GIS Best Practices

Using GIS and SAP

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ESRI

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What Is GIS?

Making decisions based on geography is basic to human thinking. Where shall we go, what will it be like, and what shall we do when we get there are applied to the simple event of going to the store or to the major event of designing a global distribution network. By understanding geography and people's relationship to location, we can make informed decisions about how we conduct activities on our planet. A geographic information system (GIS) is a technological tool for comprehending geography and making intelligent decisions.

GIS organizes geographic data so that a person reading a map can select data necessary for a specific project or task. A thematic map has a table of contents that allows the reader to add layers of information to a basemap of real-world locations. For example, a business analyst might use the basemap of Eugene, Oregon, and select datasets from the U.S. Census Bureau to add data layers to a map that shows residents' education levels, ages, and employment status. With an ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every industry from agriculture to utilities.

A good GIS program is able to process geographic data from a variety of sources and integrate it into a map project. Many countries have an abundance of geographic data for analysis, and governments often make GIS datasets publicly available. Map file databases often come included with GIS packages; others can be obtained from both commercial vendors and government agencies. Some data is gathered in the field by global positioning units that attach a location coordinate (latitude and longitude) to a feature such as a pump station.

GIS maps are interactive. On the computer screen, map users can scan a GIS map in any direction, zoom in or out, and change the nature of the information contained in the map. They can choose whether to see the roads, how many roads to see, and how roads should be depicted. Then they can select what other items they wish to view alongside these roads such as storm drains, gas lines, rare plants, or hospitals. Some GIS programs are designed to perform sophisticated calculations for tracking storms or predicting buying patterns. GIS applications can be embedded into common activities such as verifying an address.

From routinely performing work-related tasks to scientifically exploring the complexities of our world, GIS gives people the geographic advantage to become more productive, more aware, and more responsive citizens of planet Earth.

Using GIS and SAP

By Steve Benner, Director, Strategic Accounts, ESRI

ESRI brings a rich suite of mapping and map analytics functions to SAP users across a broad range of industries worldwide. Users can access and use SAP data through intuitive, user-friendly map interfaces; see that data in context with other data from within SAP or other business systems; and perform a wide range of spatial analysis. This helps people make better decisions. Work orders, for example, can be assigned based on proximity to avoid unnecessary driving time for work crews. Marketing campaigns can be targeted to specific areas that match demographic profiles. Executives and operational personnel can share a common operating picture that reflects the real-time status of opportunities, problems, resources in the field, and much more.

ESRI delivers this capability through a common technology platform that supports traditional desktop, thin-client, embedded, mobile, and Web service deployments. Each can be integrated with SAP NetWeaver in both traditional client-server and service-oriented architectures, giving users the flexibility needed to support all integration scenarios.

The ArcGIS platform provides all the capabilities needed to create, manage, use, and deploy mapping data and applications within the SAP NetWeaver software suite. It is designed to meet the most demanding requirements for open standards-based, scalable, and user-friendly GIS across the enterprise. It leverages the investment in SAP by using data in new ways, improving internal business processes, expanding the SAP user base, and providing customers with better service and support.

