BIOGRAPHICAL INFORMATION

Lawrence W. Brys
Project Management Supervisor
Anchorage Water and Wastewater Utility

Specific Responsibilities

Mr. Brys joined Anchorage Water and Wastewater Utility team in 1996 as an Information Technology Project Manager. He currently supervises a systems development and project management unit that is responsible for a seven digit annual capital improvement program in addition to maintenance of most of the Utility's business systems. He is responsible for IT support of GIS initiatives and was the project manager of the Utility's GIS infrastructure upgrade.

Past Experience

Mr. Brys has twenty-five years of experience with information systems design and implementation. Much of the experience was with State and Federal Government land information systems. In recent years he has specialized in object/relational database systems and web based software implementation.

Educational Information

B.S - Michigan Technological University
M.S. - University of Alaska

Professional Memberships

Member Geospatial Information Technology Association.
Past member of Data Processing Management Association, Society of American Foresters, and Michigan Forestry and Parks Association.

BIOGRAPHICAL INFORMATION

Diane Thompson
Project Manager/Senior Analyst
Resource Data, Inc.

Specific responsibilities

Joined Resource Data, Inc. in 1998. Responsible for project management of information technology and geospatial projects for multiple clients. Supervises teams and is a systems analyst on teams that provide database design, application design, and implement custom systems as well as providing assistance with the implementation of enterprise and commercial off-the-shelf systems.

Past Experience

Ms. Thompson has 16 years of experience as an analyst with the last six years being focused on systems design and deployment, especially web-based deployment.

Educational Information

B.S - Geology, South Dakota School of Mines and Technology
M.A - Teaching, University of Alaska Anchorage

Professional Memberships

GITA

Live Integration of Geospatial Technology With Enterprise Systems
Functional Perspective

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ABSTRACT

The Anchorage Water and Wastewater Utility (AWWU) is improving employee efficiency by tightly integrating geospatial technology with enterprise systems. One desired outcome is to minimize the amount of redundant data. Data will be maintained only in the enterprise application that “owns” the data, and all other systems access this information without duplication. To facilitate this, AWWU developed a multi-year strategy to move from a traditional GIS based on coverages and shapefiles to one based on a relational database (RDBMS). Once the GIS data are in an RDBMS like the other enterprise applications, data sharing between GIS and non-GIS applications is realistic. AWWU’s strategy involved putting together a project team, selecting a GIS product, training staff, revising the enterprise data model to incorporate an RDBMS GIS, implementing the conversion, modifying the data maintenance workflow, and providing consolidated information access to GIS specialists and non-specialists. This presentation focuses on the strategy, revising the data model, workflow modifications, and providing effective access to the enterprise data. Case studies will examine how specific workflow modifications reduced data maintenance time by integrating GIS and non-GIS applications as well as how new data presentation tools provide rapid access to information that was not previously available.

INTRODUCTION

The Anchorage Water and Wastewater Utility (AWWU) underwent a major upgrade of its geospatial technology. The previous GIS, a batch mapping system, was replaced with an online system hosted on an RDBMS. The capability for distributed concurrent editing of geospatial data was leveraged for reengineering workflow. Information now gets into the system earlier, and employees take advantage of computer tools for jobs that were previously done manually before the data were entered into the GIS. The capability for online access to spatial data was leveraged to integrate spatial data with all of AWWU's major information systems.

In this paper the authors will discuss the project justification, funding, vision, implementation architecture, and strategies as well as the notable challenges and how they were overcome. In the second half of this paper, case studies will demonstrate how the new technology was leveraged to improve the efficiency of AWWU's workforce.

CONCEPTS

Vision

The project's designers envisioned an information centric architecture. Both technology boundaries and system boundaries would be transparent to information users wherever practical. The information foundation would be based on four large enterprise systems: PeopleSoft Financials and HR, a CIS, a Land Base/Tax system and a Computerized Work Management System. These systems deliver a large amount of localized functionality. They would be used for their strengths and would host and maintain the majority of the enterprise data. Custom local systems would extend these systems to AWWU specific needs and serve as the bridges that linked them together.

