DESIGN AND IMPLEMENTATION OF WEBGIS FOR GOVERNMENT EMERGENCY MANAGEMENT BASED ON SOA

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ABSTRACT:

This paper describes the design and implementation of a Web Geographical Information System (WebGIS) for government comprehensive emergency management, which is based on advanced technologies such as Service-Oriented Architecture (SOA), Web Service etc. and show how WebGIS could be used to support decision making and manage geospatial information in emergency risk management. This system is on the basis of unified geospatial framework, taking geospatial sharing and construction as the main clue, effectively integrate fundamental geographical information, social economy and population information with thematic resource information of all industries by the way of loose coupling. The emergency management system described in this paper as a practical example of WebGIS instantiation provides a tool to access spatial-related data for management as well as communication for emergency planners. This paper mainly introduces the design of system and service framework, analysis of business process and implementation of WebGIS system.

1. INTRODUCTION

In recent years, due to natural disasters, public health, safety in production caused by unexpected events, the risk of accidents have become increasingly prominent, such as "9.11" event and the "5.12" earthquake in 2008 etc. All these events not only caused huge losses of life and property, but also directly influenced on social stability. Faced with sudden emergencies, in order to minimize the serious consequences of the accident, emergency management has also been the hot topic in recent times. Emergency events imply all events that endanger normal functioning of services and companies, endanger lives or resources (living environment) as well as events that are threatening stability of state. All situations resulting from fires, explosions, technological and traffic accidents, terrorist attacks, transport of hazardous materials all comprise hazardous events. Individuals and organizations responsible for emergency management use many tools to preserve economic assets before, during and after a catastrophic event. Correct and timely information is a critical part of any successful emergency management program. Therefore, emergency management departments at all levels of government want to establish a comprehensive emergency management platform, and on this basis by means of an effective emergency incident analysis and, timely and efficient emergency rescue organizations have been particularly important. A Geographic Information System (GIS) and related spatial information technology can provide that sort of information and tools for the analysis of the spatial data and the representation of the results in spatial format, and it can also show the visual characteristics of expression, as well as its powerful spatial data analysis and management capacity is being applied to a wide range of government information of the ordinary course of business, including e-government, land environmental protection, emergency management and other fields.

The main purpose of this paper is to introduce the design and implementation of a comprehensive WebGIS for emergency management. In this paper, the author illustrate system how could be used to manage emerg resources and decision making in emergency risk management. This system uses advanced technologies such as WebGIS, Web Service etc., applies system structure based on SOA and development framework of ArcGIS Server, and builds a multilevel distributed comprehensive emergency management of emergency events for provincial governments by B/S method. The emergency management system described in this paper as a practical example of WebGIS instantiation provides a tool to access spatial-related data for management as well as communication for emergency planners. This paper mainly introduces the design of system and service framework, analysis of business process and implementation of WebGIS system. Our work represents a practical e-Government application, where the stakeholders are the governmental agencies, and the end-users are governmental employees. The application has been designed for the Emergency Planning Department, but can be adopted by other public authorities and rescue corps dealing with emergency response situations.

2. SYSTEM REQUIREMENTS ANALYSIS

In an emergency situation, relevant information about involved elements is required. This information ranges from demographic data, weather forecasts and sensor data, available transportation means, presence of helpful agents, land use and cover statistics or values, etc. Moreover, the emergency management process is dynamic as it involves several definite steps, described in standard procedures from which the Emergency Officer (EO) should not depart without good reason. Multiple agencies own the relevant data and possess parts of emergency related knowledge. The emergency WebGIS

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platform is mainly for every sector of the government emergency management, for major unexpected events to the analysis of high-performance, contingency management and disposal of spatial information systems to support decision-making. We can find the objects information, data management, analysis of integration of disaster, emergency management departments for real-time, accurate data reference, in order to deal with emergencies provide advanced technology and decision support.

Several phases can be differentiated in the process of emergency management (Fig.1): Planning, Mitigation, Preparedness, Response, and Recovery. Geographic information is involved in all phases of emergency management processes, from prevention to immediate reaction. In each of the mentioned phases GIS can provide additional tools and make the phase more efficient and intuitive.

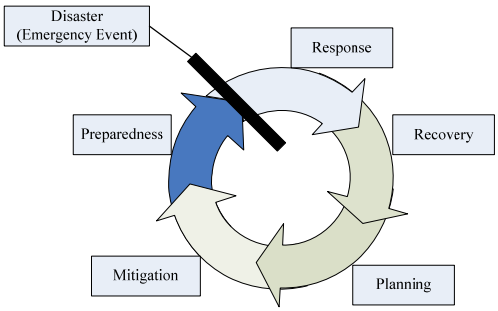

Figure.1 Phases in emergency management process

Emergency management poses significant challenges for data collection, data management, discovery, translation, integration, visualization and communication. Emergency management can be managed well through spatial planning and one requires a GIS for such a management. Typically, emergency management depends on large volumes of accurate, relevant, on-time geo-information that various organizations systematically create and maintain. GIS as a tool in emergency management can been used in the emergency prevention phase for managing the large volumes of data needed for the hazard and risk assessment. In the emergency preparedness phase it is a tool for planning of evacuation routes, for the design of centre for emergency operations, and for integration of satellite data with other relevant data in the design of disaster warning system. In the emergency relief phase, GIS is extremely useful in combination with GPS (Global Positioning System) in search and rescue operations in areas that have been devastated and where it is difficult to orientate. In emergency rehabilitation phase GIS is used to organize the damage information and the post disaster census information and in the evaluation of sites for reconstruction.