Benefits/Value Proposition

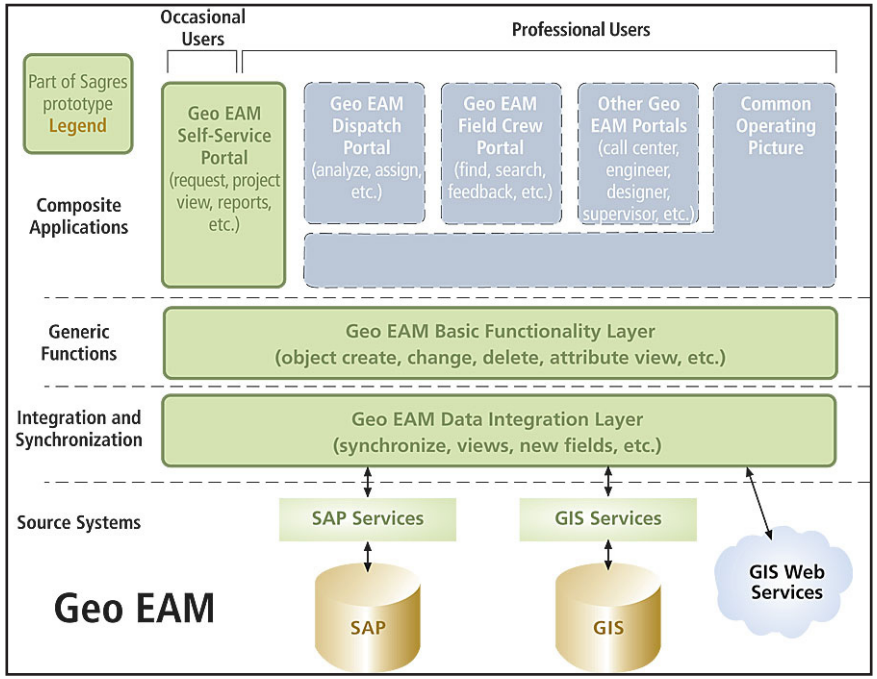
- ArcGIS is a complete, scalable system of software for geographic data creation, management, integration, analysis, and dissemination for every organization, from an individual to a globally distributed network of organizations.
- The ArcGIS suite of applications supports every kind of GIS need, so it is particularly suited to grow alongside the SAP system. As additional SAP components and solutions are brought on line, there is no need to introduce multiple GIS products.

- Users from operations, engineering, marketing, sales, and other functional areas can be served using the same tools and a common set of spatial data linked to SAP, stand-alone databases, or legacy systems. This promotes data sharing, provides a single common view of corporate spatial and related data, and allows GIS to be easily embedded into cross-functional business processes.
- Because of its scalable framework, ArcGIS is suited for single desktop users as well as organizations that require a rigorous collaborative environment where GIS viewing and analytic capabilities are embedded in business processes accessed through SAP desktop, portal, and mobile applications.
- Because ArcGIS is based on contemporary IT standards and supports heterogeneous hardware, operating system, database, and development environments, IT departments can assemble, deploy, and maintain their enterprise GIS using familiar methods and tools.

SAP and ESRI Collaborate on Enterprise Services

By Steve Benner, Director, Strategic Accounts, ESRI

Since 1996, SAP and ESRI have concurrently been both customers and partners of each other. ESRI runs its business on SAP software, and SAP uses ESRI components in its software. Together they have sold their integrated technology to many leading organizations in utilities, local and national government agencies, and businesses of all types. As a partner, ESRI has helped SAP understand and define various GIS integration scenarios and approaches as technologies have evolved. Today, the emergence of the Web and its associated standards, together with the development of enterprise platforms from application suites, has created an environment where new applications can be easily created from the shared services of other applications in a loosely coupled, standards-based, and system-independent environment.



Geo EAM: Simple graphic (© 2005 SAP AG).

The ArcGIS platform enables the development of GIS visualization and geoprocessing services that can be easily used by other platforms, such as SAP NetWeaver, to create composite applications for a wide variety of industries and application areas. This article will discuss who uses GIS with SAP software today, the evolution of integration objectives and approaches, the emergence of composite applications, and what SAP and ESRI are doing to take advantage of the new services-oriented world.

Who Uses GIS with SAP Software?

