Title: Business GIS: Applicable and Obtainable

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ABSTRACT

Although the following quote refers to programming languages, it could also aptly apply to software in general:
"Programming languages should be designed not by piling feature on top of feature, but by removing the weaknesses and restrictions that make additional features appear necessary." (Clinger, 2003)

GIS data comes from many sources: images, survey data, digitized data, scanned data. The unique integration capabilities of GIS bring together data from many sources for visual display and analysis. Consequently, GIS must support platform-independent solutions that can be implemented for varying server hardware, operating systems, networks, databases, development tools, and desktop applications in addition to Web and mobile clients. (ESRI, 2003)

The abundance of data in addition to the many types of available programs, languages and structures provide challenges to the developers of the easy-to-use applications demanded by the business user. Most businesses are seeking a user-friendly application that efficiently manages their specific data set. Building a stable, easy to use platform usually outweighs the gains afforded by more options, more buttons. Today's GIS software user will not be satisfied with a user-unfriendly program, no matter how smart. More powerful and innovative products for less money provide businesses with faster and more accurate access to market data and improve resource management.

Ideally, a generic data format could be created which would be read by existing GIS programs, independent of make or platform, like many CAD files, or image files or data based on Spatial Data Transfer Standard (SDTS). The processing of this base data would then create software specific solutions, which could be generalized for public use, or locked for internal use. (After all, a company may not want to share all of its value-added products.)

These programs would, ideally, be able to interact with each other and would be software independent: they would be applicable and affordable - customizing functionality to fit within budget.

This would represent an application environment where data is collected, loaded, stored and computed on different operating systems applying various programs. Client and server computers are set up in the system. The procedure represents the next generation GIS processing, with benefits such as fewer consultants and faster learning curve. Drawbacks would include having to set up the systems itself with TCP/IP protocols and authentication. Finally, standards need to be developed and attached to the data itself, otherwise operations at various scales would create elegant, but potentially flawed results. Scale, projection, appearance all still need to be set correctly for mapping programs to work efficiently and usefully.

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1. INTRODUCTION

GIS, or Geographic Information Systems, is becoming a multi-billion dollar industry. (McLaughlin, 2003)

This growing industry offers a countless variety of software applications to create and manage our spatial data. The many available programs that manipulate data have at least one thing in common: they are set up to have minimal user interaction (or should be). The user interface is built around the concept that although the people using it are computer literate (after all, they create some of the files used in the programs), they are usually not computer experts.

Thus, if the data exchanges and the data manipulations performed by an application can be tailored to be minimally intrusive to the users, these users will probably be return customers.

As with any successful desktop application, successful GIS programs will be portable, platform compatible and easy to use. The easier it is to use and cheaper it is to purchase, the more commonplace GIS will become (Schultz, 2004). Web applications may take up a part of the market, since they are platform independent: all types of data, applications, images, etc. could be retrieved from a web site one day.

"You'll be able to go online and instantly get what you need. You'll pay depending on how long you're there and how much you need. You'll be willing to pay because, as costs drop, the value proposition of GIS data will become very clear." (Schultz, 2004) The GIS web services may become like today's pay-per-view cable services: use it, and pay for the time allotted.

How could GIS become universal?

- Desktop computer based (whether Mac, Linux or laptop), hardware increasingly affordable
- Numerous software products run on different platforms
- GPS data integration possible with web applets and mobile devices
- Data sets available (TIGER files, TIFF images)
- Current emphasis on security and emergency response

Mapping organizations will, as always, be technology dependent and have a rich history of successfully utilizing emerging technology to deliver programs. The major technological trend will involve linking the multitude of existing spatial databases, as we move towards integrated, total solutions markets. Information will be our primary commodity and the growth potential will be in developing value-added applications and uses of that information. (O'Donnel, 1997)

This paper addresses the success of business GIS, by discussing the evolving markets and changing demands on GIS companies; providing a real example of a GIS company providing open system solutions; what advantages open systems provide; and finally, a look at what the future holds for business GIS.

2. EVOLVING MARKETS

By providing a service shaped to fit that individual business, GIS can be made available to many businesses, particularly smaller businesses with less overhead.

