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DEVELOPMENT MULTI-PLATFORM VERSION OF DECISION SUPPORT SYSTEM FOR NUCLEAR EMERGENCY MANAGEMENT IN EUROPE (RODOS) ON BASE OF MODERN JAVA AND GIS TECHNOLOGIES

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INTRODUCTION

RODOS system for nuclear emergency management in Europe has been developed under the funding of European Commission from 1992 (Ehrhardt, et.al., 1997). RODOS has been designed as a complex system, which includes models and data bases for modeling and evaluation of all the consequences of nuclear emergencies and for the emergency planning. Originally RODOS system was developed as HP UNIX software. Recently the work had been started concerning the redesign of the RODOS system, which addressed the following main topics: 1) developing multi-platform system with ability to run on PC; 2) developing distributed system; 3) databases redesign; 4) modern GIS and UI; 5) easy administration of the system with data base functionalities; 6) easy integration of new simulation models. Last year first releases of the redesigned RODOS named JRodos as developed using Java technology were distributed among the RODOS Users Group for preliminary evaluation (Ievdin Ie., et al, 2007). A number of comments received from end users indicate generally good impression on JRodos.

MODELS

Models are integrated in form of plug-ins which is loaded dynamically at runtime.

The first prototype contains atmospheric dispersion module ALSMC (ATSTEP Local Scale Model Chain) performing calculations of atmospheric pollution transport and the corresponding acute doses and dose rates. In last releases in addition to ALSMC six new models were integrated into redesigned system. Two of them (ERMIN and IAMM) are completely new models which were not integrated in the old versions of RODOS. Below integration of new models is briefly discussed.

Early countermeasures module EMERSIM (EMERgency SIMulation) calculates areas to be affected by sheltering, evacuation and administrating of iodine tablets also the public doses and dose rates with countermeasures(for open air and normal living) and without countermeasures on base of dose bricks information from ALSMC and intervention level criteria. All the necessary input information for EMERSIM is stored in Rodos data bases. ALSMC data are large and stored in compressed form (zip utility of Java) which utilizes the fact that most values in ALSMC arrays are of zero value. This allows significant reduce in memory for storage (by the factor of about 5) and correspondent reducing in time for loading and extracting data from data base.

Automatic operation mode is important part of original RODOS system was implemented. In this mode the system uses on-line meteorological and radiological measurement for calculations. For handling on-line data three separate models (Data preprocessing, ATSTEP and Dose for acute dose and dose rates calculations) were integrated. These models are called one after another in Diagnosis part of calculation. JRodos solution involves Diagnosis calculation triggered only by new incoming data in contrast to old RODOS in which Diagnosis calculations were performed with the fixed 10 min. time step independently of whether new measurements had come or not. For missed measurement data forward interpolation of the past measurements is used. Prognosis calculation for 24 hours including ALSMC and EMERSIM models on the base of Diagnosis results is automatically started after predefined number of Diagnosis steps.

Supporting for two different scenarios (Stack release in which measured data of release rate are used/User-define source term) was implemented.

Swing based GUI was developed for IAMM and model was integrated into redesigned system. IAMM (Kaiser J.C., 2006) is a software tool to produce maps of the radioactive contamination in urban areas either from measurements alone or from a combination of measurement and model results using data assimilation algorithms.

ERMIN (Jones A., et.al., 2005) calculates the consequences within inhabited areas of accidental releases of radioactive material, from sources both inside and outside the inhabited area. It uses deposition from atmospheric dispersion module, from IAMM and from manual input. It includes: 1) initial deposition to different surfaces in the inhabited area; 2) subsequent behavior of material following its deposition, including the amount of material remaining on each surface as a function of time after the initial deposition, the concentration in air of material resuspended from the surfaces; 3) external β and γ exposure from deposited material; 4) internal dose from inhalation of resuspended material; 5) the effects of countermeasures on the activities on each surface and on the doses in the inhabited area.

Complex UI which completely supports model functionality has been developed and manual deposition input has been implemented. UI for ERMIN allows manual selection of the areas for calculations through GIS (Fig 1), and interactive feedback from user during calculations. In that sense ERMIN is classified as a complex model in contrast to other implemented models which produce output results after an input is finished without further interaction with a user.

