

## **Biographical Information**

### **DAVID J. MAGUIRE** **Director of Products, Solutions and International** **ESRI**

#### **Specific Responsibilities**

Dr. Maguire is the director of Products, Solutions and International and member of the senior management team for Environmental Systems Research Institute, Inc. (ESRI). He joined the ESRI family in 1990 as the technical director, later becoming the managing director for ESRI's international office in the United Kingdom. Dr. Maguire has authored or co-authored over 70 books and publications on GIS, including the industry recognised *Geographical Information Systems*. He received his doctorate degree in Geography from the University of Bristol in 1983, and is a Fellow of the Royal Geographical Society.

#### **Past Experience**

Dr. Maguire joined ESRI in 1997 as the director of Products, Solutions and International at ESRI's Corporate Headquarters in Redlands, California. In this capacity, he is responsible for coordinating company-wide product development, and all business outside the USA. He is also a member of ESRI's senior management team, and works closely with the President, directors of Product and Software Development, and the directors of Marketing and Sales to develop and communicate ESRI's product direction.

Dr. Maguire works with users, developers, and staff in regional and international sales, vertical marketing, and applications to articulate user requirements. He also directs improvements made in product interoperability, and facilitates the integration of the product development and sales/marketing processes. Dr. Maguire creates and monitors product specifications and timelines, and is responsible for directing ESRI's medium and long term product planning.

Prior to joining the corporate management team at ESRI's headquarters, Dr. Maguire worked as the technical director, and subsequently the managing director, for ESRI in the United Kingdom. ESRI (UK) is one of the main international offices of ESRI. As technical director, he was responsible for all technical and training activities, consultant work, software development and database automation. As managing director, he managed the day-to-day office activities including budgeting, strategic planning and resource allocation. In 1996, ESRI (UK) generated over \$9 million and employed over sixty people.

For over a decade David Maguire has been a project manager and advisor on over 100 GIS implementation projects all over the world. These have spanned government, education, and the private sector including several large utilities. He has considerable experience of enterprise technology integration, and technology and business planning.

#### **Other Professional Experience**

From 1987 through 1991, Dr. Maguire worked as a GIS lecturer for the University of Leicester, UK.

From 1988 through 1991, he served as director and primary instigator of MSc in Geographical Information Systems, University of Leicester.

From 1989 through 1991, he was the co-director of the ESRC-funded Midlands Regional Research Laboratory and University Computer Board-funded Computers in Teaching Initiative Centre for Geography.

From 1984 through 1987, Dr. Maguire served as a geography lecturer for the University of Plymouth.

Dr. Maguire has been a keynote presenter of papers at major national and international GIS conferences in more than 25 countries.. He has served as a visiting Professor of Geography at Birkbeck College, and Univeristy College, University of London, and at the University of Redlands.. In the past he was an elected member of the UK Association for Geographic Information, and a member of the Editorial Advisory Board of GISEurope, GeoWorld and GIS@Development.

### **Presentations and Publications**

Dr. Maguire has authored and edited seven books and atlases, including:

*Computers in Geography*. Longman, London 248 pp. Reprinted twice and translated into Italian, 1989.

*Geographical Information Systems*. With M.F. Goodchild and D.W. Rhind; Longman, London 1086 pp. Reprinted twice, 1991. Second edition 1997. Established as the definitive GIS text. Also described as one of the four major achievements of the ESRC-funded UK Regional Research Laboratory Initiative by Prof. Peter Burrough in his ESRC-commissioned review of the Initiative.

*Geographic Information Systems and Science*. With P. A. Longley, M.F. Goodchild and D. W. Rhind; John Wiley & Sons, Chichester, 454pp. 2001. The is the best selling undergraduate/graduate text on GIS.

Author of over 60 papers including refereed articles in *International Journal of Geographical Information Systems*, *Computers & GeoSciences*, *Area*, *Journal of Biogeography*, *Quaternary Science Reviews*, *Journal of Geography in Higher Education*, and *Computers, Environment and Urban Systems*.

### **Formal Education**

B.Sc., Combined Honours, Biology and Geography, University of Exeter, 1979.

