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Study on the Redesign of Emergency Command Information System

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Abstract: Based on the analysis of the status quo of the emergency command information system, this article puts forward the construction of the command information system based on emergency Response thinking, explains its design principles, overall framework as well as functional modules and finally focuses on analyzing the system's key technology.

Key words: Emergency command, information system, redesign

INTRODUCTION

Rapid population growth, shortage of energy resources, environmental degradation, ecological imbalance and the waves of terrorism make security issues the focus of attention. With the outbreak of the unexpected events like the "911", "SARS" and the "bird flu", a new upsurge of the building of the emergency command system has been set off both at home and abroad, in order to improve the Government's capacities in rapid emergency response and resisting risks. At present, almost all the developed countries have established a relatively comprehensive range of emergency treatment systems to deal with social crisis. These systems include the city police alarm system as well as various types of specialized emergency response systems, such as the earthquake emergency response system, the environmental pollution emergency response system, etc. China's public security, fire, transportation, medical care, disaster reduction and other departments have also set up their own command systems which have played a huge role in the relief for disaster reduction (Hua *et al.*, 2001; Li *et al.*, 2005; Shi *et al.*, 2005).

With the development of the society, the types of social emergencies are more complex and varied and the traditional coping mechanisms can not meet the needs of the increasing urgent emergencies. When a great social event occurs it can not be completely settled only by a sector, an industry, or a kind of technology. Instead its solution needs the joint efforts of many or even all the social sectors. As a result, there is an urgent need to build

a unified and highly effective social emergency command system, whose functions include early warning, monitoring, evaluation, analysis, consulting, decision-making and scheduling. In order to achieve the real-time information sharing in the emergency response, this article focuses on the design and research of the emergency command system based on Emergency Response thinking (Wang, 2005; Zhang *et al.*, 2005).

CURRENT RESEARCH OF THE EMERGENCY COMMAND SYSTEM

Emergency Command System first appeared in the United States in the 60's. In 1967, the United States proposed the nationwide use of a single number-911 for the police and the public for help, gradually all the cities established a "911" system to deal with emergencies. The United States already established the "emergency rescue service system" (EMS) in the 1970s.

Since 2001, the research team on the Emergency Command System from the Department of Computer Science of Peking University has started researching the key technical issues of the Emergency Response. This team proposed the business model and case model of the Emergency Response System and developed such components as event query, monitoring, analysis and processing. The Geographic Information System of Nanning City, a sub-system of its Emergency Response System, is the first informational and digital platform at home with the largest amount of information, consisting of public security, traffic police, fire fighting, first aid,

flood control, forest fire prevention, earthquake, air, water, electricity, gas and other 56 types of emergency relief resources and economic and social development information. A number of other cities such as Beijing, Shanghai and Guangzhou have also set up their emergency response systems which provide the experience and pattern for the establishment of a sudden public emergency command system.

DESIGN AND IMPLEMENTATION OF THE EMERGENCY COMMAND INFORMATION SYSTEM

The Emergency Command Information System is an information application system that uses the geographic space information technology to achieve the visual query and analysis of the basic information of the relevant departments on the basis of spatial electronic maps. It is based on electronic maps and network and regards information sharing and utilization as its target and it provides the relevant information access, measures to deal with inquiries, as well as decision-making support for the government's carrying out emergency responses and emergency command. The ECIS has such functions as accessibility to disaster information, inquiries of information sharing, rapid assessment, decision-making, the issuing of orders, on-site command, dynamic display and information bulletin. It provides technical support for the realization of the goal of the emergency command system: "open communications, on-site in a timely manner, complete data, command in place". Therefore, the emergency command system has two prominent characteristics: the first one is "fast" and the second one is "complete". "fast" means being fast in receiving reports, response and disposal which requires us to establish the appropriate mechanisms to respond rapidly; "complete" means being complete in system information, decision-making and strategies which requires us to be able to do coordinated responses.

Designing principles of the emergency command information system: The design of the Emergency Command Information Systems should follow the basic principles:

Extensibility: The system should be extended and must be easy to extend. Under the premise of the running of the system, the number and types of users and the functions of the system must be able to be increased and extended which do not affect and increase the existing functions and complexity of the system.

Interactivity: Each terminal may become the source and feedback of information. Meanwhile it may also be the receiver and implementer of information, so the various types of terminals should have the capacity to interact with the server.

Customizability: In order to achieve rights management and application needs, end-users customize the useful functions and the contents and ways of the display according to their needs.

Real-time: The realization of the real-time release of information guarantees the validity of information. According to the Emergency Response thinking, in order to ensure the real-time and validity of information it should be classified based on importance and needs. The time measurement node should be set and be used as the basis for determining the transmission and distribution of the information.

Security: Security is important in the establishment of open systems the authentication mechanism is an important means to ensure the security of the system.

