RESEARCH ON GIS CONSTRUCTION AND APPLICATION TECNOLOGY BASED ON CNGI

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Abstract

In this paper, in view of the technical features of CNGI and IPv6, we introduce the construction and transplant of China's first CNGI-based GIS, and carry out new geographic information application technology research as well as build demonstration application of government GIS based on “GeoWindows”, which is a GIS software platform for E-Government application, and establish a series of technical foundation for the development and application building of GIS technology in Next-generation network environment.

Keyword: CNGI(Chinese next generation Internet); GIS(geography information system); IPv6; Application demonstration

With the rapid growth of users and informazation development, which require higher and better performance computer networks than ever. There are serious shortages in the field of address, bandwidth, transmission speed, security, etc, in the existing network based on IPv4. Since 1995, some countries have started research and development of next generation internet protocol (IPV6), and have begun to build next-generation internet. IPV6-based applications are emerging and have been used in some degree. In 2003, China has implement next-generation internet research, and launched the China Next Generation Internet (CNGI) construction project. Now, China has built the nation network environment, which is linking major cities of China. CNGI technology origins from high-performance computing and communication protocol, it can mainly solve IP addresses shortage and low network data transfer rate problems, and it has some advantages, such as built-in security protocol, high mobility, high quality of service, and plug-and-play, etc.

The emergence of new generation network technology has supported environment to enhance the efficiency of geographic information services, expand GIS applications. In 2006, Chinese Academy of Surveying and Mapping started to make GIS application

technology research and demonstration system building based on multi-year government GIS construction. More than two years later, the work has achieved remarkable results.

1 Current problem of Network GIS and solving methods

At present, information technology has been developing steadily in China's departments at different levels. Most of departments have established GIS and accumulated a great deal of geographic information resources. GIS has become the technical means which can help the majority of managers and professionals in the different departments carry out work. In particular, in recent years, the developments of technology and application of WEB GIS are extremely rapid, which can effectively promote the sharing of geographic information resources and social services and have made tremendous social and economic benefits.

However, the current network environment is based on the IPv4. Because of IPv4 defect, GIS applications have to deal with technology problems as follows:

i)Geospatial information required by government management often comes from many departments and needs for real-time collaborative applications. Because IPv4 is short of address, we usually use the method of network address conversion, which maybe undermine Peer-to-Peer model of IP. Therefore, this has made synchronization difficult between multiple devices, which can result in the problem of difficult information coordination processing.
ii)IPv4 only has lower security options. Security issues in the low-level of network protocol stack are not supported, security responsibility of the application operate through their own mechanisms, which are resulting in lower security, more and more threats are under application. Online security hole is not resolved which restricts the wider use of spatial data.
iii)In the case of IPv4, IP addresses configuration is complex and computer and network connection is static, IP address have rarely changes. With the growth in demand of government departments, mobile computing requirements increase more and more than ever, such as office On site, field monitoring, emergency command etc need GIS supporting.
iv)Contradictions between lower data transmission in existing network and bigger amount of geography space information data are outstanding.

CNGI has adopted IPv6 protocol with the typical characteristic of the next generation internet, it can effectively solve the technology problems of restriction on the GIS application and has provided feasibility for upgrading GIS application. CNGI is the next-generation Internet with China’s property rights. It is greater, faster, more secure

credible, more convenient, easy management than Internet IPv4.
CNGI can execute large-capacity, high reliability data transmission between nodes. This reflects high-performance P2P transfer of internet technology features, and offers possibility for major GIS applications with characteristics of large-scale, multi-site distributed collaborative computing and data mining. High-speed, wireless / mobile access networks will make various information terminal equipment flexibly to access network, real-time to conduct mobile geographic information. In view of large address space characteristics of IPv6, sensing devices can be accessed using IPv6 addresses, real-time collect atmospheric, hydrological, ecological environment and disaster monitoring data. More large-scale three-dimension virtual scenes sharing based on high bandwidth and high performance can be easily achieved.

