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Study on the Technologies for Dynamic Update of Resource Database Based on Service Chain

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Abstract: In view of the existing problems in the integration and dynamic update of resource database, service chain is introduced into the update of resource database, with an aim to improve the quality of data in resource database and ensure the real-time property of database. Meanwhile, this intends to maintain the correlation of business to enhance the information value of resource data, in order to provide the foundation and supporting information for effective supervision and finer management of resources. This paper particularly elaborates on the connotations and main ideas of dynamic data update technology based on service chain and puts forward four key techniques to realize the dynamic update of resource databases, namely, change information retrieval based on data interception technology, data update service chain definition based on business rules, intelligent organization and call of service chain, monitoring and tracking of update process based on data quality. In the end, this paper presents a comprehensive application demonstration in Chengdu City, builds a central database of land and resources in Chengdu and connects each business database to the central database, so as to realize dynamic linkage update between the business database of land and resources and the central database in Chengdu to support and serve all the work of land and resources management of Chengdu in an all-round way.

Key words: Service chain, resource database, dynamic update, correlation

INTRODUCTION

The establishment and update of database is the core and important content of system and application. The quality and real-time property of data can directly decide the accuracy and reliability of data analysis and application results. Along with the development of modern information technology and the expansion of informationization, national and relevant authorities have completed all kinds of necessary resource databases. To apply dynamic data update technology in guaranteeing the integrity and real-time property of resource database will become the focus of future work. The relevant theoretical and technical research of data update will be also developed and improved constantly and become the hot topic and difficult point of the research (An *et al.*, 2010; Huang, 2012; Li *et al.*, 2012).

It has been gradually agreed in various circles of society that science and technology can be employed to strengthen the supervision of resources. Undoubtedly, the establishment of various resource databases and their application systems based on information technology is

an effective technique and method to strengthen the supervision of resources. Along with the expansion of application and the fine management of resources, the quality and real-time property of existing resource databases fail to satisfy the needs and even restrict the application value and scope of resource data. China is still much behind developed countries with regard to the research on dynamic data update mechanism, theory and technology, etc., so that data update cannot fulfill the objectives of sustainability and efficiency. For this reason, service chain is introduced into the update and management of resource databases. This paper focuses on the key technologies and realization methods for dynamic linkage update of resource databases with the assistance of service chain.

CONCEPT AND CONNOTATIONS

Concept: The concept of service chain was put forward in ISO19119 codes for structure of service system and defined as an array of service (s), which two neighboring services, except the first and last services, are paired and

the earlier one is the prerequisite of the later one and whose role or function must satisfy the needs of requester (Fu *et al.*, 2007; Jing *et al.*, 2008; Alameh, 2003). The established mass resource databases and their application systems have typical heterogeneous characteristics, such as, different time of establishment, different data sources and acquisition channels, diverse basic software platforms and differentiated forms of data organization, etc. Therefore, application systems are restricted from communication, data sharing and interconnection and unable to give full play to their value and benefits. Service chain provides a new method and solution for sharing of resource databases and interoperability of application systems. The technical basis of service chain is the Web service developed by realizing the new technology for new protocols and standards based on Web technology and facility. Thus, all the technologies, standards and protocols related to Web service can also apply to service chain. All the services in service chain can be classified into functional service and data service. The data service at each node of service chain mainly provides data sources for this node and next node, while the functional service at each node of service chain provides the task or function that must be achieved in the provision of service at this node.

Connotations: From the approach of data update, service chain has two functions as follows: 1. improve the quality of data; 2. enhance the efficiency and intelligent level of data update. Therefore, the dynamic update process of resource database is not only a process of data processing, but also a process of data derivation.

The process of data update should not only keep the real-time property of data, but also maintain the logical relationship of data and discover from these data and their logical relationship the information that has value for application and is focused and needed for management and decision, according to business rules and model.

Based on the execution and call modes of service chain, data update has three modes, namely, automatic activation, business activation and manual activation. Automatic activation means to automatically activate the service chain of data update according to the preset rules and can be further classified into real-time update and fixed-time update. Business activation means to call or activate the service chain of data update by means of trigger mechanism according to business rules when the application system of business is in operation. Manual activation means to manually execute the service chain of data update based on actual needs.

Therefore, the dynamic update of resource data based on service chain has a feature that the favorably

real-time and highly logical data set or the data elements stored in a centralized manner should automatically adjust to the change of source data and call different services to intelligently update target data, so as to finally improve the quality of data set and data elements in resource database in a real-time and dynamic manner and maintain their logical relationship. Initiative, intelligence and relevance are the most fundamental features that differ this technology from common data update technologies.

