkages between incidents during a crisis. This mechanism is rule-based, implemented as an elaborate SPARQL-based ruleset coupled with appropriate Python code. More specifically, it falls under the KBS' jurisdiction to calculate the severity level of reported incidents, based on rules that resemble the human reason. Consequently, the KBS classifies such incidents into clusters, based on spatial data, and, then, updates the severity levels per cluster. Another fresh KBS feature is that it is now capable of monitoring the human occupancy levels at places of relief - based on incoming images and videos – and, using the existing knowledge of each place's capacity, it calculates the occupancy index per such place to be displayed on the dedicated dashboard.

Finally, a validation process of incoming data is intended to be integrated, with existing methodologies currently being under inspection. In detail, a two-layer validation approach will be developed to filter fake or inappropriate system information during a) the collection of data by the various system components, and b) the data storage by the KBS and its association with existing ground truth knowledge originating from, for instance, system sensors (water level data, weather data, etc).

2.3.3 Social Media Analysis Modules

Social Media Analysis (SMA) comprises two separate modules.

The first module, having the same name, i.e. Social Media Analysis, exploits Twitter's Streaming API[1] to collect social media content in four languages (English, Italian, Greek, Spanish) that contain predefined keywords regarding flood, fire, and heatwave incidents. A three-step process follows in order to filter out the irrelevant tweets. Firstly, emoticons of the crawled tweets are taken into consideration, e.g. a smiley face cannot refer to a crisis. Secondly, the crawled tweets are automatically classified as reliable or not, so as to deal with the current trend of fake news. And thirdly, they are automatically classified as relevant or not, based on their textual or visual information. All posts are stored in a MongoDB database for training purposes and evaluation metrics, but only the relevant ones continue in the flow of the beAWARE system. They are forwarded to the Knowledge Base Service (KBS) in order

[1] https://developer.twitter.com/en/docs/tweets/filter-realtime/overview

to populate corresponding incident reports and to the Multilingual Text Analyser (MTA) for further analysis.

The second module, namely Social Media Clustering, receives the analysed texts from MTA, performs a spatiotemporal clustering on the tweets and creates one summary per cluster, which is called Twitter Report. The reports are sent to the KBS and are handled as incidents. Although the clustering technique is completed, the communication with MTA is pending, since the retrieval of the location of tweets is still under development.

2.3.4 Media Hub Module

Media Hub's sole task is to forward media files to the appropriate modules for analysis; in detail, audio files to Automatic Speech Recognition, images to Image Analysis, videos to Video Analysis, and drone captures to Drones Analysis. When the analysis is completed, Media Hub informs the Knowledge Base Service about the results, in order for the respective incidents to be updated. In the case of audio files or drone captures, Media Hub also informs the Multilingual Text Analysis and the Drones Platform respectively about the analysis results.

2.3.5 Crisis Classification Module

The main objective of the Crisis Classification module is to process the available forecasts from prediction models (weather, hydrological etc.) and data obtained from sensors as well as other heterogeneous sources to estimate the crisis level of a forthcoming event or to monitor an ongoing event and to generate the appropriate warning alerts to timely notify the authorities.

The Crisis Classification module consists of two components. The *Early Warning* component that provides alerts during the pre-emergency phase and the *Real-Time Monitoring and Risk Assessment* component that is activated during the emergency phase and is responsible for monitoring the evolvement of the crisis.

In the 1st prototype of the project, several functionalities were already developed and integrated, including a flood, fire and heatwave Early Warning modules, which are able to timely notify stakeholders for the upcoming natural extreme event, as well as to estimate its level of crisis (severity level). Furthermore, during the crisis, functionalities able to track the evolution of the hazardous event have already deployed and assess the risk of the crisis. These modalities rely on the forecasting data and/or observations obtained from sensors.

During the 2nd prototype further enhancements will be accomplished aiming to the updated versions of 1st prototype modalities. Specifically:

- Enrich the risk assessment process in pre-crisis phase. The *Early Warning* component will be enabled to estimate the crisis level in local scale (identifying small areas of interest) and global scale for the whole Region of Interest.
- Enrich the risk assessment process in crisis phase. The *Real-Time Monitoring and Risk Assessment* component will be enabled to estimate the risk of the ongoing crisis event by employing a multi-level assessment process. Obtaining real-time sensing observations, the *Sensor Fusion Module* will fuse them providing the Observed Crisis Level. Thereafter, the *Decision Fusion Module* will consolidate the information

acquired from Sensor Fusion module (Observed Crisis Level) as well as from the outcome (Crisis Severity Level) of the analysis the others beAWARE modalities, in order to provide a total risk assessment of the crisis event. It is worth to note, that the innovative aspect of this module is the engagement of citizens and first responders to the risk assessment process by the utilisation of the mobile app and inserting into the system useful and valuable data from the field. The obtained data will be analysed and took under consideration in the assess the crisis risk in local level.

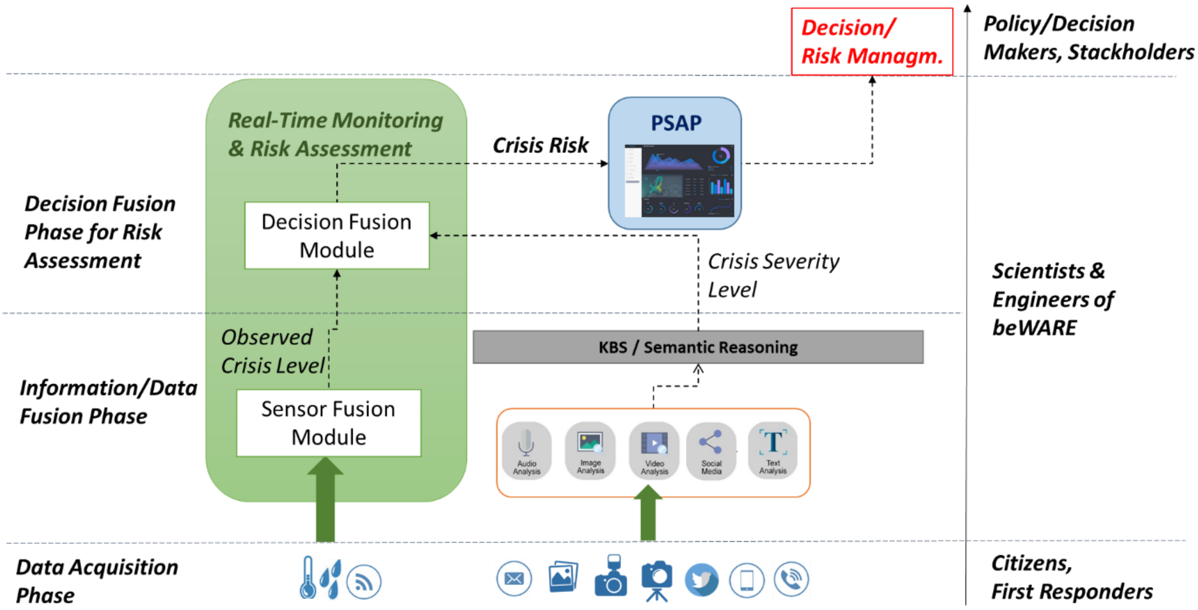


Figure 6: High-level architecture of Real-Time Monitoring and Risk Assessment component

- Integrate functionalities to enhance the interoperability with other numerical weather forecast systems, such as the HIRLAM model, hydrological forecast models, such as AMICO model.
- Integrate functionalities to enhance Crisis Classification Module's interoperability with European Flood Awareness System (EFAS), by employing impact/risk flood maps, such as the "EFAS rapid impact assessment" which provides a risk assessment of an extreme flood event.

2.3.6 Visual Analysis Module

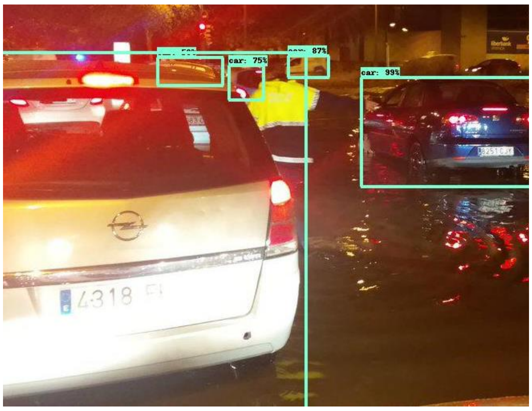
The Visual analysis module's main objective in the beAWARE project is concept extraction from visual content (image/video), and it is supported by two separate components, namely IMAGE ANALYSIS and VIDEO ANALYSIS. In the 1st prototype of the project, several modalities were already integrated, including a fire and flood detection system, as well as functions for detecting people and vehicles that may undergo danger inside images or videos that are taken during flood or fire emergencies.

For the 2nd prototype among further developments towards the updated versions of 1st prototype modalities, several other new functions were developed and integrated in such a way that the interoperability between the functions remained possible. Together with the 1st version's integrated modalities they deploy an array of cutting-edge computer vision techniques:

- (1st prototype) Image classification, so as to determine which images/video frames contain an emergent event or not (i.e. a fire of flood event).
- (1st prototype) Object Detection, so as to find people and vehicles that exist in the images/videos.
- (1st prototype) Object Tracking, so as to track targets throughout sequential video frames.
- (2nd prototype) Face Detection, so as to accurately count persons in images/videos.
- (2nd prototype) Dynamic texture localization so as to localize fire or flood dynamic textures in videos.
- (2nd prototype) Sensitive content blurring, so as to protect the privacy of targets inside images/videos.

All of the above techniques have been successfully integrated in the beAWARE platform 2nd version and several of them were tested as well in the Heatwave Pilot that took place in Thessaloniki.

