SPATIAL DATA MANAGEMENT BASED ON STANDARDS AND OPEN SOURCE SOFTWARE PRODUCTS

Vladimir Komosko[a], **Sergey Serebryakov**[b]
[a] Ural State University (National Research University) in Snezhinsk, Department of Humanities, Social and Economic Sciences, Russian Federation, vkomosko@yandex.ru
[b] "Technology 2000", LLC, Russian Federation, SerebryakovSV@mail.ru

ISPRS WG IV/2

KEYWORDS: spatial data infrastructure, object model of spatial data, geoportal, Editor for Geospatial Data Catalogue (information management system), Standard ISO 19110, WMS and WFS standards.

Abstract: In order to create a geospatial data infrastructure (GDI), it is necessary to solve complex organizational, legal and technological issues. Currently, there is a number of multi-purpose commercial GIS, the most common of which are ArcGIS (www.arcgis.com), MapInfo (www.mapinfo.ru), GIS Panorama, etc. These GIS can store, manage, publish maps and map layers of indefinite scale and complexity. They have powerful functionality; through their use one can solve almost any application tasks. However, the high cost of the GIS and the high level of qualifications required in the projects push many users to consider other options.

We offer the efficient technology for GDI management by building an integrated domain object model in the form of appropriate classifiers and by developing spatial data storage and geo-portal on their basis.

GDI in Russia has been created over almost ten years. [1] There are numerous external and internal reasons due to which the goal of building a global geospatial data infrastructure has not been reached on a nationwide scale up to the present moment. There are some infrastructures covering a particular industry or area, but They are usually autonomous and isolated.

According to the conclusions of the UN Committee of Experts on Global Geospatial Information Management [2]:

1. The growing number of sensors in everyday devices which collect and provide geospatial information will increase and alter the dynamics of data collection. This will also increase the role of geospatial data, both active and passive, creation and collection by citizens.

2. Free and open access to data will become a standard and geospatial information will increasingly be seen as an essential public good.

3. Monopolies held by National Mapping Agencies in some areas of specialized geospatial data will be eroded completely.

4. Progress will be made on bridging the gap between official and crowdsourced data, moving towards true collaboration.

Thus, there is a need to create some tools for geospatial data preparation which would possess sufficient functionality, but it would have affordable price and reasonable quality for the general public.

Currently, there is a number of multi-purpose commercial GIS, the most common of which are ArcGIS (www.arcgis.com), MapInfo (www.mapinfo.ru), GIS Panorama, INGEO, etc. These GIS can store, process, publish maps and map layers of arbitrary extents and complexity. They have powerful functionality; by using them one can solve almost any application tasks. However, the high cost of the GIS and the high level of qualifications required by the projects make many users to explore other options.

In this article, we propose a Web-GIS solution that is an original product of Technology 2000 LLC. Considering the features of the new approach from the viewpoint of service recipient (organizations, agencies or individuals), the following competitive advantages of Web-GIS solutions can be named:

- It provides an easy and flexible tool that allows you to create a collection of object models in different subject areas (e.g. energy companies), to cost-effectively and efficiently build an integrated spatial data infrastructure;

- Deliberate restriction of the functionality and drastic simplification of the working methods in the system results in a significant increase in the number of potential active users;

- Reducing costs of acquisition and ownership of the system through the use of open source software products results in significant economic benefits for system users;

- As it complies with common standards set for exchange of geographic information in networks, the situation of sticking to once selected provider of software solutions and their specific encoding formats/storage of geographic information is avoided;

- By providing their own geospatial data to general public for a fee, get the opportunity of a right of joint use with other users to access other geospatial data resources;

- Along with applications (analytical, calculated, report wizards, etc.), it is not limited in scope of application and can be used in local government bodies, ministries, economic entities and by individuals.

GDI information model

At the designing stage of the GDI information model, it is important to determine the composition of the databases, the sources of their formation, the use of information resources contained in these databases. Besides, it is important to sustain compliance with certain design criteria.

The first of them is to select the data presentation model. Standard data models are basically two-dimensional. They are based on well-known principle of essence - relationship and allow building relational tables of any complexity. However, experience shows that the concept of essence is not rich enough in its capabilities and does not provide a logical transition from one and the same essence in the different states.