3. THE KEY TECHNOLOGIES IN SYSTEM

The emergency management system is a WebGIS which is based on Web Service and SOA. So these technologies are very important due to system's architecture and framework based on these technologies.

3.1 Web Service Model

Web services are becoming the prominent paradigm for distributed computing and electronic business that creates new opportunities for software providers to develop more valuable services to combine the existing services. Web service is the basic principle in the SOA, especially in integrated enterprise systems and business process modelling. Following the W3C's standards such as SOAP,WSDL, UDDI, etc. , it supp lies both the communications and the interface between services and the presentation layer. Thus users can invoke web services and utilize the enterprise information system more conveniently.

3.2 Service-Oriented Architecture

Service-Oriented Architecture (SOA) is a set of independently running services communicating with each other in a loosely coupled manner via event-driven messages. Although the concepts behind SOA were established before Web Services came along and a service within a SOA is completely independent of the concept of a Web Service, current SOA architectures employ them. Web Services naturally implement the philosophy of a SOA by using lightweight protocols based on widely accepted standards.

Established technologies for SOA include for example the Common Object Request Broker Architecture (CORBA)4 administered by the Object Management Group (OMG). It is a vendor-independent architecture that applications based on different programming languages can use to work together over networks. In contrast to Web Services which are mostly based on SOAP/HTTP, services in CORBA typically communicate via the IIOP (Internet Inter-ORB Protocol). The second major differences is the tight coupling of two CORBA services in comparison to the loose coupling between Web Services. In CORBA objects are shared between components, whereas Web Services communicate primarily over message.

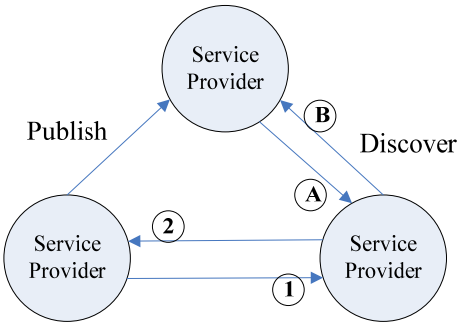

Figure.2 Activities in a SOA

4. SYSTEM DESIGN AND IMPLEMENTATION

4.1 Framework and Prototype Design

In full consideration of the large amount of data, users easier to understand, use convenient, rapid response etc. System framework based on J2EE architecture of B/S structure mode, with model - view - controller (MVC) for software design using patterns and Java Server Faces (JSF) framework. In addition, system separating the module of input, processing and output, guarantee the system scalability and portability.

According to the process of data processing, the entire system platform structure can be divided into three layers. Firstly, system enables the data and functionalities provided by existing legacy systems to be exposed as Web Services (WS). Then, the latter are semantically annotated and published using IRS-III SWS infrastructure. The following layered architecture of the application reflects and explains this double stage process (Figure 2):

• ***Data layer:*** The data layer is the basic layer in the framework, which is similar to some traditional solutions, containing two major components: data storage and data access interface. In general, data storage describes the way how data are organized. Data access interface defines the interface through which the service layer accesses the physical data.

In this system, there are many kinds of data which can be divided into two categories: special data and attribute data. Types of data usually needed in emergency management can be classified to three types[5]. Data on the emergency phenomena (for example, landslides, floods, earthquakes), their location, frequency, magnitude and so on. Data on the environment in which the disastrous events might take place: topography, geology, geomorphology, soils, hydrology, land use, vegetation and so on. Data on assets that might be destroyed if the event takes place: infrastructure, settlements, population, socioeconomic data and so on.

• ***GIS Service layer:*** exposes the functionalities of the legacy systems as WS, abstracting from the hardware and software platforms of the legacy systems. Whenever a new service is available at this layer, it will be semantically described and properly linked to existing semantic descriptions.

• ***Web Service layer:*** given a goal request this layer, implemented in IRS-III, will (i) discover a candidate set of Web services, (ii) select the most appropriate, (iii) mediate any mismatches at the data, ontological or business process level, and (iv) invoke the selected Web services whilst adhering to any data, control flow and Web service invocation requirements. To achieve this, IRS-III utilizes the set of WSMO descriptions, which are composed of goals, mediators, and Web services, supported by relevant domain ontology. This layer provides the flexibility and scalability of our application. Managing the semantic description, the semantic developer can introduce new functionalities of the application or updating existing ones.

• ***Presentation layer:*** The presentation layer is the closest layer to public users, containing some technical factors in the internal side, such as AJAX, HTML, DPL (dynamic programming language) , scripts, flash, etc. , where designers may combine some layout components together to make the sites more attractive. With direct operation on this layer, users can interact between the collaboration and the service layers on the portal easily. Presentation layer is also a application accessible through a standard Web browser. The goals defined within the previous layer are reflected in the structure of the interface and can be invoked either through the IRS-III API or as an HTTP request. The goal requests are filled with data provided by the user and sent to the Web Service layer.