At the module's process level, its job is to handle analysis requests of media files (images/videos), construct a suitable processing pipeline for each request (resource allocation, media pre-processing, analysis, result postprocessing, result transmission) and communicate the results back to the system. Before the actual analysis begins, all the analysis modalities that are appropriate to run on the current request have to be selected. All the possible outcomes of the analysis are the detection, classification and localization of fire or flood concepts, detection and localization of objects that are of particular interest like people and vehicles, people or vehicle counting in indoor or outdoor spaces respectively and severity level estimation which is the task of predicting the level of danger that the people and vehicles undergo based on their proximity to the localized flood or fire texture.

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 "width": 800,
 "crisis_type": "flood",
 "height": 450,
 "timestamp": "2018-03-27T11:40:35Z",
 "target": [
  {
   "left": 300,
   "width": 127,
   "type": "car",
   "height": 240,
   "top": 411,
   "risk": 1,
   "confidence": 0.995
  },
  {
   "left": 9,
   "width": 253,
   "type": "car",
```


Figure 7: Example of the Visual Analysis results

From the system's point of view the Visual Analysis module is triggered by the Media Hub component that is responsible to inform the Image/Video Analysis listener about new incoming analysis requests. A link referring to the location of the media to the OBJECT STORAGE (CDR) is provided in order to download the appropriate media file and start the analysis. To handle an arbitrary number of simultaneous incoming calls every analysis request is placed last into a FIFO queue. The FIFO queue is processed in a sequential manner in order to provide results more efficiently. After the analysis is complete for each item, an analysed version of the media fire is uploaded to the OBJECT STORAGE and provided back using the appropriate Media Hub response connection. Similarly, a JSON item is also forwarded to the system which contains all the findings in a suitable format that is readable by the KB service.

Figure 7 shows an example of an analysed image and the contents of the JSON file that is constructed.

Visual River Sensing

For the needs of the flood pilot, two static surveillance cameras have been installed in the wider area of Vicenza (Figure 8, Figure 9), which are used for flood monitoring and are connected to the rest of the platform through IP streaming. Additional functionalities have also been added to the visual analysis component, in order to analyze the footage from these static cameras and estimate the river water level, in order to create an alert, after threshold exceeding. At the final prototype, this functionality would be triggered after notification for an imminent flood from Crisis Classification module. Currently, this module is triggered manually.

Figure 8: Location of the two surveillance cameras in Vicenza.

Figure 9: Footage of the surveillance camera in Ponte degli Angeli, in the centre of Vicenza.

2.3.7 Automatic speech recognition

The automatic speech recognition module provides a channel for the analysis of spoken language flowing into the system as audio recordings from citizens and first responders. The purpose of this module is to transcribe in four languages (English, Spanish, Italian, Greek).

The module is based on open source available language and acoustic models and currently supports all the beAWARE languages. However, not all available open source models are in a mature state and consequently, development is focused on adapting the acoustic models and the dictionaries to the needs of the project. During the preparation period of the Heatwave pilot, for example, the Greek dictionary was carefully inspected in order to remove erroneous or rare words, that could possibly affect recognition accuracy. Additionally, Greek acoustic model was adapted, by creating audio recordings in Greek, containing phraseology related to emergency incidents, with the aim to enhance the recognition of emergency related terminology. The same procedure was followed for the Italian model and is planned for the adaptation of the Spanish ASR model.

Additionally, in order to address reviewers' comments, ASR has been adjusted to include emergency calls also, apart from audio files. For that reason, an open-source call center solution has been set up, based on VoIP technology, in order to receive emergency calls, record the calls and forward them to ASR module. The call center solution employs the widely used open-source software VICIdial[2].

2.3.8 **Drones Platform**

The drones platform is intended as a service to connect providers of drones, drones services, and customers, to easily configure, launch, and monitor drone related activities. The essence of the drones platform capabilities is the combination of route planning and autonomous dynamic piloting, with the provisioning of data collected by the drone making it available to corresponding analysis components, all deployed in a cognitive cloud based platform.

Drones can carry different types of equipment collecting data (such as cameras, sensors), providing corresponding analysis tools data from a different angle (aerial data), and may reach locations which are difficult for humans. Thus, autonomous flight capabilities combined with cognitive edge analytics lead to novel ways of bringing lifesaving impact. Building such a generic platform for drone operations needs to overcome various technical and scientific challenges. Managing, provisioning, storing and analyzing high volumes of data and dynamically changing the route based on insights extracted from this data is a critical success factor. The platform created shall support easy creation, management, provisioning, and consumption of drone services which are drone vendor agnostic. Among the main capabilities provided: (i) Automatic route planning (ii) Autonomous piloting (iii) Automatic invocation and control of on-board equipment (iv) Collection of data and events (v) support local and remote data storage (vi) Interaction with analysis components (vii) management dashboard.

The drones platform shall be connected to the beAWARE platform, according to the generic beAWARE architecture. The main means of interaction between the drones and the beAWARE platform shall be via the message bus and the object storage. The drones platform shall operate just like an additional data source, thus new data shall be stored in the object storage by the drones platform, and a corresponding notification shall be sent over the message bus. On the reverse path, the drones platform shall be subscribed to incoming

[2] http://www.vicidial.com/

messages via the message bus, for example to learn through it the results of data analysis, including potentially changes to the original route, such as flying to a specific location which was deemed important by the analysis or the PSAP components.

Drones Analysis module

In order to take advantage of the integration of drones in beAWARE and maximize their efficiency, a new analysis module has been added to analyze drone footage. Analysis, currently focus on the detection of people or vehicles in danger (Figure 10) and on flood localization, through water segmentation techniques (Figure 11), and inform the Drones Platform and PSAP about the results of the analysis. The new module is called Drones Analysis (DA) and is based on deep-learning object-detection techniques and models trained by CERTH on drone footage.

Figure 10: Examples of object detection algorithm.

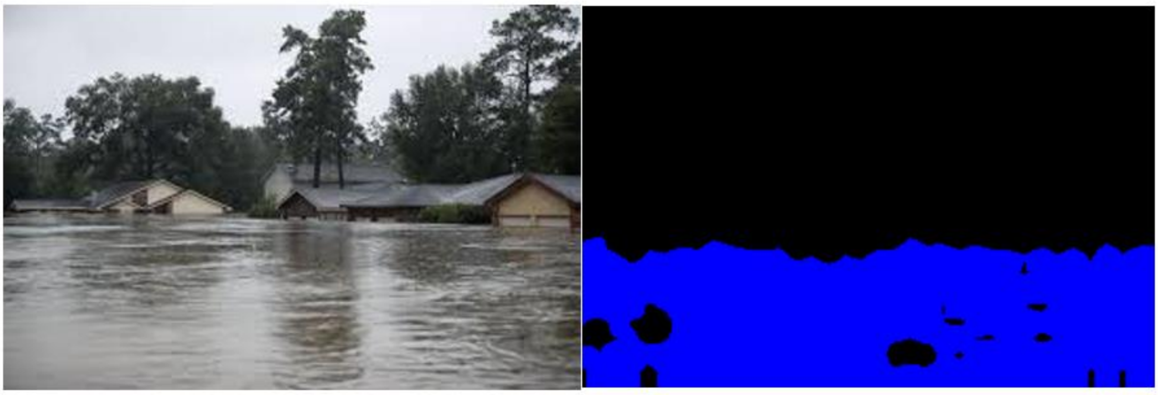


Figure 11: Example of water segmentation algorithm. Image on the right depicts the detected mask of water surface in blue.

2.3.9 Multilingual Text Analyzer (MTA)

The purpose of this component is to extract relevant information from natural language text obtained from social media or from the transcription of audio messages, and in any of the project languages –English, Greek, Italian and Spanish. The first implementation of this module has its coverage limited to the two first pilots of the project. Analysis is tailored to a fixed set of multilingual input texts and a reduced set of concepts and events modelled in the project ontology. The output produced reflects incidents detected in the input messages, the objects impacted by these incidents and the location, e.g. a flood event affecting five cars in a bridge.

Current work aims to expand the coverage of the module to detect arbitrary concepts and locations found in several well-known knowledge bases and geographical databases. More precisely, and in addition to the ontological types already produced in the current version, the analyzer will be able to produce disambiguated references to BabelNet -a lexical semantic network covering both Wikipedia- and two well-known geographical databases, WordNet-Open Street Maps and GeoNames. Together with lexical cues, these references are being used to determine the ontology concepts referred in the texts.

2.3.10 Multilingual report generation

Two types of reports are foreseen in beAWARE, short reports providing situational updates during ongoing crisis scenarios and wrap-up summaries providing an overview of a crisis. So far, the report generation module only supports the production of situational updates in any of the project languages. These reports describe incidents, their locations and the objects impacted. A selection strategy is followed to avoid redundancies and repetitions across multiple reports. Surface realization uses a mixture of dictionaries, rule-based and statistical tools to map the information received from the KBS to grammatical and fluent natural language.

Ongoing work focuses on producing wrap-up summaries. This involves, on the one hand, selecting and ordering incidents, locations and impacted objects so that the resulting summary concisely communicates the most relevant developments and, on the other, using linguistic aggregation strategies to produce non-redundant fluent texts.

2.4 Internal Services

This layer handles services that are used internally for data storage and communication between components. The services within this layer have been updated to accommodate the new requirements and the new modules integrated into the system.

2.4.1 Communication Bus

The main purpose of this component is to provide generic communication capabilities among different beAWARE components and participants. It is used to send messages and notification among components and to share information among various entities. The dominant paradigm is the publish/ subscribe pattern leading to event-based communication among collaborating partners by registering interest in particular events. Using this paradigm producers and consumers do not have to be aware of each other and need only to agree on the topic via which they are going to communicate, and the message format of the agreed upon topic.

This component enables the distributed collaboration among different micro-services, with a minimal amount of synchronization required. The dominant flow is for a micro-service having a new piece of data (such as a new image has been uploaded) to publish the new event. All the micro-services interested in that specific kind of events shall be informed of the occurrence through the message bus and will be able to act accordingly (for example access the image via a provided link and perform the corresponding analysis).

2.4.2 **FROST-Server**

The FROST-Server (previously called SensorThings API Server) is the single-point for storing and retrieving time-series data (like most sensor data) within the beAWARE project. Sensor data offers big potential through long-term collection of objective data, enabling decision makers to assess emergencies and raise situational awareness. Data collected in beAWARE comprises for example temperature, humidity and rainfall, or the water level of a river section as well as weather forecasts. Depending on the use case, different sorts of sensors are available and their data can vary strongly concerning their type, frequency and format which makes the integration into the platform difficult. The FROST server helps to solve this problem since it offers a unified and standardized interface for the sensor data. Furthermore, it takes care of the sensor data management and offers rich querying mechanisms, based on, for example, location of the feature of interest, time, type of sensor, and/or observed property. FROST is an open-source implementation of the SensorThings API; the SensorThings API is a standard developed by the Open Geospatial Consortium that defines a data model as well as interfaces to store and retrieve sensor data or more general time series data. The established data model describes how the sensor values, collected for example by Internet-of-Things devices, together with their metadata, can be represented.

To access data stored in the FROST-Server the provided REST-interface is used. It returns JSON-formatted data (in Figure 12 the response of temperature measurements is show). This data is used by the crisis classification module for further analysis and integration with the other available data. To visualize the data the Knowledgebase module contains a visualization-submodule, like described in section **Error! Reference source not found.**. To uery the FROST-Server for data matching a specific filter, operators described in the OData standard can be used. For example, the following request */v1.0/Observations?$filter=result gt 5* will return all observations with a result greater than five. By using logical operators like ‘AND’ or ‘OR’ more complex search queries are possible. For further information, we refer to the Sensor-Things-API standard (Open Geospatial Consortium, 2016).

