

MONA – A Situation-Aware Decision Support System for Emergency Situations

Bernhard Holtkamp¹, Norbert Weissenberg¹ and Heike Speckmann²

Abstract

In this paper we present a decision support system for emergency situations for mobile use. MONA filters from the abundance of altogether available information and services those relevant for the operation situation and puts them to the operation control at the spot and also the directing center at the disposal. Long delays, caused by complex procurement processes for relevant information, can increase risk for lives and for the environment and can be reduced by using a system like MONA.

1. Introduction

Emergencies can have manifold reasons, for instance, natural hazards (e.g. storm, earthquake, flood), infectious diseases (e.g. SARS, foot and mouth disease, avian influenza), accidents (fire, collisions) or transport of hazardous substances (e.g. chemicals, nuclear material) via different transportation means (e.g. on the road, by ship, by airplane, by railway, in pipelines). Many of these examples imply environmental risks. A characteristic feature of emergency situations is their sudden occurrence at an arbitrary location. Hence, an efficient emergency response has to be based on context information (Dey 2001) to benefit from an adequate geographical information basis combined with geo referenced risk management information and application domain specific information.

Sound decision making in such emergency situations requires an efficient combination of experience and situation-specific information. As today's operation control systems cover only standard information demands, a commander on the spot often needs additional information from various information resources for better decision making. Typical examples are weather information, geographic information like maps, information on hazardous goods, checklists or specific intervention plans. Hence, an integration of such services into a mobile decision support system like MONA (MOBILE emergeNcy Assistant) are of particular interest. To relief a commander from being flood with information that are not relevant for the particular emergency situation, MONA deploys a situation model (Meissen 2004) and context information (Haseloff 2001, 2004) to filter out the relevant information from the large amount of available data. The underlying technology is taken from a semantic Web services platform for public services (Holtkamp/Gartmann/Han 2003).

2. MONA system overview

In case of interventions response teams often have to decide on the spot how to react to an emergency situation. In general, at alert time basic information is provided that characterizes the emergency situation.

¹ Fraunhofer ISST, Emil-Figge-Straße 91, D-44227 Dortmund, Germany,
Tel: +49 (0)231 976 77 300, Fax: + 49 (0) 231 976 77 198, Email: {holtkamp, weissenberg}@do.isst.fhg.de

² Duisburg City Fire-Brigade, Wintgensstraße 111, D-47058 Duisburg, Germany
Tel: +49 (0)203 308-0, Fax: + 49 (0) 203 308 4001, Email: heike.speckmann@stadt-duisburg.de

Only on the spot, however, a more precise picture of the situation can be gathered. Therefore, MONA supports mobile clients like PDAs and smartphones or laptops on the fire engine, besides PCs in the control center. This is supported by the gross system architecture of MONA depicted by Figure 1.

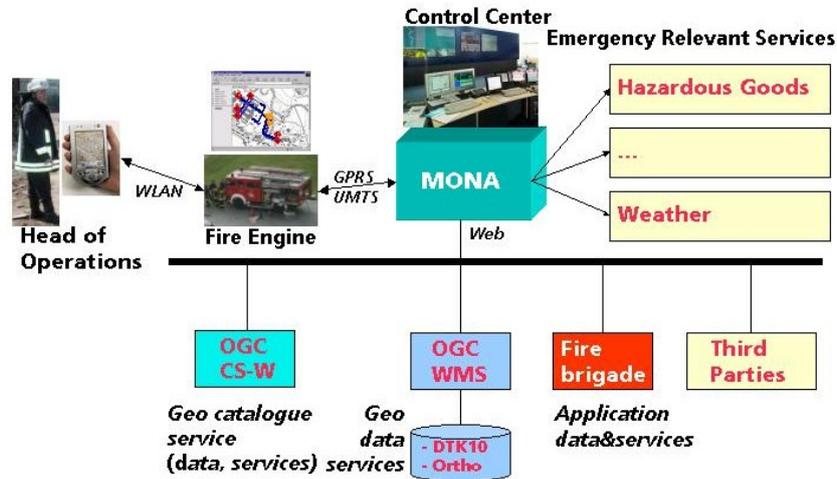


Fig. 1: MONA Gross System Architecture

MONA possesses among others the following characteristics, which define this system in relation to existing command & control systems:

