Design and Implementation of Beijing Fundamental Geospatial Framework Platform

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ABSTRACT:
The construction of fundamental geospatial framework is an important infrastructure project. It provides spatial positioning and plays an indispensable role for city development and informatization construction. This paper discusses about the design and implementation of Beijing Fundamental Geospatial Framework platform. It mainly describes the goal and content of the construction , the technical architecture,the design of fundamental geospatial database , and main functions of the systems, and also introduces to the key relevant technologies in detail. At present, the platform has been put into use, and has provided data service for Units or individuals internal and external. Construction of Beijing fundamental geospatial framework platform is similar to other cities,so techniques and methods in this paper can be used as reference for other cities.

1. INTRODUCTION

1.1 Current Situation

Beijing Institute of Surveying and mapping (Beijing College) is the specific department of producing Beijing city based mapping, responsible for the city administration, enterprises and institutions, and the community by providing all kinds of basic surveying and mapping services. In recent years, Beijing has made considerable developments in basic surveying and special surveying, geographic information service and other aspects, but in contrast to the situation of surveying and mapping and geographic information, it also has some shortcomings: updating speed of basic geographic information data is still slow;data range is small coverage; the ability of geographic information data service is insufficient; the data resources is scattered and lack of integration and depth mining, as well as the lack of providing foreign services.

In order to meet the demand of smart City, geographic condition monitoring, and emergency service, since 2008, relying on the Tsinghua EPS platform, Beijing Institute launched integration of the inside and outside process innovation, include a large-scale topographic map in city (1:500, 1:2000,1:10000), planning (planning road alignment and Building land stake) , which shorten the production cycles. Afterward, to establish a set of standardized management, sustainable development of basic spatial information platform and spatial information service technology, integration of the basic and rich geographic information resources in our college, going through the basic spatial data ‘channels for getting and updating, providing data service internally, serving for the government, enterprises, public, become the major objective of the construction of "Beijing Basic Geographic Framework Platform" [1].

1.2 The Project’s Construction Purpose

In order to meet the requirements of the smart city , GIS situation monitoring , emergency services and other city -based geographic information security framework platform since 2008 , relying on Tsinghua 3D EPS platform , Beijing city hospital launched a large-scale topographic maps (1:500,1 : 2000,1:10000) , planning measure (planning and building land road alignment pegs) and other major businesses " within and outside the industry integration" process transformation , shortening the production cycle data from the production process . Therefore, the establishment of a standardized management, sustainable development on the basis of geo-spatial information and spatial information services platform technical support system , integrating a wealth of hospital -based geographic information resources , and clear channels of access and update spatial data base , internal service data production Foreign service in government, business , the public, has become the construction of " Beijing -based geographic framework platform," the main purpose.

The Project’s Construction Content

The project’s goal is using the latest cloud computing, service GIS, database management, theory and technology of spatial data center, combined with the internal and external integration technology, meet requirements of smart City, Emergency support, geographic condition monitoring .Construction content includes two major infrastructure, four supporting systems:

(1) Two infrastructures:the hardware and software infrastructure and data infrastructure.

The software and hardware infrastructure refers to build a Cloud Architecture which is high available, high security, high scalability, easy maintenance, and saving physical resources. Data infrastructure includes the unified data resources planning, data resources directory construction, such as built the data resource directory, meta database, ensuring the data timely and effective to be provided for foreign and publishing service.

(2) Four support system: data resources integrated and display system, data resource distribution service system, data resource integration management system, data distribution service portal, respectively, to provide users with comprehensive, multidimensional and direct display, and data distribution service with work flow and strict distribution model ; intelligent efficient data storage, editing, updates, backup, recovery and history data management; and the public data service.

2. PLATFORM DESIGN

2.1 Architecture Design

Based on Standard specification, infrastructure construction, security protection construction, and the four support systems, the platform becomes the data storage center, processing center and service center, which can enhance the service ability and quality. Refer to fig.2-1 for the platform’s overall design.

The whole platform based on strictly standards , including database construction standard, data update specifications, product service specifications. The Platform’s network layer includes internal LAN and the public Internet. The basic platform layer using advanced construction of cloud infrastructures, which can allocate hardware resources dynamicly. The data layer includes spatial data,personal database and metadata database, and system support data etc. which can provide data services,including two-di

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mensional map service, three-dimensional map service,geoproce ssing services etc. The platform designs four subsystems, respec tively, are responsible for data display for geographic informati on resources , distribution services, data management and exter nal publicity (portal). System relies on the GIS service, all funct ions are released by REST or SOAP service, which can be devel oped secondly. All this functions can be used by the client layer includes basic surveying users, special surveying users, GIS pr oduction users etc.