Organizations that integrate GIS with SAP software today include

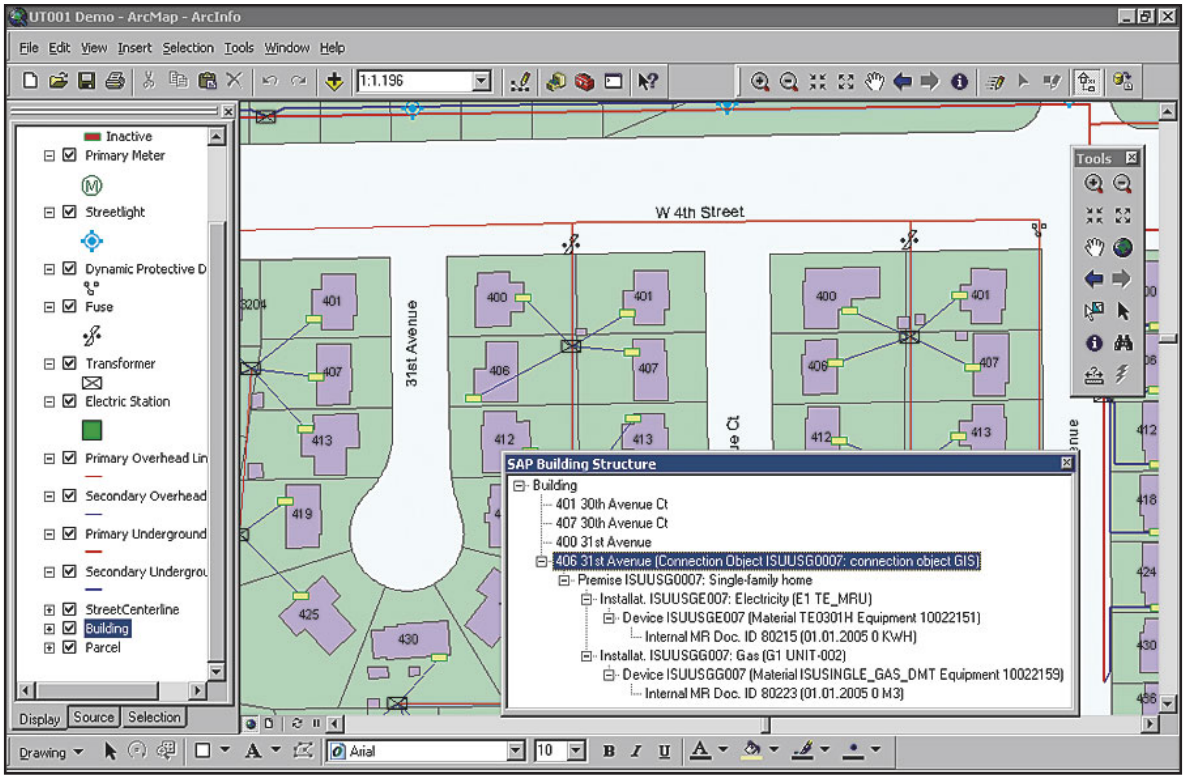
- Utilities (water, electric, gas, waste, recycling)
- Local government
- Oil and gas production
- Defense and public security
- Service providers (routing and logistics)
- Real estate
- Forestry and forest products
- Waterways, airports, ports

All of these organizations have several things in common:

- Assets and infrastructure distributed over a wide area
- Mobile field forces that need access to corporate data
- A need to better utilize assets, infrastructure, and people in the field through fast, accurate, and easy access to data and tools to efficiently and effectively execute business processes and optimize resource utilization

For most of these organizations, SAP is the repository and "go-to" system for all business data. Even where other specialized systems or applications exist, they are often tapped for data that gets added to the SAP repository for broad access and use by various SAP tools

and components. Some of these specialized systems, such as GIS, are tasked with providing more than simple data feeds to a central repository of data. A GIS is an enterprise system in its own right, managing a broad set of spatial transactions in the same manner SAP manages nonspatial business transactions and must be integrated with SAP applications in more of a real-time, peer-to-peer scenario.



Showing ArcGIS Server and SAP for Work Management integrated using SAP NetWeaver Exchange Infrastructure and SAP NetWeaver Master Data Management.

Evolution of Integration: Objectives and Approach

Early integration efforts were narrowly focused and project specific, often arising because attribute data used in the GIS was moved into SAP applications, such as asset and work management. Getting to the data in SAP required the use of various proprietary SAP APIs,