In order to create GDI information model, one needs use more complex data models, including not only two, but three data element representation: object, property, and attribute. The use of this model for data processing resolves difficulties in concepts of logical transition from one category to another, thus enables to reflect and set multiple links between different concepts (objects, properties, and attributes) and ultimately, provides the depth and quality of the analytical work, reducing the effort applied in information systems.

The analysis shows that the GDI information model can be completely described by international standard ISO 19110 (Geographic information - Methodology for feature cataloguing [3]). According to ISO 19110, any spatial data catalogue is described with the help of the following pieces of information: the type of the object with its properties, the association between types and restrictions that can be imposed on all the information. In this case, the correspondence between the conceptual information model and ISO 19110 can be set as follows: object - feature (object type), listed value - property, the attribute – listed value (domain).

Technology for GDI creation

The distinctive features of the proposed technology are:

- No need to program for creating spatial data layers. Through use of Editor for Geospatial Data Catalogues (information management system) create an object-oriented model of a particular domain, and then automatically generate an integrated software & information environment that is configured to this object-oriented model.

- Based on the open source software products.

The architecture of Web-GIS technology is presented in Figure 3. The main components of this architecture are:

• Editor for Geospatial Data Catalogues (information management system) (original design of Technology 2000 LLC) to create an object-oriented models of particular service domains and integrating them into a single model;

• Storage of spatial objects for collecting, storing and processing geospatial data, based on DBMS (Oracle 11g Spatial, PosatgreSQL / PostGIS, etc.) which incorporates components for processing spatial data;

• Joint geoportal implemented with the help of Liferay geoportal constructor;

• Geoserver implementing WMS and WFS services according to OGC standards [5];

• Web-server like Tomcat, to link the Web-services with DBMS.