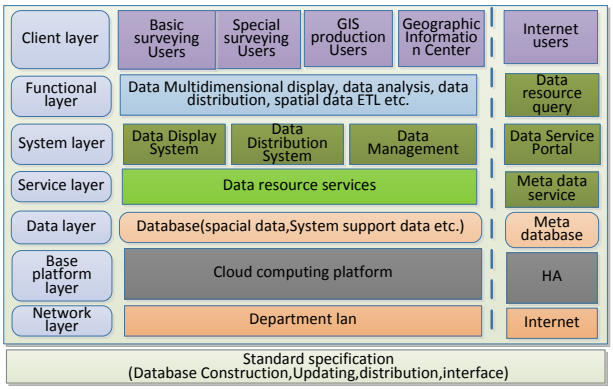

Figure 2-1. Platform's overall design

2.2 Private Cloud Architecture

The server system is the key part of the IT platform. By full eval uation to the risk of the hardware failure and software fault, th e virtual platform VmwarevSphere5.1 was adopted. applicatio n system use the resource pool which includes 4 physical server s, 128 core CPU calculation, 1024GB memory, 40TBvirtual sto rage. Disaster recovery in private cloud resource pool includes 1 physical servers (32 nuclear, 256G), 20TB virtual storage. In or der to reduce the pressure of I/O, there are one FTP server, two database servers(with DataGuard), and one historical database s erver.

3. DATABASE DESIGN

The basic geographic framework data of Beijing Institute is com plex and huge, including control surveying data, city large scale of 4D products (DLG, DRG, DOM, DEM), the address data, th ree-dimensional model data, special surveying data (road planni ng, underground pipelines etc.) ,thematic data, emergency data .

3.1 Data Analysis

The geographic data has the following characteristics: ① multiscale FeaturesFeaturesFeatures characteristics: Beijing urban basic geographic information data covers 1:500, 1:2000, 1:10000; ② multitense characteristics: Beijing urban basic geographic information has the status information, also has the historical information; ③ the heterogeneous characteristics: Beijing basic geographic information data has variety of formats. ④Application of the data sharing: 4D data, control surveying data, the address data, road planning, underground pipeline is frequently used in the daily work, and have high requirement for data updating.

3.2 Logical Database Design

Database ware designed according the classification of the resou rce directory database to design. Each part of the data and then s eparated by the data subject, scale, data version, layering, and d esign different table space. Such as the basic geographic data w are divided into control surveying data, DLG, DRG, DOM, DE M, the address data. DLG (GIS format) data is divided into 1:50 0, 1:2000, 1:500 is divided again for 2001, 2003 and other versi ons, each version will include residential, transportation, water, vegetation and other factors.

3.3 Database Physical Design

As the fundamental geographic framework data has multi-sourc e, multi-scale, multi tense, large quantity characteristics, large re lational database system Oracle11g and non relational database mongoDB ware selected:

1) ArcSDE and Oracle database integration. This approach is su itable for data query, edit, update, more concurrency and freque nt data, such as the control surveying data, DLG (GIS format), t he address data, emergency data etc.. All kinds of data accordin g to the theme, scale, version design table space, different type o f table space, and the data is stored in physical space associated with the table data in the file. This logic is clear, easy to manage.

2) Oracle document cataloging library. The file with relational d atabase management mode. Which ware more suitable for frequ ent file data needed to divert, such as the standard framing 4D p roducts (DOM, DEM, DRG, DLG); thematic document data, sp ecial surveying data etc.

3) personal database (MongoDB). MongoDB is a high performa nce, open source, unstructured, distributed file storage, which c an support very loose data, data content is suitable for structural change, particularly suitable for storing personal online upload data, such as all kinds of statistics, spatial data in ShapeFile for mat, DXF format, commonly used in engineering measurement.

3.4 Database updates and maintenance

After the fundamental geographic database framework is built, t he need for dynamic maintenance and updating, in order to mai ntain the vitality of database[2]. Process of the platform construc tion, also supporting the establishment of basic data, data updati ng rules of operation specification and manual, the establishmen t of professional department maintenance and management, ens ure the data maintenance and updating.

4. PLATFORM DESIGN

4.1 Data Resource Integrated Display System

Display system is the external display window of all the data resources, provide flexible data display, data search, statistical analysis, data mining and service: (1) data display module provides a two-dimensional map, spatial data infrastructure, street map, a three-dimensional map of the two or three dimensional linkage, 2/4 screen, the historical timeline and other forms of display. (2) data search provides full search function on the basis of geo spatial data framework, according to data type, data update, data production department, responsible person query, can also support the geographical location query. (3) statistics provide statistical functions of various data resources analysis. (4) data mining provides mining for various data resource analysis display window. (5) products and services is the display window for our service ability, including undertaken software services, emergency services, data products, mapping service.

