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A STEP FORWARD IN THE MODERN EUROPEAN CRISIS MANAGEMENT SUPPORT [1]

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Abstract

Due to the complexity of the current living environment of the western world one of the top priorities in the European countries is the protection of the critical infrastructures considering an advancing the field of crisis management. The main concern when responding to a crisis is how to facilitate the integration of information from various sources through different media in a meaningful practical way. This challenge has been considered in the European project "*Management Decision Support for Critical Infrastructure*" (MEDSI) which finished at the end of October 2005. The main objective of this project was the development of a first step in a new European crisis management support considering the information aspects. This paper focuses on a summary of the MEDSI project considering mainly the project results based on specified user scenarios. In special, the different research areas like interoperable geographical information services from the crisis management perspective, ontology as well as symbology for crisis management will be presented.

Introduction

Nowadays accessing existing, up-to-date information is one important precondition for a modern decision support for critical infrastructure. This requires a new approach considering modern available IT technologies as one essential basis. Against the European background one step forward in a modern European crisis management support has been considered in the frame of a STREP European Research & Development Project called "Management Decision Support for Critical Infrastructure" (MEDSI) which was finalized by a consortium of 11 partners from 8 countries at the end of October 2005. The main objective of this project was the development of a web-based integrated set of software services used as a tool for enhancing the capabilities of crisis planners or/and managers from the IT technology side. MEDSI enables to utilize various existing information sources for better monitoring and reduction of potential and current risks and for more effective response in case of threats imposed espe-

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cially to the subjects of the critical infrastructure. For it, a data fusion of geospace, organizational and other territorial and operational area is realized in a standardized IT environment. The standardization and openness brings the possibility to further grow this seed in national and international levels and to assure the interoperability with other systems. The resulting system environment should be used by users from general security areas as well as environmental protection, utilities management, airports and seaports, healthcare, transports, roads, energy plants, borders control etc. MEDSI considered only the first step in the right direction against the European background. The focus of this paper is the presentation of the general MEDSI approach, architecture and various selected research areas based on different specified user scenarios.

MEDSI Approach

The underlying objective of MEDSI is to make the process of crisis management more efficient, in an innovative framework, in order to give an effective answer to a crisis and reduce the likelihood of damage to people and critical infrastructures. From the specified real user scenarios, it is known that most of these processes are done by hand. MEDSI has innovated through the basis of a system oriented to solve the stated problems that are detailed in the scenarios, that is, a system that helps crisis managers take decisions for the solution of crisis situations.

Since there are many different scenarios in which this kind of systems are applicable, the system should be flexible enough to adapt to every situation, especially from the point of view of the acquisition of local data (information, maps, etc.) and the customisation of the standard procedures.

Besides, the granularity of crisis centres and their jurisdiction is varied, and so do their interdependencies, and as a result MEDSI envisages a deployment based on independent cells, adaptable to any organization. It is able to work in different situations at different geographical places with only changes in the data sets of the organizations and their jurisdictions. The communication among *MEDSI cells* and the fostering of interoperability with non MEDSI systems are other important objectives. Therefore, MEDSI is conceived as an organized structure (likely hierarchical) of interconnected cells, in which the usage and fostering of standards will assure the interoperability between cells and with external systems.

On the other hand, the current technologies provide higher levels of interoperability between loosely coupled systems and platforms. One of these technologies is Web Services and MEDSI uses these technologies to tackle different aspects of a crisis management system, in order to assess its feasibility. It enables to cover both geographic and non-geographic information exchange.

Regarding the functionality of such a system, it should include the whole lifecycle of the crisis management processes. Mainly, it should cover the risk assessment, the identification of information needs, the collection of data, the analysis of all the available information, the planning of responses, the dissemination of information to action forces and media, the response action monitoring etc. This functionality is clearly explained in the defined use cases. In order to assure that it will be possible to cover both current and future needs, the system envisaged a layered component-based architecture.

One of the MEDSI project objectives is to find a new way of supporting decisions in the area of crisis management against the European or international background. As a result of this challenge a general approach considering two main aspects is required:

- In each country different command or organisation structures exist to deal with crisis situations. These structure varieties must be accepted in a possible future solution

meaning the concrete solution must be integrated in the existing local social, organizational and system environments.
- The whole system must be shown as a network of crisis management solutions. In this network information and decisions must be exchanged. As a result, not only a local solution is required but also a wider concept for the international emergency management.