For information users, web based portals would provide information centric views of the data. An assortment of technologies would support the portals. The portals would present character, geospatial and multimedia information to users in views free from any system or technology boundaries. They would be designed to deliver the information in views that best support workflow. The portals would allow a user to navigate the information following the normalized paths in the data.

Planning and Preparation

Obtaining funding was the first step in getting this project established. AWWU maintains an Information Technology Master Plan (IT Plan), as part of its Capital Improvement Plan. The plan looks forward six years and is updated annually. The IT Plan is business driven, not technology driven. The Utility looks at business processes to identify areas where better use of Information Technology could reduce business costs. Of course evolving technology offers new options for addressing business needs so the Utility keeps at the leading edge of technologies that have the potential to reduce operating costs.

In the 1999 IT plan, GIS was identified as one of the areas falling behind its potential for improving business processes. Although the Utility had skilled GIS staff, they were burdened with aging technology that was limiting the use of GIS within the Utility. The IT Plan identified the need to upgrade the GIS to an RDBMS platform. This allowed integration of the GIS data with transaction processing systems as well as distributed and concurrent spatial editing that would facilitate workflow improvements. The plan also identified the need for an Internet Map Server to present spatial information over the web. Funding was allocated over a several year period.

The IT Division and the GIS Section of the Engineering Division previously operated independently of each other. This project required closer teamwork between these two groups. The new technology requires a much broader spectrum of technical expertise than was required with the previous coverage based GIS. Data design, database design, database administration, SDE administration, map server administration, software development, XML and dynamic web page programming were added to the required skill set of both organizations. Additionally, the GIS toolset was a complete change. The selected platform, ESRI's ArcGIS required a major skills upgrade for the Utility, both in the GIS and IT areas.

AWWU attacked the skills gap with a major training initiative. IT staff were sent to classes in SDE Administration, ArcIMS implementation and administration and ArcObjects programming. GIS staff were sent to classes in ArcGIS. Appropriate GIS and IT personnel were sent to classes in Geodatabase Design and Geodatabase Implementation. Including tuition and employee salaries, and in some cases travel, over $80,000 was spent on training over a three year period. Though this represented a significant investment by AWWU, it surely was one of the requirements for the projects success.

Training was an important step but still, there was much to be learned. The first year of the project included a prototype conversion of the GIS coverages to the SDE/Oracle Geodatabase. At first, design issues were largely ignored. The initial objective was to provide a full size Geodatabase for performance observation while experimenting with data maintenance. AWWU needed to determine the best techniques to use with ArcMap to perform functions previously accomplished with Workstation ArcInfo and AML.

Geodatabase Design

To implement the new vision, a new database architecture was created. The previous coverage based GIS provided a level of mapping and analysis capability but didn't possess the potential to support the new vision. We needed the database to support interactive data delivery, distributed data maintenance and integration with online systems, and object/relational technologies to handle the complexity of today's real world information demands.

The database platform created by AWWU uses ESRI's ArcGIS 8.x Geodatabase coupled with ESRI's Spatial Database Engine (SDE). It is hosted on the Oracle RDBMS. ArcEditor is the primary spatial data maintenance tool and ArcIMS is the foundation of the primary spatial data delivery strategy. Enterprise systems' character data are maintained with the enterprise systems' software. Oracle materialized views are employed to help achieve quick response for online map operations that need to join in enterprise systems data to select and symbolize map features.

The design began as a fully normalized logical data model that included previous GIS feature classes as well as relevant object classes from the Utility's enterprise systems. In the logical model there was no distinction between GIS and other systems data. As the design progressed, data were partitioned into several schemas based on affinity of the object classes. Traditional UML data modeling techniques that have grown up around character database technology served well in some areas but proved useless in some of the spatial polygon relationships. An example is the relationships between surveyed land parcels and buildings. Neither is a subset of the other. Traditional UML data modeling techniques might show this relationship as a vague many-to-many relationship implemented with an associative entity when in reality the overlap of the polygons is spatially well defined.