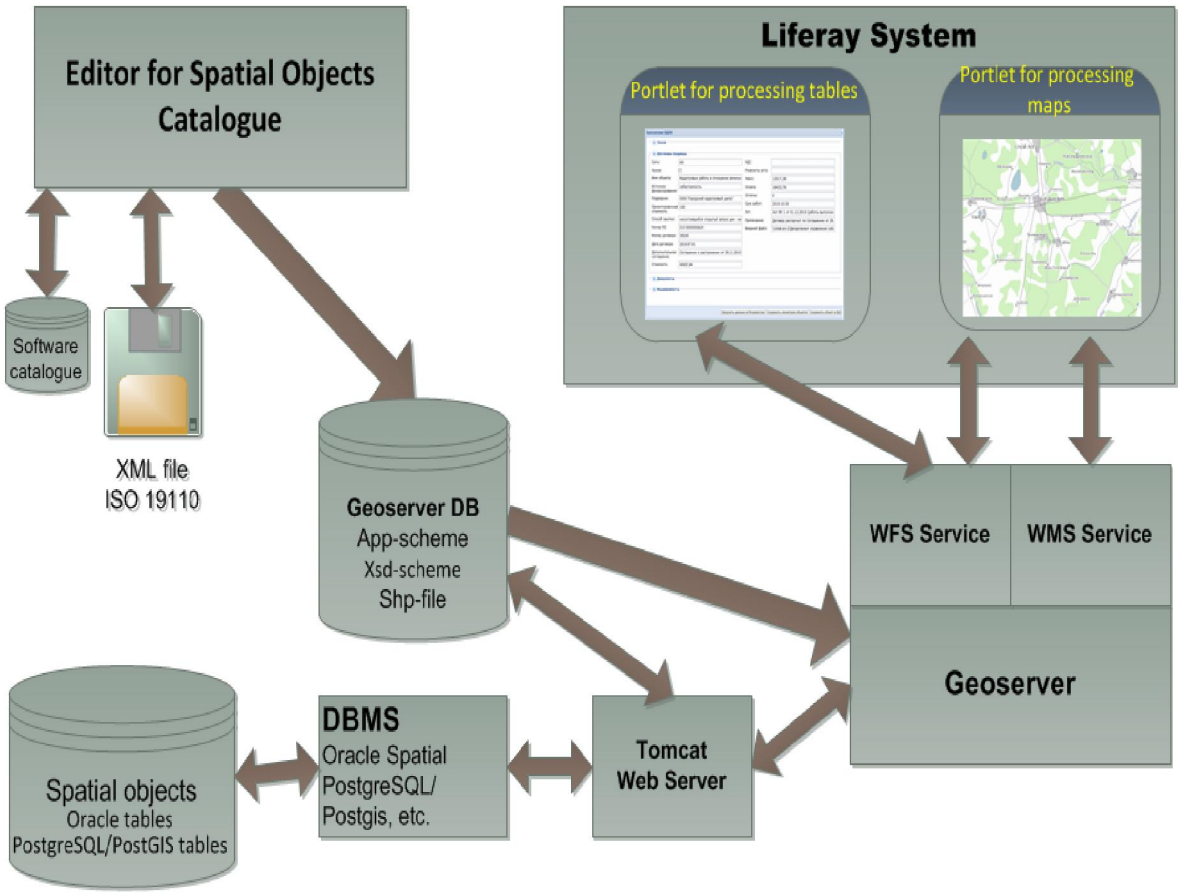

Figure 1 Web-GIS technology for creating GDI.

GDI creation for a particular service using this technology consists of the following steps (Figure 1):

1. With the help of Editor for Geospatial Data Catalogues (information management system), create a feature catalogue of the data domain.

2. Editor for Geospatial Data Catalogues (information management system) generates APP-scheme.

3. APP-scheme is connected to Geoserver.

4. Editor for Geospatial Data Catalogues (information management system) generates structure description of service spatial data. The structure is loaded into the storage of spatial data.

5. Geoserver is connected to the storage of spatial data containing different sources of spatial objects (shp-files, DBMS Oracle, PostgreSQL / PostGIS, etc.). The source can be either empty or contain some pre-loaded with information.

6. Liferay registers project and users. Access privileges are set i.e. the proper administration is ensured.

7. In Liferay, the portlets are connected: for processing objects in tabular form and in the form of maps, as well as a portlet for spatial object storage. In the portlet processing objects as tables, Geoserver interacts with objects via APP-scheme based on the WFS service. The map portlet visualizes maps with the help of Geoserver based on WMS service. In order to work with object attributes, one can use the same forms as ones in the table processing portlet based on WFS - service.

8. User starts filling his partition of spatial data storage using portlets common for all services.

High speed and quality of the GDI can be achieved thanks to simple interface (context-dependent graphical editor of spatial objects), and by providing the full functionality needed for processing spatial data. Spatial objects are applied by the users to the cartographic basis, using a specialized editor.

Editor for Geospatial Data Catalogues (information management system) is based on the international standards ISO 19110. This standard defines how to classify the types of objects, their attributes, relationships between objects (hierarchical and associative), their operations and restrictions imposed.

Editor for Geospatial Data Catalogues (information management system) plays an integral role for the Web-GIS technology (Figure2), as it is used to prepare an app-scheme, which is later on used in other services for generating database schemes for a specific DBMS or spatial data files. It can also play an integral role in the interaction between various GIS (Figure 4). For example, it can be used to transfer a catalogue from KB Panorama GIS into MapInfo. The process is as follows. First, the KB

Panorama GIS catalogue file in rsc-format is imported into the internal database framework by using Software Catalogue Editor, and then exported into a Mif/Mid (MapInfo) file. The process is fully automatic, without any manual data correction.

Software Catalogue Editor supports the distributed data processing technology:

- Local level of offline databases;
- A central master data database directly related to the catalogue section of Spatial Object Storage.

Local level consists of a set of offline databases, each of which contains one or more catalogues of spatial objects being stored in the local database, i.e. DBMS Access. These databases may operate in geographically remote locations. Catalogues can be shared in data bases with the help of XML-format file, whose scheme is based on ISO 19110 standard. The local version of Software Catalogue Editor has absolutely the same functionality and interface as a version based on a central database.

