THE DESIGN AND IMPLEMENTATION OF A DECISION SUPPORT AND INFORMATION EXCHANGE SYSTEM FOR NUCLEAR EMERGENCY MANAGEMENT IN THE NETHERLANDS

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Abstract: An information system for decision support and information exchange is designed and a prototype has been build for use in the Back Office Radiological Information (BORI) of the EPAn; the Dutch nuclear emergency organisation. System developments are directed at a fast and efficient production of a radiological status report and the improvement of information exchange and communications between the participating institutes of BORI. Special attention has been given to network security and the information infrastructure to manage virtual workplaces. We have chosen for a standard web based system development for the presentation and communication facilities. This is supplemented by a GIS based system for the aggregation of measurement data and model calculations.

1. INTRODUCTION

In the Netherlands the organisation and response to nuclear emergencies is incorporated in the National Plan for Nuclear Emergency Response (NPK, 1990; Aldenkamp, 1997). Recently this organisation was significantly revised (RNPK, 2002). As a result, new developments on information and communication systems have emerged on different levels in the organisation.

This paper discusses the design and the (partial) implementation of an information system for decision support and information exchange of the Back Office Radiological Information of the EPAn.

The Unit Planning and Advice nuclear (EPAn) is a governmental organisation, which usually advises an (inter) departmental ministerial policy team on response issues during nuclear emergencies. The EPAn consists of decision-advisors, organised in a front office, located at the Ministry of the Environment, and three back-offices. Members of the back-offices cover the respective areas of "Medical Information", "Public Order and Safety" and "Radiological Information". The three back offices co-ordinate various institutes, support centres and public service organisations. An overview of the organisational structure of EPAn is given in figure 1.

2. BACK OFFICE RADIOLOGICAL INFORMATION

The Back Office Radiological Information (BORI) is managed by the National Institute for Public Health and the Environment (RIVM). BORI co-ordinates and processes the technical information that originates from various supporting institutes and

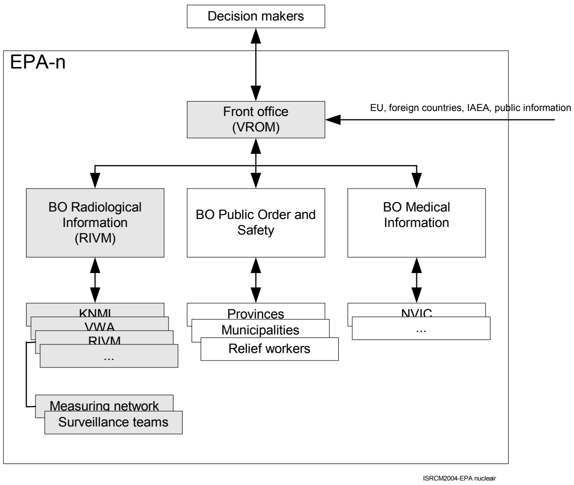

Figure 1: Organisational structure of the Unit Planning and Advice, EPAn. The Back Office Radiological Information co-ordinates and handles all technical radiological information. The shaded boxes indicate the users of the information system.

centres. These institutes include the Institute of Food Safety (RIKILT), the Food and Consumer Product Safety Authority (VWA), the Institute for Inland Water Management and Wastewater Treatment (RIZA), the National Institute for Coastal and Marine Management (RIKZ) and the National Weather Service (KNMI). Activities of these support centres include extensive radiological measurement programs on agriculture (RIKILT), food (VWA), and salt and fresh water (RIZA, RIKZ). The Nuclear Safety Authority (KFD) handles information on the technical conditions of the facility and the (potential) release. Besides the co-ordination of BORI, RIVM also acts as a support centre, responsible for the deployment of mobile radiological surveillance teams and the operation of the real-time National Radiological Monitoring Network (NMR). Besides the automatic measurement of gamma dose rates, the NMR network includes sophisticated nuclide specific analyses on air concentration and deposition. These measurements are performed by eight different institutes, evenly distributed over the country and co-ordinated by RIVM. In addition to these measurement programs RIVM provides modelling facilities for the calculation of atmospheric dispersion of radioactive substances and dose projections. These latter calculations are of key importance in the Dutch emergency response, since intervention levels for urgent counter measures are defined in terms of dose projections, often evaluated over the first 24 hours.

The prime responsibility of BORI in the repression phase of a nuclear emergency is to co-ordinate the activities of the support centres and integrate and aggregate the measured (diagnoses) and modelled (prognoses) radiological information into a radiological situation report. This report is aimed at supporting the decision preparation process in the front office and has a generic informative function directed towards all BORI members.

