Study on the Data Model of Digital Map Product

Li Li, Wu Zhipeng
National Geomatics Center of China
State Bureau of Surveying & Mapping, Beijing , China 100044

Abstract Mechanization is the characteristic of the industrial era and computerization is the characteristic of the Information Era. Now we are facing on the transition from Industrial Era to Information Era. The spatial positioning character of Geo-spatial information is attracted by Information Technology (IT) industry. Map plays an important role in the phylogeny of humankind. Concomitance with the development of the implementation, the advance theoretic and technology has been much involved in Cartography. Therefore, the data source, the material, the tools, the methodology, the production process, the formation of map making and even the needs of the map user are greatly changed in 20th century. This paper base on the concept and principle of topographic map, designed a new digital Map Product Model to satisfy with new requirements of the map users.

Key words Digital Map Product Model，Geo-spatial data

1. Overview

With the development of micro-electronics, computer-sciences, communication and network technologies, gradually, material, energy, as well as information are considered as the 3 most important resources for modern development. Geo-spatial information is one kind of important information for describing the earth's yesterday, today and tomorrow, and will play an important role for social continual development. The mankind has made a very strong affect to our living environment, and the decision making for the important issue is mostly related with geo-spatial information. "Digital Earth" is a leap in the processing of cognition base on the development of geomatics and information technology. The real world is a boundless, seamless and continual geo-space. From the microscopic to macroscopic，the information is getting more and more detail. The aim of integrating the multi-scale geo-spatial information is to describe, roam and inquire about the real world. Along with the procedure of information industry and national economy move forward, geo-spatial information will be treat as the fundamental information for planning, management and decision making.

Building National Spatial Data Infrastructure (NSDI) has become the major thesis of the surveyors all over the world. NSDI is composed of those tasks, such as the founding of National Spatial Data Commission, the working on spatial data standards and principles, and the establishment of spatial data exchanging network and fundamental geo-information database, etc. Along with the development of information industry and the achievement on digitization of national economy, fundamental geo-information, as the spatial information, has greatly supported macro-scopical decision, planning and management, microcosmic producing, science research and normal life. It is said clearly in CHINA 21th AGENDA, that Exploring and apply remote sensing, image processing, surveying and Globe Positioning System(GPS), fully developing information industry, especially to fasten the building

of National Fundamental Geo-information System. The rapid development of modern social productivity and the enlargement of social activities

2. The achievements of the digital mapping data

In recent years, some developed countries have fasten their constructing of National fundamental geo-information Infrastructure. European Economic Community (EEC) issued documents about Establishment of the Infrastructure framework two times in 1995 and 1996. The 10th International Geo-information Conference held in Canada in June 1998 selects Building Spatial Data Infrastructure as its themes, those policies, technologies, and applied examples about how spatial data works on international/national information highways would be discussed there. For the producing of fundamental geo-information products, surveying and mapping organizations all over the world are busy realizing the shift form analogue mapping to digital one. USGS introduces their series products: DEM, DOQ, DLG, DRG, LULC, Place-name, and so on. OSCAR, DEM, Boundary Lines, Vector Topographic Map, Place-name dictionary are provided by British Bureau of Ordnance Surveying. In Canada, the target of Building National Topographic Database (NTDB) is almost achieved, and now they have used digital national atlas to exploit Canada Earth Survey Net on WWW and provides internet services for public activities such as Students Education Web and Competition Statistical Analysis, and also realizes the hardcopies for digital maps when 1:50 000 geo-information database is being built at the same time. And 1:250 000 geo-information database for the whole country has been finished in Germany, and they even have updated the database by use of remote sensing images. In New Zealand, Digital Cadastral Database has established, the smallest unit inside is a cadastral plot, in which the streets central lines, boundary and relative attribute file would be included. Its precision can be satisfied for most commercial applications.

In China, for the national map databases consist of 1:4,000,000, 1:1,000,000, 1:250,000, 1:50,000, 1:10,000 and more larger scale of special construction area. From 1980’s the State Bureau of Surveying and Mapping and other agencies which charged for the geo-spatial data handling had made a great effort to NSDI, and have finished national wide database on the scale of 1:4,000,000, 1:1,000,000, 1:250,000 including the DEM database and place name database, and larger scale map database for some big cities. Our aim is under taken, we shall endeavor to establish the architecture of national –wide spatial database as quick as possible, to service the geo-spatial information to the users.