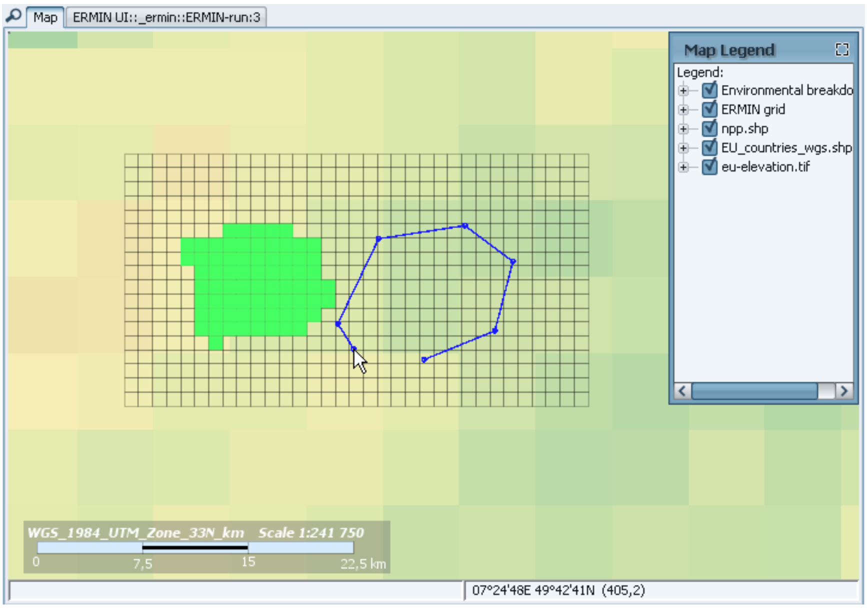

Figure 1. ERMIN model: Map tool for manual selection of the areas through GIS interaction

DISTRIBUTED SYSTEM

Redesigned RODOS system is developed as a distributed system with *Computational Engine* for executing calculations, *Management Server* for performing database access, collecting information from other parts of system and *Client* for capturing input information, visualizing results etc. First steps in implementing distributed architecture including separating database, logical isolating code for three above-listed parts, supporting multi-user functionality with different roles and privileges were realized and tested.

MULTI-PLATFORM

During redesign multi-platform system was developed with ability to run on PC with different OS. Java solution allows providing cross-platform compatibility of the main system. Other parts (databases, native models) should be used as customized for each type of OS. The PostgreSQL DB engine was selected as the main database backend providing installers for Windows and Unix. Now with the database separated from the JRodos system it is possible to use database installed on another host with different platform.

Model is typically native code (Fortran, C). Model codes are loaded to JRodos system dynamically at runtime and implemented as dynamically load library (DLL) on Windows and shared object (SO) on Unix. Connection to the native part is made through open-source JNA library (Java Native Access) which provides an easy access to native shared libraries without writing complicated JNI code. Access is dynamic at runtime without code generation. Open-source free developing NetBeans platform is used to compile native model binaries for both Windows and Unix platforms.

Currently the JRodos system was successfully tested on 32bit Windows (win 2000, XP, win2003 server) and 32bit Unix (openSuSe 10.1, 10.3, Ubuntu 7.10). Also, the system is expected to work on generic 32bit Linux machine.

GIS

GeoTools open source (LGPL) Java toolkit for manipulating geospatial data was used in JRodos. Its main functionality is the ability to read and write a wide variety of geospatial formats, allowing programmers to focus on the task at hand instead of the underlying details. It handles reprojection of data, as well as rendering the geospatial information in to a variety of output formats.

GIS UI component has three distinct components – map control, layer list, layer and symbolizer editors. User interacts directly with these three components; all of them use GeoTools library extensively. The map control is the component which actually displays the map and the geo-referenced data in map form. It allows the user to navigate the map, zoom in/out, measure distance and select, print and export to image geographical features presented on the map. The layer list permits the user to manipulate and customize the map: adding new layers, moving, changing and hiding layers, import and export layer data to external files in standard formats. The layer and symbolizer editors allow the user to change the list of symbolizers associated with the layer, edit particular symbolizers, and import and export symbolizers to external .sld files.

CONCLUSIONS

Since the first prototype JRodos was essentially improved. Six models were integrated; among them the two were integrated for the first time in RODOS project. Data storage, visualization was improved. Jrodos system was successfully tested on 32bit Windows (win 2000, XP, win2003 server) and 32bit Unix (openSuSe 10.1, 10.3, Ubuntu 7.10). First steps in realization of distributed system was performed, database was successfully tested on separate host.

Installation procedures were defined and installer implemented.

