Deploying Enterprise GIS in a State Agency

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Introduction

GIS is a technology. As such, it is a synthesis of hardware, software, data, personnel, and protocols that combine into a single paradigm to do business using the power of geospatial methods. GIS is an integrating technology that provides the mechanisms to allow data from disparate sources to interact. Most importantly, data from different hardware and software systems can be combined to create new information. It is GIS technology that provides the ability to leverage data across all levels of government and produce new information to address the problems of modern society.

To realize the benefits of GIS, the technology must be integrated into existing workflows and procedures. An enterprise implementation of GIS will make this happen by placing the powerful tools of GIS in the hands of the professionals working in an agency. They already know how to do their jobs and only lack the capabilities that spatial data query, analysis, and presentation can add to their work product. Once GIS is available across an agency, as part of its IT infrastructure, a synergy will occur that will build more expertise and demand for GIS solutions to address the agency's mission. This section develops an approach that can implement agency-wide, enterprise GIS using three (3) professional GIS positions, at a salary cost of less than $115,000.

This section outlines the basic components of GIS technology and how they interact to create an enterprise system. It is important to understand that GIS is *not* an end unto itself, but a means to convey data to professionals that allows them to perform their work more effectively and efficiently. Furthermore, it provides a means to communicate the information they produce, to policy makers and the general public. In this regard, GIS is truly an enterprise resource, not limited to the few who specialize in its development and maintenance, but for all who seek and require the information it can deliver. With this approach, GIS becomes a tool for everyone to use, across the enterprise. Like other applications in common use today (word-processing, spreadsheets, presentation software), GIS should be viewed as another tool at the disposal of every employee who needs to use the technology in their work. Thus, enabling employees to adapt GIS to their work and better meet the unique and particular needs of an agency in support of its mission.

Terminology

GIS technology brings together the disciplines of geography and information technology, incorporating the terminology used in both fields, as well as generating new terms. For this reason, the following terms are defined:

Application – A program or system of programs that perform a specific function or set of functions.

Application Server – A computer that provides programs to clients. The programs (applications) they serve are designed to perform specific tasks or sets of tasks. The programs are run on the server and their results sent to the client.

DMZ – The "demilitarized zone." A feature of network topology that defines an area neither wholly within nor outside of an agency's computer security border.

Enterprise – An organization taken as a whole. It may be a state agency or the entire state as a body of government.

Firewall – A network feature that describes a security barrier that demarks the "inside" and "outside" of an agency's computer security border.

Geospatial – Anything pertaining to the location or juxtaposition of features on a map and where they are located on the surface of the Earth.

GIS Client – A computer that performs GIS functions using local data or data provided by a GIS Server.

GIS Server – A computer that provides GIS data.

GIS User – A person (professional, lay person, whomever) using GIS to perform a task or set of tasks.

GIS Professional – A professional trained in the areas of information technology, geography, and/or other professional disciplines with the technical expertise to develop, support, and maintain geographic information systems.

Internet – The network of computers connected by the "World Wide Web." Typically, this is the part of a network that resides outside of the security border of an agency.

Intranet – The network of computers connected within the agency, including wide-area networks (WAN) and Local Area Networks (LAN). This is the part of a network that resides within the security border of an agency.

IT Professional – A professional with academic or technical training in information technology, computer science, or information systems.

Professional – A person performing any skilled or professional work functions, such as an employee in the academic, private, or public sectors.

Thick Client – A computer application that runs locally on the user's desktop and performs sophisticated functions on that computer, using data from a server, *e.g.*, ArcGIS.

Thin Client – A computer application that runs locally on the user's desktop and relies on a server to perform sophisticated functions and display the results on the local computer, *e.g.*, Internet Explorer.

These terms are used throughout this discussion and in its figures.

User Levels and their Support

GIS technology can support the needs, and can provide important information, to all levels of users, from the least sophisticated to the most experienced GIS user. Users fall into four (4) categories, supported by an IT-GIS staff. In this model, the location of a user, inside or outside of an agency is irrelevant. It assumes that users of all levels exist, inside and outside, and will served by the enterprise GIS. These categories range from the completely naïve, Level 0 user, to the occasional user, at Level 1; the regular, Level 2 user; and the sophisticated Level 3 user. There are less people in each subsequent category. However, this will change as GIS is integrated into regular workflows. User experience and demand for more GIS data and capabilities will grow across the agency. Training and experience is the means by which any user can move up to the next level. This will be dictated by their needs and interests. Another feature of this user structure is that any higher-level user can benefit and use the technology that supports lower-level users. The structure is represented in Figure-1.