To deal with these challenges in the scope of MEDSI it was required to introduce a flexible approach. For that it has been introduced the idea of *MEDSI cell* and *network*. The *MEDSI cell* is the concept for supporting the local decision maker in the crisis management, and the *MEDSI network* is the concept for the interoperability of MEDSI cells against the national and international emergency management support. This concept can be defined in detail as follows:
- A MEDSI Cell is a specific implementation/instance of a MEDSI system and consists of the system functionality and specific data and data sources covering a certain geographical area (usually corresponding to the jurisdiction of a specific crisis management organization).
- A MEDSI cell communicates with other MEDSI cells (according to the hierarchical structure of the crisis management organizations)
- A MEDSI cell communicates with the existing systems used by the crisis management organizations and providers of data on critical infrastructures. These information providers may be shared by several cells from the same or different hierarchical level, in case of territorial overlap, general information providers (i.e.: maps providers) or common resources.
- A MEDSI cell is an autonomous entity. This means it is able to work independently irrespective of whether it is connected to others cells; i.e. each MEDSI cell has capacity to support decisions in crisis situations within its pre-defined area.
- A MEDSI cell is not a new/different organization or organizational structure for dealing with crises.
- The MEDSI network is a number of MEDSI cells that basically follow the existing hierarchical structure/network of crisis management organizations.

Based on these considerations the MEDSI project can be arranged on the cell level as first step in the modern European crisis management support.

MEDSI Cell Architecture

The general system architecture for a MEDSI cell is shown in figure 1. The MEDSI system is composed on of nine different system components with following objectives:
- *Administration*: This component provides all required functions for the management of user, user groups, and privileges for the groups and the logging of user interactions.
- *Planning*: This component provides functions for the dynamic content of plans meaning provision of content to this point in time, when the plan is needed.
- *Reports*: This component focuses on the creation of specific report types in order to gather the Analysis, the Planning and the Symbology needs.
- *Symbology*: One of the main concerns of Geographical Information Systems is how to facilitate the integration of information from various sources through different media in a meaningful way. Here, the crucial task is how to obtain timely and accurate geospatial information to quickly visualize and understand the context of emergency situations. This component provides all required functions for it.