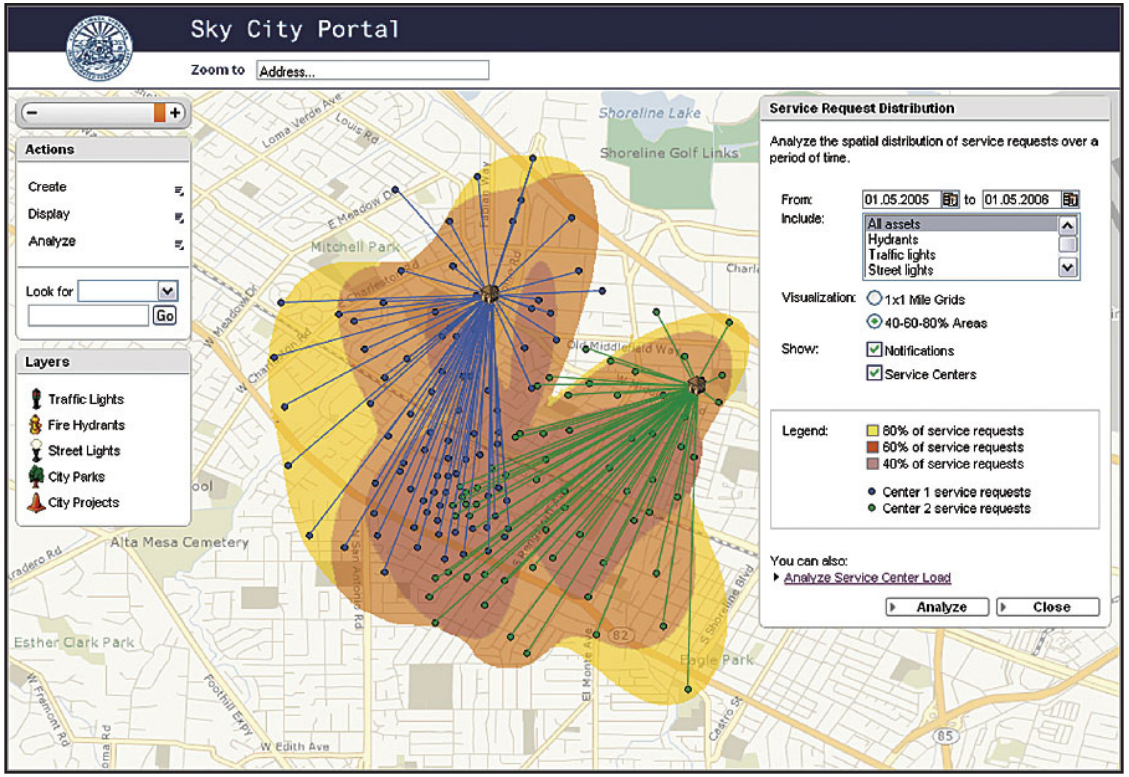
typically for read-only access to SAP data. These early applications were GIS-centric and primarily meant to reconnect GIS users to their relocated data sources.

Over time, GIS users were granted more rights to the SAP data, including the ability to create, change, and delete SAP data linked to GIS features, and SAP users were provided GIS views of their data and the ability to launch business process transactions from them, such as creating a work order. Java and .NET developers created integrated capabilities from scratch, building custom applications using simple and free connectors to meet narrow business requirements.

Most of these integrated applications barely scratch the surface of what is possible, displaying simple maps with little functionality beyond basic map navigation; feature selection; and the ability to execute simple, singular transactions. And because they are project specific, not much attention is given to how they fit within the broader IT landscape or system architecture. Reuse of code is typically not an integration design goal.

Once GIS is deployed, however, users soon discover that it can enhance business processes broadly across the enterprise and that simple access to SAP data for ad hoc mapping projects or simple transaction execution is not enough. They need access to real-time data coupled with advanced GIS visualization and geoprocessing functions composed into a task-oriented integration scenario. The integration needs to orchestrate several GIS and non-GIS transactions via two-way interaction embedded directly into the operational and analytic applications and processes that drive the business.

Today, more and more non-GIS users want access to GIS capabilities. Rather than using stand-alone GIS applications that require setup and training, business users want to leverage embedded GIS functionality as an integral part of their SAP application without shifting application contexts when moving from SAP-centric views to GIS views or from operational processes to analytical ones. GIS becomes assimilated by the primary SAP applications that users employ to do their jobs, and they may not even realize that they're using distinct GIS tools. This operationalization of GIS is the next wave in enterprise GIS integration.



Sagres Geo EAM Analytics Prototype.

Composite Applications

To implement operational GIS pervasively across the enterprise, project-based point-to-point integration approaches must be replaced by flexible, reusable integration components that merge SAP and GIS transactions into task-level enterprise services. Users and applications tap into these services to deliver information and insights on demand, transforming SAP and GIS applications from stand-alone products to reusable, shared enterprise services that make integrated applications easier to build and use. These services become vehicles to launch operational processes and tasks from within a user's primary application, whether SAP, GIS, or a portal or dashboard to monitor key business events, trigger alerts and workflows, or execute tasks within operational applications.