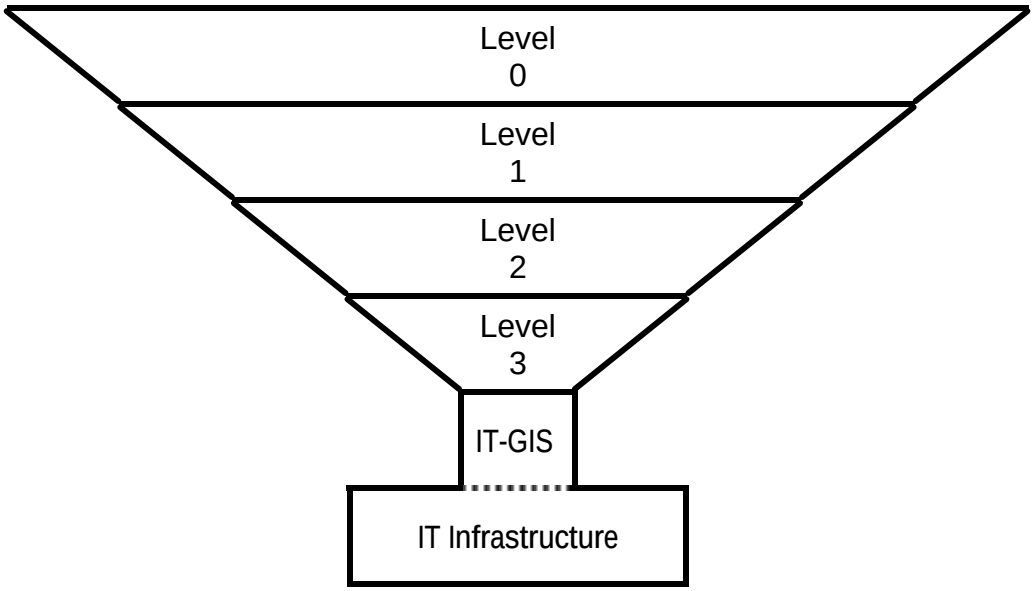


Figure-1. GIS user structure and IT support. Users increase in sophistication and decrease in number from Level 0 to Level 3. They are all supported by a small, professional IT-GIS staff which is integrated into the enterprise

As GIS becomes a more important part of an organization's workflow, the user structure is likely to change. There will always be a large Level 0 user-base in the form of the general public. Private sector professionals (Levels 1-3) will also always be present. In the model, any user, inside or outside, of an agency will benefit from training and experience and will move up in the structure, as a result. The user groups, their definitions, and the technology that serves each of them are listed, bellow:

GIS User Categories

Level	Description	Technology
0 Naïve User	Naive user, lacking access to or knowledge of GIS. These users have immediate information needs that only GIS can provide.	Complete GIS services must be provided to these users, for example, a map, report, or table. Within an agency these users should receive basic training to advance them to Level 1.
1 Occasional User	Professional performing work that occasionally requires information provided by a GIs.	Thin client, Internet services and some applications that perform specific functions. Example: DEQ "Make a Map."
2 Regular User	Professional performing work that regularly requires data from GIS.	Thin and thick client applications, as well as web and GIS server applications. Examples: DNR and DOTD ArcIMS websites, ArcGIS.
3 Advanced User	Professional who performs analysis using GIS data and/or creates GIS data as part of their job.	Thick client applications that run locally on the desktop and provide advanced and sophisticated GIS functionality. Example: ArcGIS.
IT-GIS GIS Professional	Professionals with advanced skills in IT, geography, and experience in applying GIS in a professional discipline.	Responsible for developing and maintain the enterprise GIS environment. This includes training, technical support, application

programming and web development.

Some salient features of this user model include:

- The entire continuum of users is addressed and information can be delivered to all persons across the enterprise, as well as outside the agency.
- Training and experience will move users up the continuum.
- The entire user-base is supported by a relatively small professional IT-GIS staff (as few as three) that is integrated into the enterprise IT infrastructure.
- Users at any level can benefit by the technology applied to serve lower user classes.
- The IT-GIS staff is part of and supported by the agency's existing IT infrastructure.

Enterprise Architecture

GIS technology is assembled and organized into an architecture (or "configuration") which represents how various components comprising the enterprise GIS are connected and relate to each other.