Some digital and electronic maps, such as China Digital Map (1:1 000 000, international version), Hong Kong Electronic Map, Beijing Electronic Map, Shanghai Enterprises Electronic Dictionary, Shanghai Tour, etc, have appeared recently. For the styles of products distribution, besides basic analogue maps and images, there are universal digital geo-information products with fixed data formats copied in read-only CD-ROM, and also special digital ones that can be provided according to user's needs.

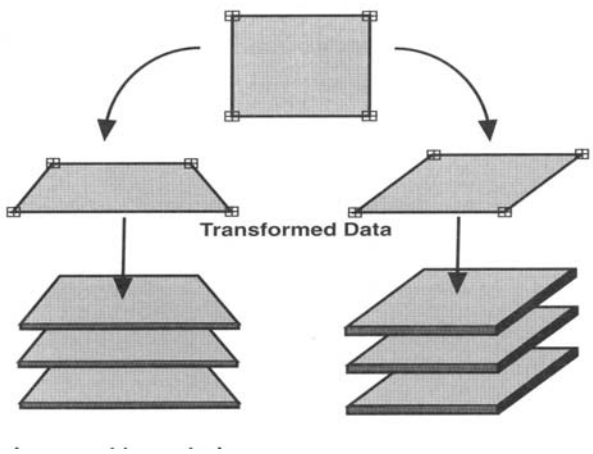
3.Characters of Fundamental Geographic Information

Traditional results of Surveying & Mapping are by means of manual work, and the production procedure keeps for a long period. The categories of product are very limited, and are not easy to integrate together. After the liberation, the Chinese Government expensed more than hundred millions to survey our territory and obtained a great deal of basic surveying and mapping results and specialized surveying and mapping results which promote the service thereof to the national economic construction, building up of the national defense and scientific research. Map is one kind of scientific technical product, which based on the mathematics rule, used special symbol system; take advantage of cartographic generalization and selection method to describe the real world feature on the paper sheet. Not only the quality and quantity characteristic of the spatial feature are represented on the map, and also the relationship, the changing from time to time of the spatial feature are represented. The user of the map can measure the coordinates, the length, the area, the altitude and volume of the spatial object. Comparer with the letter, maps are more obvious and easy understandable. Along with the development of the computer science and digital mapping technical methods, the new means has been offered to the surveyor for data capture, representation, storage and usage.

With the development of computer technology, aerial and space technology, space position technology, the sources of surveying and mapping data and the processing methods of information have been greatly changed. The following are characters of Digital Fundamental Geo-information.

•Coordinate System/Projection exchanges, Spatial positioning and Measuring

When dealing with fundamental geo-information, the processes are strictly based on mathematic principles, which are the references for space position. Since those information is expressed in digital form, it's easy and fast to carry out the transform of coordinates and maps projects, and calculate the position, length, area, volume, gradient, surface area of the spatial target precisely accurately in real time.



Spatial positioning function is the specific functions of topographic map and can

be used as the geo-reference for any purpose. The Geometric and relationship information of the geographic object provide the background and position location control for point feature (such as bridge, traffic incident, toll station etc) and for linear feature (such as route line, communication line, road management etc). A lot of information and product can be derived from these data.

- **Thematic information loading and integrating**

Digital map can be treat as a 3-dementional space. About 2/3 data in world are related with spatial position from the statistic data. It is because that the computer is popular and widely used by all kinds of departments, the information integration becomes a reality. The data can be integrated by their location coordinates, and can overlay each other. All kinds of data source such as road situation, traffic facilities distribution, and satellite images can be displayed together and easy to turn on or off, offer a very efficient way for decision-making.

- **Continuously and multi-scale, multi-dimension View**

The real world is a boundless, seamless and continual geo-space. From the microscope to macroscopic，the information is getting more and more detail. The technology of Data Warehouse of Spatial Information is a way for managing and distributing the vast amount of spatial information, and the user can access the information for analysis and presentation by means of zoom in and zoom out.