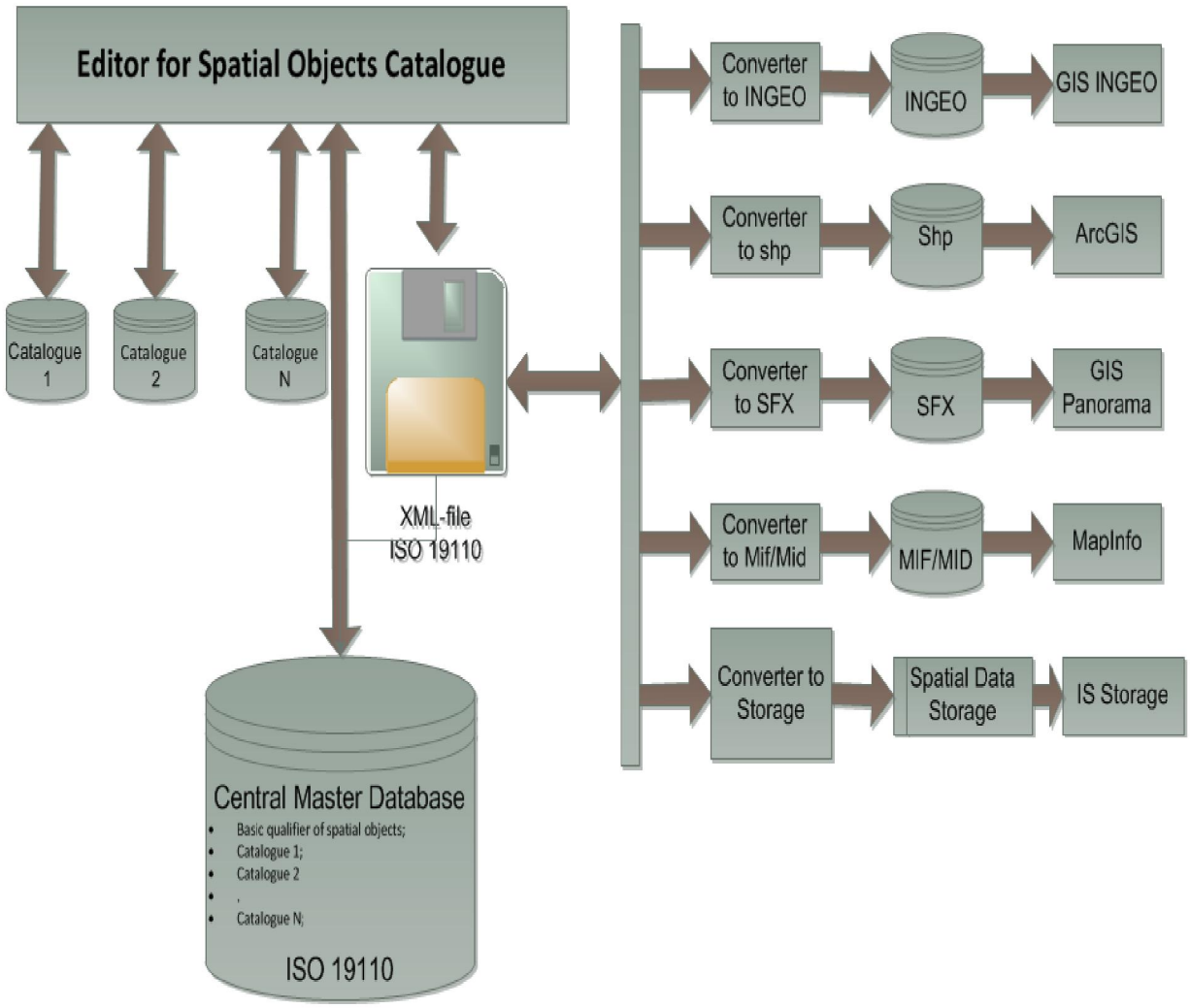

Figure 2. Scheme showing automated preparation of catalogues and qualifiers

The central database contains all the catalogues required for operation of information systems in a GDI node. The central database can be set on the basis of any standard back-end DBMS, such as Oracle 11g, PostgreSQL / PostGIS databases, etc. For most types of spatial data sets, one should develop standard qualifiers of objects. Where appropriate, it is preferable to use the established symbols and object types (topography). One object for different tasks may relate to different types. The required standardized or generic qualifiers include a master plan, urban management, duty plan of the land plot (as part of a master plan), etc.

