A Web Portal for Early Warning and Risk Management

Walter Hürster, Private Researcher and Independent Consultant, Scultetusweg 24, D-89075, Ulm, Germany; E-mail: walter.huerster@t-systems.com
Thomas Wilbois, T-Systems, Ulm, Germany; E-mail: Thomas.Wilbois@t-systems.com
Fernando Chaves, Fraunhofer IITB, Karlsruhe, Germany; E-mail: chaves@iitb.fraunhofer.de
Roland Obrecht, Ministry of Environment, Stuttgart, Germany; E-mail: Roland.Obrecht@um.bwl.de

ABSTRACT

The universal concept and the general technical implementation of a Web Portal for Early Warning and Risk Management are described in this paper. As a prototype example for public access to a modern environmental monitoring and surveillance system, the Web Portal of a system for the remote monitoring of nuclear power plants is presented here in more detail. The concept, the architectural design and the user interface of this system had to meet high demands. Fulfilling the imposed requirements, a solution was developed which is universally suitable for environmental monitoring and surveillance, for early warning and for emergency management.

INTRODUCTION

Almost every day TV news reports on disastrous environmental events from somewhere in the world. Earthquakes, tsunamis, volcanic eruptions, hurricanes, heavy thunderstorms, floods and avalanches alternate with tanker collisions, oil spills, coastal pollution, wildfires, accidents in chemical or nuclear plants (related to the emission of toxic gases or radioactive nuclides) and terrorist attacks.

The loss of human life and the tremendous damages caused by those catastrophes as well as the increasing sensitivity of the general public make it reasonable to protect the population and the environment by means of a new generation of intelligent surveillance, information, early warning and emergency management systems. This includes a highly sensitive monitoring, fast and reliable prognostic calculations, but also a timely dissemination of the relevant information to the general public within the endangered area and in adjacent regions. A most comprehensive way to do this is to foresee public access to those systems via a dedicated web portal.

BACKBONE: THE OPERATIONAL SYSTEM

Due to the complexity of the challenge, it is obvious that only a network of computers with dedicated individual tasks and appropriate communication structures will provide a promising approach to solve the problem of monitoring, surveillance, threat prediction, decision support, early warning and emergency management. However, defining an adequate logical structure for those networks, a variety of subtasks and prerequisites have to be fulfilled in each case in order to include intelligence in various ways and to reach the goal of an integrated operational system:

- Development/integration of adequate sensor systems and sensor networks (autonomous or remotely controlled) providing data and background information. This may include mobile sensory platforms and remote sensing systems (air space surveillance and satellite systems).
- Advanced modelling, i.e. development/improvement of scientific prediction models for prognostic calculations of each disaster type supporting interpretation and extrapolation of data, e.g. calculation of the atmospheric dispersion in case of NBC releases, taking into account the current meteorological situation and the expected forecast values
- Integration of scientific prediction modules into operational systems and definition of adequate interfaces to allow for fast response actions even under critical conditions
- Integration of GIS functionality for an online situation display, using various types of geographical maps to facilitate the recognition of affected areas
- Development and implementation of risk analysis and decision support systems based on sensor data, prognostic calculations and disaster specific experience
- Development/improvement and inclusion of knowledge management components (in general and disaster specific) to integrate the long-term experience of experts and observations made in the past
- Definition of adequate information, alarm and warning strategies, using the full range of state-of-the-art technology, such as satellite communications, web technologies, radio broadcast, TV, telephone (fixed network and mobile systems), siren systems and loudspeakers
- Definition of appropriate interfaces to catastrophe handling and resource management subsystems (transport facilities, shelters, medical care....)

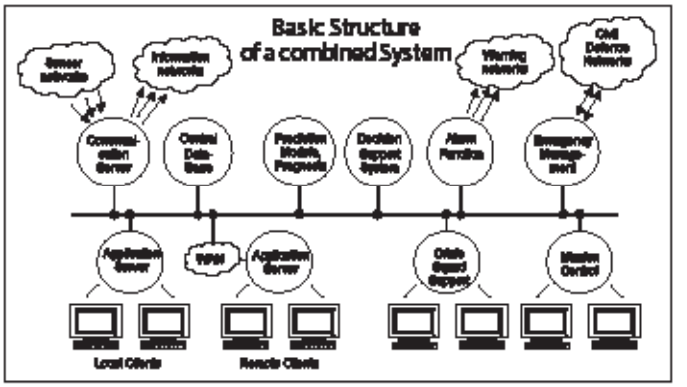
The proposed logical structure of such a combined system is shown in Figure 1 in the form of a Local Area Network (LAN), although some components may be linked together physically by means of a Wide Area Network (WAN), depending on the actual needs of the system under construction.

