An Enhanced Microkernel for the Design of Location Based Services (LBS) using Free Open Source Software (FOSS)

Shang ZHANG 1, Ming XIAO *1, Feng Tao LIU 2

1. College of Computer and Information Technology, China Three Gorges University, Yichang, China
2. Faculty of Information Engineering, China University of Geosciences, Wuhan, China

Abstract — In this paper a software model called Resource Loading Manager (RLM) for Location Based Services (LBS) is designed using Free and Open Source Software (FOSS). Geographical Information System (GIS) always play an integral role in information systems, but it comes with technology problem, such as low efficiency, less flexible, no redundancy of existing GIS application configuration which have high entry cost. The aim of this paper is to presents a lightweight, efficient and scalable microkernel plug-in geospatial information application system and its implementation method for GIS in microkernel design and practice. Through the RLM efficient allocation of geographic information resources and security management could be achieved. Using existing cloud computing technology, GIS of spatial public service will impact the ordinary way of life, bring enormous business opportunities.

Keywords - RLM; microkernel; LBS; GIS; FOSS

I. INTRODUCTION

Spatial Information technology prompted the generations of Space-Air-Ground Integrated Earth Observation Network, a new spatial information technology field [1]. The goal of this new technology of spatial information includes not only the institutions, the government, companies and other professional groups, but also the public. How to solve the massive integration of heterogeneous data management and storage, parallel spatial information processing and analyzing, optical service on demand and other technical needs, has driven scientists to focus on meeting the diverse users with different types of needs, providing the information service based on spatial, Which is considered to be one of the most promising applications of Geosciences.

The increasing needs for commercial spatial service has driven scientists to pay more attention to accurate positioning solutions. It connects people to points of interest with accurate, real-time positioning and brings them current conditions such as weather and traffic situations, or provides tracking or routing information with using wireless devices. It is important to integrate the Wireless Communication (WC) technologies and the mobile computing technology in order to meet the needs of public spatial service [2], which is considered one of the most promising applications of GIS.

Cloud computing is a new shared infrastructure, on top of parallel computer systems which allow the application to run with a lot of features, such as processing scale, centralization of management, storage based on open strategy, balanced load among clients [2]. It enhances the ability of spatial information services with its good technical support of scalability, availability and high reliability.

Meanwhile, open source strategy is another way to promote developments within the Geospatial processing domain currently, especially for the ongoing development and research topic “cloud”. The availability of Free and Open Source Software (FOSS) for Geospatial Information systems (GIS) have increased tremendously in recent years [3].

II. BRIEF REVIEW OF OSGIS AND LBS

A. About FOSS

Free/libre/open source software (FLOSS) or open source software (FOSS) is technically defined as software whose licenses grant the right to use, copy, study, change, and improve its design for any purpose to the users, and no further limitations or royalty payments need when redistributing either the original or modified program. This, to a certain degree, prevents the users to set restrictions to other users. In order to make this possible, access to the source code is a necessary condition [3, 4].

B. Brief of OSGIS

GIS technology is rapidly improved and stabilized with the automation of map-based information. More and more GIS have been applied in national economy and social life, they stand in need of the interoperability and re-usability. GIS is becoming an important framework for understanding a dynamic world. It is not surprising, then that a large commercial GIS industry has emerged to provide customers with software tools, training, and source data. The scope of GIS implementation is also extensive—from a desktop implementation to an enterprise operation investing significantly in data storage and processing assets. However, the cost of large deployments using commercial software can be prohibitive [2]. At the same time the limitations of traditional programming method with the interoperability, portability and data sharing became more obvious. In these cases, open source applications have an equal potential for large-scale
implementation across a broad range of platforms, but they can be far more cost-effective and flexible [4]. Open GIS (Open GIS Interoperability Specification) is coming to address the above issues, the specification defines a detailed criteria for GIS software developers.

Microsoft's OLE/COM and the Object Management Group's CORBA model is currently the two dominant models for software component. To satisfy such trends of the information system, the open community has been developing the component-based Open GIS software system [3]. The OGC (Open GIS Consortium) is an attempt to create open standards for geo-spatial data and systems that further the cause of interoperability. Component is a software pieces that can be assembled into various applications. For the sake of the reusability, a component-ware or distributed objects is a new approach to software development.

