TERM PAPER
DATABASE MANAGEMENT SYSTEMS

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DBMS Requirements for Geographic Information System (GIS)

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1 Abstract

In geographic information systems (GIS) large amounts of data are stored and must be made available to multiple users. Database management systems (DBMS) were designed to facilitate storage and retrieval of large data collections. They include facilities to protect and secure data, enforce consistency of the data stored, and make data available to multiple users at the same time. These services are necessary for GIS, and GIS should therefore be built using database management systems. However, geographic information systems demand high performance and pose some very special requirements for database management. DBMS designed for commercial usage are not well suited for GIS because they cannot accommodate spatial data and cope with retrieval of map graphics. An overview of the architecture of a DBMS especially suited for spatial data handling is presented.

2 Introduction

GEOGRAPHIC INFORMATION SYSTEMS (GIS) must store large mounts of data and make them available on demand. Users have learned from their personal computer experience to demand nearly instantaneous responses even for relatively complex requests. Traditional solutions in which data are stored on disk or on magnetic tape and must be searched sequentially cannot respond fast enough to user queries and are no longer sufficient to accommodate frequent changes in the users needs. A modern GIS is expected to be able to integrate data for different topics and from different sources. The integration of multiple data sets, often visualized as multiple data layers, is expected to produce a synergistic effect and yield better information for decision making. Traditional file oriented storage cannot easily respond to this requirement either. Geographic information systems are comprised of a complex of several parts that interact. In order to build computerized GIS, we have to deal with organizational, software, and hardware problems. It must be noted that organizing the cooperation of different groups to collect data and to share the results is an especially difficult task, for which few guidelines and rules are available. Many projects fail not for technical

reasons, but for lack of organizational arrangements or because of a poor understanding of social or economic implications. Hardware problems are more easily resolved the components for storage and processing of very large amounts of data are available from various manufacturers. Prices are increasingly reasonable and the general trend is toward "zero cost hardware" (Dangermond and Morehouse, 1987). GIS software, on the other hand, is much more difficult to build than many had previously thought. The software system to manage GIS data must contain a module that provides database management system functionality. This paper deals primarily with this software component and the requirements placed on it by GIS applications.

Database management systems (DBMS) are appropriate tools for GIS. Fast access to spatial data out of a large data collection is difficult to achieve. Many current GIS store data as a collection of map sheets (or similar spatial partitions) which are then handled as units. This requires all users to understand their structure and hinders access by postal addresses or other logical concepts, for example. To achieve the desired "seamless" database where objects (i.e., map features) are not arbitrarily divided by map boundaries and where users can freely move or zoom over the map, special methods and optimizations are necessary DBMS software provides the services needed to integrate and protect the data. But, the conventional DBMS does not deliver the performance and cannot retrieve map data quickly enough for interactive work. Not all GIS software packages currently on the market contain a DBMS or include all the services necessary for data protection. In this paper, we detail these necessary DBMS services and show in an architectural overview how they interact. We use modern software engineering concepts to organize the discussion. Particular attention is given to the integration of database management systems with other software specifically written for spatial data processing. Emphasis is placed on data storage and retrieval functions, including the protection of the data in a GIS. Equally important problems of adequate modeling of reality and the data model support necessary for GIS are excluded and treated elsewhere in order to conserve space (Egenhofer and Frank, 1988). The discussion of access methods and, especially query languages is therefore intentionally limited. Many of the ideas reported here are based on experience with the PANDA database management system (Frank, 1982a, 1984b, 1986a; Egenhofer and Frank, 1987a). We identify methods successfully implemented, and include a critique of methods which have not worked as well and will be replaced in the future.