

DESIGN AND IMPLEMENTATION OF LINKAGE UPDATE MANAGEMENT SYSTEM FOR GEO-INFORMATION SERVICE PLATFORM

Zha Zhuhua^{1*}, Huang Wei¹, Tang Dejin¹, Wang Cong¹, Zhang Hongping¹, Yang Jing¹, Li Heng¹

¹ National Geomatics Center of China, No.28, Lianhuachi West Road, Haidian District, Beijing, China(zhazh@ngcc.cn, huangwei@ngcc.cn, tangdejin@ngcc.cn, wangcong@ngcc.cn, zhanghongping@ngcc.cn, yangjing@ngcc.cn, liheng@ngcc.cn)

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ABSTRACT:

The data update of the geographic information public service platform requires the joint investment of the resources of the national, provincial and municipal nodes of the platform. How to efficiently organize the collaboration of nodes at different levels is a problem that needs to be solved in the construction of the platform. The platform linkage update management system proposed in this paper is based on a workflow engine and driven by data flow. Its functions include data fusion agreement handling, data update, data access and distribution, problem feedback, announcement, statistics & analysis, system management and other functions. The system is suitable for the joint participation of construction and maintenance units suitable for all nodes to participate in, get through the online and offline update process and related resources. The construction of the system can better coordinate the construction of national geographic information public services, and achieve the effect of "linked update and shared services". The system provides higher efficiency for the dynamic update of the geographic information public service platform, allowing geographic information data resources to provide services for natural resource management and economic and social development in a more timely and extensive manner.

1. INTRODUCTION

The geo-information service platform is a geo-information sharing and serving website, which is constructed by the government functional departments and runs in the wide area network environment. It provides many kinds of online geo-information services to the society and promotes the open sharing of geo-information data. The platform consists of national, provincial and municipal nodes. The provincial, municipal nodes collect and integrate all kinds of geo-information products in the region, integrate and share up level by level, integrate to the national node for publishing service. The national node provide uniform basic maps, API, catalogue service and other functions and services. (General office of MNR, 2020; Jiang Jie et al. 2016; CHEN Jun et al. 2009)

In order to keep the platform data fresh, all nodes need to carry out dynamic data update according to the data requirements of local economic and social development and natural resource management and update ability. Update from data producing to service publishing needs to be jointly participated by nodes. Local nodes produce updated data, provincial nodes confirm data and integrate with provincial data, submit to national node for unified processing, generate online service data, such as query data and tile data, publish online services.

Data updating involves all nodes, with multiple levels of participation, multiple units, and multiple operators. It requires high efficiency of data update, high data quality, many data types, high integration technology requirements, and more communication. In order to improve the efficiency of data update and create the collaborative effect within all nodes, an online business management system that can be updated by multiple people online is needed.

At present, the online business information system mainly focuses on project management. The system designed by Xu Ting et al. solves the problem of multi-level linkage of surveying and mapping business management (Xu Ting et al, 2017). It is aimed at cross-level and cross-unit surveying and mapping transaction management, and not specific to a single project. The project management system designed by Yang Gang is only used for National Geographic Condition Census and Monitoring Projects, focusing on project level business management, and does not taking data update scenarios as the main business process (Yang Gang et al, 2020). Du Xiao et al. introduced the rule architecture of key technology in the linkage updating of fundamental geographic information, But it did not give a solution for the collaboration between various organizations (Du Xiao et al, 2017).

The system designed by Tian Shouquan et al. solves the problems of standardization in the management of surveying and mapping units, but it is limited to the internal, not be used for large-scale cooperation across units and regions (Tian Shoushan, et al. 2019).

Based on the network and workflow engine technology, this paper establishes a set of geo-information service data linkage update management system driven by the data flow. Around the core goal of data update, it establishes the workflow model of data update, data distribution and agreement handling, etc. The workflow model organically integrates the scattered nodes into the linkage update resource, and continuously and orderly carries out the normalized data update business.

* Corresponding author

2. BUSINESS REQUIREMENT ANALYSIS

The system in this article is used to establish the management process of data updating of multi-level nodes, and mainly assists in completing the following business scenarios.