3. REQUIREMENTS

To support the processing of the technical radiological information an information system is designed and build in our institute. The functional requirements are aimed at:

1. improving the information and data exchange between the BORI members and the Front Office,
2. integrating diagnosis and prognosis results into a consistent picture of the actual radiological situation,
3. a fast and efficient production of the BORI situation reports, allowing for frequent (hourly) updates,
4. providing an automated logging of reports, data exchanges, user interactions and the supporting processes,
5. providing facilities to support “virtual” workplaces for BORI members.

The primary information exchanges of BORI are shown in figure 2. Technical developments and the functional design of the system implementing the above requirements took place in house in an iterative process. Two prototypes of decision support systems have been build; a web based system, the emergency website (CalWeb) and a GIS-based modelling and presentation system.

4. DESIGN CONSIDERATIONS

In the repression phase of a nuclear accident fast responses are a crucial success factor, especially in the (pre)release phases when the fast implementation of urgent counter measures can make a large difference in the exposure of a population group. The requirement of a fast response time has led to many automated and (semi) automated processes to be build into the system. Notably the dispersion calculations and the publication of the BORI situation reports on CalWeb require highly automated process and validation mechanisms to comply with the demand of an updated status information report every hour.

Emergency management operations cover a relatively long period in time. While the passing of a radioactive cloud is typically of the order of hours to

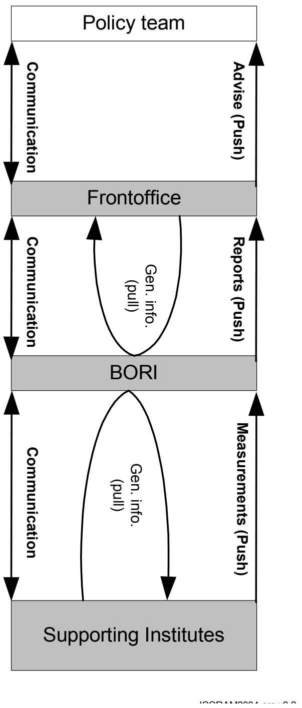

Figure 2: The primary information exchange of BORI. BORI receives measurement and projected data from the supporting centres and publishes a situation report. These information exchanges are mandatory. In addition a number of communication channels exist between BORI members and the Front Office of EPAn.

days, exposures from contaminated grounds and surfaces in urban environments as well as a contamination in the food supply chain may demand emergency centres and systems to be operational for weeks. It is therefore of particular importance to have a good overview of the status of the accident, especially when new shifts are introduced in the crisis centres. As a consequence participants should have the possibility to view the historical activities, messages, e-mail correspondence, reports and data exchanges between the participants.

A 24/24-hour availability of the system is of key importance for an emergency response organisation. In general this requires detailed considerations with respect to back-ups, replication of data, multiple exchange and communication channels and a comprehensive test program to ensure the operational status of the system.

Another consideration in the design of the system is the need to provide users with a simple but exhaustive interface covering all the technical emergency management tasks. We believe that during an accident users should not have to deal with how to operate a system. This means that at least the primary functions have to be easily understood and operated by the radiological expert. An extensive exercise program complements this requirement and provides for familiarity with the system and signals inadequacies and imperfections. To maintain acquaintance with the system, it will also be used in the regular transmission of radiological data between supporting centres and RIVM where possible.

Since many users from different institutes and organisations can access the system from different locations security and user authorisation is an important aspect in the design and maintenance of the system.

5. EMERGENCY WEB

Easy access to the information is implemented by the use of Internet technology. We have built an emergency website called CalWeb, which enables users to access the information from wherever they are using an Internet browser: there is no need to install anything specific on the client pc's. The supporting institutes use the system to send measurement data, reports and other information to BORI and retrieve information from the other institutes and the front office, see figure 3.

Because each of the support centres has its own system with which they are used to work, CalWeb has a variety of interfaces to receive and process the received information. The interfaces range from parsing an Excel-sheet with measurements uploaded by ftp, processing an XML-file send by e-mail to SOAP message communication. The interfaces are independent of the main system. Everything received is saved into a datastore. CalWeb provides an interface to all participants to extract information

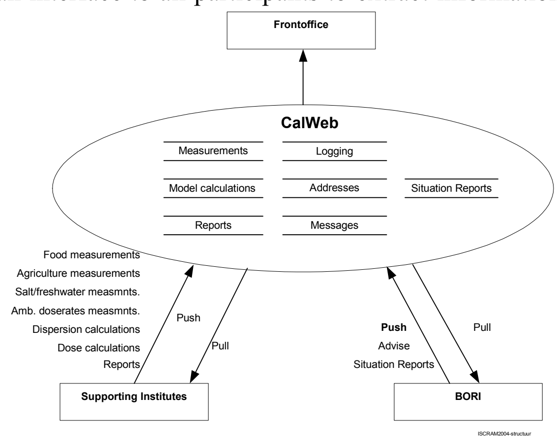

Figure 3: Basic layout of CalWeb. The system is shared between all BORI members and the Front Office. All institutes are responsible for the information they provide. Elementary processes are indicated in the figure.

from this datastore. The participants may download or view the information using tools provided by CalWeb, e.g. web based GIS-functions.