Geodatabase Implementation

AWWU's GIS upgrade included not only a database redesign but an entirely different GIS toolset (ArcGIS 8.x/ArcMap). Rumors and apprehensions ran deep that the new toolset would not adequately perform. It was an entirely new way of doing things for AWWU. Some disappointing and worrisome performance results were observed in first attempts to use the new toolset. These turned out to be a product of mixing old and new technologies and the need to commit 100% to the new technology. The new ArcMap based tools performed poorly with the old coverages but worked very well with the new Geodatabase. A second concern was the expense of having to rewrite the many AML macros in VBA. It turned out that almost none of these previously used macros were needed as their functionality was inherent in ArcMap. A major part of the upgrade strategy was to explore the ArcMap functionality and determine the best way of accomplishing tasks that were previously done with ArcInfo Workstation.

Data migration required its own system design. The Geodatabase design incorporated many data design improvements. The meaning of the data was analyzed and more precisely defined through data modeling. A largely normalized structure was selected in order to be able to accommodate the real world complexities of the Utility’s data. Constraints were added to enforce domains and relational integrity.

The existing data couldn’t be programmatically converted to the new database because it fell far short of meeting the new database requirements. However, the existing data couldn't be upgraded to the new specifications until it was moved to a database that accommodated the new structure. Furthermore, much of the data couldn't be upgraded at all without extensive manual intervention.

A conversion strategy needed to be developed that provided a bridge between the old and the new. It needed to include an optimum combination of programmatic and manual effort. The two primary areas where this was an issue are the sewer infrastructure and the water infrastructure. Each of these was developed as a two phase effort that produced a functional interim Geodatabase as a product of the first phase.

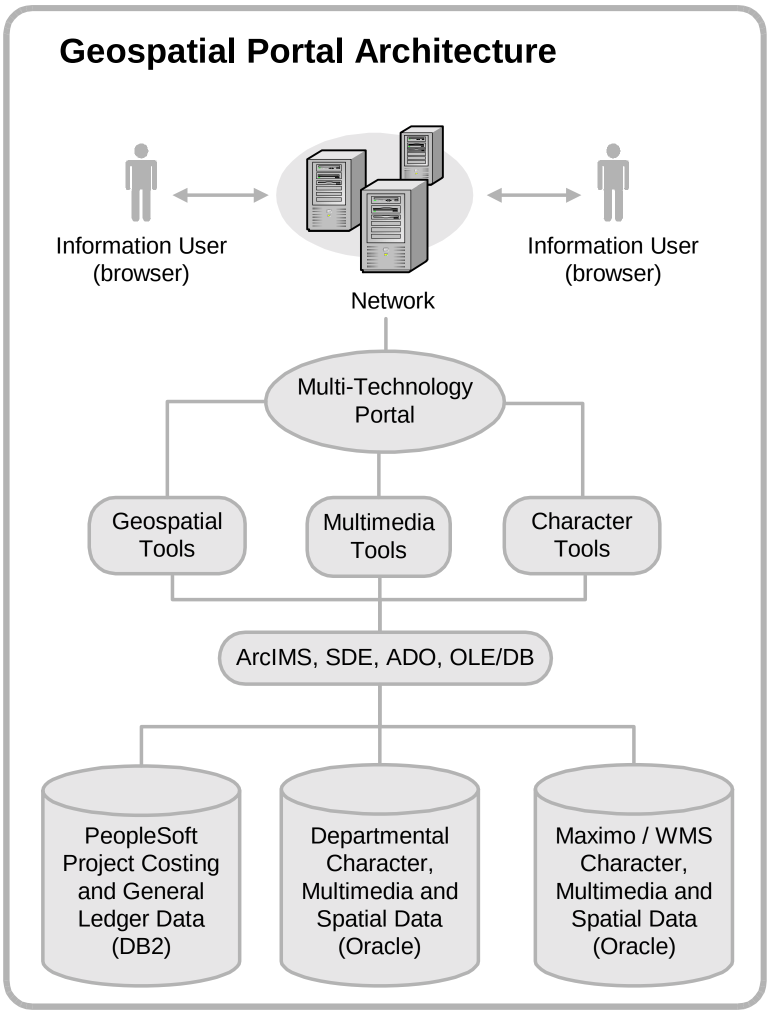
The interim database was the final database design minus the constraints plus many interim attribute columns. For attributes where a complicated transform was required, columns were provided for the data to be stored in both the old and the new format. Some data were converted to the interim database in the old format then, during phase 2, upgraded to the new format in preparation for the second phase conversion. Topology, where pertinent, was previously enforced with ArcInfo so this didn't create a problem. Data upgrade challenges can be grouped into three categories.