4.2 Data Resource Distribution System

Distribution system is the distribution window for all kinds of data resources,major modules: (1) my work area: survey scheme design, check results, achievement sharing, which can provide a shared channel between users. For example, a surveying staff can take the final results (can be DXF, Excel, SHP and other formats) onto the platform,check whether it's right. (2) data distribution: provide online data by workflow, online approval,

online downloading function based on distributed data resources, abundant (Fig. 4-1), including the control survey, topographic map, road planning, land, image etc.. which support the topographic map according to the scope and elements extraction distribution, image data support framing, splicing or by cutting the distribution range. (3) the humanized service tracking: the system will record the distribution of data, when the data changes, timely remind to notify the user.

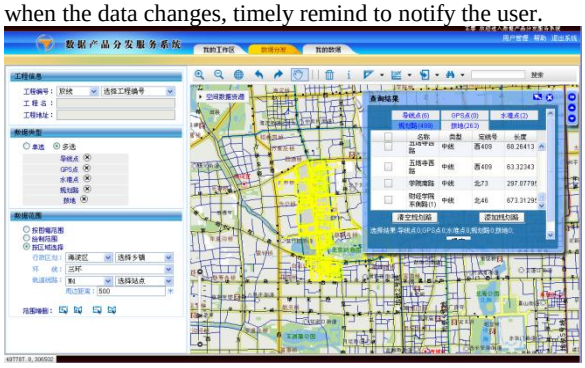

Figure 4-1. Data resource distribution system

4.3 Data Resource Integrated Management System

Data resources integrated management system is the core part of the basic framework for geospatial platform, providing resources directory management and maintenance, data storage and updating, data output, data services, monitoring and other functions. System main features:

① Resource Directory Management: Resource Directory provides data maintenance, including resource directory node and data collection, data entity metadata to add, delete, edit functions. ② data warehousing and updates: to provide users with various forms of data import functions, such as control of the measurement data, topographic data, video data. Project also includes the engineering survey, the results of data GIS projects. ③ Data output: provide background processing large amounts of data or complex data requests for data distribution systems. Distribution services such as video cropping system request, extracting large quantities requested topographic maps, topographic maps integrated output, etc. are done by the module. ④ Data Services monitoring: data services running queries and monitoring.

4.4 Data Distribution Service Portal

System is based Products and Platform B / S structure of the purchase, providing products and catalog search, browse product information, product ordering and other services deployed on the Internet. System main features:

①Resource Directory: The directory publishing hospital data resources to the Internet, provide resources directory search function, allowing users to quickly get a list of the required data. ② Data buy: through the "data buy" module, the user can be like like Jingdong Mall, Amazon, Eslite, etc., order online, then staff in data distribution system, the first ready these data, in the future there may be increase data distribution service.

5. KEY TECHNOLOGIES

①Multi- source heterogeneous based on ArcSDE, space-time database management technology . ArcSDE is a channel between ArcGIS and GIS relational database that supports all of the GIS data model (vector, raster , surveying , topography, and other metadata) , support for multi-user editing , historical data management. ② two dimensional map service based on REST - style publishing technology . Two-dimensional map services , spatial data services , spatial analysis services , geoprocessing services through ArcGIS Server to publish . Three-dimensional map service using CityMaker Server to publish . ③ SOA-based enterprise mashups (Mashup) technology. Through the data layer, service layer , or service of the presentation layer , application functionality or data aggregation from multiple sources to create new services. Aggregation of data resources integrated three-dimensional map display system services , but also multi-dimensional aggregates of housing construction site statistics service . ④ non-relational database management technology . MongoDB is a NoSQL non -relational databases , supporting data structure is very loose , you can store more complex data types , mainly to solve the problem of massive data access efficiency , especially for personal maps online communication , sharing and analysis.

6. CONCLUSION

Based on the comprehensive various types of data resources and planning , combined with the current mainstream spatial database management , map publishing technology , Web services technology, this paper puts forward a package of solutions to the Beijing -based services architecture of geographic data center. Which can support our transformation from the traditional production-oriented to service-oriented initiative , data mapping results our college management more scientificly and more systematicly. Currently the system has been put into trial operation stage, and provides for the efficient and successful smart Zhongguancun , geographical conditions monitoring, college information management decision support platform for other projects, it has provided timely and convenient data services.Continuously updated and regular operation of the database is a fundamental scientific databases exist [3]. How to improve the database update mode , establish regular operation for data updating gradually, such as establish the relationship between the basic map and special surveying , GIS projects. How to optimize all types of data while historical data management issues , how to dig the accumulation of years of hospital data resources, and scientific decision support is the focus of further research .

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