Software engineers will develop the product which can meet the requirement and inter-operate well, as long as strictly abide by the OpenGIS standards, that is, the product can achieve the data and function sharing between GISs.

III. FEATURES OF SPATIAL CLOUD COMPUTING

Cloud computing has become a popular technology to provide spatial information, which including transparent data accessing, service standardization can be achieved only if spatial information services need spatial information sharing, integration and inter-operation.

A. Data Access Transparency

Spatial information services related to the different data formats according to various types of data. In order to reduce the difficulty of user accessing, a variety of heterogeneous spatial data sources must be supported by spatial information service platform based on cloud computing, which providing standard spatial data services to users with access method transparent. Through a unified system of space data source configuration, the user could freely access the spatial data from different data sources.

B. Parallel spatial analysis

The data processing in spatial information services is massive, heterogeneous, multi-source, which totally is intensive task. But the computing power of single CPU is limited. At this point, parallel algorithms and the parallelization strategy of this kinds of tasks take full advantage of cloud computing on multi-CPU platform, which could improve the processing efficiency is essential.

C. Service Capabilities Flexible

Cloud computing technology has the characteristics of elastic expansion of computing power, storage space and resource which would be dynamically allocated and shared through networks. Spatial information services are based on cloud computing with space service capable and spatial data storage capacity scalable. First, this technology refers to the different services to multiple users and storage capacity scalability, such as fast to meet the different needs of different users or concurrent requests; second, refers to the same service, the strength of its services (such as complex calculation of space services and space scalability for the huge amount of data)[4].

D. Information Services Standardization

Cloud computing provided through the internet to a variety of IT resources as a service is presented to the user. Through the cloud based spatial information service platform, spatial data and processing capacity could be delivered via the internet to the user as service. Standardization is the premise of sharing and interoperability; visualization, information services standardization, flexible service, parallel spatial analyzing and flexible secondary development.

Standardization can be achieved only if spatial information services need spatial information sharing, integration and interoperation.

IV. MICRO KERNEL AND RLM

A. Brief of Micro-kernel

In recent years, as the development of software systems in style of "component" and "hierarchical", micro-kernel technology has gradually been introduced into software design framework for the "decoupling possible relationships between components." The concept of Micro-kernel (micro kernel) was originally made for building micro-kernel operating system based on message passing mechanism, not for software architecture services [5]. But in the field of GIS, micro-kernel-based system has not yet been established. But the way of microkernel based system provided several benefits that traditional GIS platform don't have:

a) Easy to modify the existing similar software systems.

b) There is no need to develop new application systems to meet user changed needs;

In traditional way the efficiency of scheme a), b) is low. Even if there is a little small change, or users have new functional requirements, the engineers often need to develop system or modify the code. These will resulted in high development cost, and poor scalability.

For the enterprises, government, individuals and other different types of users which need a efficient, scalable and lightweight geospatial information operation support environment. A geospatial information support platform based on micro-kernel architecture technology which provides a lightweight run-time environment has been established in this paper, including open geographic information processing, remote sensing data processing and mutual integration process. In this case, not only a lot of software purchase costs can be saved, but also a variety of personalized geospatial information processing demand can be meet.[6].

B. Resource Loading Manager

In order to ensure the reasonable resource management, a geospatial information application system based on micro kernel technology is designed in this paper. Geospatial information resource loading manager (RLM) which used to load the application of the plug-in function module of
program could realize the business logic of the application program. The structure of the RLM is shown in Figure 1.[8]

From Fig (1), FSRL (functional service requirements list) is used to count the resources required by the client software. The information includes at least: client software security level, the features of required resources, and the method of administration.

According to FSRL, FR (function resolver) puts the functional requirements of client software in accordance with the rules of the system function modules to subdivide, and builds functional modules list of requirements.

FMRL (functional modules requirements list) used to describe the function modules refined from the functional service requirements of client software.