A second goal of CalWeb is to make it possible for all users to participate wherever they are. CalWeb therefor makes available a variety of applications through the use of Citrix. These applications can be used with via an Internet browser, e.g. MS Word can be started using a browser on whatever operating system one is working. The supporting centres are allowed (within certain limits) to export their windows-applications via Citrix. CalWeb also provides web-based GIS-functions. With these functions users are able to put measurements onto a geographical map, compare their measurements with those of the other institutes or decide on the basis of the dispersion prognosis where to measure.

Besides the aforementioned services, CalWeb provides for e-mail, logging of all actions, e-mail distributed newspaper articles, task scheduling, automatic daily dispersion prognosis on a fixed number of nuclear plants with fixed source term, documentation on a wide variety of subjects, address lookup of participants, hyperlinks to different institutes (e.g. IAEA, ICRP) etc.

The CalWeb system is developed in our laboratory in close co-operation with the supporting centres. We started a year ago to develop a prototype. This prototype has been used in several exercises and was discussed with the support centres. The results of the discussion and the experience will be used to build the final version. With each of the support centres we have made arrangements about the format in which they will send their information, the formats are as close as possible to the formats the institutes use in their daily work.

During development special attention is paid to security (arrange as much as possible on the server, authorise users before any action is performed), the use of standard technology and standard libraries for easy updating (e.g. security updates), modularity etc. Whenever we contract a software supplier, he has to adhere to our standards of software development: use version management, deliver readable and usable (design) documentation, perform tests and most importantly produce robust code that allows smooth operation of the system during emergencies, also for less experienced users. Since our laboratory is responsible for the availability of the website we also want to be able to install and maintain the software ourselves.

6. RADIOLOGICAL INFORMATION SYSTEM

The function of the Radiological Information System is to assist in the production of the situation reports on the actual and prognosticated radiological

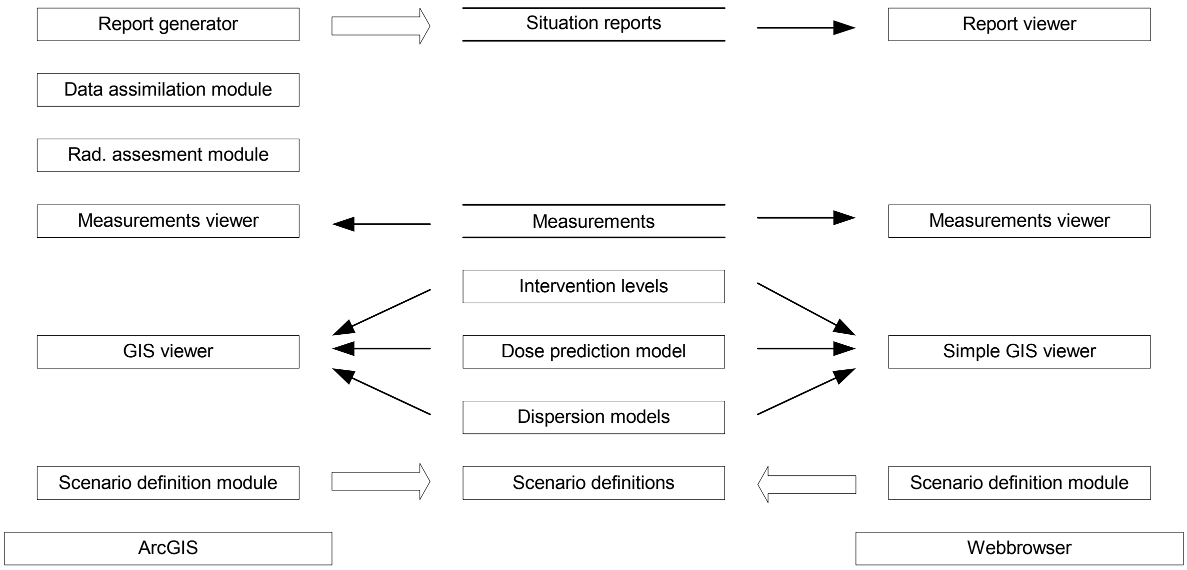

Figure 4: Layout of the functional modules of CalWeb and the GIS based radiological evaluation system. The GIS system provides facilities for interactive radiological assessments. Standard tools and modules are provided to enable fast and automated calculations in the very early phases of a nuclear accident. Advanced and interactive evaluation tools are available for the radiological expert after the very first emergency stages of the accident. Functionally simple versions of GIS viewers are used on CalWeb to enable the visualisation of model output and measurement data. Many modules are shared between CalWeb and the radiological assessment system.