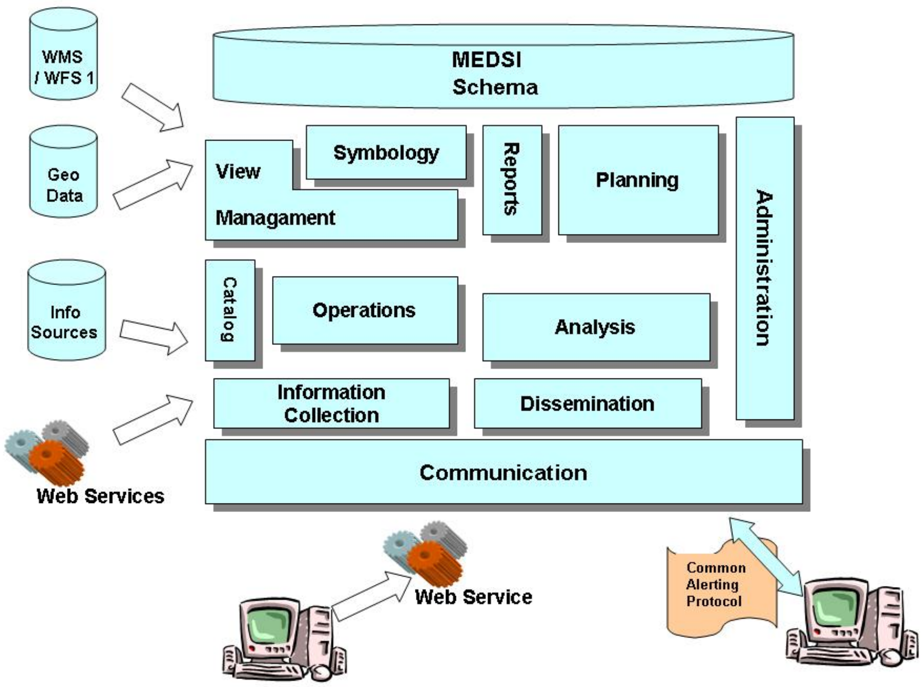

Figure1: Architecture Overview Diagram of a MEDSI Cell

- *View Management*: The immediate access and use of geospatial information and applications are essential for effective management of all types of critical infrastructure systems. The ability to rapidly share and apply geospatial information is important because emergency and disaster management in these domains require cooperation among a broad range of organizations operating across many jurisdictions providing by this component.
- *Operation*: This component includes functionalities which enables the crisis management in real time.
- *Analysis and SOP*: The key innovation lies in the definition of the common crisis management ontology, which enables procedural interoperability of various regional, national and international agencies, private subjects etc. in favour to share the "Common operation picture" of the situation. Based on this ontology, the large-scale co-ordination of the crisis management activities is facilitated. This component provides all required functions for its.
- *Dissemination*: This component provides a message oriented middleware that is used to enable message exchange between users in a MEDSI Cell, among MEDSI Cells, between MEDSI cells and other systems.
- *Information Collection*: This component provides all required functions for interoperability among European data sources for crisis management based on the standardization of the acquisition of data from heterogeneous sources through web technologies.

In the frame of the project all components has been implemented prototypically and integrated in a useful way as validation of MEDSI concepts and ideas in a running prototype.

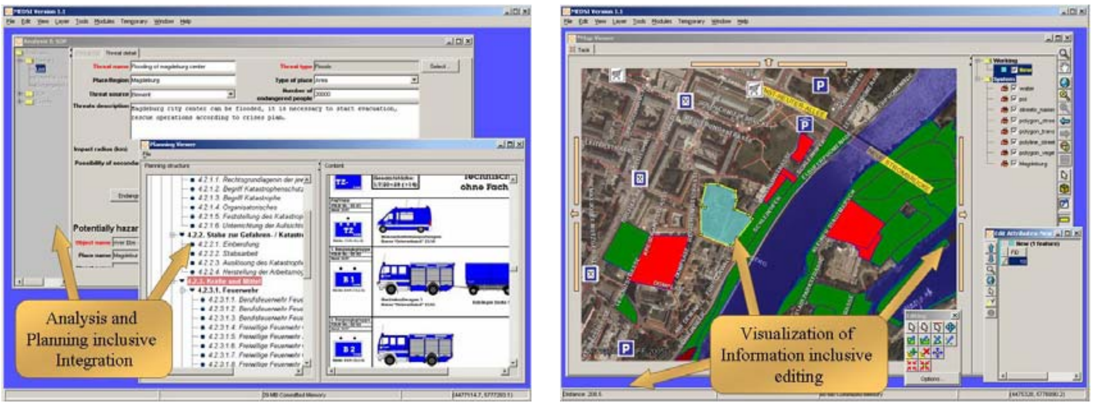

Figure2: Selected Screenshots from the MEDSI Prototype Instance for the Magdeburg Scenario

User Scenarios

Defining all user requirements is a mandatory first step in the process of developing a new approach in the European crisis management within the framework of the MEDSI project. For this purpose two different specific user scenarios in Holon (Israel) and Magdeburg (Germany) were specified. Two different crisis situations are considered in these scenarios:

- flooding along the river Elbe and
- a chemical fire event in city Holon.

Both scenarios are based on reality and consider past events. The scenarios served as the basis for the specification of all user requirements. The main objective of these scenarios was to provide a clear idea about the basic requirements of crisis management, being in this way an important precondition in the process of MEDSI system requirements definition. To reach this goal, the following aspects were considered in the user scenario specification:

- Specification of two main crisis scenarios
- Specification of a domain model, identifying entities, organisations, environments, and events that play a significant role during the crisis management process
- Specification of a general process for crisis management which should be considered in the MEDSI system
- Specification of actors that participate in the crisis management
- Specification of a set of high level generalized uses cases showing the basic activities in the crisis management process, in order to derive all relevant components and processes
- Specification of selected required non-functional requirements for the proper operation of the system

All these tasks contributed to the specification and development of a system that considers the real user requirements in the area of crisis management.