```
@iot.nextLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Datastreams(382)/Observations?$skip=100"
value:
  0:
    phenomenonTime:        "2019-01-10T10:00:00.000Z"
    resultTime:        "2019-01-09T03:47:39.000Z"
    result:        6.54
    Datastream@iot.navigationLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5072070)/Datastream"
    FeatureOfInterest@iot.navigationLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5072070)/FeatureOfInterest"
    @iot.id:        5072070
    @iot.selfLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5072070)"
  1:
    phenomenonTime:        "2019-01-10T09:00:00.000Z"
    resultTime:        "2019-01-09T03:47:39.000Z"
    result:        4.25
    Datastream@iot.navigationLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5071846)/Datastream"
    FeatureOfInterest@iot.navigationLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5071846)/FeatureOfInterest"
    @iot.id:        5071846
    @iot.selfLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5071846)"
  2:
    phenomenonTime:        "2019-01-10T08:00:00.000Z"
    resultTime:        "2019-01-09T03:47:39.000Z"
    result:        3.17
    Datastream@iot.navigationLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5071622)/Datastream"
    FeatureOfInterest@iot.navigationLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5071622)/FeatureOfInterest"
    @iot.id:        5071622
    @iot.selfLink:        "http://beaware-1.eu-de.containers.appdomain.cloud/sensor-things-server/v1.0/Observations(5071622)"
```


Figure 12: Temperature measurements stored inside the FROST-Server

To copy the data to the FROST-Server importer for multiple data sources have been developed and deployed. For example, current and predicted water levels are imported from the AMICO system provided by AAWA or weather forecasts are automatically gathered from services provided by FMI.

2.5 External Facing Layer

This layer handles the interaction of the platform with external entities, both as input providers and output recipients.

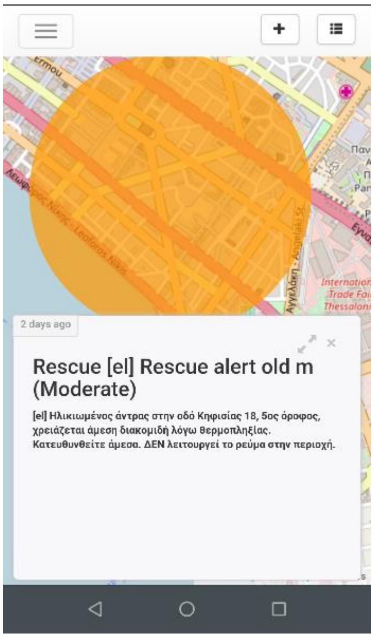
2.5.1 Mobile Application

The mobile application is the interface used by citizens and first responders to interact with the beAWARE platform. The application is available as '.apk'-file that can be installed on Android-based mobile devices. For testing purposes, an additional web-based version is available which can be accessed using a web browser. The mobile application consists of an additional backend, which is integrated with the other components through the message bus.

In the second version, the mobile application will be used to send reports to the beAWARE platform. Either these are geo-located through the current position of the mobile devices, retrieved through GPS or the position is selected on the map displayed in the app. Each report can contain a textual description, an image, video or audio. All media files can be directly recorded or selected from existing files on the device.

Figure 13 illustrates the possibility to receive public alerts sent by the authorities through the PSAP to the users. These alerts are automatically delivered to the mobile application and a notification will be shown to inform the user about the newly available information.

Moreover, in the second version, the application offers to the Users the possibility to enable additional functionalities by signing in. These functionalities are related to the reception and handling of tasks assigned by the authorities as well as the "team status report" mechanism.



a)

b)

Figure 13:a) Public alert, b) List of Public Alerts

2.5.2 **PSAP**

The objective of this component is to serve as a means for public safety answering points (PSAP) to obtain situational awareness and a common operational picture before and during an emergency, and to enable efficient emergency management based on a unified mechanism to receive and visualize field team positions, incident reports, media attachments, and status updates from multiple platforms and applications.

In the second version of PSAP, we improved the map visualization and incident clustering mechanism including Raw and analyzed media like images, videos, and audio, stacking multiple media files from different incident updates, thus creating a unified situational picture together with enhanced Incident manager module to show all the necessary information to the user. In further versions, will be enabled to edit the incident details via PSAP (like Priority, certainty, status etc)

In addition, the first version of the Operations Manager module has been integrated. The Operations Manager is in charge of assigning responder teams to handle incidents and tasks and monitoring their progress. The interface includes incidents, teams and task management.

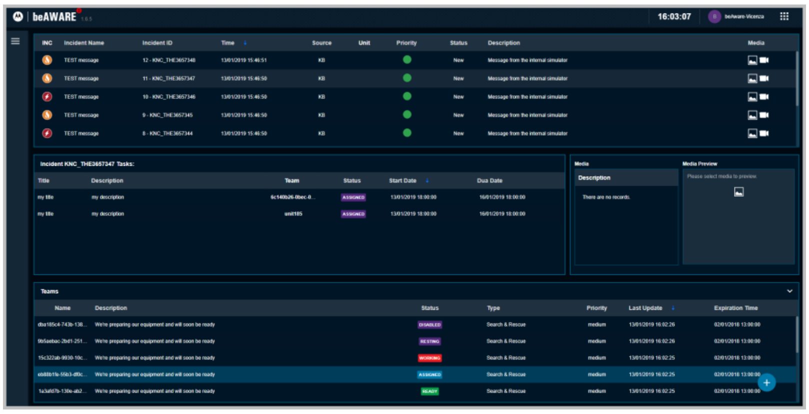


Figure 14: Incident Manager

Figure 14 show the possibility to view all incidents, available teams and assigned tasks. The operator has the ability to select an Incident from the list and assign tasks and teams

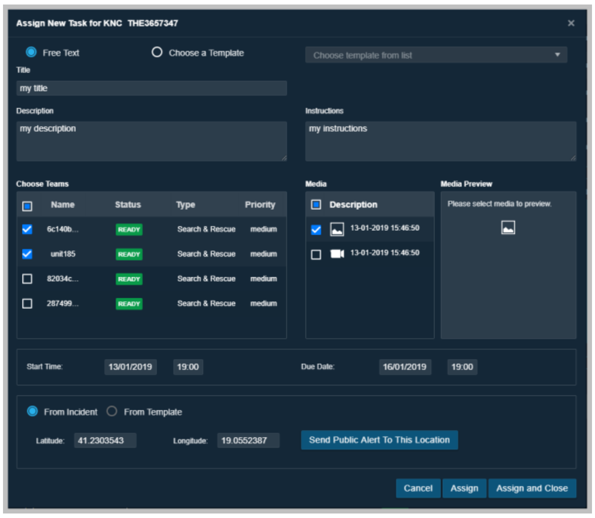


Figure 15: Task assignment feature.

Figure 15 show the form of assigning task to teams and sending public alert to the task location area.

3 Components and Integration status

Table 1: Social Media Analysis Tool status

Service name	**Social Media Analysis**	**Social Media Clustering**
CI cluster	beAWARE-project/social-media-analysis-live	beAWARE-project/social-media-clustering-live
Functional Description	Version 1.1, working version	Version 1.0, working version
Deployment status	Deployed	Deployed
Integration status	Integrated	Integrated
Integration issues / dependencies	All dependencies are included in pom.xml. Environment variables: SECRET_MH_API_KEY, SECRET_MH_BROKERS, SECRET_MONGO_URI, TWITTER_API_CONSUMER_KEY, TWITTER_API_CONSUMER_SECRET, TWITTER_API_SECRET, TWITTER_API_TOKEN	All dependencies are included in pom.xml. Environment variables: SECRET_MH_API_KEY, SECRET_MH_BROKERS, SECRET_MONGO_URI
Next steps		Communication with MTA to get the extracted location of the tweets

