ISSUES IN BUILDING NATIONAL GEOSPATIAL FRAMEWORK DATA: SOUTH KOREA CASE

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ABSTRACT

In this paper, we address several issues that one could encounter during the construction of National Spatial Data Infrastructure(NSDI) with respect to database management. We shortly present the history of the NGIS project in Korea to explain circumstances that surround us. Under these circumstances we discuss how we deal with these issues such as integration, single- or multi-layered structure, feature identification.

1. INTRODUCTION

The NGIS(*N*ational *G*eographical *I*nformation *S*ystem) project in Korea set up at 1995 had eight objectives(*NGIS Committee*, *2002*). To achieve these objectives, Korean government established eight committees for each objective, which are the construction of framework data, the development of geographic utilization system, the development of geographic information distribution system, the development of GIS technology, the promotion of GIS industry, the standardization of the NGIS, human resource development and notification, and the research and the development / revision of regulation. In (*Onsrud, 1999*), he suggested there are four major components or concepts in the NSDI, which are metadata, clearinghouse, data

standards, and core data(or framework data). The NGIS agreed on four components as most of countries replied does (see http://www.spatial.maine.edu/~onsrud/GSDI.htm). The NSDI project requires massive amount of budgets, man powers and time spans and thus it may differ from nations to nations depend on their circumstances. The NGIS has pursued to achieve four components in parallel and has finished the first master plan of the NGIS at the end of 2000. This matches "the first generation" referred in (*Masser*, *1999*).

The second master plan of the NGIS, which started at 2001 and planned to finish at 2005, focuses on the construction of the framework data which is the base data set for the utilization and the distribution of geographic information. This is due to facts that digital topographic maps constructed during the first project period of the NGIS were not qualified enough to be used in developing GIS applications, where they needed geographic features to be correct topologically, to be referenced spatially and to be manageable records in databases(*NGI*, *2000*, *NGI*, *2001*). It is not easy to satisfy these requirements by the DXF-format, which is the data format of the first plan of digital topographic maps of the NGIS. There were many problems and issues in the construction and the management of the framework data. These range from political/organizational issues to technical ones. Which organizations are budgeted and are responsible to construct and manage the framework data ? How to describe or to specify the framework data ? Which features are included in the framework data and which are not ? And etc. In this paper we focus on technical issues related to the construction and the management of the framework data rather than political and organizational issues. Especially, we focus on the following issues:

- Geospatial data model of the framework data
- Integration issue
- Structural issue on the framework data
- Identifier

Chapter two introduces a brief history of the NGIS in Korea and describes the roles and requirements of the framework data. Chapter three discusses issues mentioned above and approaches of the NGIS. Chapter four describes the achievements of the first plan of the NGIS and chapter five concludes our work.

2. BACKGROUND

The construction of the framework data has big impact on promoting GIS applications in a nation. This is due to the roles of the framework data as follows:

- it leverages cost by reusing common geographic data sets
- it provides the reference system for different geographic information and thus helps to

keep consistency among related geographic data sets, and
- it provides the reference of locations and UFID(unique feature identifier) with various types of databases, which in turn provides unified views on different databases.

The roles mentioned above become major objectives of the NGIS project and thus included as major activities in this project. A major task to be performed at the NGIS project, which started at 1995, is to construct the framework data. The needs to manage efficiently lands, facilities, and utilities are emerged from wide ranges of sectors in Korea in the years 1990s because of rapid economic growth in Korea. Thus the NGIS constructed digital topographic maps which had limited functionalities and provided a kind of the framework data to satisfy users who had narrow-scoped requirements during the first plan period, that is from the year 1995 to the year 2000. To resolve problems – limited quality and usability, inconsistency, inaccuracy, etc. - arisen related to data sets constructed at the first plan, the NGIS initiated the second plan at the year 2001 and the part of it was to enforce data specifications and a data model of the framework data till the year 2005.

The framework data produced has three different user groups as targets. The first one is a local government, which is the most important user group of the framework data. Users pertained to this group are not only mere consumers but also producers of the framework data. Cooperation between NGI(National Geographic Institute) and local governments constitutes an operational cycle or feed-back. The second group is users who need national level geographic data like KEPCO(the *K*orea *E*lectric *P*ower *CO*rporation), KT(the *K*orea *T*elecommunications), and Ministry of Environment. Users in this group do not participate in constructing base data but can add additional attributes or features on base data. The last one is ordinary users. In most cases, there always are companies bridging NGI and end users, who build and supply value-added thematic maps. For example, traffic information and tourist information maps are examples of value-added thematic maps.

3. ISSUES

In this section we first introduce shortly the characteristics of the framework data of the NGIS. And we discuss issues and problems during the construction process of the framework data. In addition, we also introduce approaches that the NGIS took. We deal with major issues and problems arisen during the construction process of the framework data with respect to databases, rather than overall issues and problems.

Category (Theme)	Class
Transportation	road centerline/boundary, railroad centerline/boundary
Facility	building, culture properties
Hydrology	river centerline/boundary, lake, coastline, watershed
Boundary	administrative boundary
Parcel	Parcel
Geodetic control	geodetic control
Topographic	DEM, contour line
Imagery	aerial and satellite photogrammetry

Table 1: 8 Categories and 13 Classes of the framework data of the NGIS.