It is strongly recommended to use a communication server to handle the input data streams from various sensor systems and sensor networks and to convert different data formats, if necessary. This server may also handle the connection to external information networks. In case of higher system loads or larger systems, a specific server computer may be used for this purpose, e.g. a dedicated web server.

Since most of the data are usually needed for central access, the concept of a central database has been confirmed by practical experience. The distribution of specific subsets of the data for decentralized use (e.g. remote application servers) can be achieved by means of dedicated replication functions.

Prediction models and prognostic calculations, such as those for the atmospheric dispersion of toxic gases or radionuclides, tend to need large sets of data and

Figure 1. Structure of the system



therefore are also best served by a central access. Agent technologies and service accesslayer ontologies have proven to be most suitable for the integration of the various scientific components into an operational system.

Decision support systems, based on data describing the actual situation as well as the prognostic development, will reflect the implications for the population in the affected areas and thus help the crisis squad to make their decisions. These systems will have to include advanced knowledge management components and sets of metadata providing access to the long-term disaster specific experience of experts and to observations made in the past.

REQUIREMENTS AND BASIC CONCEPTS FOR THE WEB PORTAL

It is obvious that various user groups and stakeholders have their specific needs and therefore emphasize different aspects of the system. The following user groups can be identified and categorized (see Fig. 2):

- Administrative Sector
- Operational Sector
- Restricted Public Sector
- Public Sector

The administrative sector covers the system administration, maintenance of configuration lists, adaptation and optimization of the system itself and of the related workflows.

The operational sector deals with the main task of the system, i.e. surveillance and monitoring functions, display of the current and prognostic situation, risk assessment and decision support.

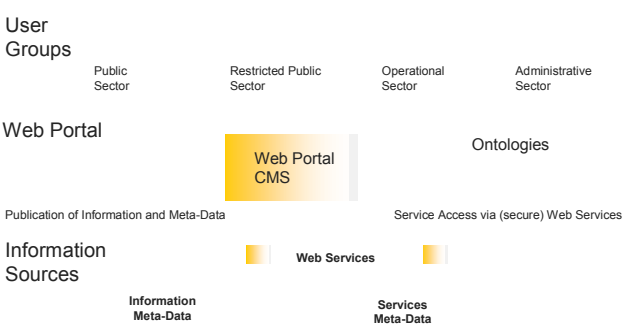
The restricted public sector will provide the necessary information for the crisis squad, for public services (the staff of rescue forces, fire brigades etc.) and all other authorities responsible for civil protection. This may contain confidential information or security related orders which are not foreseen for public disclosure, e.g. in order to avoid panic reactions and pillage.

Finally, the public sector will serve as an information platform for the general public, giving an overview about the current threat situation, exposure risks and the development of these risks. The public sector will also provide general and specific recommendations in case of an imminent dangerous situation. Special attention will have to be drawn onto the web accessibility according to W3C WAI, Section 508, and corresponding national laws.

The large extent and the complexity of the available information combined with various views of diverse user groups call for specific selection and preparation of the data for display in graphical and/or tabular form (depending on the user group). This is the core point for the design and implementation of the Web Portal: to provide for each user group a specific set of web pages which contain all information that is needed to achieve the assigned tasks in the best possible way.