Innovation Areas

For the provision of an innovative framework for a step forward in the modern European crisis management support, the following selected innovation areas were considered in the frame of MEDSI project:

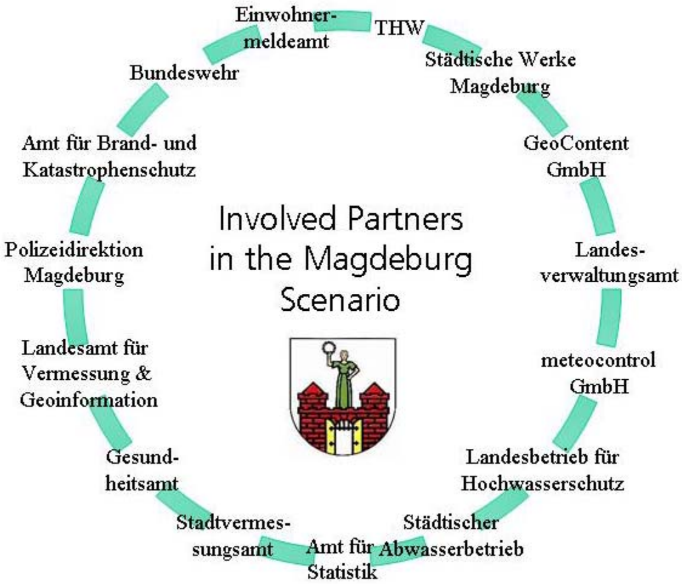

Figure3: Overview about the involved local Partners in the Magdeburg Scenario

- *Innovation in Data base schema*: As part of its research effort, MEDSI comes up with a definition of a generic database model that covers the needs of crisis management agencies in terms of providing the needed information. Starting from domain model (conceptual schema generally expressed in terms of entities and relationships) it was created the logical model with its entities and descriptive attributes and finally it is obtained a data model, specifying the data structures in the database which will be used by several application components. MEDSI works in heterogeneous information environment of distributed geographical information and not geographical information sources, which means not only need for using common ways of accessing data (e.g. WFS, WMS, XDI), but we face also the problem of maintaining coherent contents/semantic metadata descriptions through mechanisms such as ontology's.
- *Innovation in Architecture*: In the emergency management area a lot of different heterogeneous information sources exit which are required for supporting the decision making process. For latter, special generalized components are needed, like for analysing or planning. Furthermore, in each European country different preconditions exist considering the available information sources. In fact, for the realization of MEDSI approach, a more general approach is needed. For the technological side the Web-Service based architecture promises one possible solution. As a result, the architecture of MEDSI is a three tiers architecture based on a web service approach for accessing heterogeneous information sources and existing software component providing special functions like analysis or simulation functions, in general. For accessing information and functions a Catalogue Service based on ontology approach was developed inside the architecture.
- *Innovation in Symbology*: Symbols, built from basic icons, will be augmented with dynamic information. For example, a hospital can publish the number of free beds, and this information can be incorporated in the symbol representing the hospital. Research outcome in MEDSI is a proof of concept implementation of the framework for displaying of dynamic attributes. Use of web services to provide values of symbol attributes. The values of the dynamic symbol attributes will be received by the MEDSI system via web services, thus establishing a standardised and technologically up-to-date way for various entities (e.g. hospitals) to provide additional information. Research outcome of MEDSI is a proof of concept implementation of acquiring the values of symbol attributes via web services. Use of the SLD standard for conveying symbol information. Styled Layer Descriptor (SLD) is a language, defined by OGC, which can be used to customize the output of WMS and WFS on the client side. Instead of information about

the symbol in internal format, the symbology package will build an SLD file, which will be placed as a parameter in the WMS request.

- *Innovation in Geographical Information System*: Enabling Collaboration over a distributed and interoperable GI Framework has been made available to MEDSI in a framework capable of accessing Geographic Information in an interoperable fashion over a distributed environment (the Internet). For that, an OpenSource client (JUMP) has been abstracted, merged with MEDSI framework and extended to support specific functionalities of other business specific modules. Aside from this, other geographical information specific functionalities have been created or improved because of their importance in providing a proof of concept of the system applicability. Examples are improved GML support and development of WFS support. As a result, MEDSI is now able to have distributed access to interoperable geographic data sources in two types of standard requests:
    - Web Map Service (WMS) for portrayal services (maps rendered as images)
    - Web Feature Service (WFS) for querying GI data