- Some data problems were simply the result of applying more stringent domain enforcement. Where feasible, these were upgraded in the coverages prior to conversion and the new specification was enforced in the interim database.
- Some attribute data required a fairly simple conversion but needed analysis and correction that could be more easily performed in the RDBMS. These were converted without the constraints then corrected after conversion.

- Some data required complex conversion and/or a combination of automated and manual upgrades. These data were generally represented in the interim database with two columns, one in the old format and one in the new format. The data were first converted to the old format columns and then upgraded to the new format.

Data Presentation - The Geospatial Portal

The information presentation platform is a custom web based application that AWWU calls the Geospatial Portal. It is a multi technology portal that presents the information in seamless, information centric views independent of system, database, and technology boundaries. Internally, and transparently to the users, the portal is divided into a sophisticated map service, an inbound API, an outbound call interface and a collection of enterprise system interfaces. Figure 1 shows the Geospatial Portal Architecture.



The map service is a highly customized ArcIMS 4.x map service that lets the users interact with the information in functional groupings. For example users would choose whether to turn on or off the water network rather than selecting water pipes, water nodes, water service pipes and water service nodes. From the map view, users can link into a number of sophisticated enterprise system interfaces where they can navigate the information following the inherent relationships in the data.

The inbound API is a modular interface that is designed for easy expansion that provides for external applications to use the Portal. It provides a set of services, each with its own logic module. The portal can be called by a URL with the query string specifying the service requested and required parameters. For example, if the requested service is infrastructure, the request gets dispatched to the infrastructure module which expects the next parameter to be a Maximo Work Management System location ID. The infrastructure module of the API then determines which layer contains the requested infrastructure feature, sets the appropriate display layers, sets the appropriate display envelope size and zooms the map to the selected feature.

The outbound call interface associates the active layer with the appropriate enterprise system interface. When a user selects the hyperlink icon and clicks on a feature in the active layer this interface is activated. It picks up the ID of the selected feature, synthesizes a URL which calls the appropriate enterprise interface with the selected feature ID. The invoked enterprise interface then receives control.

The enterprise systems interfaces are sets of dynamic web pages, programmed in C#, using ASP.NET and ADO.NET. They access the databases directly rather than using API's of the enterprise systems. This provides the portal with complete control of the data presentation which can therefore provide consistent look and feel and avoid the appearance of artificial "system" boundaries in the information. Each interface is specific to one enterprise system. The interfaces allow users to navigate the information following the inherent relationships in the data.

Summary of Challenges

The following is a summary of the major challenges encountered and how they were overcome.

- Major shift in the GIS toolset - This was overcome by an extensive training program and extensive research into the best ways to use the new tools.
- New database requirements not supported by old data - This was overcome by a major effort to format, audit, and upgrade the existing data.
- Data redundancy and synchronization with Work Management System - If WMS contains the attribute, it was removed from GIS and linked using a view or an enterprise system interface.
- Maintaining adequate performance with distributed data - Oracle materialized views allow AWWU to provide acceptable performance.
- Integration with enterprise systems - Keys to enterprise data are stored in the GIS and custom enterprise system interfaces access the enterprise databases.