LC (list counters) is used to allocate function modules according to FMRL.

RCF (resource configuration file) is used to identify all functional modules.

AM (access manager) is used to check the LC calls to functional modules permissions.

FC (function combiner) is used to package the function modules called by LC for plug-in, using for client software.

The Timer is used in one or more functional blocks occupied by other programs, and cannot be immediately called. The timer periodically detects the required permissions whether the function modules were released, and dynamically loaded them into the function plug-in when they were released.

C. Implementation of RLM

The basic idea of the method described above is: The process logic of programming system is implemented through a plug of expression of microkernel architecture. FR is used to decompose the functional requirements of client software into functional modules requirements. LC re-organize and dispatches modules, and through FC to provide plug-ins for client software. Furthermore, in order to ensure the timeliness, accuracy of function calls, we use RCF and AM to manage the resources. Meanwhile, the timer periodically detects the function module which unable to be used temporarily. When the function permits to release it, the FC immediately loads into the plug-in functionality for client software to use. The process of the RLM is shown in Figure 2:

The concrete implementation steps are as follows:

a) Client software confirms the service requests to generate FSRL, and submit to the RLM;

b) RLM confirms the FSRL submitted by client software. Then FR decomposes the required service into small granularity of function module, and generates the LC;

c) LC views the RCF according to FMRL, confirming whether the required function modules can be called immediately. If possible, LC will call the corresponding function modules, and update the status identification of function modules in the RCF;

d) FC unified packages function service modules as function of plug-ins. These plug-ins response to the demands of client software. Meanwhile, FC generates function module identification, and returns to the client software to use.

e) Client software calls function plug-ins, and returns plug-ins access to the RLM after completing corresponding operation requirement. Then RLM updates RCF.

According to the above scheme, step b) should also include the following steps: After RLM received FSRL submitted by client software; RLM decomposes the required service into small granularity of function module by FR. Meanwhile, RLM divides call requests of each functional module into read-only requests and marks them in generated function modules.

As the same, step c) should also include the following steps: After LC received FMRL, AM is read at first, in corroding to confirm whether the client software has the right to use the required level of the selected function modules. Then the results are identified in FMRL. For insufficient permissions to demand the use of functional modules, RLM will suspend the next steps. Finally, RLM checks RCF, confirms whether the required function modules can be used immediately. If the module cannot be called immediately, then the request will return temporarily, and the status will be identified in RCF [10].
Step d) should also include the following steps: The plug-ins provided to client software adopts the loose packaging mode. For exclusive use resources such as write operation, when the user completes the functional corresponding function modules of the write operation in the plug-in use demand, the instant loading manager will return access to RLM, and updates RCF; Due to the function modules without encapsulation plug-in function modules of the summary, the function will be used by the client software to set a time interval repeat step c), until the function modules dynamic load at the function in the plug-in.

Step e) should also include the following steps: Client software will receive FMRL after functional plug-ins package, suggests that the reason why some functions modules cannot call.

V. CONCLUSION

Spatial public service will also change the ordinary way of life, and bring enormous business opportunities. At present, the high costs of information sharing system embark the spatial public service. The development and application of FOSS or OSCIG based product will provide spatial information service at high efficiency and low cost.

Based on FOSS/OSGIS, the design of middle-ware GIS platform, which can absorb technological and scientific achievements in the field of information technology synchronously, could keep up with advanced concept of software architecture, so as to promote the development of spatial service technology and software.

Meanwhile microkernel technologies, which can absorb scientific and technological achievements in the field of information technology synchronously, keep up with advanced concept of software architecture, so as to promote the development of GIS technology and software.

At the same time, based on micro kernel technology, we build the atom granularity function module of management and automatic loading, has realized the function of resource efficient scheduling and ordering management, for application of geographic information system to construct and run efficient laid a foundation.

ACKNOWLEDGMENT

This paper is supported by the China Three Gorges University Science & Technology Foundation program (No. 1114072) and the National Science & Technology Pillar Program during the 12th Five-year Plan Period of China(2012BAB11B0501).

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