Editor for Spatial Object Catalogues is a tool that enables us to distribute the process for catalogue and qualifiers development, while making it well-coordinated as well. both by distribution and well-coordination.

Storage of GDI spatial objects is based on the ideology described in [1]. This ideology is implemented by using software, issued in the form of the relevant portlet. The functions and interface of this software are described in [4], as well. We suggest using open source (freely available) DBMS PostgreSQL / Postgis as the main DBMS for the Storage, as it is the most appropriate in terms of cost. The established commercial DBMS (Oracle 11g Spatial, MS SQL Server 2008) can also be applied. The key content to be formed in the storage of GDI spatial data is the basic spatial data, such as:

- boundaries of municipal entities, settlements, internal administrative divisions;
- master plan as part of the topographic plan layers:
  - capital structures;
  - roads, streets, driveways (areal and linear);
  - graph of road network;
  - railways, rail transport;
  - sidewalks, landscaping (lawns, flower beds, fountains);
  - surface objects of water resources;
  - woodland objects, green areas, parks,
- etc.

Joint GDI geoportal is operated through such open source software systems, as Geoserver, Liferay, Tomcat.

Geoserver 2.1.2 manipulates geospatial data, providing the user with WFS (for access to spatial objects) and WMS (for working with maps). Access mechanism is independent of the data storage format, since it is based on the universal description of data in the form of app-scheme.

Liferay is an environment for the construction of geoportals based on portlets. It serves as to create and maintain portal projects. Eclipse system is an environment for portlet development.

Tomcat 6.0 is a Web server. Tomcat can provide access both to spatial data stored in databases (DBMS Oracle Spatial, PostgeSQL / PostGIS, MS SQL Server, etc.), and to the shp-files stored directly on Geoserver.

Geoportal GDI provides the opportunity for not only official services to take part in the formation of spatial data but for enterprises and individuals as well, that fully complies with the future trends of geospatial data for the next five to ten years, described in [5]. By the way, as the process is based on the general (standard) qualifiers and catalogues, it will be a well-coordinated and semantically uniform.

Geoportal is not intended to replace or absorb information management systems operated by the services. It implements a set of services working with spatial data required for departments, enterprises and individuals.

Conclusions

We have examined the object Web GIS technology and shown that it can be effectively used to create various GDI. The main features of this technology are:

- The integration of all the services on the basis of the feature (object) catalogue of a domain created with the help of specialized software Editor for Geopatial Objects Catalogue which is in compliance with the international standard ISO-19110;

- The integrated spatial data storage, the structure of which is generated automatically based on the domain in the environment of Editor for Geospatial Object Catalogue;

- Work with geospatial data through GDI geoportal, which is based on a domain catalogue, supported by the storage and provides a range of services for processing geospatial data required by organizations, companies and individuals;

- Use for the implementation of open source software.

References

1. *Concept and the development of geospatial data infrastructure in the Russian Federation* / / Spatial data. - 2006. - № 3. – p. 6-9, 11.
2. *UN Committee of Experts on Global Geospatial Information Management. Future trends in geospatial information management: the five to ten year vision*. (eds.) - Eng. - Mode of access: http://gis-lab.info/docs/futuretrendsgeospatialinformationmanagement_12april.pdf
3. ISO 19110:2005 *Geographic information. Methodology for feature cataloguing* (eds.) - Eng. - Mode of access: http://www.iso.org/iso/catalogue_detail.htm?csnumber=44459
4. Anisimova, O.L., Zraenko Yu.D., Komosko V.V., Pestov I.D., S.V.

Serebryakov. *Storage of spatial objects in the GDI UFD regional node.* Part 1. Storage model. / / Spatial data. - 2010 – No. 1 - p.14-22
Part 2. Storage model. / / Spatial data -2010 – No. 1 - p.32-40
5. *Overview: WFS, WMS, WCS* (eds.) - Eng. - Mode of access: http://www.geowebguru.com/articles/95-overview-wms-wfs-wcs