By analyzing the required functionalities and the customer needs, a set of requirements can be derived. The main aspects are:

Figure 2. Basic concept, overview and structure



- Harmonization and matching of the heterogeneous sets of information
- Electronic situation display, incl. animation features
- Simplicity of the user interface
- Modern display capabilities, especially for graphical representations
- Possibility to combine various representations
- Easy-to-use approach by offering well structured information
- Definition of user groups by means of hierarchical access privileges
- Well targeted preparation of the presentations ("generated by experts, to be viewed by anybody")
- Automated, timely publication of (selected) information and metadata
- Publication of reports via secure web services (e.g. in alarm situations)
- Implementation of an "intelligent" public warning system
- Improvement of the emergency management capabilities by introducing workflow tools and corresponding templates
- High quality standards with respect to safety, security and system availability – even under emergency conditions

A first approach is to derive the coarse structure of the Web Portal from the structure of the various user groups, as indicated and illustrated in Fig. 2. Moreover, it may be useful to adapt the basic concept of different access privileges which may have been (successfully) applied in the Operational System, e.g. with respect to individual configuration capabilities for accessible data sets, allowed functionalities (function groups) and accessible server resources.

Further requirements can be deduced from the demand for reliability and high performance of the portal. According to the structure described above, the core functionality of the Web Portal will be allocated to a central Web Server. Therefore, a highly reliable network infrastructure with good performance will have to be provided.

THE IT CONCEPT

Again, it is logical and consistent to set up the IT design for the Web Portal on the basic system concept as described in the previous section and to make use of the existing structure of the Operational System.

This system is typically conceived in form of a client/server architecture with the following components:

- Communication Server (CS)
- Central Database (CDB)
- Application Server (AS)
- PC based User Interface (Clients)
- Integrated Information System (based on HTML)

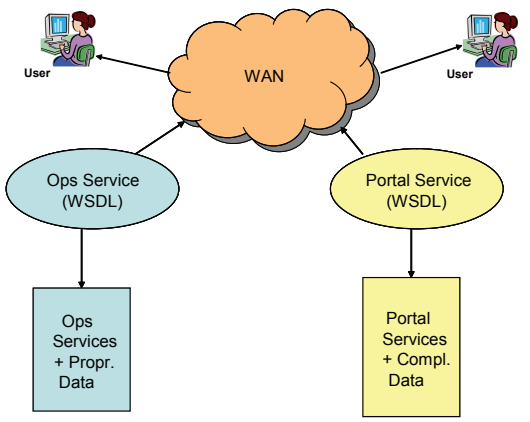
A web based solution is also conceivable for the Operational System (Intranet). However, for safety and security reasons, proprietary communication links would have to be provided.

Development costs for the Web Portal can be reduced by reusing existing facilities of the Operational System to the largest possible extent (provided that the requested views are already available) and to realize the connection with the Web Portal by means of a web service interface.

Given the current state-of-the-art, it is recommendable to use ontologies for modelling, classification, structuring of and navigation within the Web Portal. After a market analysis for adequate content management systems, a decision will have to be taken with respect to the product to be used, preferably one that is based on semantic-web technologies (like OWL-compliant ontologies) and web services for the development of content, knowledge and community management solutions. Due to the ontology based approach and open interfaces, those products allow for the modelling and input (distributed or automated) of very complex information as well as for maintenance, search/navigation and presentation of the information.

The publication of a report will now be realized by means of the communication between two web services (see Fig. 3). Proprietary data and operational services will be provided by the Operational System, whereas complementary data (originating from external sources) will be fed in by the Portal Service. The corresponding interfaces have to be implemented on both sides and have to be published by means of a so called WSDL specification (WSDL = Web Services Description Language; cf. W3C , 2002).

Figure 3. Publication of a report



Typical reports may a.o. include the following information:

- Protective measures, including their representation on geographical maps
- Evacuation areas/safe areas and their current availability status
- Overview of arterial roads, traffic flow and means of transportation (incl. status information)
- Layout plans for assembly and collecting points in case of collective transports
- Emergency stations for medical care, including hospital trains and hospital ships
- Overview of regular hospitals and medical centres (incl. status and capacity information)
- Layout plans of schools, kindergartens and retirement homes
- Layout plans of emergency sheltering capabilities, such as gymnasiums, roof covered stadiums

THE REFERENCE SYSTEM: A WEB PORTAL FOR RADIATION PROTECTION

As a prototype example for public access to a modern environmental monitoring and surveillance system, the web portal of a system for the remote monitoring of nuclear power plants (RM/NPP) will be presented here in more detail.

