THE DESIGN IDEA AND FEATURE OF CHINESE NATIONAL GEO-SPATIAL DATA TRANSFER FORMAT

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Abstract

Geo-Spatial Data Transfer Standard is an important part of "National Spatial Data Infrastructure (NSDI)", as well as a necessary means for data sharing. "Chinese National Geo-Spatial Data Transfer Format (CNSDTF)" was approved by National Quality Technology Supervise Bureau in 1999 with the standard serial number of 17798-1999. It is designed to support vector and raster spatial data and represent virtually any data model. Spatial data with different types, models, along with associated attribute data can be exchanged between dissimilar systems using CNSDTF. This paper describes some aspects about CNSDTF, including design ideas, main characters, definition of spatial object.

1 INTRODUCTION

Standardization is one of the tools we use to organize our technical world. It represents an important vehicle for the global transfer of technology. In GIS, standardization plays a very important role too. Based on GIS standardization, Spatial information can be transferred in Non-compatible systems and maintain their original meanings. Development cost of system can be reduced. Cost of data acquisition and maintenance can be cut down. Different kinds of data sources may be used to update database. Standardization also makes user to evaluate the data quality easily.

Since the 1980s many countries have issued the spatial data transfer standard, like Australian, the United States, Germany and so on. These standards have promoted the development of GIS, and provided an important guarantee for the construction of National Spatial Data Infrastructure (NSDI). But there are some gaps between the needs of the large national data producers and the needs of GIS software. The large national data producers need a spatial data transfer standard to represent the complex relationships of real-world entities with high precision. The GIS vendors need the standard to adapt to the marketplace. A lot of standards are designed for the needs of large national data. Thus they have following apparent limitations:

- Complexity. Some standards are too complex to be understood by GIS vendors.
- Slow development. Some standards lack of clear definition of geospatial features. Addition to complexity, users develop these standards difficult and slownessly.

GIS is developing fastly in China now. Several GIS software packages are becoming mature. Many GIS projects are running normally. Chinese NSDI is also being constructed favoringly. But the data sharing is a big problem. The same data are acquired repeatedly by different departments. Data can no be transferd and shared between different kinds of GIS software. Some informations are lost during transfering sometimes. The data quality can not be guaranteed. These activities have caused much waste and counterworked the development of Chinese GIS. Because of above reasons, Chinese National Geo-spatial Data Transfer Format (CNSDTF) was established in 1999.

The CNSDTF supports many different types of spatial data including vector and raster data structures, topological and nontopological data, different coordinate systems, attribute modules, and graphic representations. The CNSDTF consists of the following six parts: terms, rule, the object definition of spatial data conceptual model, vector data transfer format, image data transfer format, and grid data transfer format. In this paper, the design ideas, main characters, conceptual model and the difinition of spatial object are discussed in the following sections.

2 DESIGN IDEAS

Many foreign Geo-Spatial data transfer standards and data formats of GIS software have been consulted during the CNSDTF design. The CNSDTF is based on the following design ideas:

①Integrality

Integrality means that Geo-Spatial data transfer format should include all of GIS information without any loss during the transfer. Integrality is the key of transfer format. Transfer format will be accepted only if it could contain most of the GIS data formats.

②Simplicity

Geo-Spatial data transfer format should be simple and easy to understand. The SDTS (United States Spatial Data Transfer Standard) is an integrated transfer standard. But it is too complicated to be understood by general users.

③Compatibility

Spatial data come from different systems and include different kinds of information. Some data contain topological information, while some do not. Some have three dimension coordinates, while some only have two dimension ones. Spatial data transfer format should be compatible in different kinds of GISs and different sources of spatial information.

④Expansibility

Because of the cognitive limitation to spatial phenomena, current spatial data transfer standard may be unsuited in the future. So it should be expandable and compatible with the former data and software packages.

3 MAIN CHARACTERS

Based on the above design ideas, the CNSDTF has the following main characters:

⑴ The CNSDTF file is ASCⅡ file. Users can read dtat easily.

⑵ Spatial data are classified according to the feature, which is the entity set that have the same geometric type and the same physical meanings, such as chimney (point), road (line), vegetation (surface).

⑶ A CNSDTF file may contain many features with different geometric types.

⑷ Two and three-dimensional coordinates can be represented.

⑸ The CNSDTF is compatible for CAD data, such as circle and ellipse.

⑹ CNSDTF contains attribute data. Attribute and graphic data are stored in CNSDTF file. Different features have different attribute structures. Attribute data are linked with graphic data by object identification code.

⑺ The data model of the CNSDTF can represent topological relationship and non- topological relationship. The CNSDTF have four topological concepts:

• Connectivity: Each arc has two nodes: a from-node and a to-node. Arcs may join only at their nodes. By tracking all the arcs that meet at any node, CNSDTF is able to know which arcs may connect with each other.

• Topological arc definition: Arc can be represented topologically as other arcs, rather than as a loop of x, y coordinates. For example, a river consists of many branches.

• Topological polygon definition: Polygons can be represented topologically as the arcs defining the polygon, rather than as a closed loop of x, y coordinates.Each arc may appear in the list of arcs for each polygon. Arc coordinates need be stored only once. Storing each arc only once may reduce the amount of data and also ensure that the boundaries of adjacent polygons do not overlap.

• Contiguity: Any polygons sharing a common arc are adjacent, because every arc has direction (a from-node and a to-node). A list of the polygons on the left and right sides can be maintained.