The application areas are nearly endless: local, state and federal governments; urban, regional and national planning agencies; environmental planning, geology, forestry and hazardous water management; gas, electric and water utility; telephone, cable TV...etc. (Bossler and Thapa, 1992). There are numerous vendors and consultants who help users identify their needs: hardware, software, personnel...etc. The continuing demand for quality and efficiency necessitated the linking of various hardware and software: GPS derived points link to a digital map for instant mapping, which can be linked to real-time photography for coordinates or landmarks, which can be linked to laser ranging...etc. In addition, there are many sources of data. The Federal Government is a prime collector, user and distributor. (See diagram 2.1)

Examples of Federal Geographic Information System (GIS) Activities

Agency	Description
Natural Resources Conservation Service (Department of Agriculture)	Geospatial Data Gateway provides easy and consistent access to natural resource data
National Cartography and Geospatial Center (Department of Agriculture)	NCGC Internet Mapping offers Web access to view samples of hydrography, digital orthophotography, digital topographic data
National Oceanic and Atmospheric Administration	NOAA makes extensive use of a GIS to store the large quantity of data it collects.
U.S. Census Bureau (Department of Commerce)	Provides online maps based on Census data that can be manipulated in many different ways.
NASA & National Imagery and Mapping Agency	Shuttle Radar Topography Mission employs a specially modified radar system
National Imagery and Mapping Agency (Department of Defense)	Provides timely, accurate, global aeronautical, topographical, and maritime information
National Renewable Energy Laboratory (Department of Energy)	GIS site provides dynamically generated maps of renewable energy resources
Los Alamos National Laboratory (Department of Energy)	GISLab supplies geospatial information for internal and external users of geospatial data.
Department of Housing and Urban Development & the Environmental Protection Agency	E- Maps combines information on HUD's community development and housing programs
Federal Emergency Management Agency (Department of Homeland Security)	Provides a full range of GIS services to all FEMA program offices which include storm tracking
US Geological Survey (USGS) (Department of the Interior)	Provides a site that serves as a node of the National Spatial Data Infrastructure
Bureau of Land Management (Department of the Interior)	Uses GIS to store and analyze public land and administrative jurisdiction information.
U.S. Forest Service (Department of Agriculture)	Uses GIS to provide information on vegetation, water, fire, and soil for specified forests
Justice Programs Office for Victims of Crime (Department of Justice)	Uses GIS to map crime victim services.
National Park Service (Department of the Interior)	Strives to have a comprehensive automated information system for each national park
Volpe National Transportation Systems Center (Department of Transportation)	Uses GIS to identify data such as county boundaries, roadways, and railroads
The Environmental Protection Agency	The EPA provides a wide variety of spatial data such as information regarding air, water, land,
Tennessee Valley Authority	Provides an interactive map of the entire TVA
Centers for Disease Control and Prevention (Department of Health and Human Services)	Uses GIS to provide maps and data on public health issues in the United States.

(GAO Report, 2003)

Diagram 2.1 *Federal Government data sources*

What value do these linked programs and data have?

- creates effectiveness - no time wasted running conversion programs
- valuable in planning - accurately incorporates complex, interrelated data
- benefit from spatial evaluation of customers/clients - streamlines requests, link customer to specific location

Interoperability could also standardize the accuracy of the data, and reduce collection costs. The collection of accurate data is the most cost intensive part of setting up and maintaining a GIS (Bossler and Thapa, 1992). Many users believe that since the data is digital, it can provide data at any scale, at any accuracy. This mind set can evolve into credibility loss, when proposals and products are inconsistent with ground truth. The product may be elegant, but style cannot replace substance. Perhaps metadata for data files could include date and time of collection, along with usable scale for the components of digital cartographic data.

As a reminder, according to the National Committee for Digital Cartographic Data Standards (NCDSDS, 1988), there are six fundamental components of digital cartographic data:

- lineage
- positional accuracy
- attribute accuracy
- logical consistency
- completeness
- temporal accuracy

As technology evolves, the market will continue to reflect our need for data accuracy and user-friendly applications. These applications must reflect the needs of the cartographer and businessperson.

3. PROVIDING OPEN SYSTEMS SOLUTIONS

The goal of an open system is the free flow of uninterrupted data within a network, independent of hardware/software. Different companies have different databases, programs…etc. The list of these is far too numerous to mention. Tying these together represents the next generation GIS. Perhaps, a standard solution to each project is not available, nor advisable, as that would create limitations to each solution. Each solution is unique, and the data packets that are distributed within have to be very well defined. The increasing speed of the network capabilities, new software, and cheaper datasets all make this idea relevant.