TECHNOLOGIES IN THIS STUDY

Extraction of change information based on data interception technology: Data change detection is always a focus of research and attention and its importance results mainly from the requirements for time and space analysis and dynamic monitoring of data as well as maintaining real-time property of data. The supervision of resources is not a single application system, but involves a large variety of business systems and data types. In the process of business and system operation, all kinds of data will be generated, including properties, spatial data and files, etc. Therefore, it is urgent to keep the consistence of diversified and heterogeneous business systems and their databases. The capture of data changes is the basis and foundation for data synchronization and update and directly determines the form and frequency of data update. Based on their research (Yang *et al.*, 2010), Yang Miaoqi *et al.* () claimed that the capture of data changes is mainly carried out by employing 7 methods, namely, snapshot, trigger, log, API, shadow Table 1, control list and timestamp. Each method has its own advantages and disadvantages, so it is not right to judge which one is better simply. These methods are selected based on the objectives and actual technical environment of business. Moreover, these methods can be applied comprehensively or separately according to database characteristics and business needs as well as referential factors for data update. The referential factors for data update mainly include data size, update frequency, storage mode and data type.

Definition of data update service chain based on business rules: Resource data are typically heterogeneous and have strong relevance and correlation as well as complex logical relationship and business rules. The service chain based on Webservice technology is featured by loose coupling and able to combine the node and process control, work flow and other technologies in data update service chain, in order to customize the data update service chain based on business rules (Wen *et al.*, 2012; Zhang *et al.*, 2010b). Figure 1 presents the chart of data

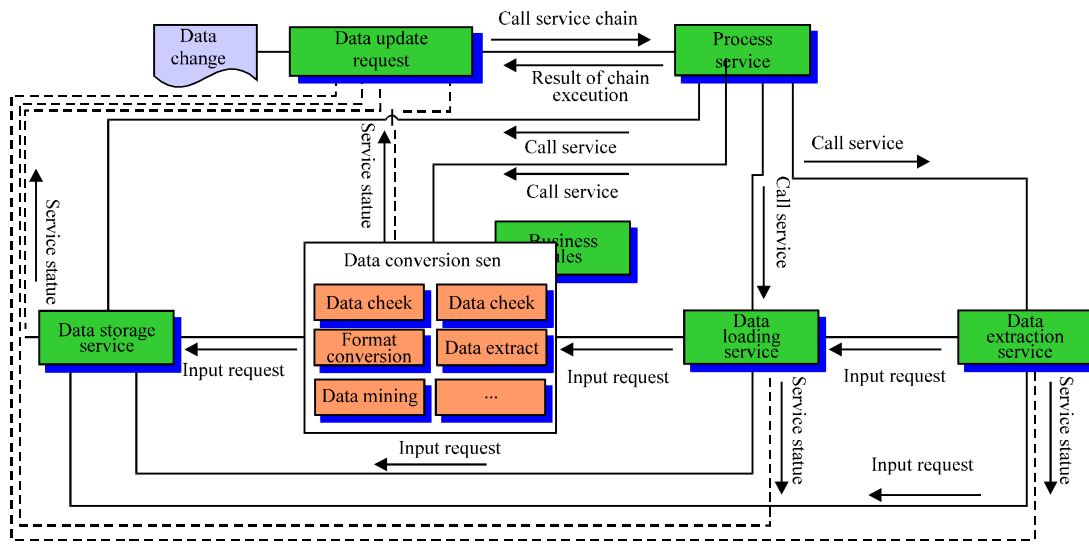


Fig. 1: Definition of data update service chain

Table 1: Method of data change capture and referential factors for data update relate table

Data update method	Data size			Update frequency			Storage mode		Data type		
	Large	Medium	Small	Quick	Medium	Low	Database	File	Spatial	Property	File
Snapshot	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Trigger		✓	✓			✓	✓			✓	✓
Log	✓	✓	✓	✓	✓	✓	✓			✓	✓
API	✓	✓	✓	✓	✓	✓	✓	✓			✓
Shadow Table	✓	✓	✓	✓	✓	✓			✓	✓	
Control List	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Timestamp	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