2.1 Data Update

Any node can start the data update process as needed. The data update business process has two types: active update and passive update. Active update is started by the lower node (usually the municipal or provincial node's construction unit) to submit the update results. The upper node (usually the provincial or provincial node's construction unit) reviews and confirms the update request and update data, and finally submits to the national node if the data meet the requirements. Passive update is usually started by the upper node (e.g., national node) when the upper node finds that a certain area or a certain type of element is urgently needed to be updated, and assigns local lower node(e.g., provincial node) to carry out specific update tasks. After the local node confirms that the update conditions are met, it can carry out data update by itself, or assigns to local lower node(e.g., municipal node). The lower local node carries out data update task, and submits update data. Data results can be submitted online or offline based on the type and size of the data, and in compliance with the management policy requirements. After the data is finally accepted by the national node, the data will be checked, stored in the database, and published online. During the process, nodes at all levels mark the progress in the system so that relevant personnel at each node can understand the situation.

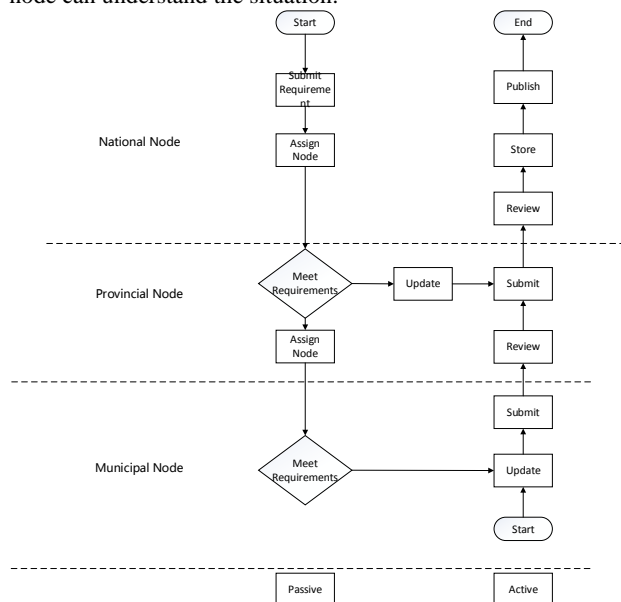


Figure 1. Data update business

2.2 Data distribution

Data distribution means that the national node will distribute the source data (reference data, updated results, etc.) to relevant units. The distribution business process also has two types: active distribution and request distribution. Active distribution is started by national node to notify the relevant node through system(sms, email, and system messages) when national node has new data version. After the nodes confirms, the nodes step into the data acquisition on the system, and the national node will carry out the distribution accordingly. Request distribution is usually started when the provincial nodes knows that the

relevant data in national node has changed, to request the new data, and the national nodes carry out data extraction, conversion and distribution for provincial nodes.

2.3 Agreement procedure

Data update is achieved through the annual data fusion agreement signed between national and provincial nodes. Each agreement stipulates the data type, content, etc., which will usually be revised and confirmed many times. In the past, it was contacted by manual, and it causes problems such as node and protocol not corresponding and unclear content. Now we hope to solve these problems by the system. The content of the final agreement is presented in text, and there are statistics functions of type and quantity in the system.

The national node prepares the agreement through the system and sends it to each provincial node, and each provincial node modifies and improves the agreement content, and submits the content text, then the national node reviews and confirms. The system can fill in indicators such as data type, data volume, area, etc., to facilitate statistics.

In order to facilitate the data fusion and update of provincial and municipal nodes, the system supports the procedures for data fusion agreement between provincial and municipal nodes.

2.4 Feedback

Problem feedback is a technical problem encountered by a node in the process of data update processing for feedback to other nodes. It is usually a provincial node feedback to a national node. The national node will give a processing response after analysis. The content of the response can be set whether to be public or not. Questions and answers can be viewed by other node construction units, sharing questions and handling experience.

2.5 Announcement

Announcement means that a national node sends an announcement to provincial or municipal nodes. When node user log in to the system, the system will remind user to read the new announcement content.

2.6 Other requirements

Users and authorization. Realize user registration and login, user information management, user authority settings, etc. User registration and login directly call platform user system function. User authorization are implemented through user roles and affiliated nodes. The roles include system super administrator, node administrator and ordinary user.

Node management. According to the three-level node model of the platform, the system can set up national, provincial and municipal nodes. Node management allows administrator to add and edit nodes, and edit user for each node.