- **Law effectiveness**

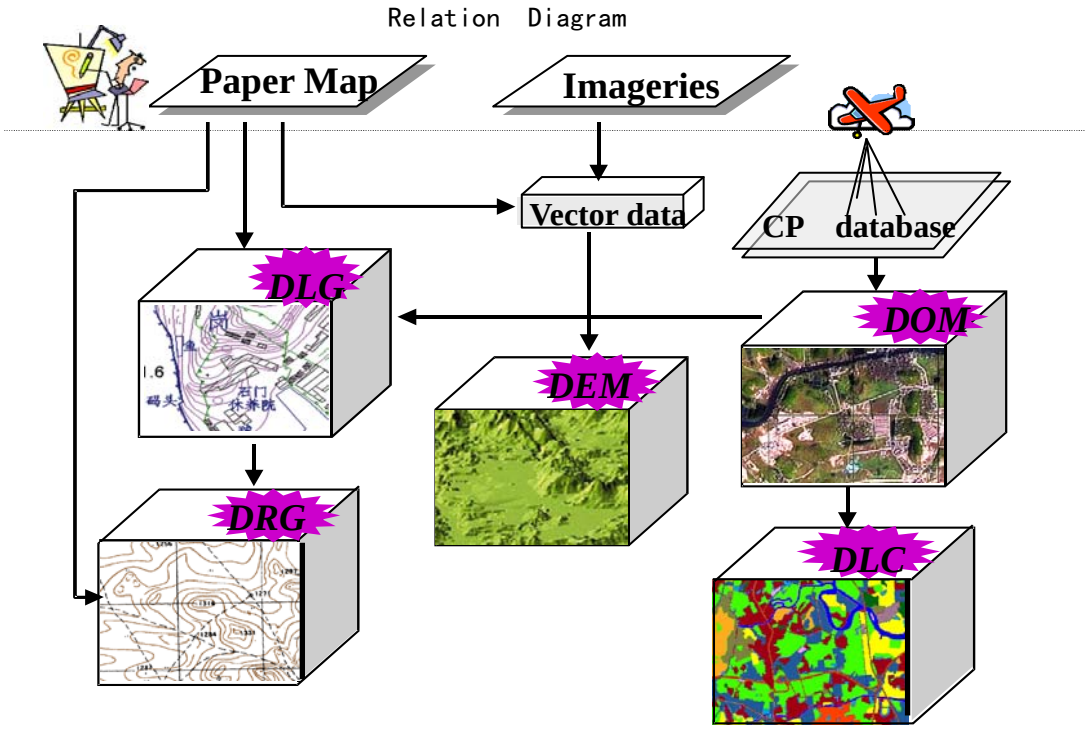
The department of surveying& mapping administration should provides a base on which to collect, register, and integrate geo-spatial information and transportation information accurately and consistently. All the data and information from the NSDI is law effectiveness.

4. The data model of digital map product

Map or ortho-photograph is a kind of scientific and technical product. According to the traditional concept, map is a graphic product of geographical reality, using special symbol system, representing features or characteristics selected or integrated in term of certain mathematic principles. Comparing with lansign, maps are really open-and-shut and it can be said that they suit both refined and popular tastes and play an important role in the phylogeny of humankind. Paper maps can be easily used without any tools. This style has great vital force not only at present, but in the future. When it comes to Cartography concept, it should be like that its theories are developing with the progress of science and technology and the improvement of people's knowledge. Now information transmission is considered as the core problem in Cartography. According to the view of information theory, map is the tool of saving and transmitting spatial information, and it studies the transfer, exchange, representation, savage and use of geographic environmental information. Map information theory is different from mathematic information theory. The former

studies the processes of information saving, processing and transferring at the view of mathematics, what it concerns is how to improve the transferring speed and reliability. The other pays more attention to how the information receivers can gain more information under certain information transferring speed and reliability, the output information may be larger than input information. Under the knowledge and technical skill of information receivers, they may derive and get more new information.

The founding of data model of digital map product should meet with the social needs. It means, adopting high technology to try to shorten products producing period and lower their costs, and providing fundamental geo-information fitable for computer processing in different kinds of ways. Different products can exist along, and also can be correlated and supplemented to each other.



Considering about the Data Model of Digital Map Product, it consists of data content, data structure, data record format, data transfer format, Meta data, simple tools, requirements of data update, data distribution channels.

- Data model

(1) Universal product model. It's a better way when the product contents, data formats, distribution methods are fixed and the circulation is large. The advantages are its lower cost for product process, its convenience for distribution and its large influence in society. But the periods of updating are a little too long, and the data are not easy to be managed.