update service chain based on business rules, including data identification and update request, management and control of process service, development and control of business rules, data loading and extraction and data storage. Data identification and update request mainly focuses on the monitoring and extraction of change data, sends a request of data update to Process Service Management Center, receives and processes the reply. Management and control of process service means to control and manage all the basic services in service chain, in order to realize their efficient and stable coordination and implementation. Development and control of business rules means to develop and manage the correlation of various data, build the data update model and determine the basic services, in order to provide the processing rules on data extraction, conversion and storage. Data loading and extraction refers to a series of data processing and treatment processes that identify data sources or change data after receiving the reply on data update request and perform the extraction, loading and conversion of data based on business rules, etc. Data storage means to save the results of data processing in a designated database and return the results. Each part can

provide service independently, or these parts can collaborate under the unified call and control of service chain to provide service, in order to form a service chain based on Web Service in the form of loose coupling. In this way, they can satisfy the needs of dynamic data update. Moreover, it is featured by flexibility, transparency and easy management.

Intelligent organization and call of service chain: The organization and call of service chain becomes complicated due to the heterogeneity of resource data, the complexity of business rules and the diversity of data change monitoring. The same type of data may be updated by employing a composite service chain consisted of multiple basic services and even service chains because of different business rules. Similarly, service chain may become more complicated for the diversity of data change monitoring and the heterogeneity of data, etc. Therefore, the intelligent organization and call of service chain are crucial to data update (Zhang *et al.*, 2010b; Xu *et al.*, 2012; Wang *et al.*, 2010). Figure 2 is the framework for intelligent organization and call of service chain, which consists of 3 parts, namely, service chain

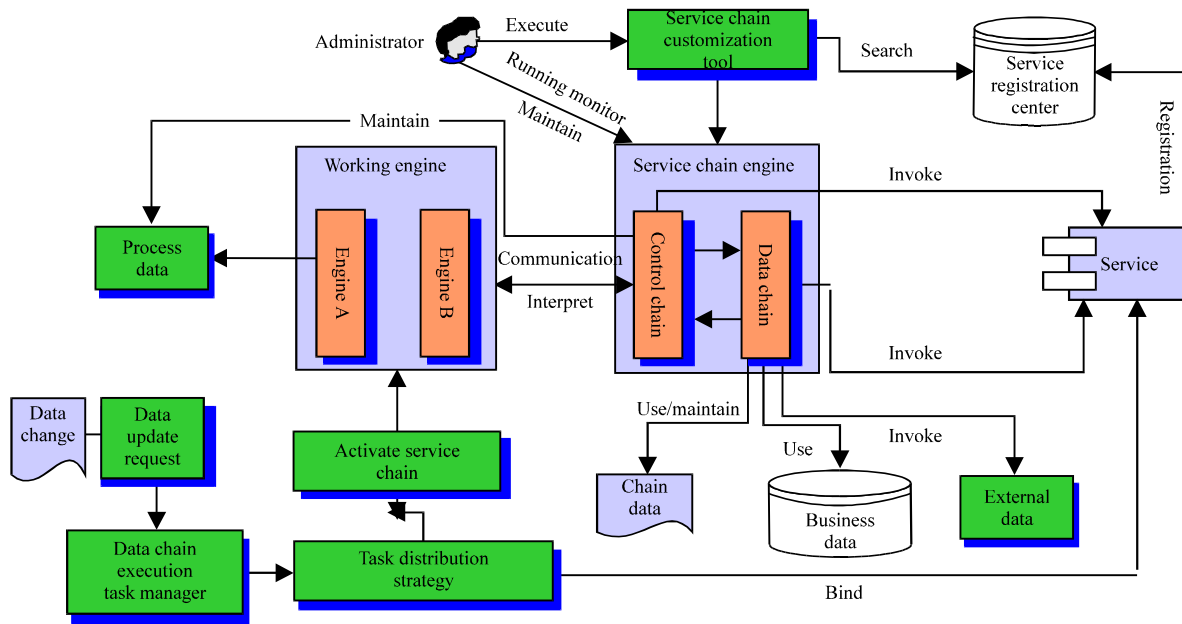


Fig. 2: Framework for intelligent organization and call of service chain

customization and registration, workflow engine and service chain engine and task management. Service chain customization and registration means to develop service chain customization tool based on the previous definition model of service chain to develop, revise and manage service chain, register the customized service chain with service registration center and perform the unified management and control. Workflow engine is used to arrange and manage the execution sequence, parameter, input and output, etc. of each service, while service chain engine extracts and identifies the information provided by workflow engine and performs the sequence control, parameter transmission, input and output control, etc. of all called services and is consisted of control chain and data chain. Task management means to receive and process data update request, assign and call the tasks based on the analytic strategy of service chain and return the execution results of service chain.

