

# THE CONCEPTUAL FRAMEWORK ON THE MULTI-SCALE AND SPATIOTEMPORAL DATA WAREHOUSE

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**Abstract** This paper states that it is necessary to develop the spatial data warehouse for the digital earth development, the spatial data integration and the spatial DSS. The frameworks of the spatial data warehouse are designed, which are the organizational content, the functional flow chart, the network structure and the hardware & software environment.

## 1 Instruction

To meet the demands of the global change and the continual development, it is necessary to integrate, generalize and save data sets, which come from different units and departments, according to unification view of information and main subjects. These data sets are combined with a kind of specialty models by different directions in order to develop DSS.

### 1.1 The needs of digital earth development

The aim of digital earth is to integrate the spatial data and the thematic data, which comes from nature source, environment, society, economy, military etc, to form the framework of spatial information from local to whole parts, region to globe. The framework in digital earth is established on the distributing network and is based on the common geographic coordinate system. Besides to support the integration, aggregation and mutual operation of the spatial data sets, the main function of framework is

to overlay the thematic data sets on the spatial data sets to support DSS and the scientific research for some organizations and departments. These thematic data sets which contain temporal data are consist of the data sets of natural source、environment、society、economy、military etc. These data sets are saved in different nodes on the spatial information network. It is a key technology for digital earth to how to obtain the spatial data sets and thematic data sets from different spatial databases and thematic databases in different organizations and departments and how to integrate、generalize and save these data sets according to the principle of unification view of information and main subjects.

## **1.2 The needs of integration for the spatial data sets**

Because of the development and application of GIS, It results in the multi-source spatial data sets that make some difficult for the application and share of the spatial data sets. The characters of the multi-source spatial data sets are concluded below:

- Multi-semantic character
- Multi- spatiotemporal character
- Multi-scale character
- Multi-mode character to obtain spatial data sets
- Multi-format character to save spatial data sets

With development and popularization of Internet in computer, it is necessary for different organizations and departments to share information. Also, geographic spatial information is asked to share. With development of information technology and GIS, GIS has divorced from pure geographic system of science and technology and is combining with IT. People demand more and more geographic spatial information. Owing to multi-semantic character、 the multi-spatiotemporal character、 multi-scale character、 multi-mode character、 multi-format character for spatial data sets and isolation development of GIS, it becomes difficult to share GIS information. Because of emergence of digital earth concept, it is an

important foundation to share GIS information for the application of geographic spatial information in all kinds of unit. It is a key step for sharing GIS information to integrate Multi-semantic、Multi-spatiotemporal、Multi-scale、Multi-mode and Multi-format GIS data sets.

### **1.3 The needs of the spatial DSS**

#### **1.3.1 the main elements to determine spatial DSS**

The main elements to determine spatial DSS include the spatial information、the thematic information and the temporal information which make up of the environment information. The content of the spatial information contains Geodetic control database、Orthoimagery database、Elevation model database and digital map database. The content of the thematic information contains politics factor、economic condition、society environment、nationality and culture nature、weather condition、communication equipment、troop information、traffic status、science and education、medical treatment etc. The content of the temporal information contains time information that is combined with the spatial information and the thematic information.

#### **1.3.2 the data characters to determine spatial DSS**

Spatial DSS is based on the spatial information、the thematic information and the temporal information. It is impossible to determine spatial DSS with traditional databases. In condition of high technology, there are five abilities for spatial DSS. They are described below:

##### ① Data integration

The data sets to be integrated are needed for spatial DSS. Not only the spatial DSS needs the spatial data sets, but also the spatial DSS should own to the thematic data sets and the temporal data sets. The traditional databases are not provided with the capability of data integration for the spatial data sets、the thematic data sets and the temporal data sets.

##### ② Data generalization

Spatial DSS needs a lot of data sets to be generalized. Before spatial

DSS is operated, a number of detail data sets must be generalized into outline data sets. It is impossible for the traditional databases to generalize the spatial data sets and the thematic data sets.

### ③ Data dynamic integration

After data integration, if the data sets that happen to change can't connect with people, spatial DSS shall be based on old data sets in order to make an error determination for spatial DSS. It is impossible for the traditional databases to dynamically integrate the spatial data sets and the thematic data sets.

### ④ Temporal data

It is an important for spatial DSS to own a lot of the temporal spatial data sets and thematic data sets. In traditional databases, a lot of the temporal data sets can't be saved.