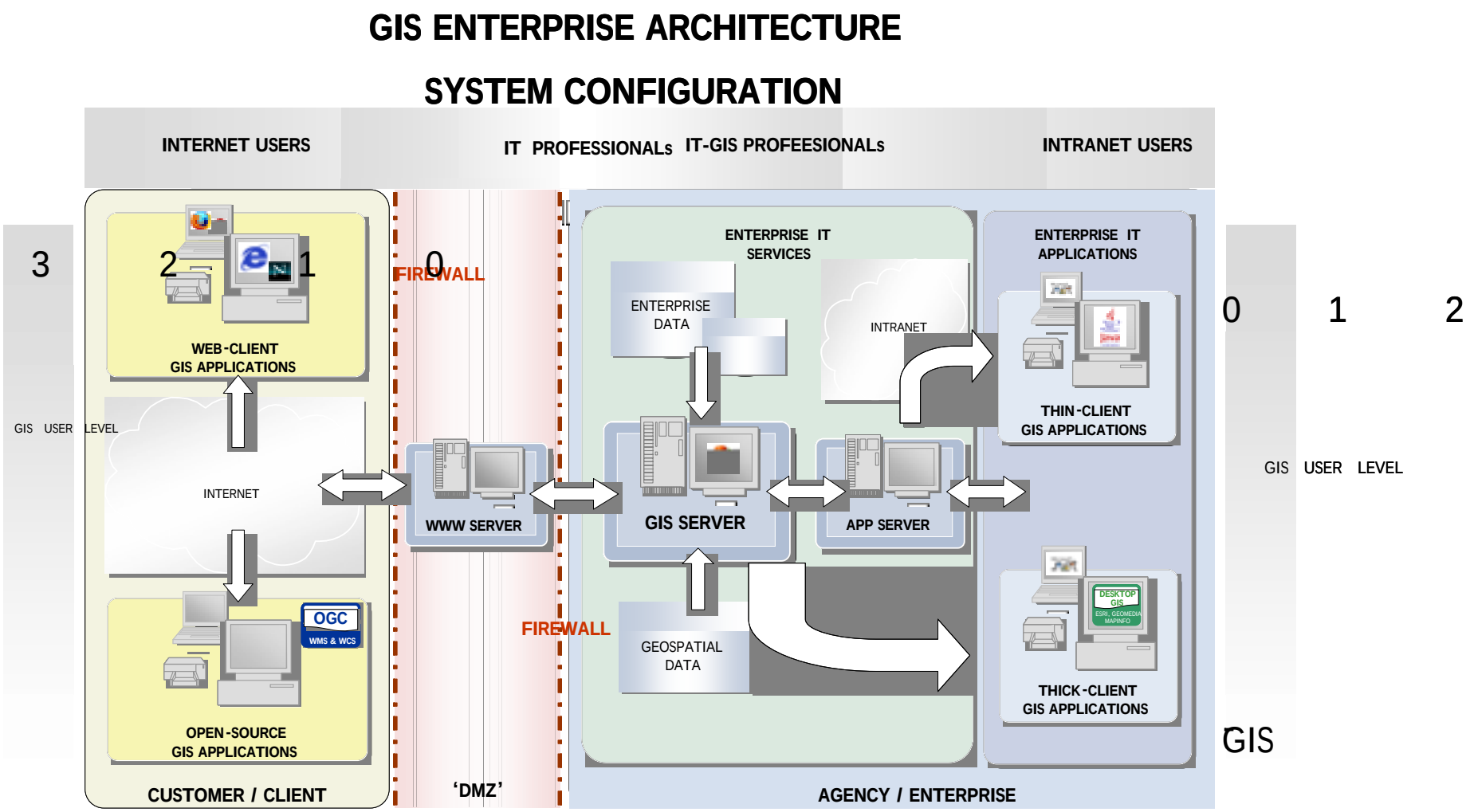
Enterprise architecture includes all aspects of the system. The users of GIS data were addressed in the previous section. This section addresses the hardware, software, and personnel required to maintain the enterprise GIS environment. It is provided as a template for implementation of GIS at an agency level. It can be implemented with a minimum of personnel (three professional, IT GIS positions), integrated into an agency's enterprise IT infrastructure.

It is important to understand the role of GIS as an enterprise resource, not another "stovepipe" application within an organization. Just like every other IT resource, GIS is a tool for professionals to use to do their work. In the same way that an agency's IT staff provide network, mass storage, and technical support for activities such as word processing or email, GIS staff works in concert with the other parts of the IT staff to deliver geospatial information. This includes the maintenance of servers, software, and databases. This approach frees the IT-GIS staff to concentrate directly on activities that support the GIS parts of the enterprise IT environment.