- **Situation-specific information supply:** Operation and high-level personnel are supplied locally with exactly the information needed in the respective operation situation. This is achieved by a matching of meta information assigned to both the documents and services, and the respective operation situations. If the situation was not correctly specified by the dispatcher in the operations control system, then this is still locally correctable. The situation filter can also be completely switch off.
- **Support of mobile devices:** Since MONA is to support the task forces locally, it was made certain that MONA runs also on smartphones and PDAs. Thus also an OGC conformant Web map client (Open Geospatial Consortium 2004) for small devices was developed.
- **Flexibility and generic elements:** Web-based services and documents can be simply integrated as sources of information in MONA, as its meta information is registered. Basis generic elements are available such as two Web mapping clients and a file browser, which can be used in different forms for the definition of MONA services.
- **Automatic map positioning:** In MONA geographical maps (city plans, etc.) are merged, which are centered automatically to the current operation position.
- **Multi-operation support:** Since several operations can run at the same time, multi-operation ability of the clients is supported. Normally the users automatically get the data of the current operation (operation number and its situation, location and situation-specific functionality). If task forces added later log in and a new operation already started, the operation number must be indicated. Changes of the operation situation affect the front-ends of all terminals used in this operation.
- **Device type and user group** are considered as follows for the filtering of contents made available: Currently two device classes are considered: devices with a broad display (PC/laptop) and devices with smaller display (smartphone, PDA). On the latter documents and services can be suppressed, which need a broad display. Furthermore three user groups are differentiated at present: High-level personnel,

task force and guest. A high-level personnel has access to all services offered in the respective situation, while a task force cannot access the typical guidance services. The guest entrance is strongly limited and has no change functionalities. In future, hierarchy levels such as BvD (officer of head office), BvE (officer of operation control) and security department leader can be provided with different information (e.g. check lists) for a certain operation.

- **Administration interface:** MONA provides a simple Web-based administration of meta information for services, documents, situations and other relevant objects, which forms the basis of situation-specific information supply.

2.1 MONA mobile clients

MONA provides the following functionality. Its homepage provides access to three different categories of services, grouped in two-level menus.

1. The select button »Basic« enables access to different static and dynamic information and services that are independent of a particular emergency situation. An example for static information is the emergency response guide, and weather information is an example for a dynamic service. Another typical example is the access to geographical data that are related to the emergency location. Such geographic data could be provided by services of the emergency response organization as well as by external organizations, provided they support OGC compliant geo services (Open Geospatial Consortium, Inc., www.opengeospatial.org). For the deployment of MONA by the Duisburg city fire-brigade geo information provided by the State Land Survey authority of North-Rhine Westphalia and the Duisburg city cadastral information system have been integrated. The maps are centered to the operation position.
2. By the »Situation« category action force people can access situation-specific information and services. A hierarchy of more than 180 situations have been identified. For each situation sets of relevant information categories have been defined and documents and services are assigned to the currently relevant categories. Examples are intervention plans and check lists.
3. The »Extra« category provides access to an emergency knowledge base that can contain a wide variety of emergency related information, including information on and plans for the current objects and vehicles, descriptions of previous situations, laws and regulations.

2.2 MONA backend

The MONA backend is an application that runs on a laptop in the command vehicle and in the operations control center. MONA clients are connected with the laptop via WLAN. The MONA backend user interface is basically the same as that of the mobile clients. As a consequence of the extended capabilities of a laptop, for instance, larger segments of geographic maps can be displayed and a more sophisticated service interaction can be provided. Moreover the backend supports the administration of MONA, e.g. configuring situations, services and documents.

2.3 Integration of content documents

For the different types of emergency situations that have been identified a large amount of related documents is available. Examples are emergency specific checklists and intervention plans, object related information (e.g. contact persons, engineering drawings, local maps, information on security equipment), calculation aids, legal information and so forth. These documents are available in various formats and are often organized in a computer's file system. To avoid redundant maintenance of these documents MONA

supports the integration of documents and of folders within a file system. Document formats can be converted to those that enable a device independent presentation of the content. Otherwise, documents that cannot be represented on a client device can be suppressed.

2.4 Integration of content services

MONA can integrate third party services from different resources. Besides general information like weather or emergency response guidelines, geographical information are an important part of decision support. Hence, MONA supports the integration of OpenGIS compliant Web Mapping Services (Open Geospatial Consortium 2004) to visualize geographic information via MONA's Web Mapping clients.

Examples for other services are hazardous goods information, street and traffic services or environmental information.