Dynamic Link Libraries (dlls) or Executable files (exes) can pass data among applications on Windows based operating systems, and also to other systems, with caveats. With interoperability comes the use of computers referred to as clients and servers. Servers provide some service, and clients use this service. A DLL is a collection of callable procedures, and are loaded into the clients address space. Dlls can be created in Visual Basic, or C languages. A dll is loaded into the client, and the client's programs access the server through the dll. For example, a website can calculate latitude/longitude values from generic measurements, then it passes on these values to a dll on the user's computer, which in turn can do various other calculations, then pass these values on to a program, which displays the final result. Executable files run separately from the client's other programs. This creates the advantage of being more stable; a server crash will not affect the client's programs.

Some real-world solutions provided by Digital Information Systems Inc., (DIS) across a variety of businesses:

- Route planning for a Midwestern executive jet company
- Homeland security data collection for an international airport
- Marketing distribution planning newspaper publishing company in one of the top ten metropolitan cities in the country
- Regional and enrollment planning for school district
- Emergency response preparedness, community mapping in several states
- Drug distribution planning for national pharmaceutical company

In every case, businesses involved in the above projects demanded the use of their existing software, which then had to be linked to the data created by the GIS software, but all of them wanted a solution which can work with other, non-mapping programs. Thus, DIS is a provider of applicable and obtainable GIS.

Digital Information Systems is a dynamic, growing Mapping/GIS company located in central Ohio. DIS initially evolved from an established engineering firm to better service the growing need for E-911 mapping solutions on the city/county level of several widespread sites.

DIS later expanded its focus, providing GIS solutions to pharmaceutical, publishing and airline companies. These are multi-million dollar companies for which DIS has been able to provide marketing, routing and demonstration tools, as well as providing customizations when the client required additional applications.

Why did top industry leaders choose a small company like DIS? Because what businesses want is a reliable, easy to use solution, with maximum efficiency. This does not have to include the most expensive software with all of the known bells and whistles. DIS was able to provide their customers with a realistic scope of work and time frame, using available software and low overhead. By combining mapping software with programs that linked various applications together, DIS was able to provide a reliable, effective solution for the customers, using their own datasets and ideas.

The software is efficient, friendly and priced right, compatible with other forms of software/data formats that the customers use with results that can be migrated from one platform to the other.

For example, DIS has provided services to a pharmaceutical company, an airline and a local newspaper.

A pharmaceutical company required assistance in evaluating their distribution systems. A dataset was created using the company's proprietary software. This data set was then input into the GIS, as the basis for the evaluation. The GIS has a pull-down menu interface set up, in which the user is able to select the distribution variables for each location. Once the variables are selected, the calculations start, and the results are automatically displayed on the screen, in a format requested by the user. The .dbf tables and other files created by the GIS are in turn used by the company's own software for additional analysis purposes.

An airline company asked for a program that demonstrates the value and capability of their services to potential customers. Airline personnel created an internal data file, describing basic information on each flight from an airport. The user then enters this file into the GIS program, the program reads the variables and the output displays the scope and range of a flight from an airport, and predicts the time necessary to reach the destination. The graphic displays and .dbf tables are then sent to the various sales agents, who load these onto their computers to demonstrate the flights with their software.

A local newspaper was in need of marketing software, to better reach its customers. Newspaper personnel created internal data files, which the GIS program employed, for the selected geographic areas. The user makes a geographic selection through an interface created by the newspaper personnel, and the program gives a list of marketable areas in HTML format, which is then used by the computers of the sales representatives.

DIS also has currently been employed to provide GIS mapping for Homeland Security applications on transportation related projects.

4. ADVANTAGES OF THE OPEN SYSTEM

Truly open systems would allow sharing of geographic data not only with other GIS technologies but also with non-GIS applications that operate on different platforms. (ESRI, 2003)

Open systems can use different applications, different languages because they can be translated into binary form.

The examples above show that the trend is towards an enterprise-wide system used for managing and accessing large complex datasets built using different platforms, and combining them into a seamless dataset. This is similar to how the browsers work on different platforms, and are able to handle various programming languages. This could be demonstrated by the following steps (see diagram 4.1):

- loading existing data (from WEB or other source) into a handheld unit with display capabilities
- collecting data (survey, GPS) with a unit that is able to store data in the same data format
- connecting the collector to the desktop using wired or wireless connection
- transferring the data over to the desktop computer
- opening a mapping program that can read the data
- converting the data into a style that is used by the mapping program
- perform some editing
- sharing the data on a web browser with other users, who have different mapping programs, yet can still read the data.

None of the steps outlined above have any appreciable user interactions, other than they have to store the data in a particular location. The transfers do not alter the data in any way. For example, ESRI has made the shapefile format non-proprietary with openly published specs so that many GIS software packages can convert to and from this format.

Some advantages of setting up an interoperable GIS:

- Led to best performing area at any time, given that the data is current
- Steered away from “down” areas of the map
- Avoid fear and emotions associated with running separate programs
- Lower risk associated with analyzing data
- Faster learning curve
- Do not have to listen to consultant
- The systems contains all elements necessary - all others can be disregarded
- No outside management needed
- Changes in other areas are already included in updates of mapping files
- Reduce time invested in search for methodology

This would represent an application environment where data is collected, loaded, stored and computed on different operating systems applying various programs. The procedure represents the next generation GIS processing. Drawbacks would include having to set up the system itself with TCP/IP protocols and authentication.

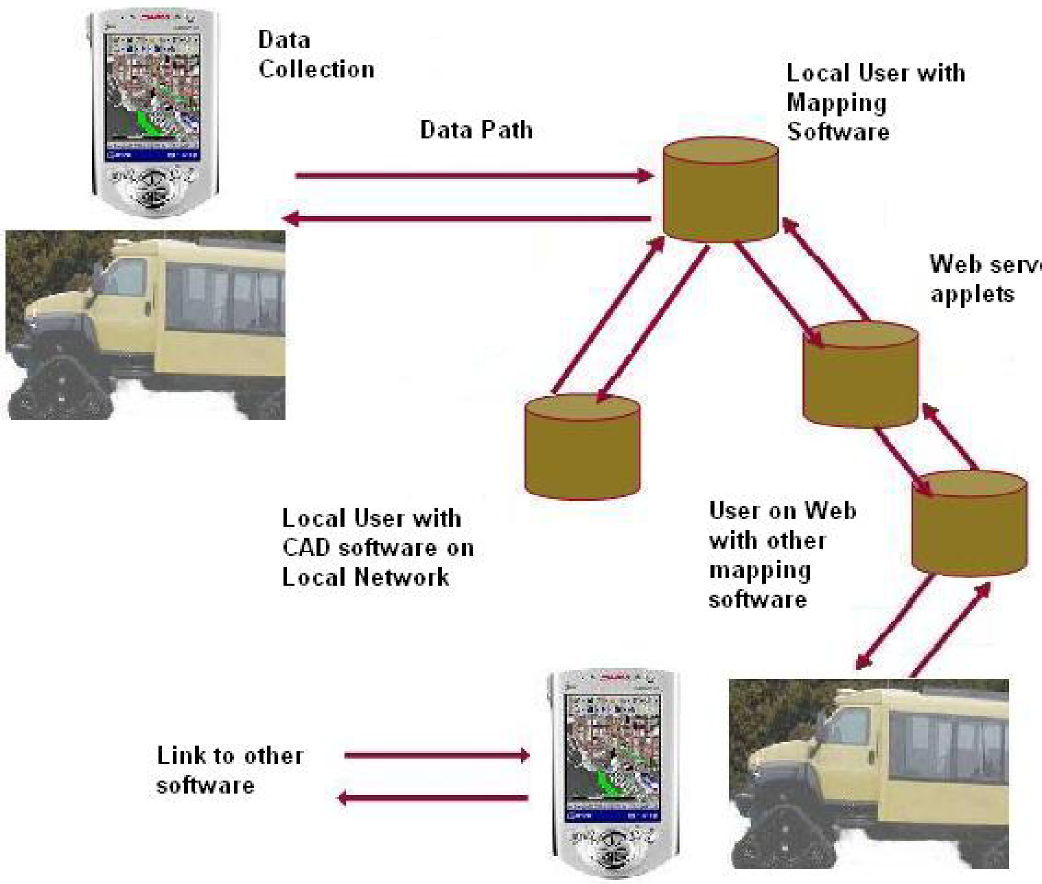

Diagram 4.1 *Data flow in an open system*

5. WHAT THE FUTURE HOLDS

In theory, the interoperability would extend from handheld devices through desktop computers and networks to web services. A continuous data flow could be provided, from one device to the next without interruption or corruption.

The question arises: how much interoperability is good for you? While interoperability is essential for taking advantage of Web-like universal access, it always comes at the cost of a lowest common denominator in specific functionality. (ArcUser Online, 2003) A user can look at data, and even manipulate the data on a website, but it may be better to have specific functions only on the user computer.

Actually, data collection just became easier with mapping software that gives cellular camera phone users ability to map pictures in real time. GPS and pictures from these phones combined with mapping software can create audio/visual data collection tools (Limp, 2004). This data can then be transmitted by wireless to other e-mail accounts.

With the incorporation of wireless technology into data collection and sharing, the size of the data packets should become less of an issue (although, of course, the data still has to be processed!) within a few years. Protecting the integrity of the data sets that are passed through wireless, however, will be another issue. After all, a company wouldn't want its highly valued data to fall into outsider's hands.

As a last point, it is impossible to discuss business GIS without mentioning the Federal Government, which is a prime collector, user and distributor of data.

These publicly available datasets, along with commercial data sets and developing technologies, like LIDAR provide a vast network of information.

6. CONCLUSION

Two related principles apply for Business GIS in general -- the KISS (keep it simple, silly) and "less is more". (Although, of course, there is only so much possible with less.) Mapping programs should be a low-stress, high return, system in practice.

In a way, although not quite as envisioned as in the 1993 National Research Council (NRC) book "Toward a Coordinated Spatial Data Infrastructure" (NRC, 1993), the National Spatial Data Infrastructure (NSDI) is making strides. This book was written before the days of the Web; development was constrained by the lack of interoperability between the major players. Each vendor had its own language, structure. In the world of interoperability, the developers need to link the data string to a dll (or other linking) file (which links to a web or a GPS unit or other programs), and the service would return the solution (Limp, 2004). NSDI is a national strategy for promoting geospatial data sharing in the government and private sectors and reducing duplication effort.

The benefits for the developers and users would be:

- Improve the spatial quality of GIS layers
- Link GIS data to other programs (not necessarily mapping/GIS programs)
- Access to data collected by primary methods (field data from Geodesy/GPS, photogrammetry, and surveying)
- Obtain spatial data easily with attached metadata
- Evaluate the accuracy of features based on information from the survey

Interoperability could also standardize the accuracy of the data, and reduce collection costs.

The risk associated with this process could be summarized by "… we can now produce rubbish faster and with more elegance than ever before" (Bossler and Thapa, 1992). There is a lot of data out there, especially true of the federal government's data set. Rigorous standards and specifications exist for primary method of data collection, yet they contain errors. Quality and accuracy of data are many times not discussed, or are overlooked when processing this data set. Perhaps metadata for data files could include date and time of collection, along with usable scale for the components of digital cartographic data. This may not mean much to the user, but the software would be able to use it for decision making.

Interoperability would represent an application environment where data is collected, loaded, stored and computed on different operating systems applying various programs. The procedure represents the next generation GIS processing. The ultimate goal of an open system is the free flow of uninterrupted data within a network, independent of hardware/software.

Truly open systems would allow sharing of geographic data not only with other GIS technologies but also with non-GIS applications that operate on different platforms. Open systems can use different applications, different languages because they can be translated into binary form.

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BIOGRAPHICAL NOTES

Gabor Barsai has worked in the fields of surveying and mapping as a GPS and GIS professional.
His GPS experience includes geodetic control surveys, boundary location and topographic surveys where he has served as instrument operator and in positions of responsible charge, and as application developer to process the data. As a GIS professional, Gabor has served as a GIS consultant, GIS manager, and application developer with international experience in both GPS and GIS (including teaching and conference presentations and simultaneous translator for several organizations). Gabor has worked at DIS for 5 years.
Gabor graduated from the Ohio State University with a Master of Science in Mapping/GIS, and has also worked in the Center for Mapping and for the Franklin County Engineers Office in Ohio.

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