The technology to implement composite applications is provided by both SAP and ESRI in their respective platforms. Both companies embraced Web services and loosely coupled systems early on, support service-oriented architecture (SOA) standards, and provide coarse-grained and fine-grained services, as well as traditional object-level APIs, for developers who may know little about GIS or SAP or who may be experts in either application and need to create custom services. While much of the basic functionality of these applications has already been exposed as services, services to build and expose coarse-grained components for supporting specific business processes, roles, and tasks are in the early stages of development. Customers must still write custom code to orchestrate basic services or develop new ones.

Defining Services

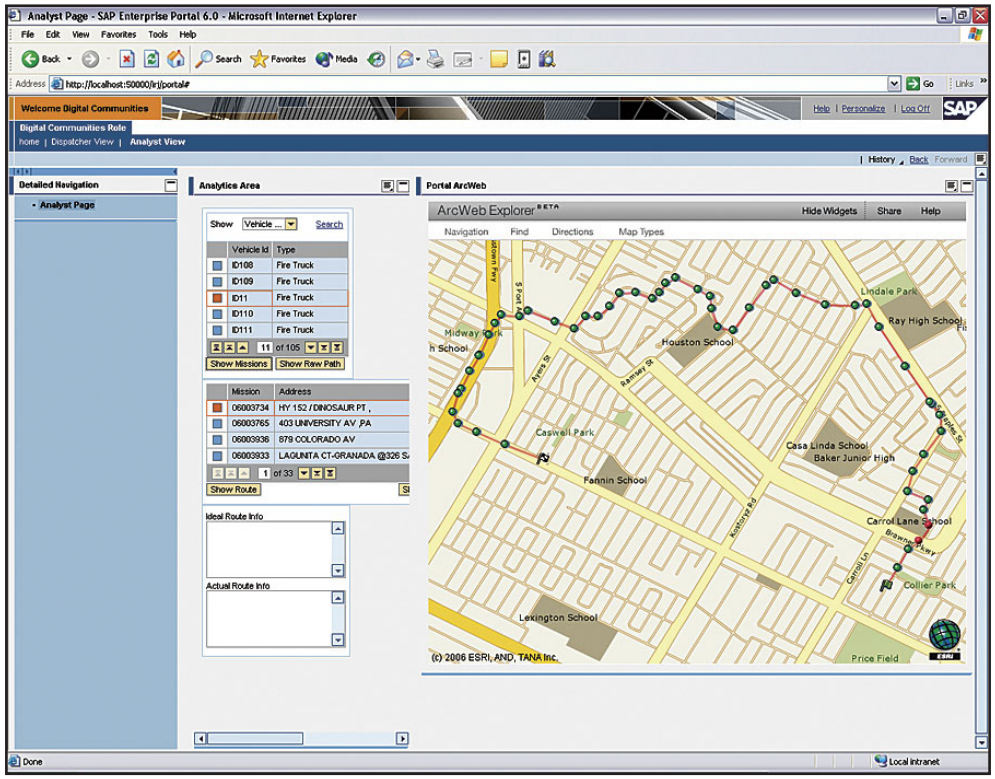
As it turns out, orchestrating services or even writing custom services is the easy part. Far more difficult is understanding specific business processes well enough to define a set of supporting services that can be flexibly used to model not only the basic process but also the process variations customers employ to gain competitive advantage. To address this demanding task, ESRI and SAP have again partnered to help define and deliver services for specific industry and cross-industry business processes, roles, and tasks.

Sagres Project

SAP Labs in Palo Alto, California, initiated project Sagres in 2005 to identify areas within SAP that could be significantly enhanced through the better use or integration of GIS capabilities. SAP teamed with ESRI and ESRI Business Partner CyberTech Systems of Oak Brook, Illinois, on the project for their experience in GIS and SAP integration. A broad initial review involving SAP and ESRI solution managers, as well as customers, resulted in more than 200 scenarios where GIS could add some value, and the most promising ones were grouped into the areas of geo-enterprise asset management (Geo EAM) and customer relationship management (CRM).