All services are registered with meta-information that enable a situation-specific selection of services, i.e. MONA users are directly provided with information and services that are related to the actual situation and access rights defined by the user group. Moreover services are filtered according to the device used.

3. MONA integration with command & control systems

Typically, emergency response organizations (e.g. fire-brigades) have a command & control system in place that supports a routine reaction to emergency situations. MONA aims at providing decision support that goes beyond the standard functionality of today's command & control systems. Hence, it can be seen as an add-on to such systems. To benefit from MONA's situation-dependent information supply, an at least loose coupling between both systems is desirable.

In general, a command & control system knows the location where the emergency occurred, the time of the event and the type of emergency. These information are transferred to MONA together with an identifier for the emergency case to provide the basis for a situation-aware information supply. MONA is able to support different emergency cases at the same time. Normally, response teams automatically log into the most actual emergency, but selection is also possible by using an emergency identifier when logging in.

4. MONA at the Duisburg city fire-brigade

The adjustment of MONA to the requirements of the Duisburg fire-brigade by Fraunhofer ISST took place in the context of a joint project of the initiative GDI North-Rhine/Westphalia (GDI NRW 2004). Further project partners were the office for land surveying North-Rhine/Westphalia and the national office for data processing and statistics of the country North-Rhine Westphalia. While the fire-brigade covered the technical side concerning the operation support, by the two national institutions geo information and services were made available.

In the yearly cut approx. 55,000 operations fall on. Among them are more than 100 major fires and more than 200 dangerous goods emergencies (Duisburg 2001). In many of these cases decision support like MONA is desirably.

In co-operation with the Duisburg fire-brigade a structure for operation situations was developed and identified to an operation situation associated information categories. The operations possible in Duisburg are generalizes at present in form of approx. 200 operation references. To operation references (situations) their short name and a description are administered, as well as a classification of the operation by a configurable set of keywords or characteristics.

5. Conclusions

To enable a situation specific information supply MONA has been developed as a context and situation-aware decision support system as an add-on to conventional command & control systems. It integrates document-based information and Web-based services from various sources. These contents and services are made available via Web browsers on a PC (e.g. in a control center) as well as on mobile devices like PDAs and smartphones.

The MONA application has been developed in cooperation with the Duisburg city fire-brigade to improve interventions. Annually, Duisburg has about 55,000 emergency interventions with about 1,500 large scale emergencies. Currently, MONA is in deployment test status.

Acknowledgements

MONA is developed in the context of the two projects “Personalized Web Services on Internet III for the Olympic Games 2008 in Beijing” and “COMPASS 2008”, both supported by the German Ministry of Education and Research (BMBF Grants No. 01AK055 and 01 IMD02B).

Bibliography

- Dey, A.K. (2001): Understanding and Using Context, in *Journal on Personal and Ubiquitous Computing, Special Issue on Situated Interaction and Context-Aware Computing*, 5(1)
- Duisburg Fire-Brigade (2001): Annual Report of the Duisburg City Fire-Brigade, http://www.duisburg.de/feuerwehr/bindata/Jahresbericht_BFDU_2001.pdf
- GDI NRW (2004): Homepage of Geodateninfrastruktur NRW, www.gdi-nrw.org.
- Haseloff, S. (2001): Optimizing Information Supply by Means of Context: Models and Architecture. *GI Jahrestagung (1) 2001*: 206-213
- Haseloff, S. (2004): Context Gathering - an Enabler for Information Logistics. In: P. Chamoni, W. Deiters, N. Gronau, R.-D. Kutsche, P. Loos, H. Müller-Merbach, B. Rieger, K. Sandkuhl (eds.): *Multikonferenz Wirtschaftsinformatik (MKWI) 2004, Band 2, 9.-11. März, Essen*. Berlin, Akademische Verlagsgesellschaft, 2004, S. 204-216
- Holtkamp, B., Gartmann, R., Han Y. (2003): FLAME 2008 – Personalized Web Services for the Olympic Games 2008 in Beijing, *Proc. eChallenges e-2003, Bologna, Italy*
- Meissen, U. (et. al.) (2004): Context- and Situation-Awareness in Information Logistics, in *Proc. of EDBT Workshop on Pervasive Information Management*
- Open Geospatial Consortium Inc. (2004): Web Map Service, Version: 1.3, OGC 04-024, ISO/DIS 19128, http://portal.opengis.org/files/?artifact_id=5316