situation. The system is build around ESRI's ArcGIS8 desktop product and closely follows the GIS standard of RIVM. This ensures maximum support and sharing of the existing GIS infrastructure. Furthermore the integration of the GIS working environments during emergencies and that used in regular desktop studies ensures flexibility of and familiarity with the system.

On top of the ArcGIS desktop application a set of modules and GIS-functions were implemented. The modules cover all aspects of the emergency support functions, e.g., scenario definition, model selection and parameters, dispersion of radionuclides, data retrieval and the presentation of results. Besides these highly automated functions the radiological experts is offered a set of powerful interactive tools, via the standard GIS desktop environment which allows a thorough and flexible radiological assessment should that be required.

The data retrieval and reporting functions of the system will be highly integrated with the functions on CalWeb and many functional modules are shared between the systems, see figure 4. The high level of automation will enable a fast production cycle of the stituation reports. The automated publication of situation reports is currently in its development stage.

As a modelling tool, the system provides a user-friendly interface to the atmospheric dispersion and dose calculation models. These models run external to the GIS application on a UNIX server in the emergency network. The system provides predefined presentations of contamination and doses to population groups, which are tested against intervention levels and counter measure strategies. Presentation functions are also implemented for the results of the measurement programs from the online radiological monitoring networks, mobile measuring teams and the measurement networks from the supporting institutes. All these data is stored in the datastore on CalWeb and can easily be visualised, analysed and reported by the application.

In a continuing effort to further enhance the quality of the system, current developments are directed towards the integration of measurement data and modelled data by means of data assimilation. The required statistical packages used for sampling the input parameter space and the minimisation of a merit function is currently being implemented into the decision support system. These techniques may offer a great enhancement of the quality of the prognosticated radiological situation.

The radiological experts test the system on a weekly basis, which serves an educational and training purpose and provides for a regular common functional test of the complete system.

7. NATIONAL RADIOACTIVITY MONITORING NETWORK

The national radioactivity monitoring network (NMR) consists of about 160 measurement stations measuring gamma radiation levels in ambient dose dose equivalent rate H*(10). Additionally α- and β-activity is measured at 14 additional sites, distributed over the country. Further specialised measurement equipment at RIVM complements these measurements with gaseous radioactive iodine concentration in air and a nuclide specific gamma activity of air-borne particles (Hoog de, 2002).

Recently the acquisition, processing and visualisation of the NMR are being renewed. In the new situation the NMR systems will be placed inside CalNet. The hourly acquisition, currently done using the national emergency phone network will migrate to a dedicated IP-network. This dedicated third-party network has a significant higher bandwidth thus giving the possibility for real-time acquisition and visualisation. The measurements done by the NMR are stored in CalNet and are available through CalWeb. All users of the NMR, including the fire brigades, will have access to the NMR data through CalWeb. CalWeb will provide background information and extra information like precipitation data from the National Weather Service.

8. EMERGENCY NETWORK

Internet (the network) is certainly not a reliable way of communications with respect to guaranteed availability over a long period and guaranteed bandwidth. Let alone that internet sites are sometimes not even reachable because of attacks or a huge amounts of visitors. This means we cannot guarantee the availability and reliability of information for long periods of time if the only possibility to access that information is the internet. We have build a network for which we guarantee the availability: the emergency network CalNet. In this network (see figure 5) every server and application has a hot standby and information is continuously replicated between the two halves. The CalNet can be accessed by several standard ways of communications: PSTN (normal phone), ISDN and the national emergency phone network. We have chosen ISDN to be our primary means of communications. The mentioned networks are secure and have a guaranteed availability and bandwidth. The national emergency phone network is available only for government related institutes