Overall framework design of the emergency command information system: Logically speaking, the Emergency Command Information Systems consist of three levels. The top-level is the first layer for information receiving and transmission and users, followed by the second layer which deals with information processing, services and management. The lowest level is the support layer for the database and the network platform. The overall framework of the emergency command information platform is shown in Fig. 1.

First scope: Affair inspection, information reception, information service and user. This scope is responsible for the real-time reception of the real-time position and information status of the affairs, staff, equipment and other elements in the Integrated Emergency Management.(IEM).

Second scope: Information processing, service and management. This scope takes the advantage of the webservice to offer function call, data access, information dissemination as well as the management of the system itself which is regarded as the core technology in the whole system.

- Offering the segments of the geographical information system in GIS function, call of the specific functions of GIS, acting the functional component of different particles

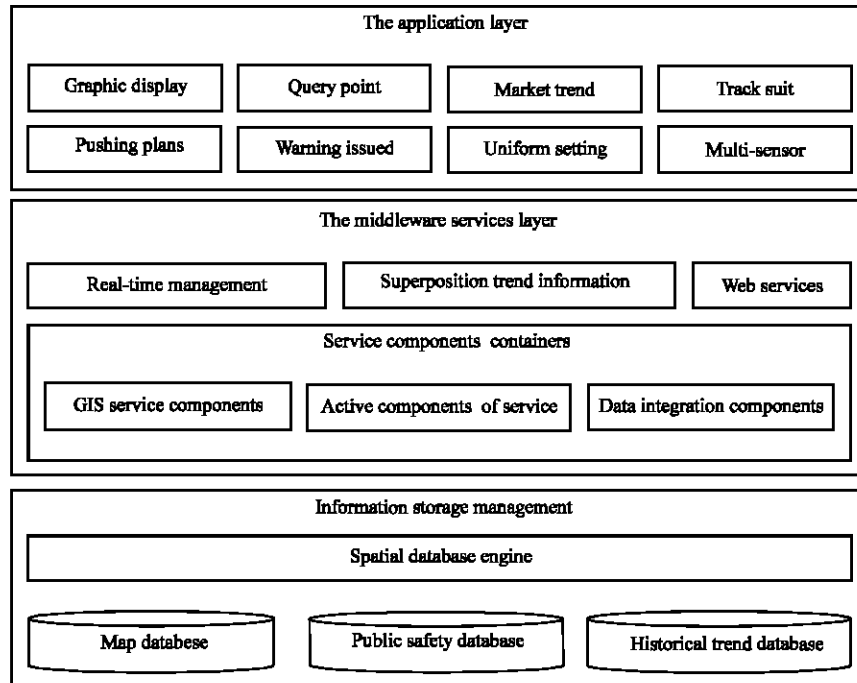


Fig. 1: Overall framework of the emergency command information platform

- Real-time data processing is responsible for collecting emergent command information from different sources and formats and storing what has been collected in database
- The Superposition of emergent command mode information
- Management of the web publication and interactive web service mode

Third scope: Acts as the platform of the database and network technology which is the supporting part of the whole system, the main database is designed according to the following:

- Space database is based on certain principles to fulfill the inputting information data in space, storage and management, complete with the multi-sheet digital map, digital elevation model and photographical map
- Public security database is made up of access information base, house number database, important unit base and hazard source base, incident base and model base
- Emergent mode information base is used for storage and management of the historical data and statistical data

Design of the emergent command mode functions: To satisfy the requirements of the effective communication and chronic management in the Integrated Emergency

Management (IEM), besides the realization of the geographical information system, the basic function, the emergent command mode information system also requires the following functions:

- **Real-time acquiring information function:** Due to the sudden and destructive feature of the incidents in essence, to serve decision-making better, this system is required to be equipped with better strategies and solutions which proves to need more device interfaces in this system to conduct real-time exchange of data
- **Function of information surveying and mapping of real-time mode:** Emergent command system is required to have the intuitive and accurate forms to illustrate information, offering generous aid to the commander on the call and decision-making. GIS is a widely-used technique which can vividly illustrate information concerning crisis management (such as crisis mode, relating source in the emergent command and emergent strategy) on the basic space geographical map, for sake of helping commanders and policy-makers to judge with an intuitive way to form idea and call the resources consequently
- **Powerful Analysis function:** In the process of emergent command process, much information is hidden which needs powerful analysis function and

data mining function. Basic methods are listed as: the shortest-path analysis, cache analysis, overlay analysis, statistical analysis and so on. Powerful analysis and mining can distract the useful information from the seemingly irrelevant information, furthermore, can provide evidence for decision-making

- **Emergency rescue and aid decision-making function:** Emergency rescue and aid decision-making function includes some professional maths models and emergency solutions models under emergent circumstances, such as polluting fountain diffusion model, incident-cite dynamic locks model, emergency rescue model and so on.