Weekly builds of JRodos system are available for those who are interested in testing. Issues and requests can be filed through established Bugzilla engine. Wiki-page was created to inform potential users of the developing stages and collecting the opinion and use cases (the way how Rodos is or will be used in their emergency centers in operational use). These use cases should guide the further development of JRodos to ensure that it matches the needs of the end users.

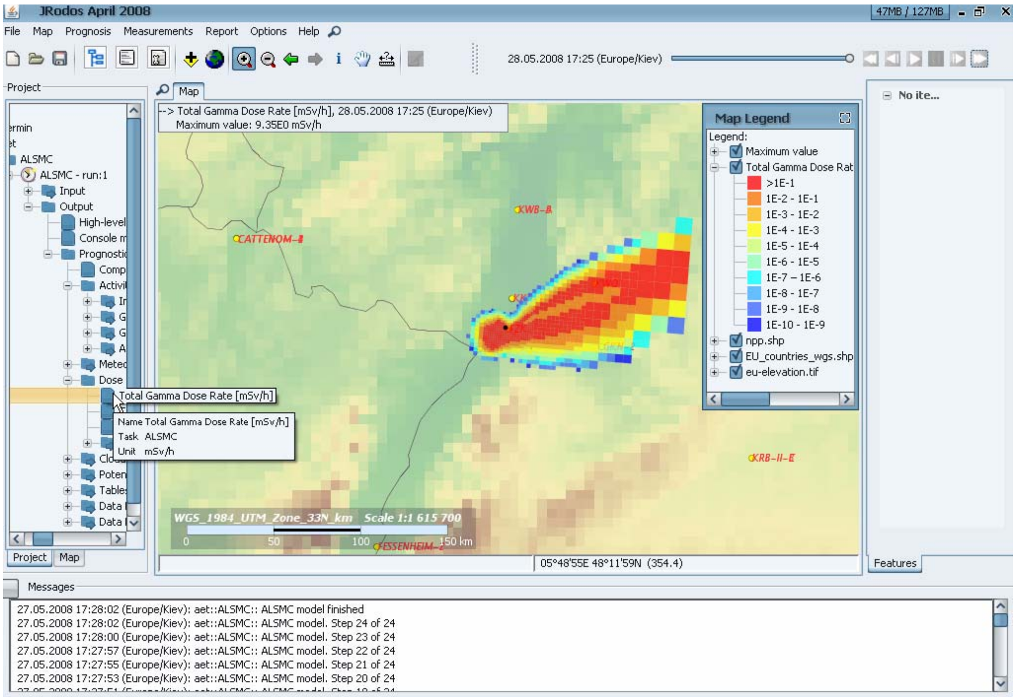

Figure 2. JRodos main window with sub-windows. Map window contains results of total gamma dose calculations caused by the hypothetical release from FZK nuclear power plant.

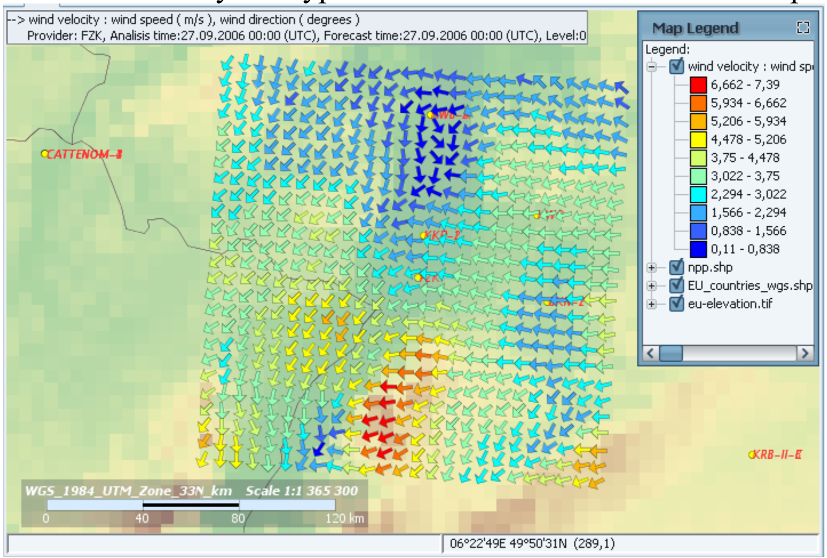

Figure 3. Numerical weather prediction data: wind field visualization.

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