Table 2: Media Hub Tool status

Service name	**Central Hub to Assign Media Analysis**
CI cluster	beAWARE-project/ Media Hub
Functional Description	Version 1.1, working version
Deployment status	Deployed
Integration status	Integrated
Integration issues / dependencies	All dependencies are included in pom.xml. Environment variables: SECRET_MH_API_KEY, SECRET_MH_BROKERS For a complete workflow, it requires CI clusters ASR, image-analysis, video-analysis, and drone-analysis.

Next steps	

Table 3: Crisis Classification status

Service name	**Crisis Classification**
CI cluster	beaware-project/ crisis-classification
Functional Description	Version 2.0, working version
Development status	Implementation of first prototype. This includes the updated versions for the *Early Warning* and *Real-Time Monitoring and Risk Assessment* components for the flood pilot. Implement interoperability functionalities with EFAS impact/risk map.
Deployment status	Deployed
Integration status	Integrated
Integration issues / dependencies	No issues regarding the integration with other components. Dependencies show up in the Dockerfile

Table 4: Image Analysis Tool status

Service name	**Image Analysis**
CI cluster	beaware-project/image-analysis
Functional Description	Version 2.0, advanced version of image analysis techniques
Deployment status	Deployed
Integration status	Integrated
Integration issues /dependencies	Communicates with Media Hub service Uses port 7788 Dependencies show up in the Dockerfile
Next steps	• Inclusion of recognition of more person categories (e.g. people in wheelchairs) • Update the current version of request handling to act accordingly to the incident type provided by the mobile app.

Table 5: Video Analysis Tool status

Service name	**Video Analysis**
CI cluster	beaware-project/video-analysis
Functional Description	Version 2.0, advanced version of video analysis techniques
Deployment status	Deployed
Integration status	Integrated
Integration issues /dependencies	Communicates with Media Hub service Uses port 7777 Dependencies show up in the Dockerfile
Next steps	• Inclusion of recognition of more person categories (e.g. people in wheelchairs). • Update the current version of request handling to act accordingly to the incident type provided by the mobile app.

Table 6: Automatic Speech Recognition Tool status

Service name	**Automatic Speech Recognition**
CI cluster	beaware-project/ASR
Functional Description	Version 2.0, working version
Development status	Adapted versions of Greek and Italic ASR models. Spanish and English model's adaptation and validation will follow. ASR has been extended to include phone calls. A VoIP-based call centre has been set up.
Deployment status	Deployed
Integration status	Integrated
Integration issues / dependencies	All dependencies are included in pom.xml project file. It communicates with Media Hub: - Data in: audio file URL, recording timestamp, language - Data out: transcribed text
Next steps	- Increase recognition accuracy of all language models by further adapting the models as new data become available. - Include a simple automatic language identification module in order to automatically recognize the language of the speaker

	- Develop advanced denoising techniques in order to address highly noisy/fragmented speech in challenging environments

Table 7: SCAPP/FRAPP status

Service name	**SCAPP/FRAPP (Mobile Application)**
CI cluster	Web based version available on cluster for testing purposes. Application for mobile devices is shared separately.
Functional Description	End user application for mobile devices.
Development status	Implementation of second prototype. This includes receiving public alerts from authorities and sending incident reports to the beAWARE platform.
Deployment status	Web version deployed to cluster.
Integration status	Interface with other components specified. Successfully integrated the first use cases with the other components.
Integration issues /dependencies	No issues regarding the integration with other components. Source code should not be available to public. Therefore, a separate, not publicly available continuous integration process is setup.
Next steps	Further development of functionality, especially team and task management.

Table 8: Knowledge Base status

Service name	**KB**
CI cluster	Deployed on cluster.
Functional Description	Server and management APIs for semantic data.
Development status	Knowledge Base fully developed. Latest version of ontology deployed to Knowledge Base.
Deployment status	Deployed to cluster.
Integration status	Provided interfaces for other components to access/modify semantic data.
Integration issues /dependencies	No issues regarding the integration with other components. To store the data internally the Knowledge Base depends on a MySQL-Server. This is provided as a service by IBM Bluemix. Source code should not be available to public. Therefore, a separate, not publicly available continuous integration process is setup.

Next steps	Change to ontology if it is needed during further development.

Table 9: Drones Analysis Tool status

Service name	**DA**
CI cluster	beAWARE-project/drone-analysis
Functional Description	Version 1.0, baseline version of Drones Analysis module
Development status	First version of DA has been added. DA currently performs object detection on images/videos for the detection of people and vehicles and basic water segmentation techniques for localization of floods.
Deployment status	Deployed
Integration status	Integrated. DA communicates with Drones Platform through Media Hub, which also informs KBs for possible detected incidents.
Integration issues / dependencies	The computational burden sets a threshold on the frame rate in the case of real-time analysis, which should not be lower than 1 frame per second, whereas, for offline analysis there is not such a constraint. Another limitation is the demand for a GPU present in order to accelerate image analysis and provide near real-time analysis.
Next steps	Develop fire localization techniques for the Fire pilot and more advanced flood localization techniques.