Statistical Analysis. According to the data update, distribution and agreement, the relevant data statistics of each province can be completed according to different attribute items such as time range, completion status, data type, task type and so on.

System log. Record the user's operation items on the system, including the user, operation time, source IP, operation module, operation item, operation type, etc.

3. SYSTEM DESIGN AND IMPLEMENTATION

3.1 System architecture

The goal of the system is to build a collaborative update scene for construction and maintenance units for all nodes to participate in, get through the online and offline update process

and related resources, make better use of the effectiveness of integrated construction, coordinate the construction resources of geo-information services platform, realize the effect of "linkage update and shared service", provide higher efficiency for the dynamic update of the geo-information service platform, allow geo-information data resources to provide services for natural resource management and economic and social development in a more timely and extensive manner.

Around the construction goal, the system adopts layered logic design, consisting of an infrastructure layer, a data resource layer, an application support layer, and a presentation layer, as shown in Figure 2.

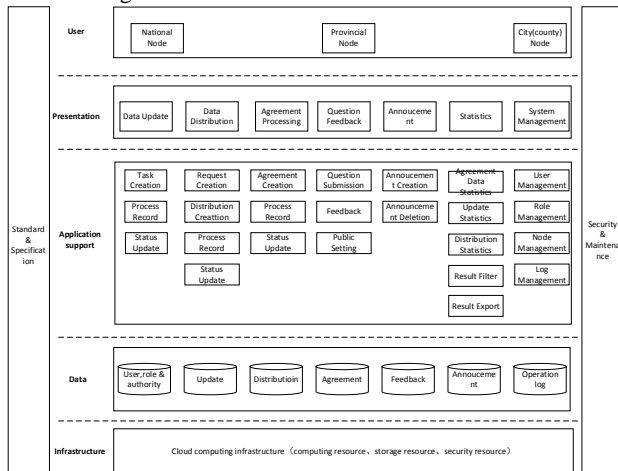


Figure 2. System architecture

The infrastructure layer includes the hardware and system environment necessary for the operation and maintenance. This system is designed to run on commercial cloud services, including computing resources, storage resources, security protection and other resources. The system runs on CentOS and uses Tomcat as a web application server.

The data layer provides system data resources to realize the processing and viewing of the linkage update business, including update business data, data distribution business data, agreement processing business data, feedback business data, announcement business data, system management such as user role and authority management and log data diary data, etc. All data is stored in MySQL database, which is safe and efficient.

The application support layer is the realization of the core functions of the software system modules, and is the bridge between business operations and data storage. It converts specific business operation results into data and stores them into database. The main functions include operation of business process for data update, the initial creation, recording, and status changes etc.

The presentation layer is the interactive interface provided by the system for user operations, including modules such as data update, data distribution, agreement handling, problem feedback, announcement & analysis, and system management. The presentation layer focuses on the user interface and operation logic, with the goal of facilitating user.

3.2 Core module design

3.2.1 Data update module

Data update has three types: vector and place name data update, image data update, and thematic data update. The node which starts the process submits update instructions, and completes the update business after a series of processes of check, storage, extraction, tiling and publishing. The current node needs to review the operation of the previous node, and the operation can be performed only after the review is passed. If the review

fails, it needs to be returned, and feedback is given, and the applicant will submit it again after modifying. The node administrator can assign tasks to node users according to the process, or directly terminate the tasks. The main function in the module listed in Table 1.

Item	Description
Update task list	List the update processes that have been started. Attribute items: serial number, task name, task type, data type, completion time, current node, applicant, application time, etc.; Process status: in progress, completed, terminated, etc.
New update task	Start an update process or task. Attribute items: task type, task name, description, complete time, data type, attachment, etc.
Edit update task	Change the task process status.
Delete update task	Delete the task from the list.
View update details	View all the update task process information, include task basic information, the attachment, the confirm information and the flow chart.
Submit	Submit the update by node level.
Withdraw	Withdraw previous submitting
Review	The upper node review the result of lower node
Attachment	Upload or download attachment
Search	Search task by keywords, administrative divisions, review status, etc.

Table 1. Function items in update module

The whole process is shown in Figure 3.