### ⑤ Multi-scale spatial data

The topographical environment of spatial DSS is based on multi-scale spatial information so that leader acquaints him with information of topographical environment in area from macroscopic state to microcosmic state. The paper map provides the spatial information of region by some scale map. It is too difficult to select multi-scale spatial information in paper map for spatial DSS. It is possible for leader to obtain multi-scale spatial information for spatial DSS by establishing some scale map database and using multi-scale selection technology of spatial information.

With development of computer technology and new demands to be provided by users, some spatial databases can't meet the needs of the digital earth development、 the spatial data integration and the spatial DSS. People try to process data in the spatial database in order to form an environment of subject-oriented 、 integration-oriented 、 generalization-oriented、 dynamic integration-oriented、 temporal-oriented、 multi-scale-oriented、 analysis –oriented. Until metaphase of ninety ages, the theory and technology of the spatial data warehouse begins to come into

being. Based on the spatial database、 the thematic database and other data files which come from different units、 different mediums and different structure, the main aim in this paper is to provide an structure environment of subject-oriented、 integration-oriented、 generalization-oriented、 dynamic integration-oriented 、 temporal-oriented 、 multi-scale-oriented 、 analysis –oriented for the digital earth development、 the spatial data integration and the spatial DSS by the theory and technology of the spatial data warehouse and the network technology of Internet/Intranet.

## 2 Description of the framework

### 2.1 the organizational content

The spatial data warehouse is divided into five parts that are described below:

- the framework of spatial data
- the aggregation of spatial data
- the management of spatial data warehouse
- the selection of multi-scale spatial data
- the analysis of spatial data

The chart of the organizational content for the spatial data warehouse is drawn below:

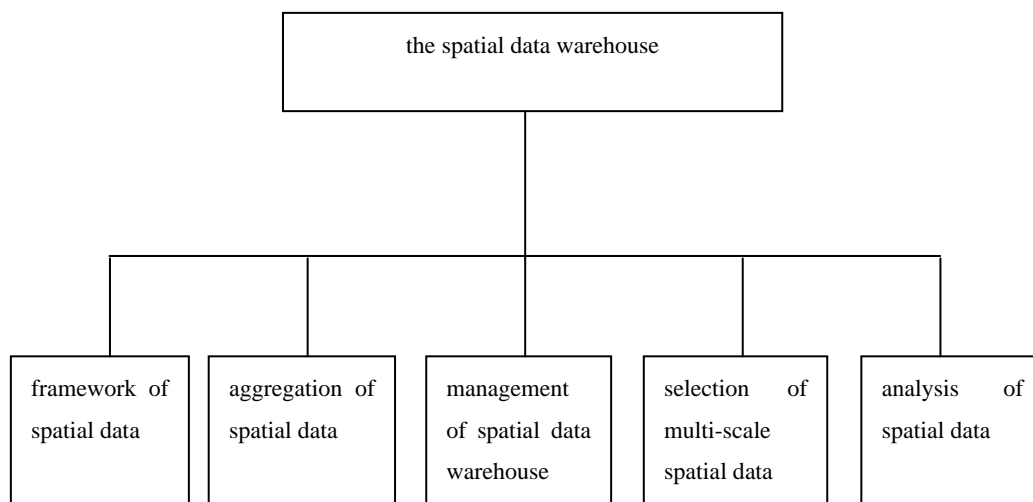


Fig.1 chart of the organizational content

### **2.1.1 Research and establishment for the framework of spatial data**

The framework of spatial data consists of the spatial data and the thematic data and provides an interface keyword to query the spatial data and the thematic data. The research contents in the framework of spatial data are to obtain and manage the spatial data and to obtain and manage the thematic data.

### **2.1.2 Research and establishment for the aggregation of spatial data**

The main aim of the aggregation of spatial data is to study how to apply the technology of the mutual operation、transformation、integration and generalization for supporting the integration of multi-source data sets which have multi-semantic character、the multi-spatiotemporal character、multi-scale character、multi-mode character、multi-format character. Its research fields contain the mutual operation、transformation、integration and generalization.

### **2.1.3 Research and establishment for the management of spatial data warehouse**

According to Digital Earth calling for the sharing of spatial information, the main subject of the spatial data warehouse is research how to manage multi-source data sets, that are the spatial data、the thematic data and the temporal data. Its main contents are to how to design the conceptual mode、physical mode、logic mode and systematic structure for the management of spatial data warehouse.