CRITICAL TECHNIQUE AND SOLUTIONS TO THE EMERGENT COMMAND INFORMATION SYSTEM

Construction of distributed database: Data storage and management of emergent command information system is featured by distributed database, seas of which logically belong to the a emergent command system while distributed on several nodes of computer network practically.

Emergent command information system database, together with the supporting heterogeneous database, is built into a virtual database to satisfy the requirements of sharing space data. In the meantime, local databases is still owned by the local organs although they can be visited from other sites. In addition, the manipulation of the local database is not controlled by other organs even by the global database.

Therefore, construction of distributed database ranks the first problem which is also the base and prelude to a successful system.

Construction of distributed database should firstly concentrate on the data provided by all departments and units. Based on the authorized standard provided it is possible to set up a logically unite while physically distributed database.

Besides it is vital to coordinate from the perspective of management. Being the base of the system, superior data foundation can be the root of reasonable policy-making.

Third, we must make the source of the data clear. Out of the need of application, emergent command system is required to include everything relating to common people's life. Therefore, in seas of data, we should select the major things from the minor things and determine which is the most authorized data and from which department.

Fourth, since the use of distributed structure can affect the operation performance it is advisable to adopt the distributed structure combined with repetition and generating method.

Owing to the great amounts in data as well as longer circle, concerning the management of space data, in emergent command center database, according to management level, the subordinate divisions of administrative unit adopts the generating database and regularly update and protect the data from the mount database. As for the management of the subject-oriented data it is also necessary to set up a mount database, the business administration departments set up their own database, updating and protecting their database from the subject oriented data.

Fast and accurate location technology: “Fast and accurate location technology” means that you could use this technology to locate the exact places where the unexpected, sudden things happened and then mark the place where people called the police on the electric map to enable the command section to gain the necessary information in good time, manoeuvre and outfit the police force.

With the development of communication technology, there is an increasing variety of ways to call the police in the emergency and command net which is a perfect system. To different ways of giving an alarm, different location technologies are adopted to locate each corresponding spatial position which not only ensures the emergency and command center's working efficiency but also saves manpower and material resources. Generally speaking, location technology is divided into three categories according to its characteristics. The first one is telephone location which is subdivided into phone location, mobile phone location and PAS location. In the second category the spatial location technology (for example, GPS) is being used. In the third category, various transducers are adopted. Omnidirectional approaches being used, geographical statistics are made good use of, thus the statistics updating costs being saved a lot and the working efficiency being improved.

Statistics visualization technology: Statistics visualization technology refers to that with the computer graphics knowledge and image processing technology, statistics are transformed into graphics and images on the screen and processed interactively. It is related to many fields such as computer graphics, image processing, computer aided design, computer vision and human-computer interaction technology. With the development of computer technology, the definition of statistics visualization technology has been expanded which now contains the visualization of not only science computer statistics but also engineering statistics and measurement statistics. Through this technology, we could find lots of hidden laws which are the basis of decision-making, from statistics.

In recent years with the development of internet technology and e-business, information visualization appears which answers to the requirement of the age. It could fall into different categories according to different standards. Here we could get the following six categories according to the characteristics of information resource itself, including one-dimension information visualization, two-dimension information visualization, three-dimension information visualization, multi-dimension information visualization, time sequence information visualization and internet information visualization.

With the increasing spread of social informationization and internet applications, the involved information sources become increasingly abundant, containing large amount of statistical information and vast space information. Visualization technology plays an important role in the emergency and command system. Statistics visualization makes the statistics more intuitionistic, has the map analysis function, provides support for decision-making and enriches system forms.

Foundation of the method bank, model bank and knowledge bank: “Method”, such as shortcut analysis, buffer analysis, is the summation of several statistics analysis methods used in the emergency and command system. “Model” refers to every applied analysis model, such as the optimal crossing blockage selection model, the success or failure of the system. Only with the three banks being perfect can we establish proper applied models and scientific emergency response plans, lessen the damages calamities bring and protect people’s lives and possessions.

CONCLUSION AND OUTLOOK

After the threat to the public safety brought by a variety of emergencies such as natural disasters, accidents and terrorisms, people clearly see that every section in our society must unite and cooperate with each other to fight against all sorts of emergencies. This article sees the second stage of “Lanzhou City Police Geography Information System” as its practical case which put the designs and functions of the emergency and command system into use partially and obtained good results.

Because of limited time, knowledge and ability, the author of this article only does a superficial research. On the basis of this article, there are still many things that need our attention and research.

- The emergency and command system is a huge system project. Its definition and meaning are changing. Its theoretical basis is still an important research direction
- Knowledge model, rule model and application model which came into being in the public safety industry are the basis of emergency and command system. The next important step for research is how to well incorporate the models and the system and apply theories in scientifically and properly
- One of the main features of emergency and command system is the automatic processing, inoculation and control of public safety transducer. Though the research content is automatic control and information inoculation, the geography information offers us an opportunity concerning how to provide a display and operating mechanism which is also one of the following important jobs

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