  Available geographic data sources (WMS or WFS) are found by means of a catalogue service also put in place. Because of the increasing complexity of MEDSI prototype, and in order to improve integration while maintaining low coupling between modules, it has been developed a plug-in mechanism for module integration based on reflection.
- *Innovation in interoperability of data sources*: One of the key issues of innovation for interoperability among European data sources for crisis management is the standardization of the acquisition of data from heterogeneous sources through web technologies. In order to assure the compatibility between crisis management systems and sources of information, it is basic to provide the proper mechanisms to exchange data based on a common ontology. The basic technology to implement this functionality for non geospatial data through the web is Web Services. However, this is a technology focused on remote invocation of methods, and not on data exchange, and it does not cover basic needs for distributed data sharing: data transactions, caching and synchronization, security policies, etc. On the other hand, it does not provide an abstract mechanism to locate data resources and data types. These needs are common to different domains, and the OASIS consortium, has launched an initiative to solve this problems through web services: the initiatives XRI (eXtensible Resource Identifier) and XDI (XRI Data Interchange). The objective of XDI is to enable data from any data source to be identified, exchanged, linked and synchronized into a machine-readable dataweb using XML documents and XRI, a URI-compatible abstract identifier scheme. MEDSI will prove this emerging technology before its final specification and will provide feedback from the crisis management domain. By the end of the project, MEDSI will be able to make a technical recommendation about the usage of XRI/XDI for critical infrastructures protection.
- *Innovation in interoperability*: In the current situation, there are lots of separate systems working on their specialized domain, like crisis information systems, public warning systems, modelling and simulation tools. One of the biggest problems is: the systems are not able to operate with each other and act as a single body. The most feasible way to make these separate systems interoperable is through message oriented middleware and a set of standardized messages specifically developed for this purpose. It has been developed the message oriented middleware that is used to enable message exchange between MEDSI Cells; between MEDSI cells and other systems. This middleware processes messages that make use of data structures developed specifically for MEDSI and the Common Alerting Protocol (CAP). CAP is a standard data interchange format being worked on by Organization for the Advancement of Structured Information Standards (OASIS) consisting of XML messages. Main purpose of CAP is to enable exchange of warnings, alerts, reports and information between parties in this domain. This standard is in the development stage and the OASIS community announced that they are expecting feedback from projects using this message set. The feedback will be used in shaping the next releases of CAP Standard. It has been adopted and being used by

organizations such as International Telecommunication Union of United Nations, Department of Homeland Security of United States. The consortium has already identified several shortcomings of CAP. It has been implemented other messages to exchange information between components among MEDSI Cells for sending attachments. Besides these, based on the results of the next analysis stage the consortium will also implement new messages that are needed for exchange of information among MEDSI Cells. In order to prove interoperability between other modelling tools and MEDSI. Using the modelling tool it will be developed a message structure that will enable information exchange between the modelling tool and MEDSI.

- *Innovation in Ontology*: The key innovation lies in the definition of the common crisis management ontology, which enables procedural interoperability of various regional, national and international agencies, private subjects etc. in favour to share the "Common operation picture" of the situation. Based on this ontology, the large-scale coordination of the crisis management activities is facilitated. The current situation shows the heterogeneous and distributed important information resources, which make the effective collaboration very difficult, both in the crisis planning and the response. The common ontology, linked to the proposed standards of Symbology and messaging, will increase the possibility to view and understand the situation, have a better control upon the resources and be fast and more accurate in the decisions. This will happen not only at the regional level, but will bring the possibility for better co-operation at the multinational scene, as the critical infrastructure is interlinked across the borders and the same behaves the crisis situations. The ontology and its manifestation in the proposals to the standardisation bodies would be a new tool to support the European activities in the critical infrastructure protection and will enable the nations to co-operate more effectively.

Conclusion

In this paper a new approach to handling the complexity of the living environment of the western world has been presented as one step forward in the modern European crisis management support. This approach was developed in a European project which finished at the end of October 2005. The general outcome of this project was development based on defined real user scenarios resulting in the MEDSI cell and network concept as one of the main project output. Latter they can be used in Europe as basis to consider the different preconditions in all European countries. To solve the technological problems on the cell level the application of existing IT technologies is possible although extensions of several technologies are required in order to deal with special user requirements in the crisis management area. The MEDSI project contributed especially on this level. Further, MEDSI could only make a first step in the right direction. Further research tasks depend on the achieved results and the clarification of different political questions will also be required in the future aiming to create the political preconditions for an overlapping European crisis management.

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