Figure 3. Data update process

3.2.2 Agreement handling module

The data fusion agreement can be started by national node or provincial node. When the process starts, fill in the information items such as the agreement name, node construction unit name, and upload the agreement document. Vector and place name data need fill in the data extent, node name list, and image data needs sensor type, resolution, area, time information, tile level and other data items. After the other node confirms the content of the agreement, it is formally signed; the modification process can be fully recorded through the system. The main function in this module listed in Table 2.

Item	Description
Agreement list	List the agreement processes that have been started. Attribute items: agreement name, submit time, data type, other node name, user etc.; Process status: in progress, completed, terminated, etc.
Agreement application	Start an agreement process. Attribute items: agreement name, data type, node name, attachment. etc.
Edit application	Edit agreement application attribute items.
Delete application	Delete agreement process.

View details	View all the agreement application information, include application basic information, the attachment, the confirm information and the flow chart.
Submit	Submit the update by node.
Withdraw	Withdraw previous submitting
Review	The other node review application.
Attachment	Upload or download attachment
Search	Search agreement application by keywords, administrative divisions, review status, etc.

Table 2. Function items in agreement handling module

3.2.3 Data distribution module

Provincial nodes can start the data distribution or accessing process through this module. When started, the node fill in the data extent, contact person, data type and other information. National node receives it, arrange staff to extract and copy data, and record the status change in the system. When the status changes, the system informs relevant user. When the provincial node users know that the data is ready, they can come to access it at any time. The system also record all the information. The main function in this module listed in Table 3.

Item	Description
Distribution list	List the data distribution and application that have been started. Attribute items: application name, province node, start node, data type, user etc.; Process status: in progress, completed, terminated, etc.
New application	Start a data distribution or application process.
Edit application	Edit data application items.
Delete application	Delete the data distribution process.
View details	View all data distribution information, include basic information, the data attachment, the confirm information and the flow chart.
Review	The other node review application.
Attachment	Upload or download attachment, include data, document, etc.

Table 3. Function items in data distribution module

3.2.4 Feedback module.

This module is used to manage information such as question and answers during the data update process. Provincial nodes can start the process after discovering problems, ask questions, analyze problems, and give suggestions. National node ask relevant experts to check and give answers. For some general questions, the national node can be set to be public or non-public. When being public, all node user can see the question and the answer to the problem. The main function in this module listed in Table 4.

Item	Description
Feedback list	List the feedback that have been proposed. Attribute items: proposer, organization, node, start node, data type, user, question title, question content, suggest, answer, etc.; Process status: in progress, completed, terminated, etc.
New feedback	Start a question feedback process.
Edit feedback	Edit data feedback items.

Delete feedback	Delete the question feedback process.
View details	View all feedback information, include basic information, attachment, answer information and the flow chart.
Export	Export feedback list.
Search	Search feedback information by keywords, administrative divisions, organization name, etc.

Table 4. Function items in feedback module

, Figure 4 shows a list of problem feedback.

标题	联系人	联系方式	单位名称	接收单位名称	日期	操作
问题反馈	国家测试用户	18222	国家级单位	国家级单位	2019-10-1...	不公开 <input checked="" type="radio"/> 公开

Figure 4. feedback list

3.2.5 Announcement module

This module is used to issue notices and announcements, started by national node. After issued, users will receive a system prompt when logging in to the system to view the content of the announcement. The main function in this module listed in Table 5.

Item	Description
Announcement list	List the announcements that have been issued. Attribute items: announcement title, content, attachment, etc.;
New announcement	Start an announcement process.
Edit announcement	Edit announcement items.
Delete announcement	Delete the announcement process.
Notify	Notify every node user when login.

Table 5. Function items in announcement module

3.2.6 Statistics module

This module provides three types of statistical functions: data fusion, data update, and data distribution. In terms of data fusion, according to the agreement, statistics are made on the spatial scope of the vectors and place names, municipal nodes of each provincial node, the area of image data, and the types of thematic data. In terms of data update, statistics are updated on the extent, area, and frequency of the updated data within the specified time range of nodes. Data distribution can count the number of data application and distribution of each provincial node within a specified time range, and the number of various types of data and other information. The main function in this module listed in Table 6.

Item	Description
Statistics condition	Include status, date range, data types.
Statistics template	construct three templates: Data fusion, data update and data distribution.
Export	Export statistics result.