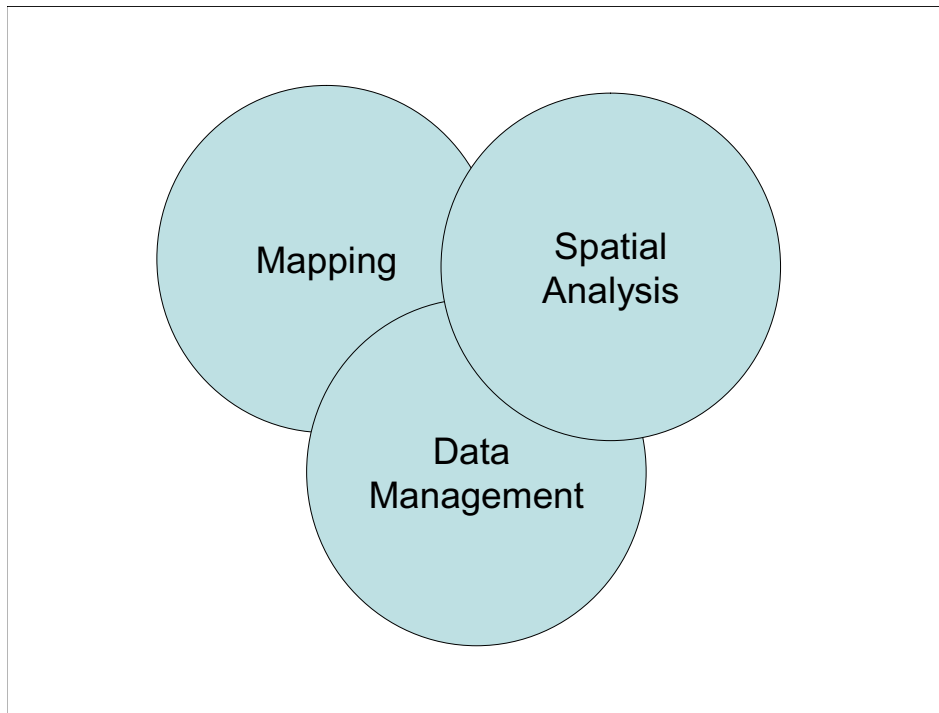
Ph.D., Geography, University of Bristol, 1983.

## Enterprise Geographic Information Servers: a New Information System Architecture

Dr David J. Maguire  
Director of Products, ESRI

Throughout the course of the last forty years, Geographic Information Systems (GIS) have been created using a variety of contemporary computer architectures (Coleman 1999). The earliest systems were built to run on mainframe and mini-computers, then came workstations, next PCs, and now system designers are recommending web-based technologies for distributed systems (Peng and Tsou 2003). A new architecture is currently emerging based on some new technologies that allow all GIS functions to run in a centralized server environment and be accessed from any device on a network. This paper will describe this new Enterprise Geographic Information Server approach and its implications for building truly distributed enterprise GIS.

GIS comprise three major subsystems that are concerned with mapping, spatial analysis (geoprocessing) and data management. A useful general purpose GIS needs capabilities in all these areas.



The three subsystems that are needed for a well-rounded GIS platform.

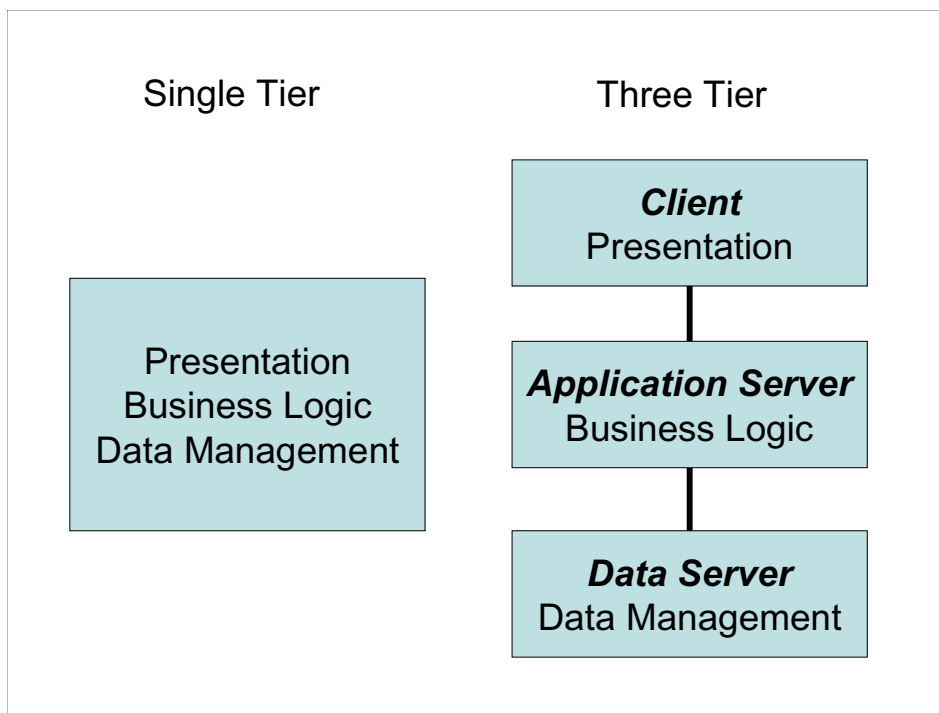
The mapping subsystem deals with the manipulation and visualization of geographic information. It is here that users will find projection and datum transformations, map to page transformations, symbology models, map displays, 2D and 3D visualization tools, editing components, and the framework for interacting with geographic data in the form of a map.