Aforementioned CNGI technical characteristics can effectively solve technical difficulties of the restrictions on the Government application of GIS, and provide possibility for the next generation GIS applications upgrading. Chinese Academy of Surveying and Mapping(CASM) has been engaged for long time in government geographic information service technology research and application development work, and has good R & D capability of new technologies. In the next-generation Internet demonstration project, it is organized and implemented by China's National Development and Reform Commission CASM uniting State Department of E-government office and Beijing University of Posts and Telecommunications, and carried out the government GIS application research based on CNGI, and built a solid technical reserves for the next generation of GIS applications.

2 Experiment environment construction and system transfer test

According to technology requisition of CNGI, we have built up CNGI user network environment, and have developed existing GIS software for supporting IPv6 protocol, and have implemented translation of database and application system, and have carried out integration of CNGI technology and geography information technology.

2.1 CNGI user local network construction

In order to carry out technical experiment based on CNGI, first of all, we have constructed CNGI user local network. In network connectivity, we determine CASM to be the Internet access point for the next generation, and have built in computer rooms in line with requirements of CNGI, and have equipped with a corresponding access hardware devices, and have laid dedicated fiber-optic lines which accesses to the China CNGI core network with connecting bandwidth at 1 Gbps. User local network routers support dual-protocol stack. There are two separated lines which can access the backbone of the existing IPv4 network and the CNGI (IPv6) backbone. Users can

directly use IPv4 networks or can directly use IPv6 networks.
According to geographic information application needs in the future and scale of network users, Numbers of IPV6 address obtained by CASM is 2^80.

2.2 GIS function reformation for supporting IPv6 protocol

"Geo-windows" is government-oriented GIS software platform developed by CASM. The platform takes foundational spatial database as its framework, combines departmental spatial information, statistical information of the national economy, statistic information of national economic, government affair documents and multimedia information. The system has integrated geographic information system with decision support system (DSS) technique and supplied uniform spatial assistant decision making platform for government management. The software platform supports information management in multi-themes, multi-levels, standardization, individuation and distribution.

The focus of "Geo-window" system transplanted to CNGI is the configuration and function perfect in the service-side. As the system development has used Java, . Net and other high-level language, most of functions have nothing to do with IP address in general. Only data access, query, analysis and other functions module, which deals with transplantation, need to change.

In running environment, parameters related CNGI/IPV6 include database, IE version,. Net Framework version, the site address and other factors, we need for corresponding changes in. The configuration and content is shown in the table below:

Altered content	IPV4	IPV6
database	SQL Server2000	SQL Server2000/2005
IE version	More than V6.0	More than V7.0
Net Framework version	V1.1	V2.0
site address	IPV4	IPV4 IPV6

Due to the upgrade of the database management system database transplantation include:

- Multi-scale spatial database transplantation. it includes vector data, raster data, remote sensing image data and metadata.
- Multi-types non-spatial data transplantation. It includes relational data, documents data, multimedia data and metadata.
- System-level data transplantation. It includes system configuration and related documents, the relationship data and so on.

After system transfer we have aimed at system original function, tested for maintenance tool and service system in control efficiency of space data, system stability, system

compatibility etc. Test items mainly include: operation responds time, biggest data quantity, biggest data transmission quantity, different operate system, system safety stability, etc based on the CNGI environment.

CNGI-based geographic information system test results show that:
i)In CNGI/IPv6 environment, the network performance has a comparative advantage than in IPv4 environment, speed, bandwidth, security and service quality have been substantially improved and system performance has significantly improved and optimized.
ii) In the same core node of CNGI, the system operation is more efficient, and response speed of various operations is less than 4 seconds. System performance, such as operating speed, load, can be markedly improved.
iii) In the environment across the core node CNGI system efficiency significantly has reduced, and graphics operation response speed is more than 20-30 seconds, due to multiple routers led to operation delay.
iv)Compared with CNGI/IPV6 network and IPV4 network environment, CNGI/IPV6 network sometimes is less-than IPV4 network, may be due to the quality of new equipment.