This system includes the collection of radiological and meteorological variables that have an influence on the diffusion and deposition of radioactive nuclides. A central role of the monitoring system is the use of these variables in the calculation of radiation exposure values and areas. These results are used for decision support, dissemination of information and the issuing of public warnings.

In the event of an imminent, occurring or already terminated release of radioactive nuclides, safety measures pertaining to disaster control and the provision of radiation protection could be required. For instance, the distribution of iodine tablets or a precautionary evacuation are included among these measures.

In its role as a supervisory authority for the nuclear facilities (Obrigheim, Philippsburg and Neckarwestheim) in the Federal State of Baden-Württemberg, Germany, and for foreign facilities close to the German border (Fessenheim/France and Leibstadt/ Switzerland), the Ministry of Environment in Baden-Württemberg has been operating such a remote monitoring system for nuclear power plants for almost 20 years. Recently, the system has been completely renewed using modern hardware platforms and software technologies (Obrecht et al., 2002, Hürster et al., 2005).

As described by Hürster et al. (2005), the RM/NPP is a complex measuring and information system which records and monitors approximately 20 million data sets per day. The actual operational state of the nuclear facilities including their radioactive and non-radioactive emissions are automatically recorded around the clock, independently of the operator of the nuclear power plant. In addition, the RM/NPP system continuously collects meteorological data at the sites and also receives data from external measuring networks (national and international). It provides numerous possibilities to visualize the data and to check them against threshold values and protection objectives. In the case of a radioactive leak, potentially affected areas can be determined at an early stage by a transport calculation (Schmidt et al., 2002) and protective measures can be adopted by the Ministry in cooperation with the authorities responsible for civil protection.

In order to allow for a broader but selective access to the information kept within the Operational System, the decision was taken by the Ministry to establish a web access function by means of a dedicated Web Portal (Hürster et al., 2006). Similar applications are envisaged by the Federal States Baden-Württemberg and Saxony-Anhalt in order to open the access to general environmental information, as imposed by legislation (Schlachter et al., 2006).

Both, the operational system and the web portal have been designed and developed in accordance with the logical structures described above (see Land Baden-Württemberg, 2004; Wilbois and Chaves, 2005). The client software offers numerous possibilities to visualize the data by means of a modern graphical user interface with GIS functions. Also, it provides standardized export interfaces to office and graphical applications.

As a result of a market analysis for adequate content management systems, the decision was taken to rely on WebGenesis®. This product fulfils the requirements mentioned above and it provides web service capabilities for external use, e.g. to establish or to shut down connections, for upload and download of data files etc. For this type of external access, WebGenesis® offers a Java subclass that can also be used from other programming languages, e.g. from C#/.NET (cf. Moßgraber et al., 2005).

The production system itself is a dynamic web application based on .NET technologies (.NET Framework is a product by Microsoft Corporation). Reports are conceived as independent (or neutral) with respect to server platforms and are stored in the form of XML files. The graphical representation (layout) and the user interface of animated reports are separated from the contents and stored in the form of so called transformation templates (XSLT). This is achieved by using ECMA conformal Java Scripts and HTML+TIME (based on W3C SMIL2.0; cf. W3C, 2005).

PROTOTYPING

For demonstration purposes, a first prototype version has been implemented. Fig. 4 shows the current start page of the Portal which is being intensively used and is therefore considered to be highly accepted by the user groups. A specifically selected representation (generated in the Operational RM/NPP System) is automatically transferred to the Web Portal and thus made available to the connected user groups. Actually, an animated presentation of a propagation cloud has been

Figure 4. Current start page of the portal (prototype version)