(2) Optional special product. The product contents(with all kinds of thematic contents or in different areas), data formats are optional, and also the distribution

methods, which can work with internet, magnetic tape, CD-ROM, floppy disk or other media.

- Product content

To shorten producing period, the contents of each products should not be demanded perfection. Because the sources of fundamental data are abundant, especially because of the achievement of aerial and spatial technology, the contents of Digital linear graphics need not be limited into those 6 elements of traditional maps, as well the old representation ways. For example, terrene and vegetable cover information would rather be collected by using digital orthophotos or producing the new ones than be done after updating the contents of existing maps. Data can be logically organized based on certain principles to be picked up and filtered expediently. And, roads should not be cut or divided by residential area. In order to do spatial network analysis of roads data, they should be constructed into a net.

- Data management

Digital geo-information products should be organized according to their characters, but not only stand on analogue map sheets. For example, Digital Elevation Model is the plane matrix of regular grid points coordinates (X, Y) and elevation values (Z). It's better to be processed by rectangle extents than the trapeziform in production and management. In the other hand, the out of the map range in analogue maps should be kept to be full ones. But it's the barrier when merging two close sheets. For digital products, these information out of the extent are always be saved as metadata (interpretative data of data), and users can easily inquire them. So, when organize digital fundamental geo-information products, data entities and interpretative information are put dividually without the limitation of traditional concepts. Moreover, they can also be combined together when needed.

- Data format

Formats for fundamental geo-information could be many kinds. For example, the vector data with topologic relations, monochrome or colorful raster orthophoto, raster graphic data, regular grids data, attribute table data, etc.

The transfer format of the Geo-reference information in the geo-spatial data (vector, grid or raster), data concept model, quality report, transfer component specification, and the definition of the attribute and graphic elements of geo-feature.

- Products component

Fundamental geo-information has many special characters the traditional products don't have. At the same time, they should be realized by through certain basic functions. Fundamental geo-information products are not only composed of data themselves, but also some corresponding software tools. For these kinds of software, their aims are to express the characters of fundamental geo-information and provide basic tool for processing data. Those complicated functions, such as complex data processing and analysis, will be ignored be fulfilled by some commercial professional

software, such as GIS, digital image processing software.

The function of the Transportation Spatial Data Transfer Standard is to solve the problem of the heterogeneity of data. The Spatial Data Transfer Standard should follow the existing international or national standard, and pay more attention to the character of transportation. The following should be mentioned in the Standard and Meta data should be offered to the user simultaneously.

National fundamental geographic information database is a national project, which spend a mount of manpower for several years and get the financial support from our government. Information Industry in our country should keep to orientated by management mode it means that should under the macroscopically unify guidance, follow the national specification and standard, coordinating the information and service from different fields, different data source and different level. There are many advantages by this way, to realize the policy to co-build the database and share the results, quick up the procedure of establish NSDI, database can keep unify and more reliable, save amount of time and money. In China, geo-information products market is at the stage of elementary forming, the system of products producing and services still need to be more advanced and more perfect. With the accomplishment of fundamental geo-information market, and the appearance of more and more products, the geo-information industry in China is to gain much more achievement, and to be the great information support for revival of China's economy and entry to be a developed country.

References

1. Ferdinand J. Ormeling Sr. . ICA 1959-1984, The first twenty-five years of the Internatioanal Cartographic Association . Enschede, The Netherlands : ITC . ISBN 90-70310-11-2.
2. Tian Desen, The theory of Modern Cartography, Surveying & Mapping Press, 1991.
3. Zhu Guorei, Cartography Ananlysis, Surveying & Mapping Press, 1994.
4. David Rhind, Framework for the World, GeoInformation International, 1997. ISBN 1-8624-2021-1.
5. Nabil R. Adam, Aryya Gangopadhyay, Database Issues in Geographic Information Systems, Kluwer Academic Publishers 1997.
6. Li Qi, Chaowei Yang, Data Warehouse of Spatial Information，Proceeding of the International Symposium on Digital Earth, 1999.
7. Carl Reed, Intergraph’s Focus is on Geospatial Information Management and Use, GIM, 1998 August.
8. Newsletter, Federal Geographic Committee 1994-2000.
9. Open GIS Consortium, ckottman@opengis.org