3 GIS application technology research based on CNGI

According to the advantages and technical characteristics of new generation networks CNGI, this paper focuses on application function researches in some fields, such as geographic information coordination services, distributed storage for mass data, information security management and mobile information computing, and solves the technical problems changing from centralized GIS application service to distributed services and explores the new application technologies of next generation WebGIS.

3.1 The collaboration technology research of Geographic information services functions

Study multi-user collaboration technology of GIS based on IPV6 network environment, which is shown in figure 3.1, and realize multi-user shared GIS environment under IPV6 network environment, multi-user real-time position sensing and multi-user real-time information transmission(in support of various transmission means, such as point-to-point, points to groups), as well as design and develop server core collaboration components, spatial data access components and three-dimensional terrain collaborative software prototype system.

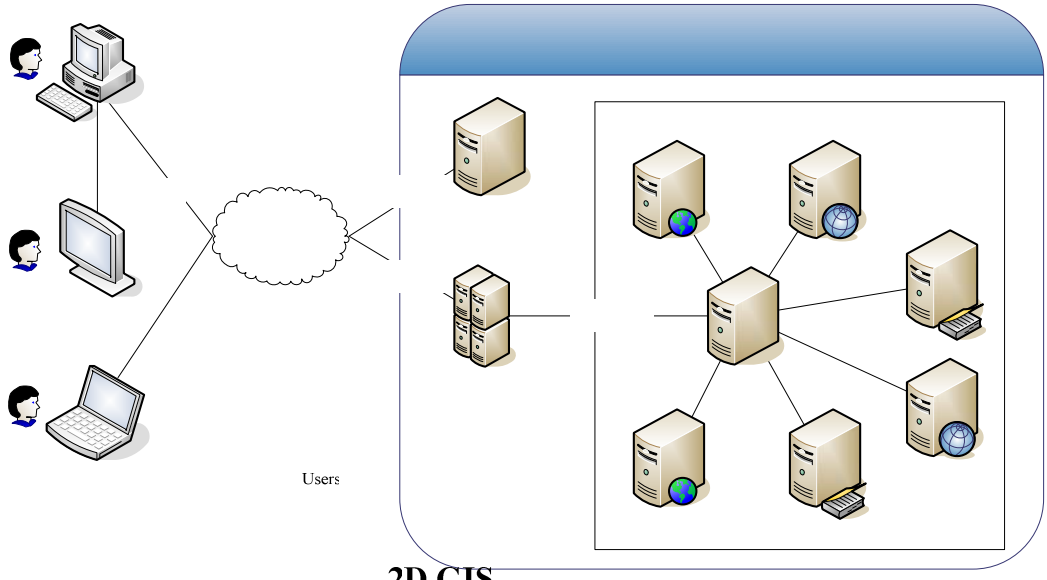

Fig 3.1 The System Structure of GIS Co-Work Service

The system allows a number of users online at the same time. Users can browse three-dimensional terrain and query names under the three-dimensional visualization environment based on Web. The system realize some collaborative services functions in real time, such as share mark, share 3D model and send short text messages among multi-users.

3.2 Research of massive spatial data distributed management technology

Research on distributed spatial database model and technology, each data server consists of active object after packaged, application and operating environment and JVM. The application server has the same environment with the data server in addition, but also contains a series of application service such as Web, business and spatial analysis, which in order to provide services to the client. The communications between application server and data server as well as the communications among data servers can be finished by initiative object which has been packaged. Adopt dynamic deployment function, application server call protocol remotely to start remote distributed database server and achieve the deployment of active objects. On this basis, the paper establish high-effective management technology of distributed spatial information, the paper proposes spatial data management methods based on database and entity, achieve object distributed functional components function of the server and the client based on long-distance call.

3.3 Management method of secret spatial data based on IPV6

Analyze and compare with several types of IPv6 remote security access technology, the paper studies safe passage to stop launching attacks through the network according to the network information applications characteristics of secret geospatial information under

the new environment, and provide a secure transmission method for geographic information data.