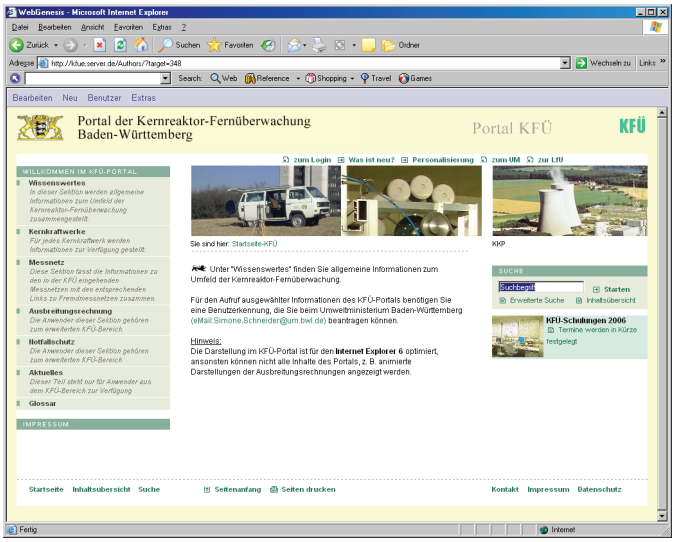
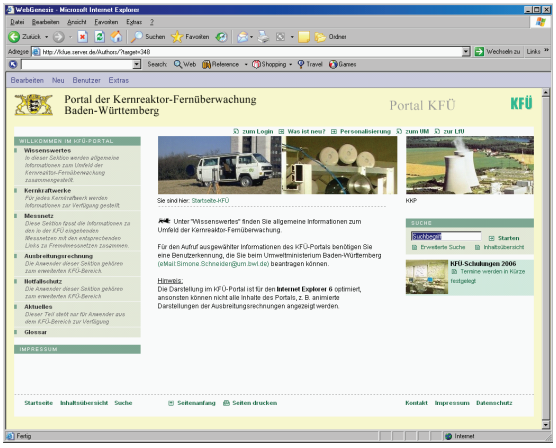


Figure 5. Propagation cloud on the background of a topographical map



selected thus illustrating the results of a Dispersion Modelled Transport Calculation (DMTC) for radio nuclides. This type of calculation has to be carried out in case of a radioactive incident or accident and the result is of greatest importance for radiological protection and emergency management.

From a technical point of view, this demonstration prototype realizes the implementation of an interface (preferably via web services) between the .NET based applications on the side of the Operational RM/NPP System and their counterpart within the Content Management System (CMS) WebGenesis® of the Web Portal (based on JAVA Servlets). Navigation within the Web Portal can be achieved either by direct selection or via specific search masks.

In order to make sure that only authorized users have access to the propagation reports (see Fig. 5) the principles of access privileges, as described in the basic concept, have been implemented by using the corresponding features and mechanisms provided by WebGenesis®.

FUTURE TRENDS

The pilot installation of the Web Portal received a great deal of interest from the user groups. The good cooperation with all of them produced an optimistic view for further developments and implementations. The next steps will be:

- Evaluation of the pilot phase (experience and best practices)
- Workshops for dissemination of the results and extension of the user community
- Completion of the IT concept in accordance with the evaluation results
- Implementation of the full system and final acceptance test
- System clearance for full public access to the Web Portal

Due to the increasing importance of early warning and emergency management systems and recognizing the great attention paid to the subject by a sensitive general public, a large number of initiatives and projects on national, international and even global scale are searching for adequate solutions. Therefore, a demand for the commercial availability of such systems is foreseen in the near future.

CONCLUSION

Based on a detailed requirements analysis, the basic concept for a Web Portal for Early Warning and Risk Management has been derived. In a logical sequence, an IT concept has been produced in accordance with the basic concept and with the aim to fulfil the identified requirements to the largest possible extent. The feasibility of the concepts has been proven by the prototype implementation of the Web Portal for the Remote Monitoring of Nuclear Power Plants (Chaves et al., 2005; Hürster et al., 2006).

This Web Portal allows for public access to the monitoring functions, but also enables effective action to be taken in case of an incident or accident. It provides numerous possibilities to visualize data and to check them against threshold values and protection objectives. In case of a radioactive leak, potentially affected areas can be determined at an early stage by a transport calculation and thus protective measures can be adopted by the Ministry and by the public in cooperation with the authorities responsible for civil protection.

Having started with an improvement of radiation protection and the related emergency management, we are confident that the system presented here can significantly contribute to finding a general solution to the indicated problems. The proof will be left to international multi risk scenarios and corresponding across border exercises, supported by the Web Portal capabilities described above.

ACKNOWLEDGMENTS

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