CIS - AWWU's Next Major GIS Integration Project

AWWU is in the process of implementing a new Customer Information System (CIS) and the vision includes full integration with GIS. Customer service personnel will be able to see the customer's premise on a map. From the map they will be able to visually access information about the Utility's infrastructure near the customer's premise or information about Municipal projects near the customer's premise. And the reverse view will be part of the interface. From a map, AWWU employees will be able to access customer information. Integration of AWWU's Automated Permit System (APS) and Maximo Work Management System (WMS) is also part of the CIS vision. Not surprisingly, the Utility expects GIS to play a key role in these interfaces also. The CIS/GIS integration will follow a strategy comparable to the interfaces with PeopleSoft and the Work Management System.

CASE STUDIES

Few successful organizations implement technology for technology's sake. Ultimately, organizations invest in new technology either to deliver services more effectively, to reduce the cost of delivering services, or both. The following case studies will address specific examples of how AWWU has leveraged their new GIS to reduce in-house costs and deliver some services more effectively. We will focus on the following areas of the utility:

- Assessing the costs of capital infrastructure
- Providing information to AWWU customers

Water and Sewer Improvement Assessments

In Anchorage, as in most cities, property owners are assessed for the construction costs of installing the water and sewer infrastructure to provide service to the property owner's premises. This is a fairly complex and labor intensive process with a significant spatial component. Historically, most assessment amounts are determined by calculating the square footage of a property owner's land that lies within the designated buffer zone from the new infrastructure. As one might imagine, for complexly shaped lots, this can be challenging to calculate using paper maps, pencil, and paper. However, as this is the mechanism by which AWWU can recoup its capital construction cost, this is an important utility function.

AWWU identified enhancing the Assessment Management System (AMS) early in the planning process for the new GIS. Historically, the assessment staff managed assessments using a combination of paper maps, paper documents, and electronic documents such as spreadsheets. Four years ago, AWWU developed a database application (AMS) for the assessment staff to use for managing assessments, but this application initially had limited GIS integration and did not calculate areas for the assessment staff.

Deploying an enhanced GIS module to the existing AMS required several subtasks:

- Creating new geodatabase feature classes for the assessment information,
- Distributing GIS editing for the assessment feature classes to the assessment staff so the people who owned the data maintained the data,
- Training the assessment staff in the GIS tools,
- Developing wizards to import the GIS data into the existing AMS application, and
- Modifying workflow so that the assessment staff could efficiently maintain the data.

Creating New Feature Classes

The assessment staff has maintained a spatial representation of the assessments for several decades using paper map books and colored acetate overlays. As property was assessed, the assessment staff would color the assessed region on an acetate overlay. Even if parcels replatted and the underlying map sheet changed, the colored overlay allowed the assessment staff to identify the land that had already been assessed. Because AWWU has three distinct assessments, water, sewer lateral, and sewer trunk, each assessment type had its own acetate overlay. We created three geodatabase feature classes, each corresponding to one of the three acetate overlays.

These geodatabase feature classes have several advantages compared to the acetate overlays.

- Because they are stored in an RDBMS, they are available to the entire utility and not just at the Front Desk of the assessment section.
- They allow concurrent editing so different staff members can be working at one time.
- The GIS can be used to calculate the area of the assessment automatically. This provides great savings to the assessment technician, ranging from several hours to several days of labor on a single project.

Distributing GIS editing

Distributing GIS editing was critical for success as AWWU GIS staff was already fully employed before we added new feature classes. If assessment staff would have been required to submit requested map information to the GIS section for data entry, the delay would have been unacceptable. Instead the assessment staff was trained with the GIS tools and given editing permission on the assessment feature classes just as they are the ones who edit and maintain the character based Oracle data in the AMS.

Training the assessment staff

The AWWU assessment staff had a great deal of experience using the maps produced by the GIS section and had often worked with the GIS staff to create custom maps. However, they had little or no experience using the GIS tools. To get started, the senior assessment technician attended a one-week end-user class on the new GIS tool. Recognizing that a single class is not enough to develop real proficiency, the GIS staff and IT staff were available to her as consulting resources when she had difficulties.