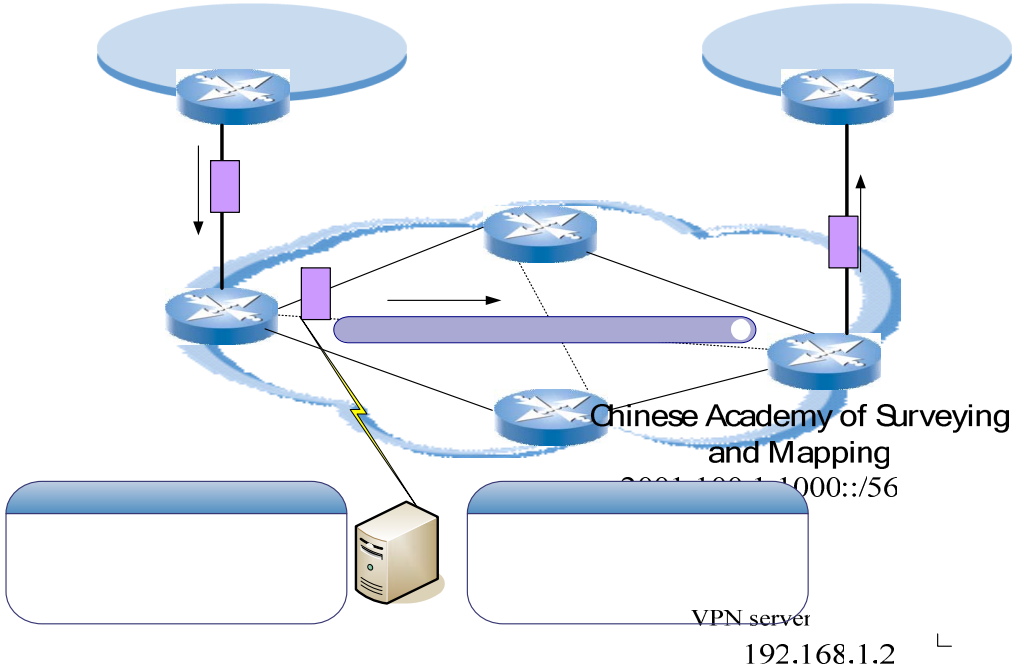

Fig 3.2 The application example of IPv6 VPN in GIS

Figure 3.2 shows secure transmission method adopting IPv6 VPN (Virtual Private Network) technology. The method is based on network layer security protocol (IP Security, hereinafter referred to as PSec) to achieve the protection of GIS data. PSec provides a security framework for an open system, and provides interoperable, high-quality, password-based security for IPv6. Its services include security, authentication, integrity control and protection against re-issued. It can make sure the safety of IP data effectively. Before and after the deployment of IPv6 VPN, the distinction between hackers and malicious nodes to obtain geographical information is: before starting the VPN, hackers can easily access GIS data files, but after the VPN is enabled, the data is encrypted, although hackers can get the file, they cannot access its information content.

3.4 Mobile computing technology of Geographic Information based on mobile access features

Based on several equipment and technology, such as Global Positioning System (GPS), wireless LAN, Bluetooth or serial port, this paper studies spatial positioning method of mobile terminal, sends information related to location to wireless base stations through wireless network GSM or CDMA network, then transmits it to the monitoring center server effectively through IPv6. The monitoring center server can obtain the location information of mobile terminal at any time and publish real-time location of

mobile terminal on geographic information system platform.

Study integrated technology of new type of video camera terminal with IPv6 address. This video network monitoring terminal has embedded CPU, A/D converter, dedicated DSP chip, embedded operating system with IPv6 dual protocol, network cameras with highly integrated network interface. It can transmit video and audio information via the Internet. Because network camera has one and only IPv6 addresses, so the remote users can access to the network camera through PC, PDA or mobile telephone at anytime and anywhere.

3.5 Data files distribution test based on multicast and P2P technology

Construct a controllable documents distribution test system supporting IPv6, multicast and P2P technology, distribute spatial data files and program files through this test system CNGI.

