Extend Municipal GIS Functions Based on Web-Services

Dean LUO and Liqiong LIAO, China

Key words: e-Governance, Web-service, Spatial data share

SUMMARY

A municipal management GIS consists of technology, personnel, and other resources to maintain, visualize, search, and share geospatial data and services, and provides all sorts of capabilities to all departments of the municipality. A few years ago some Chinese cities had constructed their municipal management GISs and these systems help them to get extraordinary quantitative and qualitative benefits. However, due to the design demerits these systems can only meet the internal demands of their municipalities and cannot meet information and service requirements of many external users (i.e. the general public, external entities). With the extension of city boundary more and more municipal facilities need to manage and maintain, the developed management systems cannot work well without the public participation.

A modern municipal management system should provide both all traditional functions and all sorts of web-based functions, which can inform public participation, deliver information timely and provide flexible interaction capabilities. In order to improve the general public interaction capabilities of existing municipal management GISs, we propose a solution to extend their functions based on web services in this paper. The service oriented architecture tries to construct a distributed, dynamic, flexible, and re-configurable service system over internet that can meet information and service requirements of different internal and external users. In this paper, firstly discuss problems related existing systems, next to present our solution, next to discuss the implementation of extending the municipal road facility management system, next to analyze the key factors of swaying the success of system integration, and finally some experiences and purposes are given.
1. INTRODUCTION

A few years ago some Chinese cities had constructed their municipal management GISs and these systems help them to get extraordinary quantitative and qualitative benefits. However, due to the design demerits these systems can only meet the internal demands of their municipalities and cannot meet information and service requirements of many external users (i.e. the general public, external entities). In these disjointed legacy systems and packaged applications, most of them were never designed for information interoperability, integration, and reuse. These alone systems had developed by different municipal departments or divisions for special objectives, and work well for their internal applications till today. Consequently, municipal IT budget will have to put into maintenance of the current running systems every year, and the major portion of budget for new capabilities goes into integrating new functionality into the existing systems.

With the extension of city boundary more and more municipal facilities need to manage and maintain, the developed management systems cannot work well without the public participation. A modern municipal management system should provide both all traditional functions and all sorts of web-based functions, which can inform public participation, deliver information timely and provide flexible interaction capabilities. In order to improve the general public interaction capabilities of existing municipal management GISs, we propose a solution to extend their functions based on web services in this paper. The service oriented architecture tries to construct a distributed, dynamic, flexible, and re-configurable service system over internet that can meet information and service requirements of different internal and external users. Related theories, methods and the extending procedures of the Beijing municipal management GIS will be presented and discussed in detail, and some experiences and purposes are given at last.

2. GENERAL SOLUTION

Most of existing municipal GIS systems have been developed with a functional orientation, and these traditional solutions come at a high cost, relying on proprietary technology and specialized skills. As the above description, the developed GIS systems can still satisfy their professional applications, and have nothing wrong with them except for the fact that they do not interact easily with other applications, since their interfaces are typically closed and proprietary. In order to satisfy new requirements we need to improve existing systems, but we do not wish to lose our large amount of effort spent on them. So the introduced solution will have to satisfy the following requirements: (1) Using existing infrastructure, (2) Reducing integration costs, (3) Increasing the flexibility of functional integration, (4) Improving the interoperation ability of distributed computers of different systems in different divisions of municipalities, (5) Improving the share ability of spatial data and its processing procedures. In
general, the Enterprise GIS Application Integration for municipal facility management based on Service Oriented Architecture (SOA) may be the best solution, which can serve for all sorts of GIS application requirements of participating public and private organizations. The interoperability standards related to all aspects of service operations play an important role for an SOA implementation. Here we will use the Open GIS Consortium (OGC) standards for the data finding and access, W3C standards for developing the web services (W3C, 2004) etc. With the help of SOA different systems can work together as long as they employ the same interoperability standards.

Here we present the basic framework of the Enterprise GIS Application Integration for Beijing municipal facility management (Fig. 1). All alone running systems will be contacted with web services by extending their functions and encapsulating their existing functions.

![Diagram of the basic frame of the Enterprise GIS application]

Figure 1: The basic frame of the Enterprise GIS application

3. IMPLEMENTATION

Municipal facility management covers all sorts of public infrastructure and facilities in a city, i.e. energy facilities, road facilities and communication facilities etc., and almost every kind of them have their own professional GIS system in Beijing. These systems work alone in a closed state and can only provide professional functions for internal applications. In order to construct an Enterprise GIS Application for whole Beijing municipal facility management, we need to extend the functions of all existing systems by web services. For saving the page only the extension of road facility management system will be discussed in detail in the following sections.
3.1 The existing work flow

The developed road facility management system serves mainly internal applications today and lacks of the public participation. So a significant amount of facility change information (i.e. damage) cannot be joined timely into the existing database. The administrative and maintenance expenses are high and the reaction speed to a project case is low, and this trend is expected to become increasingly pronounced in the future. Figure 2 shows the existing work flow of road facility management.

![Figure 2: The work flow of road facility management](image)

3.1.1 Collect facility damage information

In our today’s work flow there are two ways to collect facility damage information, one way depends on regular check and patrol of the professional staff and another way comes from phone description of the public. For a facility we need to know its location, work state, type and other relative information, especially the location, which can help to find and locate the facility quickly. The professional staff can get all necessary information with relative devices and correct methods, but the public can only describes the facility qualitatively, the professional staff in management centre will have to locate the facility from the spatial database by the qualitative description.