It is essential to maintain the separate roles of the various parts of the enterprise IT infrastructure, to be able to maximize efficiency and personnel resources. The enterprise GIS architecture is diagramed in Figure-2.

The central feature of this model is the GIS Server. It is typically a high-end server-class machine, networked, with multiple processors, as much memory as possible, and connected to a storage area network. It simply provides data to all GIS users using a relational database management system (RDBMS) in conjunction with GIS software that communicates between the

RDBMS and the GIS users, web servers, and application servers. These elements are all scalable, as requirements dictate.



GIS USER LEVELS
LEVEL-0: PUBLIC OFFICIAL, PROFESSIONAL, OR GENERAL PUBLIC WITHOUT GIS SKILLS OR ACCESS, REQUIRING INFORMATION
LEVEL-1: PROFESSIONAL OCCASIONALLY REQUIRING INFORMATION; BEST SERVED USING GIS VIA WEB / SERVER / APPLICATIONS
LEVEL-2: PROFESSIONAL REGULARLY USING DATA REQUIRING GIS; BEST SERVED VIA DESKTOP CLIENT / APPLICATION SERVER
LEVEL-3: PROFESSIONAL PERFORMING GIS ANALYSIS OR PROGRAMMING, OFTEN CR EATES GIS DATA; REQUIRES DESKTOP CLIENT
IT-GIS: GIS PROGRAMMER / ADMINISTRATOR / TECH. SUPPORT; MAINTAINS G IS APPLICATION & DATA MANAGEMENT ENVIRONMENT

Figure-2. Enterprise GIS Architecture. This diagram shows how hardware, software, and user levels are interrelated to provide information across the enterprise.

The technical management of this hardware can be performed by regular IT staff, while the data and systems are maintained by IT-GIS staff. The RDBMS, typically, can access legacy data, already present in current enterprise data systems. This linkage plays an important role in integrating existing enterprise data into the GIS environment. Web servers located in the DMZ can be used to provide external user's data and/or information from the GIS server. Web servers within the IT security boundary can provide information that is restricted to internal, Intranet users only. Application servers can likewise be provided inside and outside to deliver task-specific GIS functionality to their respective users.

Web servers play an important role providing either information or data to users. The users may reside within or outside of the organization. Web servers can provide services to both thin and thick clients. In turn, this serves the various user classes outlined earlier. Thin clients, such as Internet Explorer, can be employed to provide information in the form of maps, reports, or data. This is typically presented in an interactive map format where users identify an area of interest on the map, display the information they wish to see, and click on hyperlinks embedded on the map to "drill down" to specific data. The hyperlinks "pop-up" windows that display the information in a predetermined format. Thick clients, on the other hand, use the web services to directly access data from the GIS. In this manner, advanced users inside and outside of the organization can work directly with the enterprise GIS data in a secure environment. There is no risk of users altering data in this situation. All security mechanisms exist to provide or limit access to appropriate persons.

Application servers, like web servers, access information via network connections. The main difference it that application servers do just as their names imply. They perform a specific GIS application, locally on the server, and send the results to the user (referred to as a client). For example, an application can be developed that creates a specific map or report. This differs from a web server by actually performing a series of tasks to complete the client request and return the result. A web server can perform many of these functions, but often require more user interaction to perform multiple steps, and returns, just a map, to a browser. The application server will only provide the requested service by performing the specific tasks. Therefore, given a starting point (and minimal input of data, possibly "hard-wired"), "one-click" applications can be provided to users who need GIS functionality but lack the knowledge or resources to accomplish their end.

Open GIS standards being developed to promote interoperability between different GIS systems and hardware platforms are currently in their infancy. As a result, it is difficult to address these issues at this time. Still, at an enterprise level, this will not be a major issue, as organizations typically develop software standards to avoid interoperability problems.

Summary

GIS is a technology. It is most powerful in the hands of professionals who can use its ability to gather, analyze, and present data and information. As described in this section, the technology exists to provide all levels of users the full range of GIS capabilities using an enterprise model.

User needs vary from simple information requests, to data retrievals, to cartographic display, and at the most sophisticated level – advanced spatial analysis. Figure-2 depicts a basic

configuration of the technology necessary to provide GIS as an enterprise resource. It describes user levels and roles and the technology that serves them.

The technology described in this section is a minimal configuration of hardware and can be supported using a staff of three (3) GIS professionals, located within a department's information technology infrastructure. Implementing such a scheme, will augment existing IT resources and can be accomplished comparatively easily. Because there need be little overlap with existing resources, GIS can become a true addition to the IT environment, maximizing its benefits to the agency.