4 CONCEPTUAL MODEL OF SPATIAL OBJECT

A mutually accepted conceptual model of spatial data is fundamental to the exchange of information between dissimilar spatial data systems (Robin Fegeas, 1992). The CNSDTF presents a general conceptual model that provides a basis for a common understanding of spatial data information and a means for representing spatial phenomena digitally. The CNSDTF has five specific concepts.

⑴ **Phenomenon**: A spatial phenomenon is an object that has a fixed location in space and time, such as Zhongshan road, Jingjiu railroad, and so forth. In addition, a spatial phenomenon may have attribute data associated with it, such as the length of Jingjiu railroad.

⑵ **Classification**: The CNSDTF model classifies all spatial phenomenon into classes according to some criterias. A phenomenon is an example of its class. For example, Zhongshan road is an instance of road class.

(3) **Generalization**: The process of abstracting hierarchical classes from other classes of spatial objects. For example, the sewer is included in the general facilities class.

(4) **Aggregation**: In the CNSDTF, more complex phenomenon may be built from simpler ones. The process is called aggregation. For example, the house is the aggregation of wall, door, window and roof.

(5) **Association**: The CNSDTF model can assign phenomena into new sets according to criterias which are different from the classification criterias. For example, there are separate classes for roads, such as waterways, railroads. At the same time, there is another class for transportation routes that would include some of the phenomena from each of the other classes.

The CNSDTF conceptual model has three parts: spatial phenomena, spatial objects, and spatial features.

(1) **Spatial Phenomena:** The CNSDTF transfers the phenomena information. A spatial phenomenon is an object that has a fixed location in space and time. Every phenomenon belongs to a phenomenon feature. For example, Hongxing farm belongs to farm feature. The character of a feature is called attribute. Area is a kind of farm attribute. Entity is the term chosen to describe the real-world phenomena.

(2) **Spatial Features:** In the traditional concept, the term "feature" has been drived at either a read-world phenomenon or a digital representation. In order to express these notions distinctly, the CNSDTF defines feature as the integrated of a real-world entity and its object digital representation.

(3) **Spatial Objects:** Real-world entities are represented by spatial objects digitally. They have fixed location properties, non-location properties, and mutual relationship (topological relationship). The CNSDTF defines a set of spatial object. These spatial objects may represent entities either directly or through aggragatoins termed composit objects.

5 DEFINITION OF SPATIAL OBJECT

The CNSDTF provides standardized concepts for a variety of spatial objects. These spatial objects may be used individually or in aggregated form to represent any spatial phenomena. According to geometric concept and attributive concept, spatial objects can be classified to five types.

(1) Geometry-Only type: Which only specifies the geometric location. There is no correlative relation among these objects, such as an independent point, a contour line.
(2) Topology-Only type: Which has only the topological correlative relation and is often used in the operation of defining spatial analysis.
(3) Geometry and Topology type: This kind of objects has both the geometric position and topological relation, such as common arc and node.
(4) Spatial feature: It has associated feature coding and attribution description, such as oil, well, house and park.
(5) Non-feature type: The Non-feature object has no certain feature definition. It is used as a convenience for the expression of spatial data and organization of the in-between object, as a pure node or the common arc of a polygon.

According to above five types, the CNSDTF provides more detailed and primitive definitions for spatial objects.

5.1 Zero-dimensional spatial Object

(1) Independent point feature: Which is a geometry-only object and is a spatial feature with feature coding and attributive table.

(2) Pure node: A geomety and topology object that is used to describe its correlative relation and geometric position with the arc. It is not a feature.

(3) Node feature: A geomety and topology object that belongs to spatial feature. For instance, the node among electronic lines is often a power distribution station.

(4) Annotation reference point: A point used to identify the location of annotation. It can be stored in the annotated data structure.

(5) Polygon label point: A point used to identify the location of polygon and can be stored in the polygon data structure.

5.2 One-dimensional Spatial Object

(1) Topological arc: Which belongs to geometry and topology type and is an ordered sequence of connected, nonbranching line segments. The arc may be a part of a linear feature or the border of a surface feature. It even may be either the border of a surface feature or one part or whole part of one or more linear feature. Generally speaking, the arc

itself has no feature meaning. However, if an arc itself is a linear feature, it may have the feature coding and link the feature to the attributive table.

⑵ Non-topological arc: This kind of arc is a geometry-only feature and is much simpler than the above topological arc. Commonly, it is unnecessary to take starting node, ending node, left polygon and right polygon into consideration, such as the contour line.

⑶ Linear feature: A linear feature is composed of one arc or several arcs. Linear feature is allowed to have branches and intercross, so that it can deal with the problems as fluvial drainage area and traffic. Linear feature must have the attributive coding and be linked to the attributive table.

5.3 Two-dimensional Spatial Object

⑴ Simple polygon: Polygon with one external border but without any internal island.
⑵ Polygon with island: Polygon with external border and one or more internal island.
⑶ Compound polygon: Which is composed of several simple polygons or polygons with island.
⑷ Universal polygon: Polygon with internal island but without external border.
⑸ Pixel: One two-dimensional image element. It is the smallest image element that cannot be divided any more.
⑹ Grid: The intersection grid point of two-dimensional lines.

6 CONCLUSIONS

The CNSDTF is now popularized in China. It defines the conceptual model of spatial data and a set of spatial objects accurately. Its file structure is understandable and is fit for coding. Dissimilar spatial data systems can exchange information easily by use of CNSDTF.

Data transfer and data sharing, as a GIS bottle-neck in China, are paid more attention now. These problems will be solved gradually after the CNSDTF was approved. At the same time, Geo-Spatial data transfer standard is an important part of NSDI and Digital Earth. So popularizing and perfecting CNSDTF will promote the constructions of Chinese NSDI and Digital Earth.

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