Table 10: Visual River Sensing Tool status

Service name	**VRS**
CI cluster	beAWARE-project/visual-river-sensing
Functional Description	Version 1.0, baseline version of visual analysis module for water level monitoring
Development status	First version of VRS has been added. VRS analyses videos from static surveillance cameras and monitors water level in order to create alert, in case of threshold exceeding.
Deployment status	Deployed
Integration status	Integrated. Currently VRS is triggered manually. In the final prototype, it will be triggered after notification from Crisis Classification module about an imminent crisis event and will run periodically. VRS extracts video data directly from the static cameras.
Integration	VRS analysis is based on GPU.

issues / dependencies	
Next steps	Finalize communication flow. Improve water level estimation.

Table 11: Sensor Analytics Tool status

Service name	**SENSAN**
CI cluster	Deployed to cluster.
Functional Description	Server and management APIs for sensor data.
Development status	Server fully implemented. Data integration is done and importing new data is continuously ongoing.
Deployment status	Server, importer and processing scripts are deployed to cluster.
Integration status	Integrated. Data visualization integrated in UI.
Integration issues /dependencies	No issues regarding the integration. All available data sources are integrated.
Next steps	Extending the analysis component to enhance the crisis classification functionality.

Table 9: Multilingual Text Analyzer Tool status

Service name	**Text Analysis Tool**
CI cluster	Text-analysis
Functional Description	Version 1.0, basic version
Deployment status	Deployed
Integration status	Integrated
Integration issues /dependencies	Newly added contents in the output such as the results of geolocation require extensions to TOP028 and TOP030 Kafka bus messages and to the KBS service in order to be correctly handed by components consuming these contents.
Next steps	- Improve quality of disambiguation - Apply advanced concept extraction/mapping strategies

Table 10: Multilingual Report Generation Tool status

Service name	**Report Generation Tool**
CI cluster	Report-generation
Functional Description	Version 1.0, basic version
Deployment status	Deployed
Integration status	Integrated. Reports are integrated in the UI.
Integration issues /dependencies	Production of wrap-up summaries require additional information from the KBS.
Next steps	Complete development, deployment and integration of new summarization functionality.

4 Infrastructure

After having defined the global architecture of the beAWARE platform, focusing on its high-level component design we turn to deployment and hosting issues, focusing on the provisioning and operation of the infrastructure, on which the beAWARE system will run. This includes the internal services, business services, associated repositories and external entities (mobile applications, control centers).

Currently there is a specific BlueMix account which is dedicated for the beAWARE project; all cloud services and deployment are grouped in this account.

A view of the dashboard of beAWARE's cloud account can be seen in Figure 16. In the dashboard we can see the cloud services which are used by the beAWARE platform: Message Bus and Object Store which are used by most platform components. In addition, we can see an instance of MySQL which is mainly used by the FROST server, and an instance of MongoDB which is mainly used by the social media analysis component.

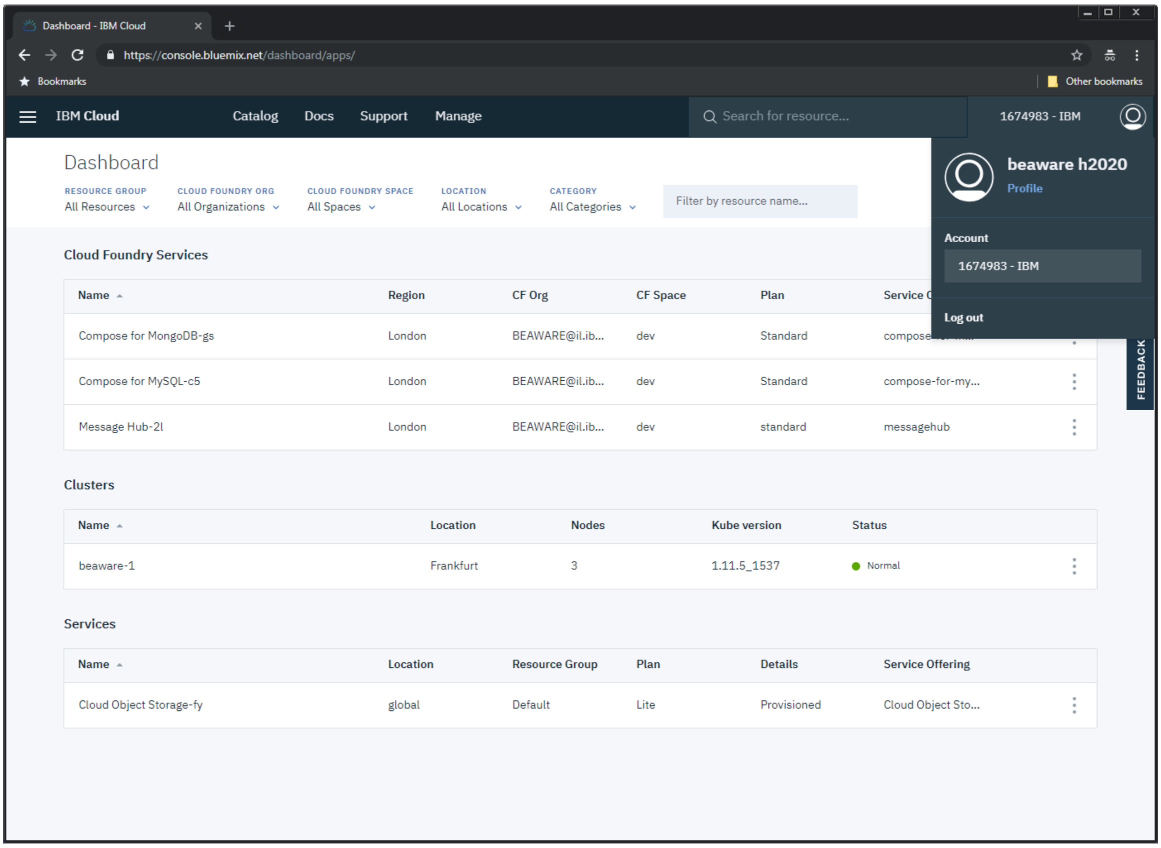


Figure 16: BlueMix account dashboard

At the centre of the figure we can see the Kubernetes cluster, which hosts the bulk of the system components. A cluster overview can be seen in Figure 17.The entry point for the platform's Kubernetes cluster is: https://beaware-1.eu-de.containers.appdomain.cloud/.

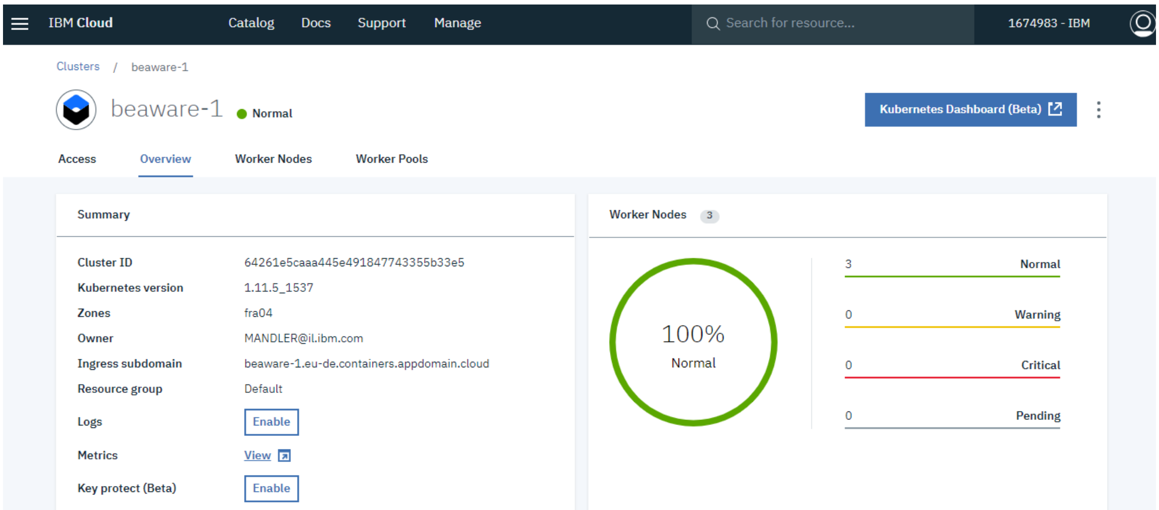


Figure 17: beAWARE Kubernetes cluster overview

Currently the cluster is composed of three worker nodes as seen in Figure 18, and it may grow based on evolving system needs. Two of the worker nodes consist of 4 Cores and 16GB RAM; the third node is equipped with 2 Cores and 4GB RAM.

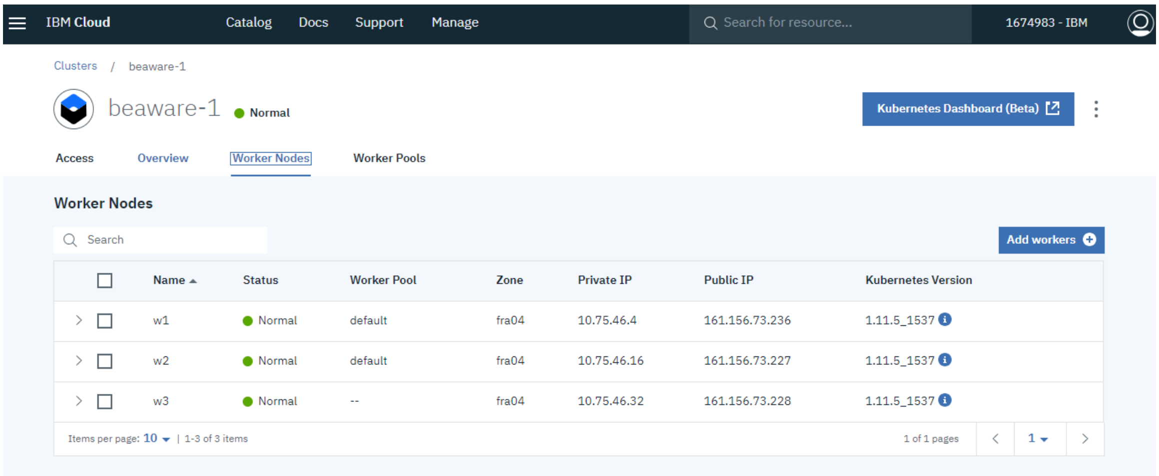


Figure 18: Kubernetes cluster worker nodes

The K8s cluster is divided into 3 namespaces:

- Default (Jenkins Master)
- Build (Jenkins Slave)
- Prod (Deployed Applications) – residing behind Ingress (a reverse Proxy acting as a gateway).

Moreover, there are components that are deployed external to the project K8s cluster, namely the PSAP, as well as the end-user applications which will have their front-end deployed on mobile devices, while their backend may still reside within the project cluster.

The Continuous Integration (CI) environment is comprised of the following components, as depicted in Figure 19:

1. GitHub repository: all components should have a repository under the beAWARE project (https://github.com/beAWARE-project).
2. Docker – a docker image is created for each component.
    - Generally, requires a dockerFile for each component
3. Jenkins: build, test, and deploy
    - Requires a JenkinsFile for each component
    - Builds are executed in a separate environment (namespace) in the project's K8s cluster. Executing tasks based on Jenkinsfile
        - Pulling code from GitHub
        - Build artifact
        - Build Docker image
        - Push to DockerHub
        - Deploy on k8s
4. Kubernetes -IBM container services - managed cluster on which all components are deployed
    - Requires specific Kubernetes configuration for each component

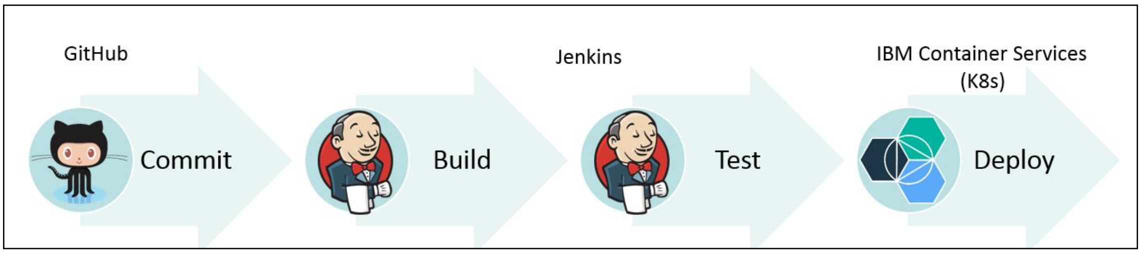


Figure 19: CI workflow

The automated workflow kicks in upon a new commit to a project in the GitHub repository. The standard procedure, dictated by a JenkinsFile, is to build the component using the dockerFile, and if no errors reported, to deploy to the Kubernetes cluster, using the specified K8s configuration. This process happens for every repository for which there is an associated JenkinsFile.

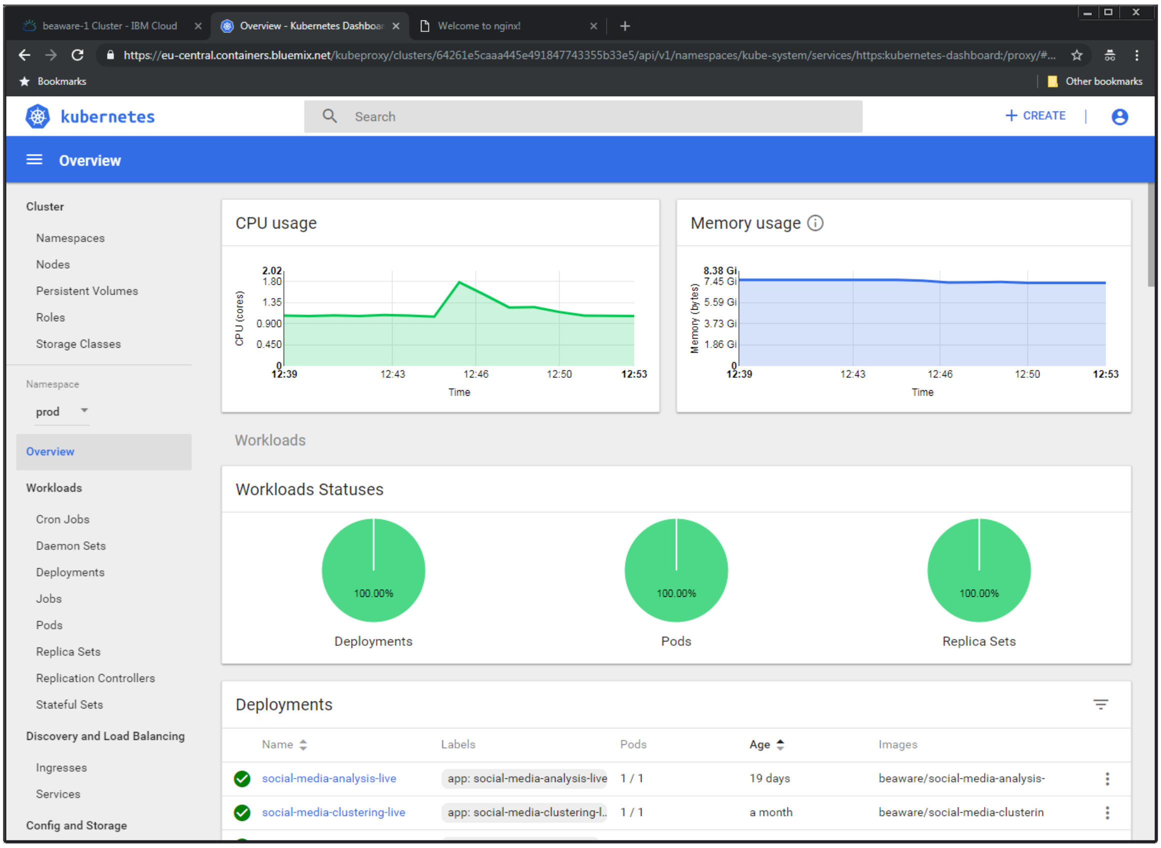