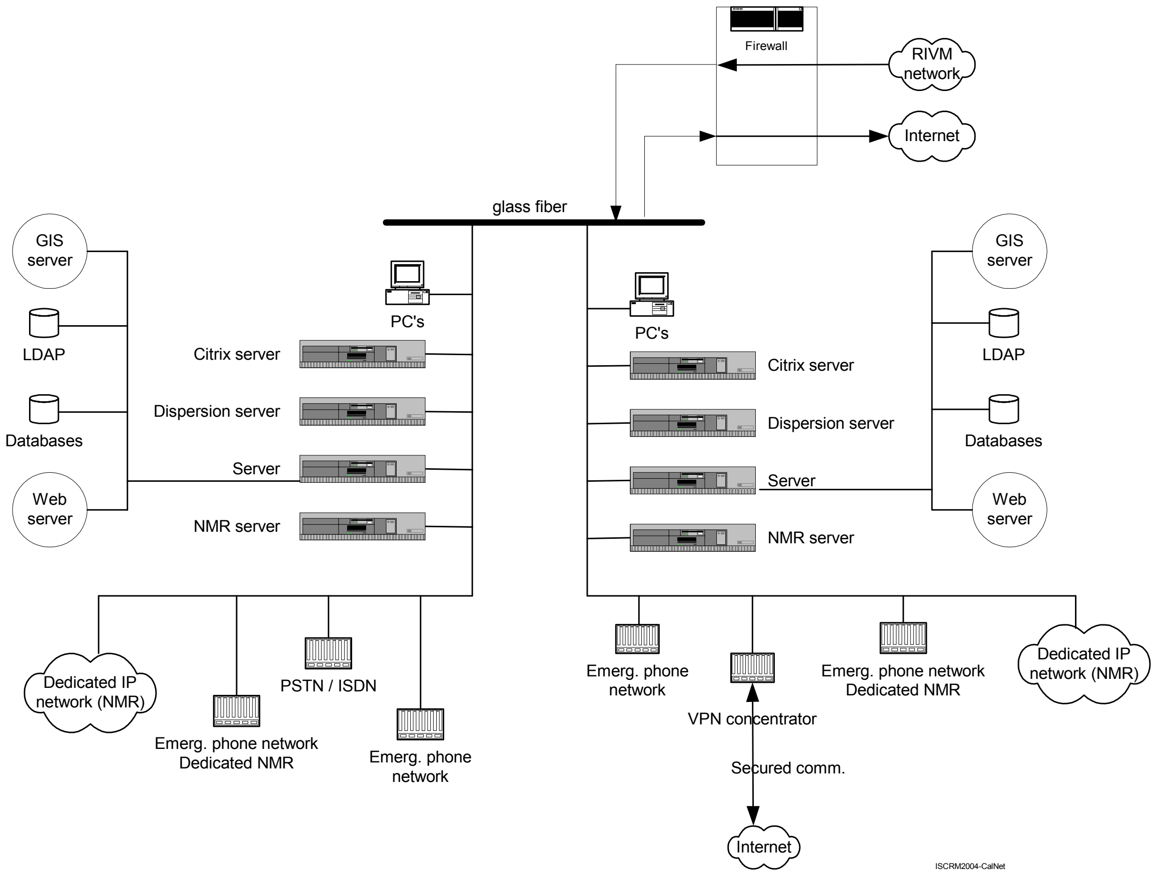

Figure 5: The hardware configuration of the emergency network of BORI (CalNet). The complete system has a mirror image. The mirrors are placed at different geographical locations. CalNet can be accessed via several standard ways of communications.

and is a separate physical network from the normal phone network.

9. CONCLUSIONS

Using prototypes from different development phases, several exercises were performed with the system. From these operational experiences it has been concluded that the system already performs reasonably well with respect to the requirements and, most importantly, the system is received enthusiastically by the BORI members. However, considerable developments are necessary to fully support all activities of BORI and the support centres, and to integrate all aspects of the technical decision support processes into the system. RIVM will continue to improve the system, adapting its specifications to the continuing changing demands and developments of the technical nuclear emergency response management organisation.

REFERENCES

NPK, 1990. Nuclear Emergency Planning and Response in the Netherlands. Parliamentary session 1988-1989, 21015, no. 3. Ministry of Housing, Physical Planning and Environment, 90044/2-89 1174/26, The Hague.

Aldenkamp F.J., Uit de Haag P.A.M., Tuinen van S.T., 1997. Evaluation of information management in the Netherlands during the early phase of an accident. Rad. Prot. Dosimetry, Vol 73, Nos 1-4, pp. 107-110.

RNPK, 2002. De Revitalisatie van het Nationaal Plan voor de Kernongevallenbestrijding, Eindrapportage project RNPK, 21 Maart 2002. [in Dutch] Available from: http://www.vrom.nl/pagina.html?id=12014

Hoog de C., Tuinen van S.T., Aldenkamp F.J., 2002. Het Nationaal Meetnet Radioactiviteit, De tweede generatie. NVS nieuws, 2002/2, pp. 32-36 [in Dutch]