The spatial analysis subsystem implements a series of geographic analysis functions for the two classic geographic operations of proximity and overlay analysis, as well as functions for data conversion (import CAD data, export graphics, etc.), grid analysis (watershed modeling, intervisibility analysis, etc.), and 3D analysis (calculation of slope, aspect, etc.).

In the past few years it has become common practice to use commercial off the shelf relational database management system (RDBMS) products - such as Microsoft Access, IBM DB2, Oracle

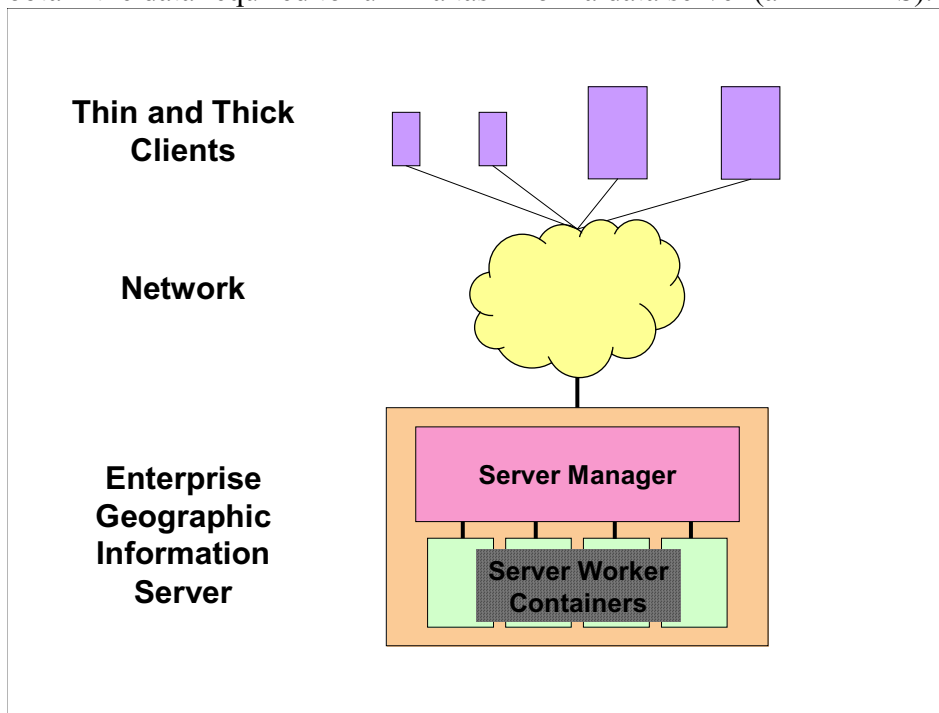
and Microsoft SQL Server - to store and manage geographic information (Longley *et al* 2001). RDBMS have been widely used in GIS because they allow users to create a single, centralized data repository (avoiding redundancy and duplication), they facilitate data sharing (by establishing *de facto* standards), they support multi-user editing of continuous geographic databases, and they allow users to employ RDBMS backup and recovery tools. However, the limited support for advanced geographic data types (Shekar and Chawla 2003), the weaknesses of SQL as a geographic data access and programming language (Egenhofer 1982), and concerns about scalability for operations such topology management (Hoel *et al* 2003) have instigated a re-examination of the role of RDBMS in GIS and have prompted the development of Enterprise Geographic Information Servers..

The three GIS subsystems can be implemented on a single computer (single tier architecture), two computers (two tier architecture), or in the case of large systems they are usually spread across three separate machines (three tier architecture). Presently, almost without exception all the major GIS software systems have been developed to operate on desktop class personal computers running the Microsoft Windows operating system. In a single tier architecture the presentation (user interface), business logic (geographic processing functions), and data management functions all run on the same machine. At the other extreme, in a three tier situation the presentation tier (including the mapping and spatial analysis subsystems) runs as a client on a desktop PC, the business logic for data access runs on a middle tier application server, and the data management tier (RDBMS) runs on a server. In this type of configuration the client has sophisticated capabilities and in advanced systems can comprise several hundreds of megabytes of code (a so called thick client implementation). This configuration has served GIS users well for the last decade, and will continue so to do for advanced GIS tasks like editing, cartographic compilation, 3D modeling and spatial analysis. However, in recent years users have become dissatisfied with this type of architecture for less demanding tasks because for large deployments the cost of client machines and software is prohibitive, it is expensive to maintain and update widely distributed PCs - especially if users can not do it themselves - and it is difficult to maintain corporate standards throughout a widely dispersed organization.