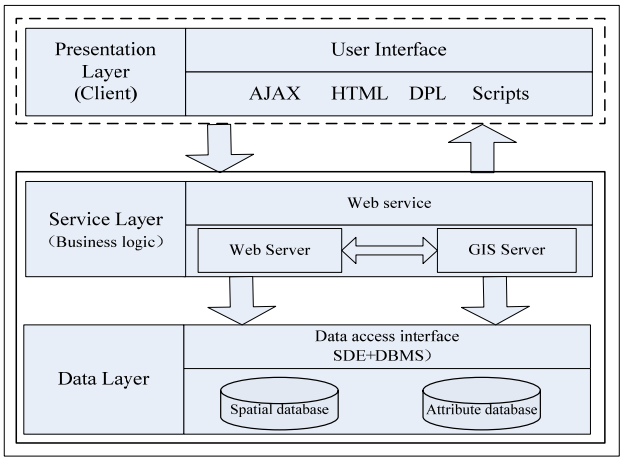

Figure.3 System Framework

4.2 System Function Implementation

During emergencies, this WebGIS enables emergency managers to quickly access relevant data about an affected area. The needed spatial and non-spatial data is usually geographically dispersed and stored in heterogeneous databases. The new generation of information systems including GIS should be able to solve semantic heterogeneity. The need to share geographic information is well documented. Making local geographic datasets publicly available and establishing a common interoperability framework over shared data interchange protocols are important parts of this application. Therefore, this system includes five function modules as follows:

• ***Map Operation Module:*** This module mainly include some tools which enable map to zoom in, zoom out, pan, identify, measure distance or area, previous extent, next extent etc. Furthermore, this module can make the perspective exchange from maps to remote sensing images, and to three-dimensional overview.

• ***Object Search Module:*** This module mainly used to search the emergency objects' information by key value, and to locate the exist district by district name, and to locate the object by its coordinate, and to find the closet route through input start point and end point. Search results name can be list into the table of web page, and each result can be quick located and show its detail attributes information with float chart by clicking the name link, and can be do the recent facilities search around the result object.

• ***Emergency Resource Management Module:*** This module can be used to management the emergency resources. Emergency resources are mainly included three categories, which are protection goals, guarantee resources, potential hazards objects; each category is also divided into a number of sub-categories and small categories.

• ***Thematic Disaster analysis Module:*** This module is mainly aimed at different disaster to do different thematic analysis, such as emergency earthquake, flood, plague, ice disaster and so on, and to do different comprehensive emergency management in the light of the different emergency preparedness. Combine with the corresponding emergency analysis model and emergency treatment process to realize comprehensive management and statistical analysis.

• ***contingency plan Module:*** This module is mainly designed to integrated manage the contingency plan, including emergency plans for the generation, storage and online publication, at the same time the contingency plan has been online editing, update and delete, as well as emergency plans for electronic publishing and download online.

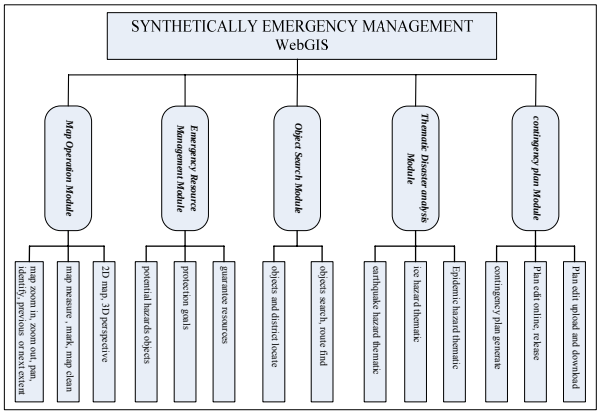

Figure.4 Function module in EM application

A web browser is just needed by the user, the database and all response process are maintained on the server side. The final product of this project will be used in Emergency Office in Xinjiang Uigur Autonomous Region. Its usage could be extended to environmental protection agencies as well as earthquake agencies. In the long term the WebGIS framework could be opened to citizens in order to provide seamless access to geographic data stored by government agencies.

Figure.5. XinJiang Emergency WebGIS application

5. CONCLUSION

The goal of this study is to provide sustainable and user friendly on-line services that will enable emergency management actors to better anticipate or mitigate hazard situations. This paper design a application of WebGIS for government emergency management based on the technologies such as SOA, web services, WSDL, UDDI etc. The significance of the research is in creating unique emergency management methodology and developing the software (based on the mentioned methodology) which can be applied in emergency management. Multidisciplinary approach is based on the new information technologies (WebGIS, Webservices, ontology, semantic integration), expert's knowledge about structure and processes in the hazard management system, hazard emerging and possible effects on living environment, as also combine the knowledge of expert's working in different domains. This will improve the process of emergency management. So, the solution efficiency provided by proposed system will be especially valuable for local community and local authorities.

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