Table 6. Function items in announcement module

3.2.7 System management module

This module includes four sub-modules: user management, role management, organization management and system log. User management obtains user information through the platform user system. User information, user name, role, organization, mobile phone number and other information can be edited. This module can list all user information in the system. The main function in this module listed in Table 7.

Item	Description
User list	List the users in the system.

	Attribute items: name, role, mobile, organization, etc.
New user	Get user information from the user system for the platform when the user login this system first time, for example, user name.
Edit user	Edit user information.
Delete user	Delete the user from this system, the user is also exist in the platform user system

Table 7. Function items in user management module

The role management module sets system roles, including super administrators, node administrators (national, provincial, and municipal), node users (national, provincial, and municipal), ordinary users, etc. This module provides functions such as creating, editing, and deleting roles. The main function in this module listed in Table 8.

Item	Description
Role list	List all roles in the system. Attribute items: role name, administrative level, administrator, authority, etc.
New role	New system role.
Edit role	Edit system role.
Delete role	Delete the role.

Table 8. Function items in role management module

The organization management module sets up organization information at various levels based on administrative division, including national, provincial, and municipal. This module can create new organization. When creating a new one, information such as name, administrative region where it is located need to be set up.

The system log records and displays the log information of system operation, includes user, time, IP address, operation module, operation items, operation type, etc. The interface provides filtering functions such as dates and items.

4. KEY TECHNOLOGY

4.1 Construction of update business management system based on workflow engine and data flow driven

Established an update business process management system centered on workflow engine technology and data flow. The system dynamically creates a workflow model with data flow as the core according to the data update business that can be carried out by collaboration between nodes at different levels. It realizes the dynamic development of update business from initiation to completion, and assists the close coordination of nodes, personnel, data, and resources. It solves the problems of unit contacts, numerous personnel, frequent updates and long processes in the update business process, which may lead to unclear update business and slow progress. It realizes the update business process management driven by update data.

4.2 Hierarchical authorization mechanism that takes into account multi-level nodes and multi-users

The users in the system have three basic roles: node ordinary users, node administrators, and system administrators. In addition, the system has established three levels of nodes: national, provincial, and municipal. The national and provincial node are created by default, the national and provincial node administrators can create municipal nodes. The national node administrator can set the node to which the user belongs, and set the node administrator; the provincial node administrator

can set the municipal node administrator. Node users at all levels can only see the corresponding data update related business content within the administrative divisions at the same level. Therefore, the system has established a multi-level node hierarchical authorization mechanism based on administrative area, to ensure that nodes can be connected up and down according to administrative relations, and nodes on the same level does not affect each other. Data update business are only delivered within the scope of necessary users to ensure that data update correspond to personnel and resources.

4.3 Multi-node data linkage update business model creation that meets the requirements of hierarchical management

Nodes at all levels work closely together to complete the data update business. At the same time, the internal business and resources of each node do not interfere with each other, and internal business and resources of each node do not interfere with each other, and the internal resources are efficiently used within the node range, which conforms to the current principle of administrative hierarchical management of nodes at all levels.

The system realizes this loosely coupled cooperative operation mode, and dispatches related resources at all levels of nodes. These resources at all levels are the technical personnel, computer equipment and software systems invested in data update, including the internal operating system of the unit, as well as some public systems of the platform, such as the online update system. Users can update data online, start the update business through the management system, schedule related node resources, complete the check and integration of updated data, generate online service data and publish related services.

5. RESULTS AND DISCUSSIONS

Modern geo-information service pursues higher efficiency of data updating, which inevitably requires the coordination of resources and collaborative operation between nodes, to complete the update task more efficiently. Firstly, the system networked the business of normalized update, and realized the overall arrangement of resources and sharing of update progress between nodes, which effectively guarantees the data update. Secondly, the system allows some data to go online, such as small number of urgently updated place names, etc., to achieve the transformation from online business to online data. Third, the online and offline integrated geo-information service data update business model is constructed, which meets the current geo-information management requirements, data characteristics and operation mode, exerts the capabilities of nodes, promotes the effective sharing of geo-information. So that the updated geo-information can be shared in the society faster and more widely, and realize the mission of geo-information service platform. With the improvement of platform capability, technological advancement and user demand upgrading, the system should be continuously optimized in the future.

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