Single and Three Tier Information System Architectures.

An alternative, more centralized architecture is emerging that addresses these problems. At the heart of this new architecture approach is the idea that the Application Server tier can be enhanced to encompass not only the data management GIS subsystem, but also the mapping and spatial analysis subsystems. Running all the GIS components on a server means that only a very thin client is required to initiate processing requests and display the results of GIS tasks. Such centralized GIS implementations are now being referred to as Enterprise Geographic Information Servers. They allow both thin (browser) and thick (desktop GIS) distributed clients to access data and processing capabilities over a standard local or wide area network. The server itself has two parts. The server object manager is responsible for interfacing with the network (e.g. a web server) and for allocating requests to server worker containers that perform the actual work. Both parts can run on the same CPU or more than likely for scalability reasons they will be spread over multiple machines or CPUs on the same machine. The server worker containers obtain the data required to fulfill a task from a data server (an RDBMS).



Enterprise Geographic Information Server Architecture.

Enterprise Geographic Information Servers have a number of characteristics that make them ideal for serving the needs of distributed GIS users.

- **Low cost of maintenance.** Because all data and processing capabilities are centralized in one location, costs of upgrade and maintenance are minimized (e.g. software updates do not need to be pushed out to hundreds of PCs). GIS servers can be installed alongside an organization's other servers and the same IT staff can be used to maintain both.
- **Easy scalability.** Adding additional resources can easily be achieved by installing new memory or disk in an existing server, or by installing a new server, without taking the system down. Moreover, the resources required are not expensive state of the art hardware components, but widely available lower cost general purpose machines.
- **Standards-based access to data and processing.** A key factor that will encourage the uptake of Enterprise Geographic Information Servers is that they have open standards-based application programming interfaces (APIs) that expose the all data and processing capabilities for use by developers. This means that users of all types can access data and

processing across a network from any location. The key standards that are supported include: XML/SOAP (extensible markup language / simple object access protocol) for messaging and data transfer over web (http) network connections; Java for building local and wide area network enterprise applications; and .Net for building local and wide area network enterprise applications. Such standards offer a rich environment for communicating with an advanced application server and for building true enterprise applications.

- Support for all key GIS data types and functions. In order to address the widest range of users and applications, Enterprise Geographic Information Servers support all common GIS data types and functions. Supported data types include 2D and 3D vectors, rasters, annotation, attributes, addresses, CAD, survey measurements and computations, dimensions, networks and topologies. The list of functions includes a full range of mapping, spatial analysis and data management tools such as topographic and thematic mapping, editing, geocoding, network analysis, data management, 3D analysis, raster (spatial) analysis, and geoprocessing.

Enterprise Geographic Information Servers are well suited to simple and medium complexity GIS tasks that can be undertaken on a remote server accessed over a network. Typical tasks include creating a topographic map centered on a user-specified location, at a user-specified scale, simple editing (e.g. heads-up, on screen land parcel creation and boundary update, or changing the attributes of street lights and road signage), and determining the shortest route for a vehicle between multiple home delivery stops. Complex applications that require high interactive performance and extensive local processing power are not well suited to wide area network deployment and will continue to be implemented on dedicated local computer resources such as a desktop PC.

Enterprise Geographic Information Servers are good examples of the new class of Information Systems called Enterprise Application Servers. Similar general purpose systems have been developed by major vendors such as BEA (Weblogic), IBM (Websphere), Microsoft (Windows Server), and Oracle (Oracle Application Server). They all rely on and enhance the capabilities of RDBMS by providing enterprise application development tools, network services, web services interfaces, and scalability frameworks. In addition to GIS, a number of other application areas have also adopted this server implementation approach. Enterprise resource planning (Oracle, Peoplesoft and SAP), and customer relationship management (Microsoft, Pivotal, Siebel) systems are both examples of server-centric applications.

In conclusion, Enterprise Geographic Information Servers are a new type of GIS architecture that supports access to potentially thousands of distributed users from a centralized location. The industry standards-based approach to data management, application development, and data and processing access makes them ideal for providing GIS services to a wide range of distributed users. Similarly, the low cost of maintenance, high scalability and excellent reliability means that organizations can create compelling business cases that demonstrate a good return on investment. In the next few years many new GIS user organizations will build systems based on this new server-centric architecture, and many existing user organizations will transition their system to it.

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