Update process monitoring and tracking for data quality:

Data update depends on the data quality of updated data and databases, including correctness, accuracy, no contradiction, consistency, integrity and integration, etc. At each node and in each link of data update service chain, inspection and control are strictly strengthened in accordance with data standards, in order to understand the characteristics of data based on the nature of updated data, pay attention to their quality and application and analyze their effect from the perspective

of business application system (Zhang *et al.*, 2010a; Song and Li, 2010; Kyung *et al.*, 2012; Min *et al.*, 2011). Therefore, the quality control of data update can be reinforced by introducing the inspection of data quality at each node and in each link of the whole data update service chain and taking the measures of abnormality treatment, logging, log analysis and tracking, etc. Figure 3 is the framework for data quality control and monitoring when defining the service chain of data update, which focuses on adding the rules of data quality inspection in the process of data update management in the form of service, in order to guarantee the correct, effective and integrated results of data update. Data quality inspection rules must be quantifiable and can be converted into the model and language that can be identified by computer, or the inspection and control of data quality cannot be performed. Inspection rules normally cover the effectiveness and topologic inspection of spatial pattern, integration inspection, consistency inspection and data domain inspection, etc.

ACTUAL APPLICATION

The Bureau of Land and Resources Chengdu followed the ideology of “Overall Planning and Urban-Rural Unification throughout Chengdu” and implemented the Phase I and Phase II of Chengdu Land and Resources Information System, “Golden Earth Project” and “Digital Land” Project to establish a data