Geospatial model and data specification

The framework data of the NGIS selects 17 classes out of 567 layers, which were DXF-formatted layers and were used during the first project period of the NGIS. Among them 13 classes deal with vector type data and 4 classes deal with raster type data.

These are further grouped into 8 categories. Categories of vector types are *transportation* (road centerline, road boundary, railroad centerline, railroad boundary), *facility* (building, culture properties), *hydrology* (river centerline, river boundary, lake, coastline, watershed), *boundary* (administrative boundary), *parcel*. Categories of raster types are *geodetic control*, *topographic* (DEM, contour line) and *Imagery*. These are summarized in table 1.

Since relationships among classes are defined in framework data model, the effect of an update at one class propagates to the other related classes. Thus the consistency of a framework data is maintainable.

For data specification of the framework data, there are 15 fields are defined. Those are as follows: class(or feature) name, category, scale, definition, feature code, unique feature identification, spatial object(*Open GIS Consortium, Inc.*, *1999*), attribute name and its description, data caption rule, a production rule when a feature under consideration is not related to other features and its input rule, a production rule when a feature under consideration is related to other features and its input rule, data verification, and example. Explanation about unique feature identification will be given later in details.

Integration issue

Integration issue is related to how construct and manage the framework data. There could be two possible approaches. The first one is an independent approach that each of categories is separated into independent one and thus is constructed and managed by an independent agency. Seven data categories in the United States are constructed and managed separately not by a single federal agency like FGDC. In this case, coordination among other federal agencies and local agencies is becoming very important issue. The other approach is an integrated approach that all of categories are treated as a single database. DNF of The UK and BDTopo of France integrate the framework data in a single database and thus a single government agency take care of it. In this case, the efficiency of construction and management is a key objective.

The NGIS is also considering this issue and many other aspects in additional; which one is more appropriate to promote utilization of the framework data, which one is more cost-efficiency for long-term maintenance, which one spends less construction or/and management cost, etc.

Single layered vs. multi-layered structure

This also has trade off between objectives, which are utilization and efficiency. In case of a flat or a single layered structure, it is easy to manage and maintain the framework data. US, England, and France fall in this category (*Masser I.,2002*). In case of hierarchical and multi-layered structure, one can build application-oriented or utilization-oriented framework data on the top of management-oriented base framework data. Australia and Canada fall in this category (*Turnbull,1997*, *Masser I.,2002*). At the first plan of the NGIS, it followed a single layered structure. Now it is examining extension to multi-layered structure. The reason is somewhat organizational perspective, rather than technical one.

Feature identification

One of major objectives of the framework data is its ability to manage features (or class instance) whether they are stored in integrated or independent databases and whether the structure of databases is single- or multi-layered. To achieve this, a feature must be identified uniquely as it is in a single database. A feature can be identified by using the common spatial reference system or by identification code. The former has practical limitations to be implemented. Different organizations holding a part of the framework data sets may adopt different reference systems. Selection of one of these is not an easy task to satisfy participants. Thus the NGIS decided to use unique feature identification(UFID) codes.

The NGIS assigns a 30-digits UFID to a feature in a seamless national-wide framework data. Important aspects considered during the design process are as follow:

(1) UFID should not change severely feature identification rules, which were adopted by organizations and by GIS applications.
(2) UFID must maintain uniqueness and persistence during its life cycle.
(3) UFID could contain some attribute values of a feature to be used to figure out the characteristics of a feature, for example its geometric location, the information of an organization responsible for managing, etc.

These three considerations are the results of reflecting users' requirements. UFID, which is in a design stage. It is composed of several basic fields; geographic location, height information about buildings, organization code, feature classification code, version number, serial number, and checksum (*NGI*, *2003*). Note that the fields of UFID derived from location information and height information do not change despite the modifications of the information to insure the uniqueness. If the change exceeds a given threshold, the corresponding feature is considered as destroyed. Readers may refer (*Sarent, 1999*) for other points of view on UFID.

4. ACHIEVEMENTS AND CONCLUSION

At the first plan of the NGIS, there were achievements in six categories: the construction of digital map(digital topographic map, digital thematic map, digital underground facility map, digital cadastral map), the development of the public GIS utilization systems, GIS technology development, GIS human resource development, Standardization of GIS, Research and Development related in GIS plans and policies.

Even though the NGIS is a government-driven project, lots of private sectors participated and as a consequence it offered driving power in Korea economy. Now, a NIGS is in the middle of the second plan while many issues descended from the past plan are unresolved yet due to urgent needs from private sectors. Internet and GIS companies do not allow the NGIS to proceed its long-term schedule on steady and stable manner. Thus it has to consider in parallel about how to select features of the framework data, boost utilization, and design clearinghouse during the initial phase of designing the framework data. Issues mentioned in this paper are suggested in these circumstances. Our work may suggest helpful comments to others who want to build NSDI in parallel during a short-term period.

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