Since most of the existing integration scenarios involved Enterprise Asset Management, and both solution managers and customers saw great value in enhancing EAM business processes with GIS, Sagres focused first on identifying and understanding EAM business processes, roles, and specific tasks. More than 100 users were interviewed, half of them in their workplace performing their daily tasks, resulting in more than 60 individual use cases. A subset of use cases was selected to be prototyped and piloted at customer sites to validate the use cases; identify existing or new services needed; orchestrate the services into task-oriented,

preintegrated components; and use these service components in the context of a composite application implemented using the SAP NetWeaver platform.



Vehicle tracking prototype in SAP NetWeaver Portal using ESRI's ArcWeb Explorer and ArcWeb Services.

Sagres has been a catalyst for defining specific role and task-level services needed for Geo EAM business processes. It has also confirmed that understanding the business requirements and processes is far more difficult than writing integration code in proven technology platforms using industry-standard tools and approaches. This relative ease becomes even more pronounced as ESRI technology takes more and more advantage of SAP NetWeaver platform components. ArcGIS Server is already certified to run on SAP NetWeaver Application Server and integrate with SAP NetWeaver Portal, eliminating the need to write code for many administration or user interface integration tasks and delivering visualization and geoprocessing services to SAP NetWeaver Exchange Infrastructure and SAP NetWeaver Master Data

Management for orchestration into composite applications and to synchronize data between the two systems.

Future Directions

With a good understanding of Geo EAM processes, roles, and tasks, Sagres is now using the same methodology to understand other application areas that can benefit from GIS integration, including CRM, real estate management, and more. Composite applications are the next wave in GIS/SAP integration because they bring GIS closer to the operations and processes that drive businesses on a daily basis. These composite applications will not replace stand-alone GIS tools. Rather, they will make the functionality offered by them more readily available. By embedding GIS functionality within operational applications and processes that drive the business, these composite applications will make GIS more operational, easier to use, and pervasive—key challenges facing the new generation of enterprise GIS adopters.

(Reprinted from the Fall 2006 issue of *ArcNews* magazine)

Cape Town's Emphasis on Systems Integration Exemplifies "Smart City" Goals

By Jim Baumann, Staff Writer, ESRI

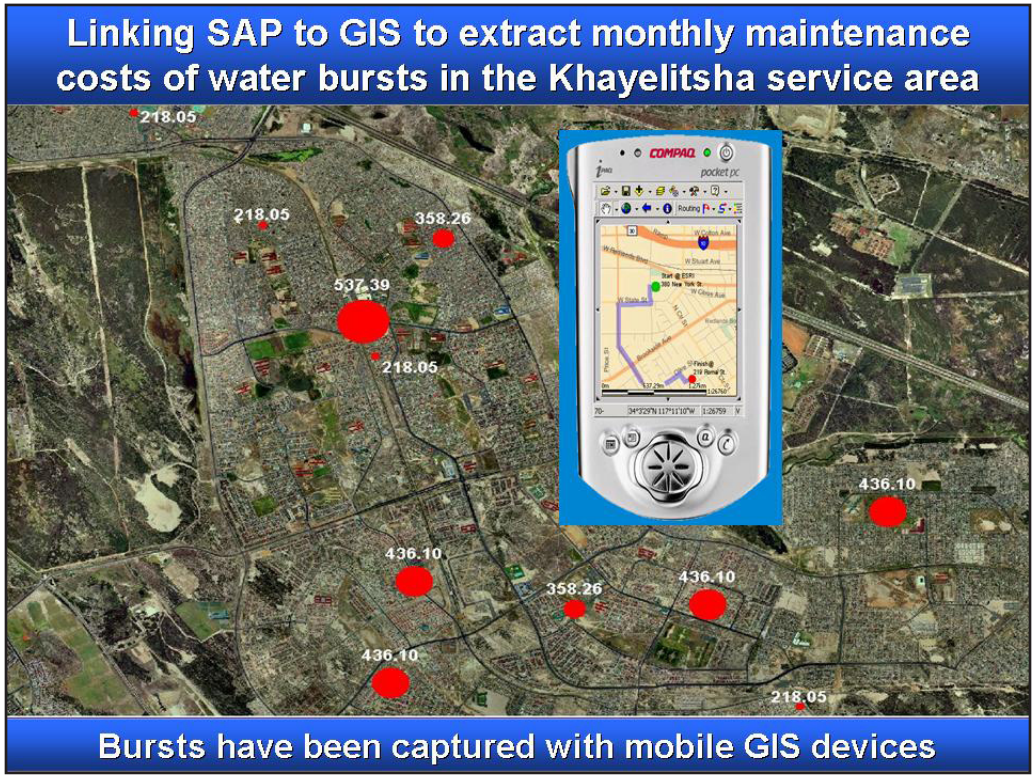
In 2001, seven neighboring local authorities were amalgamated into the city of Cape Town in the Republic of South Africa with the intention of consolidating and streamlining municipal services across the Cape Town metropolitan area. As a result of this massive restructuring process, the city of Cape Town, with a population of approximately 3.2 million, immediately became responsible for managing a number of antiquated, stand-alone information management systems holding disparate data in at least seven different IT centers across the new city.