Figure 20: beAWARE Kubernetes cluster

A sub-set of the individual components deployed within the cluster can be seen in Figure 21. beAWARE code on the GitHub repository is organised on a per-component basis. The root of the source tree is located at: https://github.com/beAWARE-project.

The code of the individual components can be found in the following links:

- **Text Analysis module**: Text analysis tools to extract information from tweets or other sources, Maven package (https://github.com/beAWARE-project/text-analysis-all)
- **Text analysis on ASR outputs**: Maven package (https://github.com/beAWARE-project/text-analysis-asr)
- **Automatic Speech Recognition tool**: for the transcription of audio recordings sent through the mobile app, Maven package (https://github.com/beAWARE-project/ASR)
- **Social Media Analysis tool**: A crawler that collects tweets and pushes the relevant ones to the bus, Maven package (https://github.com/beAWARE-project/social-media-analysis)
- **Social Media Analysis tool**: A crawler that collects tweets and pushes the relevant ones to the bus, Maven package (https://github.com/beAWARE-project/social-media-analysis-live)
- **Social Media Clustering tool**: A component that consumes analyzed tweets and performs a clustering method in order to produce Twitter reports, Maven package. (https://github.com/beAWARE-project/social-media-clustering-live)
- **Image Analysis tool**: Performs image analysis for the beAWARE project, Python (https://github.com/beAWARE-project/image-analysis)

- **Video Analysis tool:** Performs video analysis for the beAWARE project, Python (https://github.com/beAWARE-project/video-analysis)
- **Media Hub**: A central hub to receive any media and forward it to the correct component (audio/image/video), Maven package (https://github.com/beAWARE-project/media-hub)
- **Ontology**: the beAWARE Knowledge Base Ontology (https://github.com/beAWARE-project/ontology)
- **Report Generation**: Generates new incident reports, Maven package (https://github.com/beAWARE-project/report-generation)
- **K8s**: BeAWARE Kubernetes configuration (https://github.com/beAWARE-project/k8s)
- **Object Storage Service:** Applications for storing and retrieving from the data repository, Maven package (https://github.com/beAWARE-project/object-storage-service)
- **Drones Analysis:** Module to analyse drone data, Maven package (https://github.com/beAWARE-project/drone-analysis)
- **Crisis Classification:** Module to determine current crisis level (https://github.com/beAWARE-project/crisis-classification)
- **Knowledge Base Service:** Module to store system information; also performing semantic reasoning to uncover underlying knowledge from data. (https://github.com/beAWARE-project/knowledge-base-service)

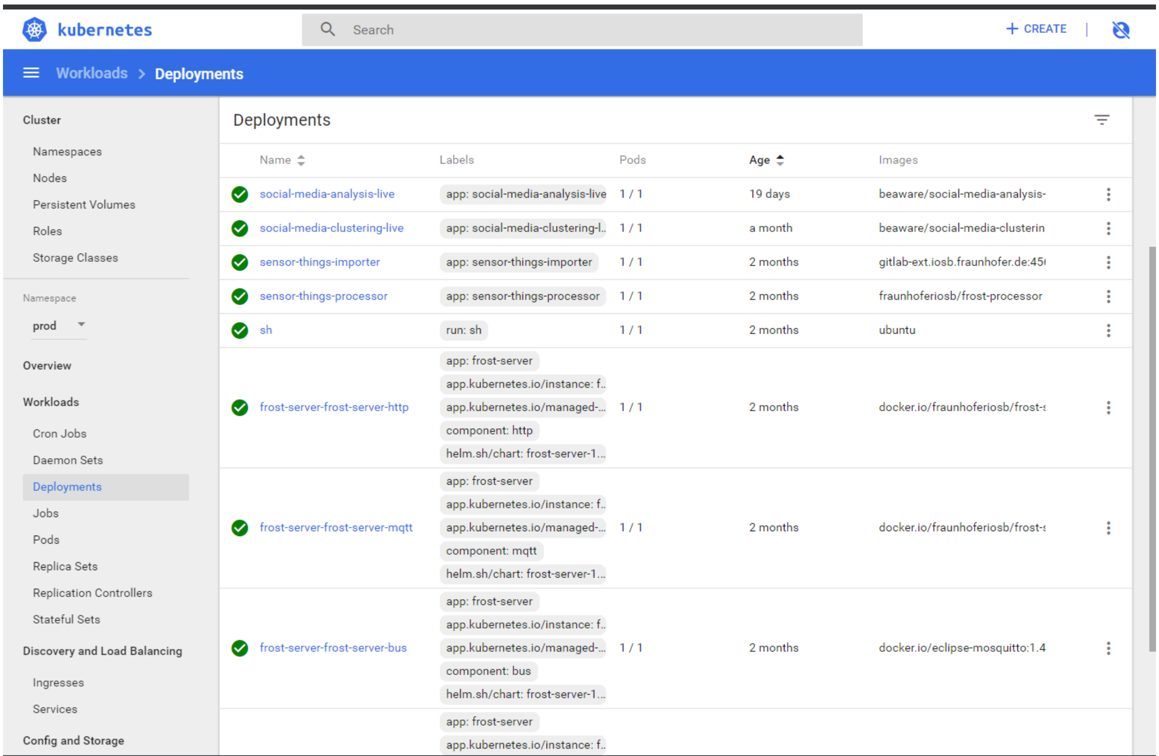


Figure 21: Cluster deployments

5 Demonstrator URLS and information

In order to demonstrate the 2nd version of the beAWARE platform, a video has been created, capturing the whole functionality of the platform and it is available in the following link:

https://beaware-project.eu/wp-content/uploads/2019/01/beAWARE-2ndPrototypeVideo_v1.mp4

Briefly, the demonstration has 4 phases:

1. **Phase 1** -Pre-emergency phase. The objective of this phase is the early provision of information on emerging hazards and the quick distribution of the first alerts to the public
2. **Phase 2** - Emergency phase. This phase is to help authorities to monitor the situation and take some preventive actions to reduce the undesirable event. It involves tasks like the management of the rescue teams and the tracking of their status.
3. **Phase3** -This phase is a continuation of the previous emergency phase and aims to demonstrate the mechanism of aggregation and semantic integration of emergency information from multiple sources as well as the insight this mechanism provides to the decision makers.
4. **Phase4** -Fade out

The rest of this section contains a tutorial with some descriptive screenshots.

5.1 Pre-Emergency Phase

During the pre-emergency phase the Crisis Classification module acquires forecasting data to classify the crisis level and provides early warnings to the system.

Specifically, during the pre-emergency the forecasting system generates periodically a prediction based on the most recent weather forecast and the sensors that are available depending on the use case. The FROST server undertakes the data management and offers the mechanism for the transmission and visualisation of these data through the SensorThings API. This module defines a data model consisted of entities which describe the sensor data, as well as the geographic metadata.

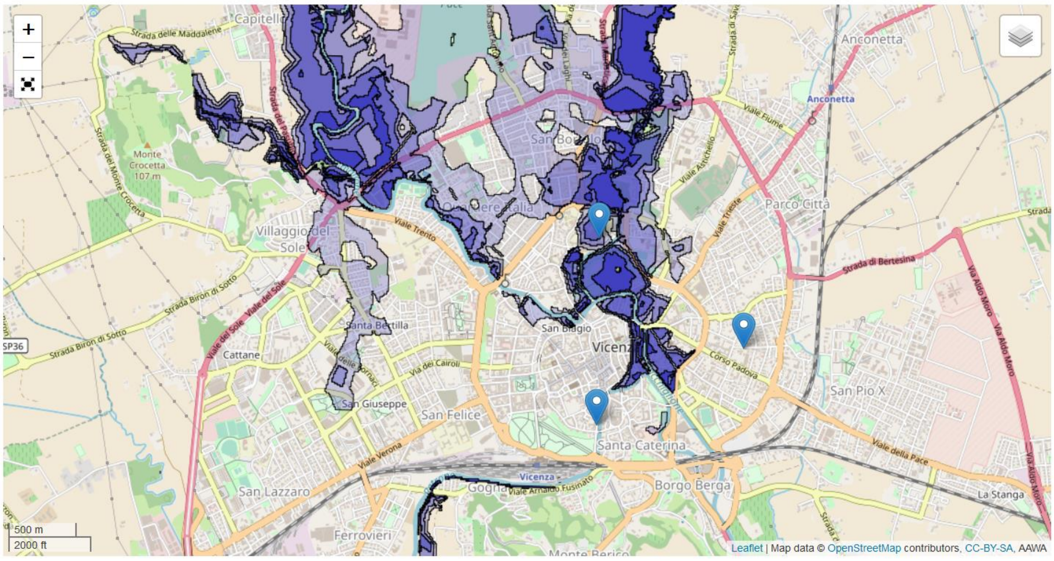


Figure 22: Displaying hospitals (retrieved from WikiData) together with risk map

Moreover, through the synthetisation of internal knowledge (Risk Map e.g. EFAS) and external knowledge (the location of all known hospitals from WikiData) valuable knowledge is generated, integrated into the beAWARE KB and visualised on the map. For example, Figure 22 shows places of interest being in endangered zone.

The Crisis Classification component acquires this data to classify the crisis event and provides early warnings followed by the estimated crisis level in local scale (identifying small areas of interest) and global scale for the whole Region of Interest. The results are sent to the PSAP where, upon users' request, a metric map and a dashboard interface are displayed allowing to the Users several ways of interaction.

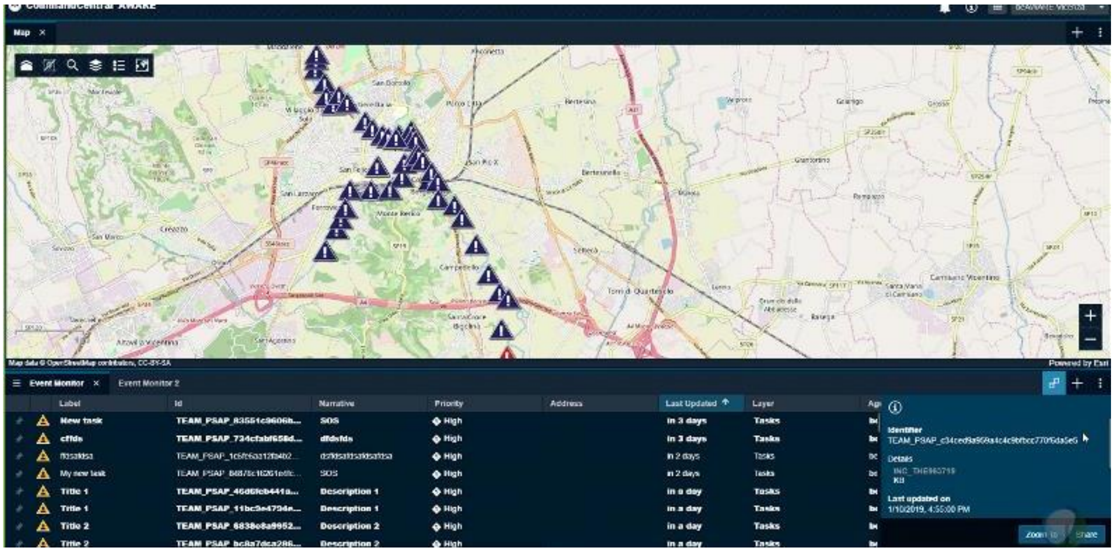


Figure 23:Incident Map

Figure 24: Dashboard snapshot from the Flood UC. Six main river reaches are constantly monitored.

After receiving the indication of a forecasted crisis event, the decision maker assesses the situation and issues a general alert informing the general public about the forthcoming event.

Subsequently, professionals from recovery organisations are requested through their mobile applications to undertake specific tasks in order to check the available resources, also guidelines are sent from the PSAP to rescuer teams for applying risk mitigation measures.