3.1.2 Information treatment

After get the facility damage information, relative system user will build a new treatment case (insert a record into the facility repair table) firstly, the next to locate the facility by geocode, attribute or geometry information, and change the state of the facility, the next to make a repair plan according to the facility location and responsible divisions, after the repair division finishes their task successfully, a close report need to send back to the control centre in order to close the treat case.
3.2 Extend existing functions by web service

Due to the close running style of the road facility management, both the public and the professional staff can’t contact the spatial map information, so that they can’t locate and label the facility on the map by internet. Today cell-phone and PDA (Personal Digital Assistant) have been widely used in all sorts of data collect fields, the authorization users can operate directly the business database with the help of these devices. With the development of WebGIS we can operate directly the spatial database too, and we can use a new work flow (Fig.3) different from the original work flow. The new work flow become more efficient, flexible and accuracy than the original.

![Figure 3: The changed work flow based on extended functions](image)

Here the authorization users can operate directly the GIS database with the help of terminal devices, so they can locate and label the damage facility on the map, and input other attributes too, the administrator only needs to check and confirm the submitted record, the next he can make the repair plan and allocate the task directly. The new work flow obviously saves time and expenses. Remember that all the functions of the digital terminals are integrated from the functions of the original road facility management system, however the functions of the original system (i.e. zoom, find, query, label) cannot be used before they are extended or encapsulated by web services.

4. DISCUSSION

For the alone running systems developed by municipal departments and divisions, construct the enterprise GIS application integration system based on web services may the best solution. The integration style can keep old investments and developed functions, and keep all alone systems to work together smoothly. The extension of road facility management system has employed the presented solution and the application tests prove the feasibility and efficiency of the presented solution.

However, in our experiences gotten from extend existing GIS functions by web services the following factors will affect the implementation of an enterprise GIS integration application.

---

FS 4J - GIS Applications on Internet
LUO Dean and LIAO Liqiong
Extend Municipal GIS Functions Based on Web-Services

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010
4.1 Standards

In order to construct an enterprise GIS application from distributed and independent professional systems, a series of IT or GIS standards (i.e. data interchange standards, web service standards) must be selected firstly, and these standards can keep the interoperability of different systems. Moreover some practical unified guides related system function extension should be made before integration.

4.2 Construct a loose technology community

Though we have obeyed proposal standards and guidelines in the process of integration all sorts of exceptional technology problems still come out. These problems cover data share, interoperation, data format and authorization etc., some of them can be solved by single department or division, but most of them can only be solved by the cooperation of all participants, so a loose technology community which members come from all participated units should be construct to be responsible for dealing with all possible technology difficulties, making guidelines and templates, inspecting each other and doing the other things.

4.3 Build data warehouse and data interchange platform

In general, the presented integration methods solves today’s difficulties in the construction of Beijing municipal GIS application system, but the integration is low level and the integration style is a loose united style, which cannot make the utmost of all sorts of data and services. Today spatial data and professional information have been stored separately in the local database of municipal divisions, in order to keep their professional applications the data collection, so much as the collection of common spatial data, is done by theirselves. So the same common spatial data will have different copies and versions, and the consistency of data cannot be kept. To a much larger degree, all sorts of professional activites of municipal divisions depand on the same common saptial data and this part should be stored and maintained by a specified division, the other divisions can access and use the data with authorization. Moreover, some of the engineering data stored in different divisions can be shared too. In order to share data and save budgets, it is necessary to build a municipal data warehouse and a municipal data interchange platform.

5. CONCLUSION

The presented integration solution solves today’s difficulties in the construction of Beijing municipal GIS application system, and application tests prove the feasibility and efficiency of the presented solution. however, this approach which extend the GIS functions based on web service would serve as an enterprise base for sharing and integrating data across all municipal departments, and can help to reduce or eliminate inefficiencies of information access and exchange, and thus lead to cost-effective and more efficient operational and strategic decisions.
ACKNOWLEDGMENT

The authors wish to acknowledge the support of the funding project for the Technologic Innovative Group Plan of Beijing (No. PHR 200907127) and the National Natural Science Foundation of China (Grant No.40871196 ).

REFERENCES


BIOGRAPHICAL NOTES

Dean LUO was born 1968 in Sihuan, China. He graduated from Wuhan University of Surveying and Mapping in 1990 and get the Ph.D. degree from Southwest Jiaotong University in 2002. His professional work started in 1990 at the Southwest Science and Technology University as a Surveying expert and teacher. He worked on many GIS application projects as a Team leader, and his main research interesting is on GIS and remote sensing.

Liqiong LIAO was born 1969 in Sihuan, China. He graduated from Southwest Jiaotong University in 1990. His professional work started in 1990 at the Southwest Science and Technology University as a Surveying expert and teacher, and his main research interesting is on GIS and engineering surveying.

CONTACTS

Dean LUO
Beijing University of Civil Engineering and Architecture
No. 1 Zhanlanguan Rd., xicheng dist.
Beijing
100044
CHINA
Tel. +86-010-68322540
Fax + 86-010-68322531
Email: luodean@bucea.edu.cn