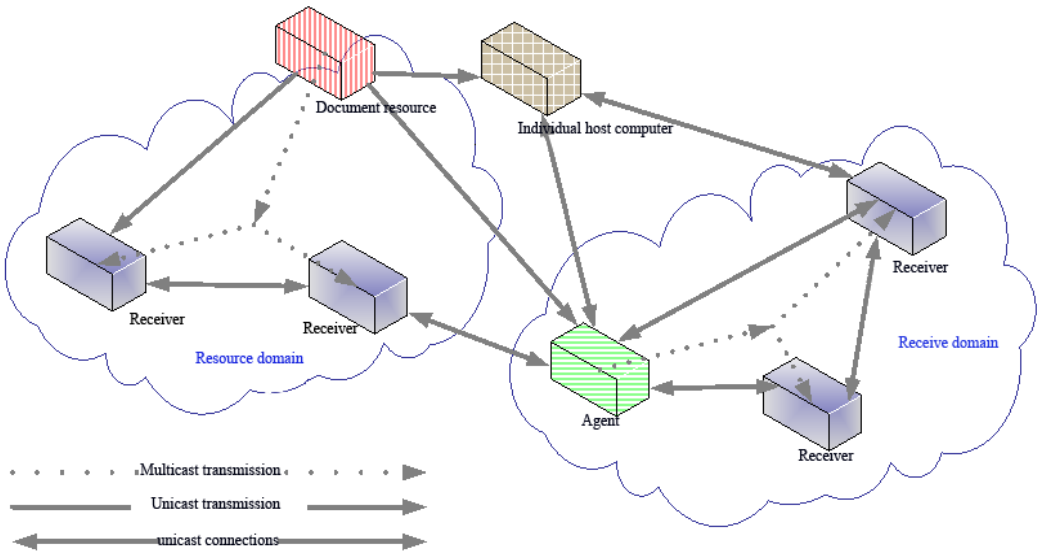

Fig 3.3 the data transmission model based on multicast technology

Figure 3.3 shows the data transfer model: the cloud in the figure denotes a multicast domain, in addition to the source domain where the document source is, other receive domain has agent, the function of the agent in the receive domain is equivalent to the function of the document source; In addition, to the multicast transmission between nodes, there are also a large number of unicast connections and unicast transmission, any node which can be directly unicast communication is a typical application of P2P.

4 Main results and research directions in the future

Through the implementation of this project, a larger progress in the GIS application and

technological research for CNGI have been gained. Use for reference advanced international network technologies in the course of the study, pay attention to technological innovation, and core technology is own developed. Acquire the features of information security timely, understand the IPV6 data management models and techniques methods which may be used, provide necessary technology maintenance for the management and maintenance of classified geospatial data, which is propitious to consider security measures for geographical information under the next generation network environment ahead of time. The research results of distributed spatial database provide technical support for sharing spatial data.

However, these results and progress cannot meet the needs of practical application. In order to promote the popularization and application of CNGI, some work must be focused on:

i) Application of long-range spatial information exchange and information integration. Carry out spatial data exchange and application integration demonstration in various business units which have linked in the CNGI network and have business association

ii) On the permission of data security, promote applications demonstration of scientific data to provide service for scientific applications computing of geospatial data.

iii) Research managed services technology of geospatial information. High-capacity bandwidth characteristics based on CNGI can "open" the function and data of geographic information application program using standard methods to provide for other application systems.

iv) Critical technology research of super geo-spatial data center. Based on basal geography database of State Bureau of Surveying and Mapping, study mass data integration storage and fast association technology based on maps, text and sound, which provide foundation for integration services of large-capacity integrated information.

The application research of GIS based on CNGI is only a beginning. It needs to be more widely promoted, solve various technical problems in order to provide technology platform timely. So, GIS related to the national economy and people's basic work gains great progress depending on network technology in the future application.

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Liang Wang, professor, deputy director of Research Centre of Government GIS.
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