5.2 Phase 2 - Emergency phase

This phase is to help authorities to monitor the situation and take preventive actions to reduce threads. It involves tasks like the management of the rescue teams and the resources.

In this phase the Real-Time Monitoring and Risk Assessment component is activated to estimate the risk of the ongoing crisis event. The Fusion Module within the component fuses the information acquired from sensors together with the outcome of the analysis of the Data Analysis and Processing components of the beAWARE platform, in order to provide a total risk assessment of the crisis event. The estimated factors are forward to the PSAP to support the constant monitoring of the emerged hazard.

On the Dashboard of the PSAP there are several indicators illustrating the information received. For example, traffic light indicators are illustrating aggregated information taken by the sensors and visualised on the platform and are one of the main parameters that triggers a set of pre-defined tasks. For example, in the flood scenario the plan imposes some specific preventive measures when the water level recorded by the sensors exceeds some fixed thresholds.

The preventive measures are assigned semi-automatically to the rescue teams through the task manager and the task assignment forms. The task assignment form is an extension to the incident view, which allows the operations manager to assign an incident to one or more response teams. The sequence is the following: i) Select a team from the available teams, ii) Write the instruction text or use predefined instructions from the box iii) Associate the mission with a specific incident followed by the incident location and relevant incident attachments iv) Assign the mission to the selected team by sending the message, v) Receive a verification when the message is successfully released.

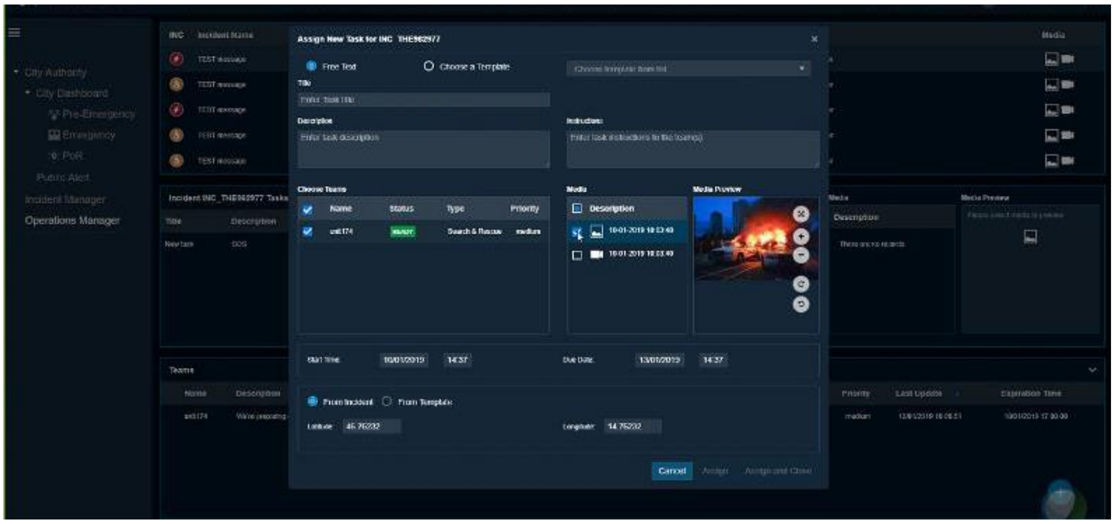


Figure 25: Task Assignment Manager

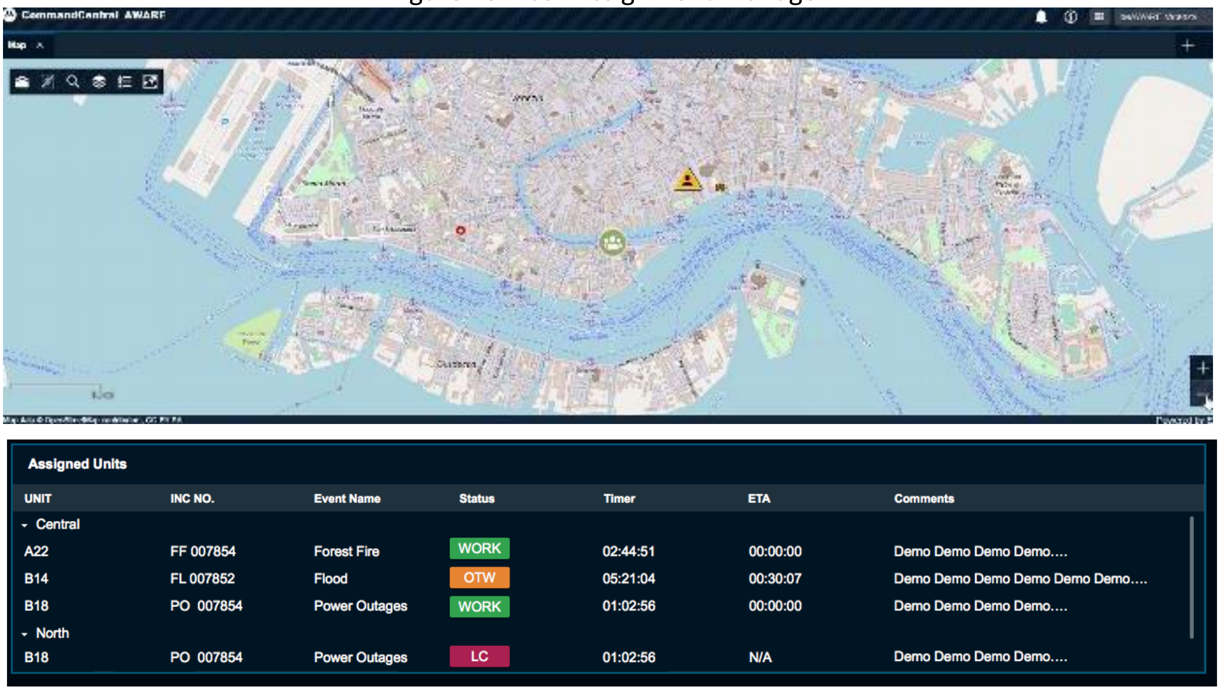


Figure 26: Task Table and Team Status report on the incident Map.

The Tasks that are successfully assigned to teams can be tracked on the Tasks Table through a list of assignments given by the PSAP operators to the rescue teams. Each task has important attributes such as title, category and type, Instructions, assignment time, priority, severity, expected completion time.

In turn, the mobile applications of people in rescue teams are reporting continuously through the TOP102_TEAM_REPORT their teams' position and the status of their assigned mission. This information is illustrated on the incident map with a team icon in the given location, coloured accordingly depending on the status of the assigned task. Under user request, for a selected rescue team on the map, can be displayed details about its identifier and the task assigned.

Except of this type of interaction, the mobile application provides also a channel to first responders to interact with the risk assessment process by inserting into the system valuable observations from the field (e.g. estimation about the water level). The obtained data is analysed and weighted in the estimation of the local level crisis risk.

5.3 Phase 3 - Aggregation and semantic integration

This phase is a continuation of the previous emergency phase and aims to demonstrate the mechanism of aggregation and semantic integration of emergency information.

beAWARE system collects and combines data from incidents reported by rescuers in the field or citizens that are in danger. The analysis components of the system analyse the content of the reported incidents to extract conceptual information. The outcome of the analysis contributes to the detection of emergencies.

For example, the Image Analysis module analyses the ingested images in order to extract conceptual information regarding the incident. All the possible outcomes of the analysis are the detection, classification and localization of fire or flood concepts, detection and localization of objects like people and vehicles, severity level estimation based on proximity of people in danger to the localized flood or fire texture. In Figure 27 is shown an example of an image received from the Drones Platform and analysed by beAWARE components. The analysis results are saved in the KB, which updates the incident severity, probability and certainty and informs PSAP about the incident update. Following, the KB requests from the Report Generator a report about the incident. The same procedure is followed for the analysis from audio messages, tweets or text messages.

Figure 27: Incident reported from Drones Platform and analysed by the visual analysis module.

Overall, the system gathers the incidents which are reported within a specific radius under a common incident ID performing a proximity-based clustering. All the analysed information along with additional details, such as the severity of an incident, timestamps etc. are sent to the report generator to generate summarization reports with a description and title for the enumerated incidents.

Two types of reports are foreseen in beAWARE, short reports providing situational updates during ongoing crisis scenarios and wrap-up summaries providing an overview of a crisis. The generation of situational reports is automatic and follows the established data flow, with the KB to request a report on every new incident arrival in any of the project languages. These reports describe incidents, their locations and the objects impacted. The wrap-up summaries are generated semi-manually on User's request. This involves, on the one hand, selecting and ordering incidents, locations and impacted objects and on the other, using linguistic aggregation strategies to produce non-redundant fluent texts.

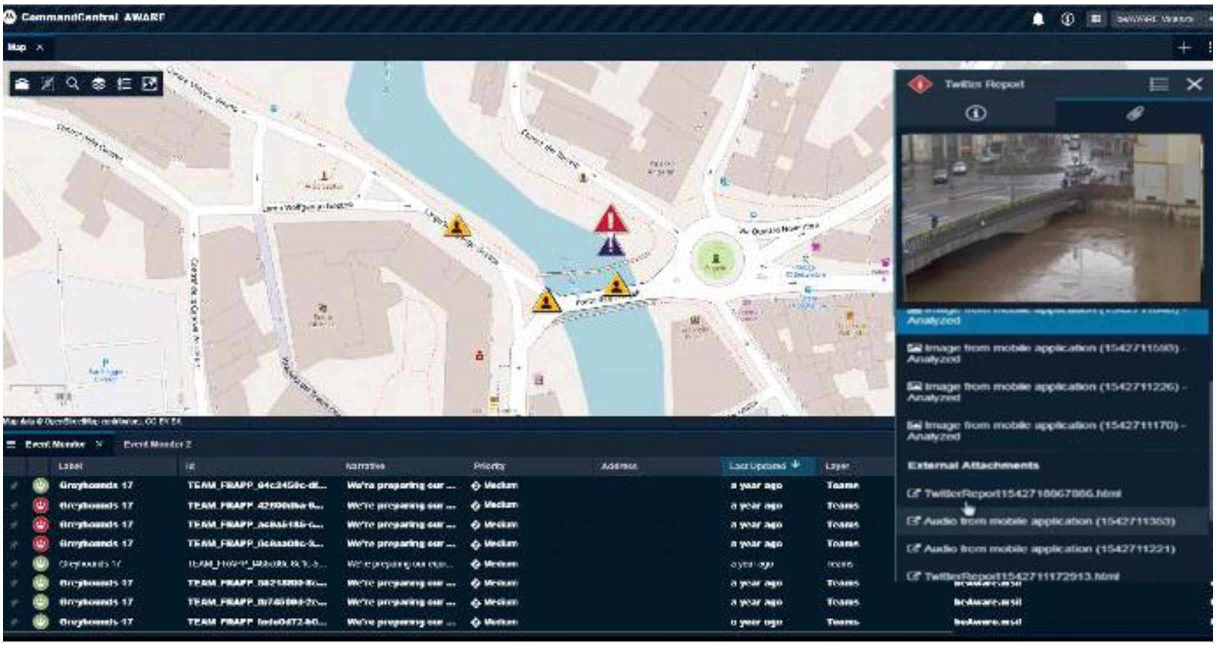


Figure 28: Proximity based clustering of incidents.

5.4 Fade Out

The purpose of this phase is to demonstrate how the beAWARE supports direct and easy communication, between national authorities, rescue teams and citizens and facilitates the distribution of information even in the final phase of the emergency management cycle