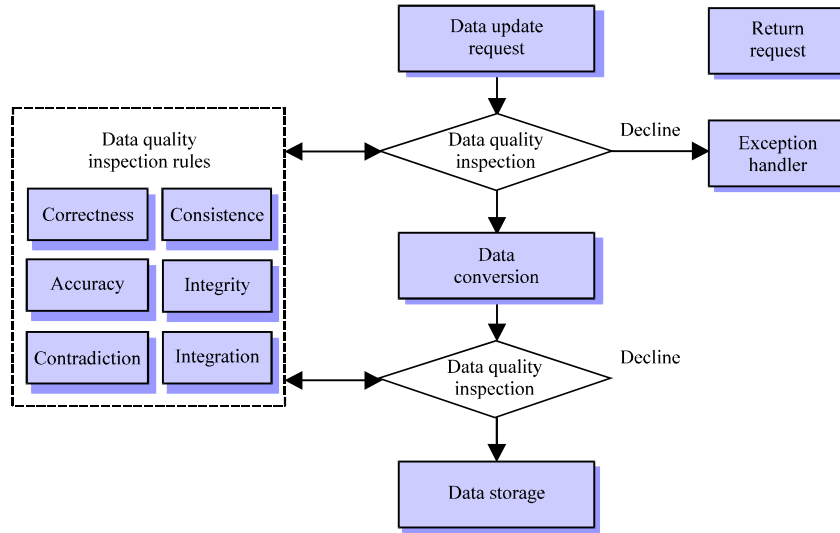


Fig. 3: Data quality approaching and tracking in data update

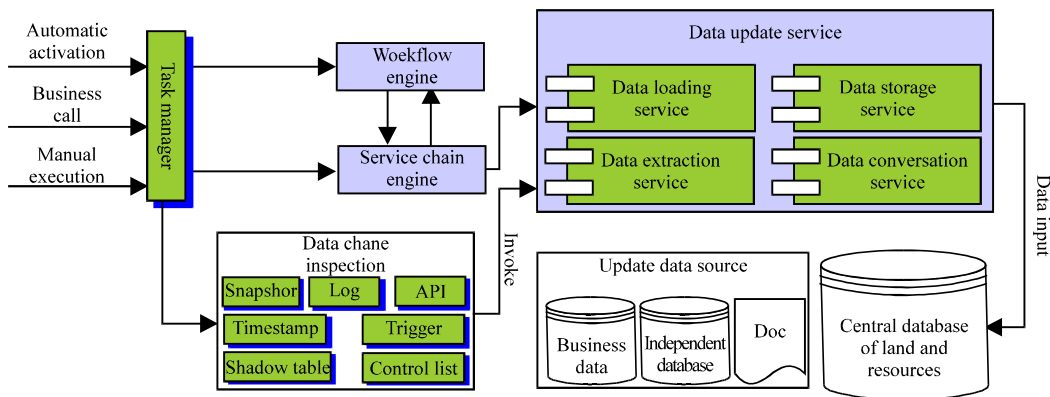


Fig. 4: Dynamic data upgrade framework of land and resources

center, three-level E-government network and three-level E-government system and develop 18 business application systems and 26 basic and special databases, in order to support and service all the management work of land and resources. In order to guarantee that all the established resource databases and application systems can serve the supervision of land and resources in a sustainable and efficient fashion, the technique and method proposed in this paper are utilized to realize the intelligent update of various resource data with the support of service chain and develop the central database of land and resources. Based on the source of updated data, this is divided into two parts. Firstly, data update standard service or data update service chain are customized in accordance with corresponding input standards and requirements for business databases that have established business systems, including data extraction, conversion and loading and background

service or application program can call data update service automatically or at fixed time, in order to realize the automatic update of business data in established business systems, such as, urban land survey, examination and approval of construction land, preliminary review of construction land, etc. Secondly, data update standard service or data update service chain should be also customized in accordance with data input standards and requirements for data that have no business system or are updated in a centralized manner or textually, etc. and data update can be performed manually or semi-automatically, e.g. remote sensing image and basic GIS, etc. The key techniques mentioned in this paper are employed and combined with the practice in Chengdu to fully analyze and straighten out the relationship among various businesses related to land and resources, so as to develop the dynamic update framework for the central database of land and resources, as shown in Fig. 4.

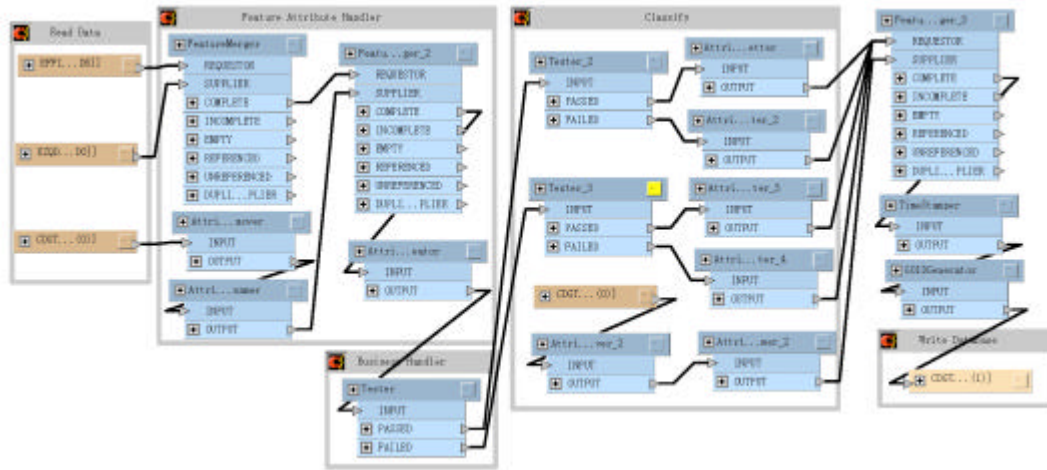


Fig. 5: Business data update service

At present, the central database of land and resources contains 47 million pieces of data in 216 categories of elements, which belong to four types of basic data, namely, remote sensing, fundamental geography, rural land survey and urban land survey, as well as 9 types of special data, i.e. land planning, land acquisition, land supply, land utilization, farmland protection, law enforcement supervision, geological environment, mineral resources and urban planning. These data are stored in the format of Oracle Spatial and the capacity is around 2TB, involving three types of businesses of land and resources management, i.e. land administration, mineral administration and geological environment management.

CONCLUSIONS

Along with the reinforced management of resources, the increase of data requirements and the expansion of data application, the constant, efficient and dynamic update of resource databases and the development of relevant technologies have speeded up the application and promotion of service chain technology. Many researchers have studied the technology of dynamic data update, but there are still many aspects we can further explore and study. This paper mainly introduces service chain into the dynamic update of resource databases to dynamically and intelligently update and manage databases while guaranteeing the quality of data. Moreover, this can maintain the real-time property of data, support and service the operation of each business system in an all-round way, enhance the level and depth

of data utilization, sufficiently identify and discover the value of information, so as to finally realize the effective supervision and fine management of resources. The technology is put into a comprehensive application demonstration in Chengdu City. The results reveal the dynamic linkage update between existing special and business databases and central database for land and resources.

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