### **2.1.4 Research for the analysis of spatial data**

According to Digital Earth calling for the analysis of spatial information, it is main suppose for the analysis of spatial data to analyze the integration data sets of the spatial data and the thematic data. Its main research contents are the conformation analysis、the overlay analysis、the buffer analysis、the connection analysis、the network analysis、the statistic analysis、the Cube analysis.

### **2.1.5 Research for the selection of multi-scale spatial data**

Its aim is to build up some scale spatial databases、 to select data according to geographic feature grade、 to code geographic feature、 to construct generalization model of geographic feature and to design the multi-scale map symbolic base.

## **2.2 the functional structure**

The functional structure of the spatial data warehouse is composed of the functional flow chart、 the network structure and the hardware & software environment that are drawn below:

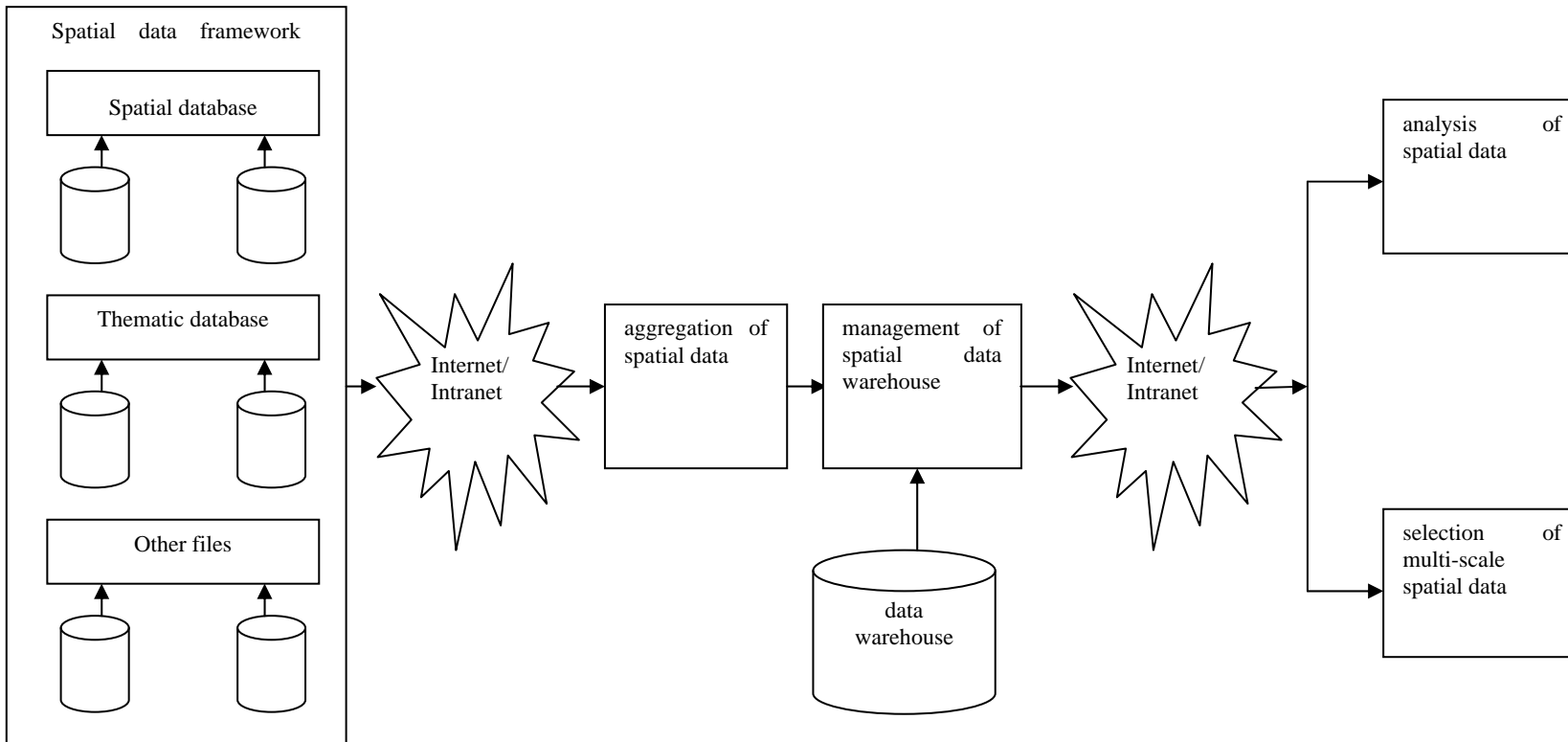


Fig. 2 the chart of functional flow



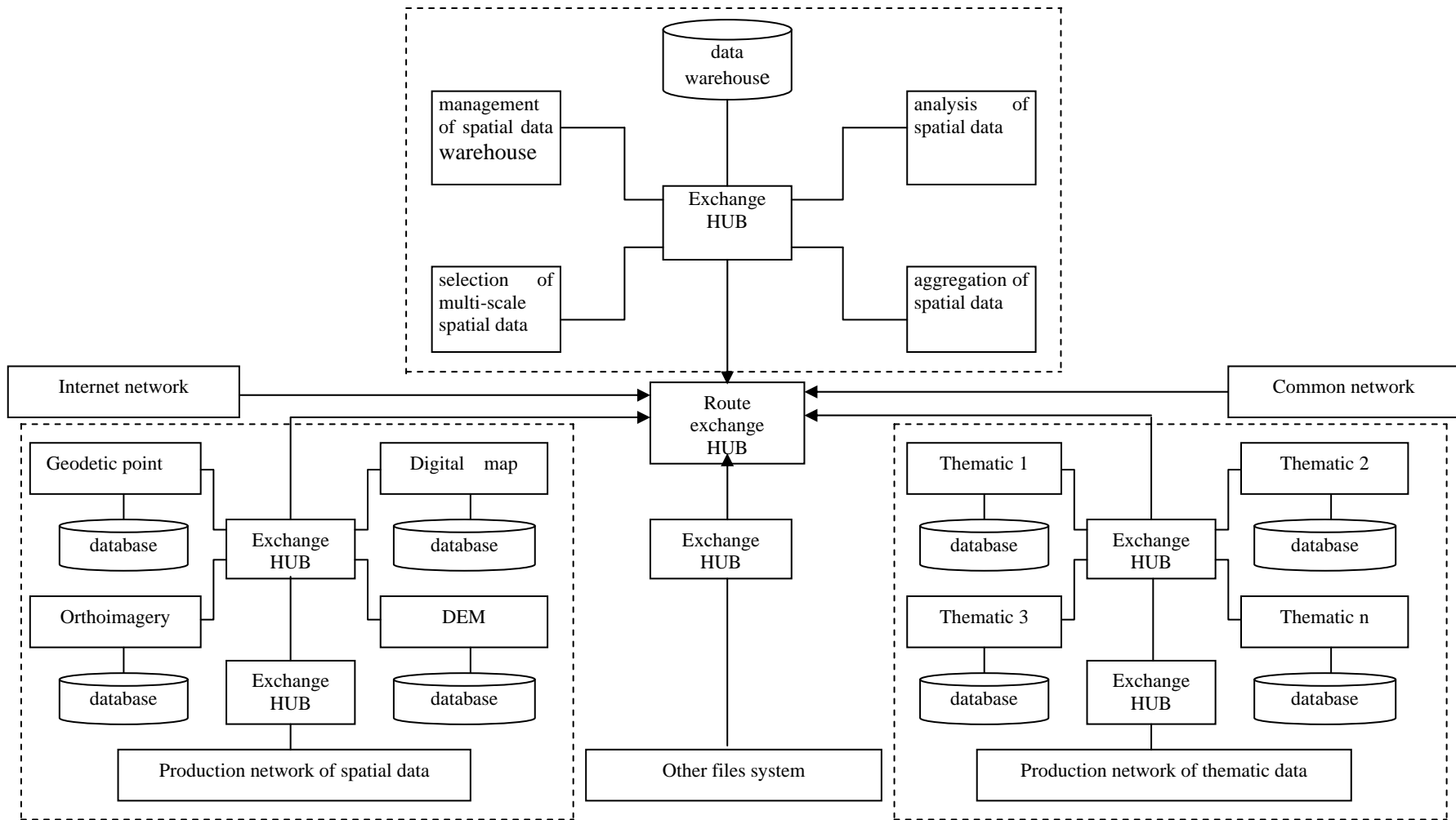


Fig. 3 the chart of network structure

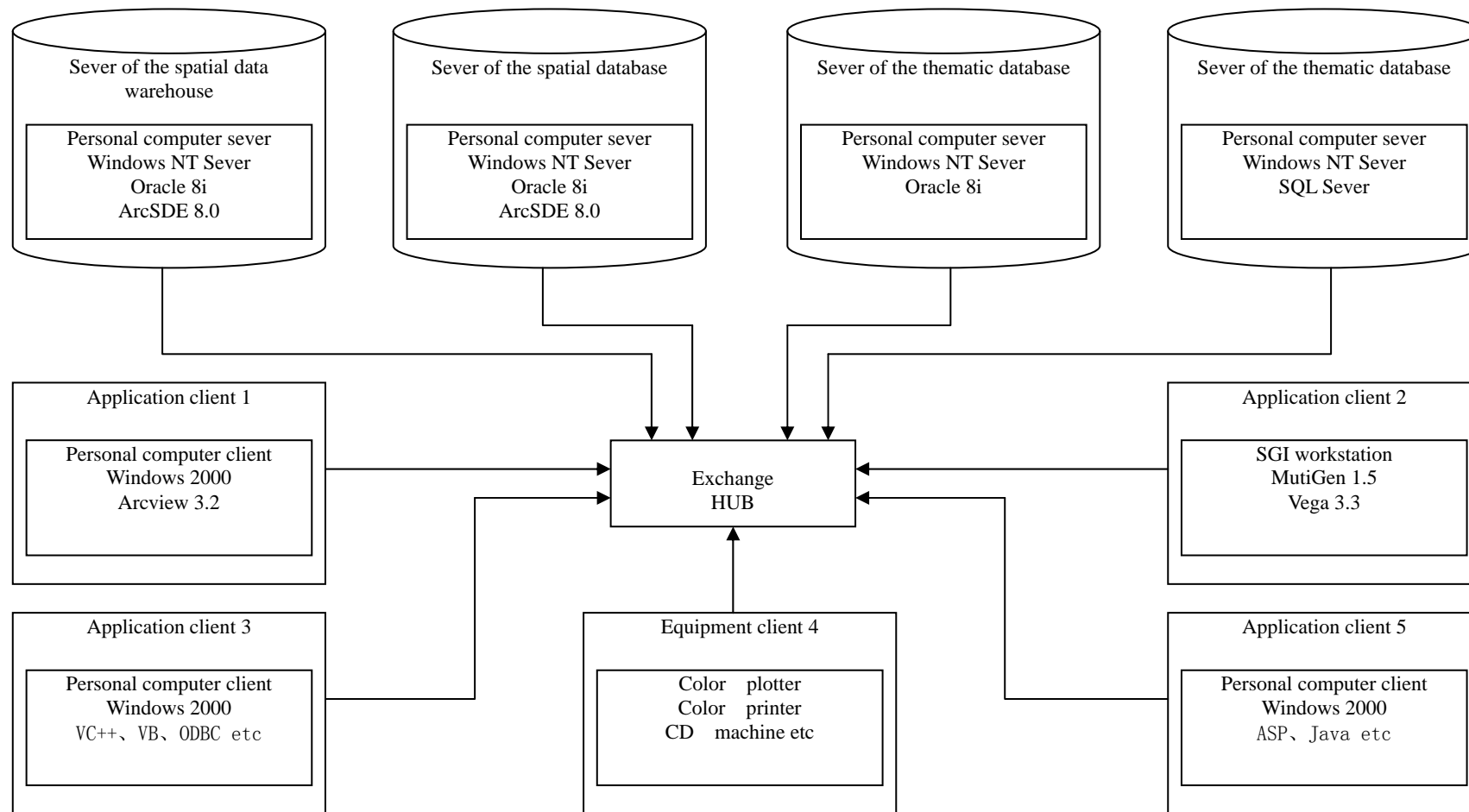


Fig. 4 the chart of hardware & software environment



### 3 Conclusion

The theory and technology of data warehouse is created in ninety. In metaphase of ninety ages, data warehouse is developed very well. In USA, data warehouse is a hot technology after Internet. So far, the theory and technology of spatial data warehouse is begun to study. Its purpose is to support the development for the digital earth development, the spatial data integration and the spatial DSS. Hence, we should catch hold of this opportunity of development of data warehouse to study and establish the spatial data warehouse for supporting our country NSDI.

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