The Crisis Classification module acquires continuously weather observations to classify the crisis level. To simulate this phase a set of artificial weather data are fed into the module to generate a de-escalation process. At this phase authorities remove the alert by sending a public message through the beAWARE platform: Recovery continues until all systems return to normal.

6 Conclusions and Future Plans

This deliverable is a demonstrator about the integration of the 2nd prototype of the beAWARE platform that was realized during MS4. This document presents the main functionalities of the second iteration of the beAWARE platform in detail on use case basis.

D7.5 report includes some updates regarding the architecture, the hosting infrastructure and the integration of all the services. This can be summarised as follows:

- Most of the services have been significantly improved.
- New services have been developed, deployed and integrated.
- beAWARE ontology is updated based on the pilot deployments.
- Hosting infrastructure has been updated.
- The UIs of the system have been significantly improved together with the interaction of the available services.

The next steps are to integrate this work into the next and final iteration of the beAWARE Platform, as well as continue working on the Platform and associated services in order to cover the user requirements elicited in deliverable D2.10.

A detailed summarisation of the functionalities that are covered in P2 as well as the functionalities that will be implemented in the final system is provided in Table 12.

7 Appendix 1: System Functionalities - second prototype / final system

Table 12: System Functionalities P2 / Final System

beAWARE components	Second Prototype	Final System
KB	• Two-layer validation of incoming information • Optimize text analysis representation • Improved visualization of sensor data	• No additional features planned • Ontology changes as needed
FROST server	• Extended data integration functionalities	• Event/Threshold detection in alignment with crisis classification
Crisis Classification	• Receive data from heterogeneous sources (e.g. photos, text messages, IoT, sensors data, social media). • Analyse the data so as to forecast an upcoming crisis event (full functionality of the Early Warning component). • Risk assessment services & real-time monitoring system to identify crisis event's severity level (full functionality of the Real-Time Monitoring and Risk Assessment component for the flood pilot) Integrate flood hazard and risk/impact maps for flood risk management.	• Receive data from heterogeneous sources (e.g. photos, text messages, IoT, sensors data, social media) • Analyze the data so as to forecast an upcoming crisis event (full functionality of the Early Warning component) • Risk assessment services & real-time monitoring system to identify crisis event's severity level (full functionality of the Real-Time Monitoring and Risk Assessment component for the fire and heatwave pilots) • Interoperability with European Forest Fire Information System (EFFIS), European Flood Awareness System so as to integrate risk/impact maps
Image analysis	• Localization of flood event • Localization of fire event • Target risk estimation based on localization • Face Detection for counting • Drones photos analysis	• Recognition of more object categories • Final updates of current implementations
Video analysis	• Spatiotemporal localization of flood event • Spatiotemporal localization of fire event • Target risk estimation based on spatiotemporal localization • Object tracking for counting • Drones footage analysis	• Recognition and tracking of more object categories • Final updates of current implementations
ASR	• Set up a call center application able to record calls • Italian Model	• Fine tune language models (in order to improve recognition accuracy) • Automatic language identification
Drones Platform	• Support sending images in RT • Send images to multiple destinations	• Support sending video in RT • Send video to multiple destinations

beAWARE components	Second Prototype	Final System
Social Media	• Automatic classification of tweets as reliable or not (fake tweets validator) • Emoticons are now accounted for.	• Communication with MTA to get extracted location of tweets
Text analysis	• Extend coverage of extraction of information from linguistic expressions in all of the project languages.	• Produce references to BabelNet and geographical databases, and map these references to ontological concepts. • Semantic abstraction over entities, locations, events and concepts. • Produce conceptual structure integrating various aspects of domain and linguistic meaning (e.g. modality, tense).
Report generator	• Avoid repetitions and redundancy in situational reports. • Extend coverage according to project ontology.	• Produce summaries • Integrate reference to BabelNet and geographical databases into the generation process.
Mobile application	• Send report with attached media files (text, image, video, audio) • Receive warning from authority • Multilingual support • Initial version of team status management	• Extended team management together with User/Role Management • Task management
PSAP	• 2nd version of the Dashboard to support single dataSeries and more metric visualization components like line charts, traffic lights and more. • Metrics and map Visualization improvements. • Operational Management – handle incidents by assigning tasks to teams and send public alerts. • Incident Management. • Optimization.	• Extend Dashboard capabilities to alert the authorities when exceeding predefined thresholds • Enhance Metrics and map Visualization by adding more details and special icons • Enhance Operational Management to track task progress, trigger events and alert the user following predefined rules and conditions • Incident Management: edit and update incident details like Priority, certainty, status etc • Overall system optimization