Developing wizards

The existing AMS was recently developed to meet the needs of managing and levying the actual assessments. While the spatial feature classes provide a valuable visual representation of the assessment, we developed Oracle procedures to update the AMS application with the assessed areas for each affected property in the project. The assessment technician then evaluates the imported areas and adjusts them as necessary.

Adjustments can be required for several reasons. One of the most common is for commonly owned property such as a park owned by a homeowner's association where each of the property owners in the association share in the cost of the assessment. Another common problem is discrepancies between the GIS area of a property and the legal land area as recorded by the tax appraisal system. As part of this import, we compare the GIS area for the property with the legal area for the property from the tax appraisal system. If the discrepancy is too large, we do not import any assessed areas and the assessment technician must research and provide the information manually.

Modifying workflow

Modifying the assessment technician's workflow to incorporate the new changes was critical to the success of the new enhancement. Had the assessment technicians not been willing to change their daily processes, none of the new tools would have offered any benefits. Fortunately, the assessment staff has been very willing to embrace change and adopt new technologies. They've worked closely with the AWWU IT section and GIS section to implement the above enhancements.

The assessment technicians have achieved their labor savings in three major areas.

- Map production
- Researching assessment and land information
- Data maintenance

Table 1 shows the reductions in the number of tools used by the assessment technicians for each area.

Table 1 – Efficiency Improvements for the Assessment Technicians

Task	**Before Geodatabase**	**After Geodatabase**
Mapping	Tax Code 100' Scales Mylar Presentation GIS Coverage	ArcGIS
Research	Assessment Records Tax Code Books 100' Scale Maps Assessment Rolls Resolutions Other Files	Geospatial Portal
Data Maintenance	Oracle Forms Manual Area Calculations Manual Data Input	Oracle Forms Automated Area Calculations Automated Data Input

Customer Service

One of the great challenges at AWWU has always been finding information for the customer. Often individuals will call or visit with inquiries on whether water service is available to a property, or if the land they are considering purchasing has an assessment pending, or why the utility is digging up the street in front of their house. Somebody at the utility always knew the answer to each of these questions, but the challenge for the person interacting with the customer has been to find the correct person. Today, most of these needs are being met with the geospatial portal. Let us examine how the new technology has improved the service for an individual who wants to know if water service is available at a property he is considering purchasing.

Table 2– Researching Customer Information

Before Geospatial Portal	**After Geospatial Portal**
Customer Service determines if the current occupant is a water customer. If not,	Any utility employee can access all of the information from the geospatial portal on the utility intranet.
Speak to Engineering Planning to determine if there is a water main serving the property. If so,	
Assessment Technician researches if the assessment has been paid or if it is still due. Then send the individual to Field Services	
Field Services researches what permits will be needed to connect to the water service.	

As you can see from Table 2, before the deployment of the geospatial portal, one might have had to speak to four staff members to determine if water service is available and what was be required to connect to the service. Today, the geospatial portal allows any employee to access the same information from the intranet.

One of the major design decisions of the geospatial portal was designing access paths for finding spatial information. Employees can find map locations using traditional map tools such as pan and zoom or character attributes such as property owner's name, tax lot id, subdivision, address, or project name. In our example, it is likely that the only information the customer knows is the address of the property. However, from this, the employee can zoom in and find the property on the map. After verifying that with the prospective customer that this is the correct property, the employee can look at the map and see if there is a water main serving the property. In the next major release of the application, the employee will also be able to see the keybox location, if any, for the property. From the map, the employee can hyperlink to pages that provide information about the current water customer, if any, assessment information, and any permit information.

As we've seen, successfully integrating geospatial information with other enterprise systems is a significant undertaking that requires a multi-year investment in planning, training, and implementation. This also requires an on-going commitment to maintain existing functionality and to extend the geospatial tools as new systems are developed and existing systems upgraded. However, AWWU found that the geospatial portal improves the effectiveness with which the utility can provide information to a customer. This improves customer satisfaction and employee morale. Even more importantly, it improves employee productivity.