Integrating its existing legacy systems into a seamless IT infrastructure became a top priority for the city. Committing itself to a holistic and comprehensive "smart city" strategy, the IT department initiated a number of projects to address the standardization of information and communication technology (ICT) architecture and connection of constituent parts to enable a better flow of information among the departments and more efficient services for its residents.

Key to the success of the smart city strategy was the implementation of the enterprise resource planning (ERP) system, which saw approximately 113 legacy systems and 70 interfaces replaced with a single functionally rich SAP solution designed to standardize and optimize the city's entire business processes. Recognized as one of the world's largest ERP systems ever implemented by a local government, it has a custom-designed billing system to help streamline the accounting process.

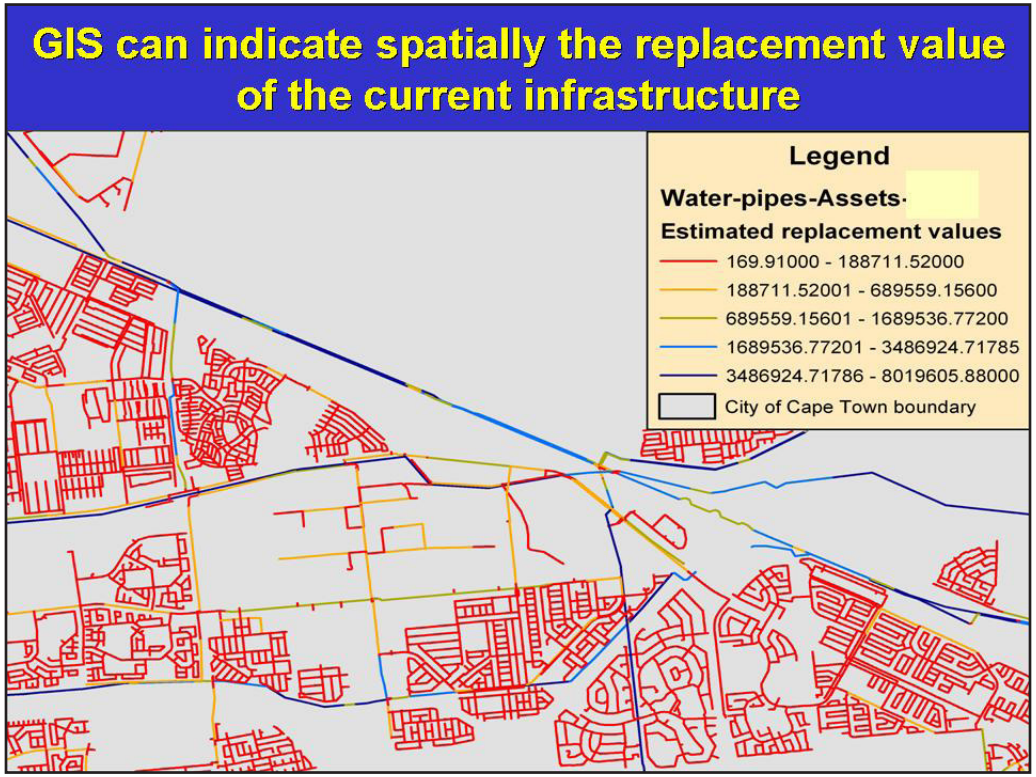
Next, the city integrated a GIS into the information system infrastructure. While GIS technology was used throughout the various local councils prior to the amalgamation, it functioned primarily as a stand-alone system with little standardization and limited compatibility. To reform this particular legacy, