Cost Saving Approach to GIS Deployment

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INTRODUCTION

Like many small to medium sized water utilities, the Olivenhain Municipal Water District (OMWD) was faced with an ever-increasing burden of information management. In particular, maintenance of mapping systems was not only time consuming, but the pace in which changes were made and disseminated was greatly outpaced by the rate of growth in the area. The traditional method of dealing with this problem is the development of a Geographic Information System (GIS).

In the case of OMWD, staffing and budgetary constraints eliminated the possibility of creating a GIS department within the organization. This paper is a case study of the unique and economical way that OMWD staff used to create a fully functional web based GIS at a fraction of the cost of the traditional methods. The end result is a savings of 80% off the cost of deploying and maintaining traditional GIS.

PRECURSORS

As of the spring of 2000, the District had no electronic mapping resources in place. All system maps of both sewer and water were maintained by a consulting engineer on Mylar sheets that had been painstakingly updated for nearly forty years. The process of updating this map in response to development was understandably very slow. The process of converting the Mylar map into atlas books for field use took even longer. The accuracy of the finished maps was frequently less than desirable and the process of correcting these deficiencies was sufficiently complicated that in many cases field personnel merely corrected their personal copies of the map rather than go through all the work needed to get the originals changed.

In addition, as built drawings, which contained the core information necessary to locate and maintain pipelines and other appurtenances, were stored in such a way that access for field personnel was very difficult. With thousands of sheets of drawings, most field personnel were more likely to search for pipelines with backhoes than with as built plans. Clearly, this is not a desirable method of pipeline location.

Finally, The District has over 1200 easements across private property under which various pipelines are located. Maintenance of access on these easements and monitoring construction activities of landowners, who tend to knowingly or unknowingly construct walls, outbuildings, and other structural elements on top of pipelines is a major concern at the District. Easement documents were stored in a vault and were nearly inaccessible to the field personnel who needed them in order to monitor these easements.

In 1995, an attempt to create a digital map was undertaken. Atlas maps were converted into AutoCAD files and new map books were made. Unfortunately, no provision was made for updating this system and it soon fell hopelessly behind the rate of growth. Field personnel used the hand drawn Mylar based maps because even though they were a year or more out of date they were better than the snapshot of 1995.

PROJECT REQUIREMENTS

During the spring of 2000, District staff defined what they wanted in a GIS, even though no funding source had yet been identified. This “wish list” contained the following items:

- Field staff needed continuously updated maps in order to match the rapid growth in District. An ongoing effort was clearly needed
- Field and Engineering staff needed rapid access to all as built drawings. The paper based storage system was not working well.
- Field right of way personnel required easy access to easement data as encroachments were becoming a problem.
- Both field and engineering staff needed the ability to make ad hoc maps for planning and presentations. The ability to display variable sets of data was desired and it needed to be easy to do.
- With a distributed work force, the District wanted unlimited access to data for authorized personnel. With various facilities covering 50 square miles, access to the system needed to be provided from anywhere and on any machine.

As this wish list was developed, the General Manager outlined a few constraints on the project. These constraints included items familiar to many public agencies:

- There were limited funds available since no specific project had been identified in the budget. A few line items held money for somewhat related projects, but rate reduction pressure meant that no more money was coming.
- A ban on staff additions was in place as the GM made it clear that he would not hire a GIS department. Other local agencies had several staffers at high cost and the Board was focused on headcount control.
- The District has limited IT capacity. No large workstations were available and no additional servers would be added to the system. There was no available staff to manage it anyway.

When the project wish list is compared against the project constraints, it becomes quite clear that the traditional methods of deploying GIS were out of the question, and the project was placed on hold. At a chance meeting at an AWWA conference, District staff initiated discussions with a GIS data conversion consultant (Nobel Systems) about the project and together the developed a completely novel approach to the project.

There were three aspects of the project that enabled the project to both meet the wish list and stay within the project constraints; data conversion methodology, application selection, and application delivery. In each of these areas, the project team developed creative solutions to develop a project that would fulfill all the needs of the District.

DATA CONVERSION METHODOLOGY

During the project development period, two basic methods of data conversion were identified: full engineering level conversion and atlas map level conversion. In the full engineering level conversion, the concept is to draw everything exactly where it is. This allows future users to generate engineering drawings from GIS as well as scale right off the GIS. It is also very expensive to do initially and very expensive to maintain. It also tends to clump certain appurtenances together when viewed at larger scales, which make it ineffective for field use.

The method that was selected for the project was atlas map level conversion. In this process, the GIS represents everything as it appears on an 11x17 atlas map. It allows for clear separation of symbols and is much cheaper, both initially and in the long term. A unique feature of the selected application as described below offset the reduced detail in the map data.

Another major factor in cost control was the use of offshore technicians for the bulk of the data conversion work. The selected contractor maintains offices in San Bernardino, California as well as Bangalore, India with project management being handled locally and data conversion in India.

APPLICATION SELECTION

As noted above, budgetary constraints eliminated the possibility of dedicated GIS specialists. Consequently, the selected GIS application needed to be simple enough for people with varying levels of familiarity with GIS. The District desired a system that a person with average computer skills could learn how to operate in a basic level in an afternoon.

After reviewing the various GIS applications on the market, the District settled on the product family offered by ESRI or Redlands, California. These products have become one of the standards in GIS applications, especially in Southern California. Unfortunately, many of the products offered by ESRI were not as user friendly as required. ARCINFO requires users to master command line interface and ARCVIEW, while a bit better, has a rather steep learning curve.

The final application selection was a custom GIS viewing application developed by the consultant using Map Objects from ESRI. This system, called Geoviewer, is optimized for water and wastewater utilities, offering special features and a very simple, intuitive user interface.

The GeoViewer application also included a feature that allows scanned as built plans to be linked directly to the subject pipeline. The scanned image can be accessed with a single click from the main GIS screen and the image can be copied, printed, and even measure right on the screen for accurate location of features. Over 5000 sheets of drawings were linked to the system in the initial conversion. This is one of the most used features of the system.

APPLICATION DELIVERY

Once the data conversion process and application had been selected, the problem of delivering this application to the wide variety of users and locations became the final hurdle. After analyzing the requirements outlined above (no new servers or hardware, no in house staff, accessible from anywhere), it was determined that a data warehousing arrangement, in which the consultant would assume the role of an Application Service Provider (ASP), would fit the bill. The GIS application and data would reside at the contractor's site and District staff access this data entirely over the Internet.

A unique contract was developed that established the terms of the agreement including the level of service to be provided, licensing issues, support, map updates, penalties for downtime, etc. The agreement established set costs for future map updates and contracted the consultant to perform these updates in a timely fashion (30 days or less). The costs for map updates is passed on to the developers who cause the need for map updates in most cases, thus eliminating fiscal impacts of map updates from the rate payers. The District pays a small monthly fee for the entire service that is much less than the cost of even a single GIS staffer, not to mention hardware and licensing costs.

After trying a number of other techniques for accessing the data over the Internet, the project team settled on using a thin client solution from Citrix Systems. Using the thin client allows a user anywhere, on any computer, running any OS, on even slow dial up modems, to enjoy a user experience nearly identical to sitting right in front of the server. The thin client technology makes the client computer into a terminal for the main server, so that only keystrokes and mouse clicks are communicated to the server and only screen data is sent back. No local computing is needed to process the GIS data and no actual data is sent over the Internet. In this way, scanned images that are several MB in size appear almost instantly – even on dial up modems.

The consultant also provides a dedicated database application called the GIS Update Manager, which provides a single place where both the client and the consultant can keep track of the various map update projects that are underway continuously. This database is also accessed using Citrix technology over the Internet and keeps track of work in progress, sorts map update costs by development projects and prints out sorted reports for easy accounting for both parties. In the three years of operation, an average of about 100 updates have been processed through this system per year.

COST BENEFITS

The cost benefits of this system are substantial. The contractor sets fees for this system, now marketed as GeoViewer Online, based on the size of the distribution or collection system and the number of users expected by the client. In the case of OMWD, monthly fees were set at $3000 per month in the contract. This fee includes all licensing fees for up to 10 concurrent users, tech support, and up to three single page map updates per month. Large scale plans for development projects are done at a set fee and these costs are passed on to the developer. This process greatly reduces the cost of maintaining the system. The hardware costs for this project are also zero, because users can use any computer – even the old DOS machine in the back room works well!

The operating cost of traditional is based on the costs of hardware, software licenses, and the staff to operate and maintain the system. Assuming a 10 concurrent user networked system, licensing fees for ARCVIEW 8.2 are $1500 per seat. Licenses for ARCINFO cost $2995 (Source: ESRI Online Store http://gisstore.esri.com). Total up front licensing fees would be $17,995 for a 10 concurrent user system with one GIS administrator using ARCINFO. Licensing upgrades cost $600 per seat and are offered on average every three years, for annual licensing cost of about $200 per seat or $2000 for a 10-seat system.

These applications require considerable computing “horsepower” to and the workstations needed to operate the applications will likely cost on average about $1000 more than an average PC and will need replacement every three years or so. This adds an extra $333 per seat per year in operating costs or a total of $3330 per year.

The main cost savings is in the lack of dedicated GIS staff to operate and maintain the system. For the purposes of this comparison, the staff time needed for users to communicate map update needs to the GIS administrator are considered to be on par with the time needed to communicate these needs to the consultant. While the use of the GIS Update Manager may make this communication even less time consuming, for the purposes of this analysis, these costs will be assumed to be equal.

According to a recent salary survey, the national average salary of a senior GIS Manager is $60,714 (Croswell, Savar, 2000). While regional modifiers will adjust this upward, for this analysis, these regional adjustments will be ignored. The national average salary for a GIS Programmer is $49,426 (Croswell, Savar, 2000). Applying a conservative overhead rate of 50% to these salaries, the total annual cost of a small GIS staff is $165,210.

The total five-year operating cost of traditional GIS versus the GeoViewer Online model is shown in Figure 1. The dramatic cost differential compounds such that over a five year span, the traditional GIS deliver costs nearly $700,000 more than the novel approach developed by the District and it's consultant. This represents an 80% savings in total operating costs.

CONVERSION TO ArcSDE AND ArcIMS

After deploying the Geoviewer system over the Citrix connection for a number of years, the District's consultant, Nobel Systems, has developed another user interface for the same data set using the ArcIMS platform. Even though the Map Objects based GeoViewer Online application was simpler to use than the full featured ESRI products, some of Nobel's clients requested an even easier user interface.

With the migration from shape files to geodatabase in mind, Nobel decided to develop the future set of applications to run on ArcIMS over the ArcSDE geodatabase. In this way, multiple applications could be developed to use the same data set with different user interfaces. The user interfaces are tailored to meet the varied skill sets of employees within municipal organizations, so everyone down to the least computer literate employee could access the data easily.

The resulting products, GeoViewer Pro and GeoViewer Express reflect the difference in capabilities in their branding. GeoViewer Pro is a more full featured application that has enhanced query capabilities and other advanced tools. It is also deployed using terminal services to allow for fast speeds over the internet. This application brings over the features of the older GeoViewer Online product and brings them to the ArcIMS environment.

GeoViewer Express is a purely browser based application that draws from the same data set as GeoViewer Pro. The simplified user interface makes it accessible to many more people in an organization: everyone can make maps, and perform simple queries – even if they don't know what a query is! No special ports need to be opened in firewalls (as is needed with terminal services), no special clients are needed (as in GeoViewer Online) and the system is optimized to allow for fast speeds over the web.

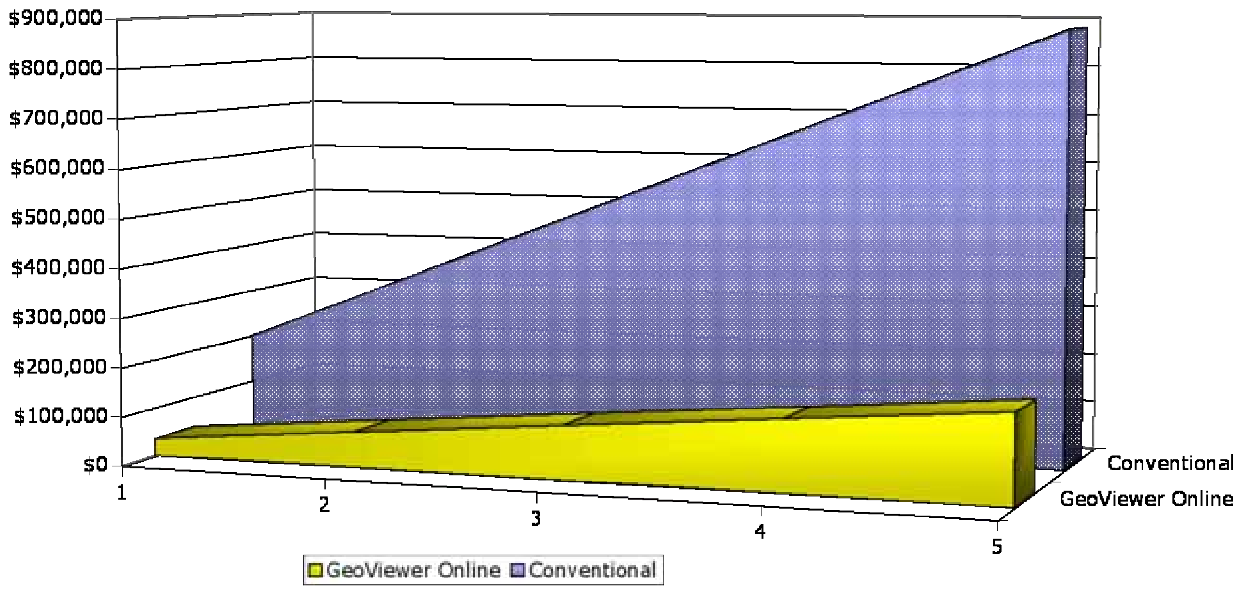
Nobel Systems is now marketing these new products to new customers and is in the process of converting existing clients, such as OMWD, to the new and improved applications.

CONCLUSION

After developing both project goals and project constraints, the Olivenhain Municipal Water District, working with its consultant, Nobel Systems, successfully developed and deployed a fully functional GIS application over the Internet and realized savings of 80% over the traditional methods of GIS deployment. The system has been up and running for about 18 months and the users of the system now include every level of the organization, from field workers to senior management. The system even served as the basis for performing redistricting using census data.

This model of GIS deployment is well suited to water and wastewater agencies that are not quite large enough to be able to afford in house GIS staffers, yet desire all the power and benefits of a GIS. As we move further into the 21^{st} century, the need for a GIS at every level only grows – especially with GASB 34 looming in the near future. With the advent of the new ArcIMS based solutions, web based GIS becomes simpler and more powerful at the same time. By deploying the data sets further into the organization, the client's Return on Investment is multiplied significantly.

Figure 1
5-year GIS Cost Comparison



Total savings of $700,695

OMWD GIS Cost Comparison
Based on a 10 user system with full access at each workstation

Initial Costs	GeoViewer Online	Traditional GIS	Comments
Hardware			
GIS Workstations	$0.00	$10,000.00	Assumes an extra $1000 per workstation over standard PC costs
Software			
ARCVIEW	$0.00	$15,000.00	$1500 per seat per ESRI Online Store http://gisstore.esri.com
ARCINFO	$0.00	$2,995.00	Single seat cost for GIS Programmer
Annual Costs			
Software Upgrades			
ARCVIEW Upgrade	$0.00	$2,000.00	Assumes an upgrade every 3 years at $600 per seat x 10 seats
			Upgrade cost per ESRI Online Store http://gisstore.esri.com
Hardware Upgrades	$0.00	$3,330.00	Assumes an extra $1000 per seat every three years for
			workstation class PC
Staffing			
GIS Manager	$0.00	$60,714.00	National Average salary per URISA 2000 salary survey
GIS Manager Benefits		$30,357.00	50% benefits and overhead
GIS Specialist		$49,426.00	National Average salary per URISA 2000 salary survey
GIS Specialist Benefits		$24,713.00	50% benefits and overhead
Data Warehousing Fee	$36,000.00	$0.00	$3000 per month by contract

Total Up Front Cost	$0.00	$27,995.00
Total Annual Cost	$36,000.00	$170,540.00
Total First Year Cost	$36,000.00	$198,535.00
Years 2 through 5 cost	$36,000.00	$170,540.00
Total Costs	$ 180,000.00	$ 880,695.00

Total Savings	$ 700,695.00

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ESRI Online Store http://gisstore.esri.com
Croswell, Peter and Savar, Nina (2000), *URISA Salary Survey for IT/GIS Professionals,* Urban and Regional Information Systems Association, Park Ridge, IL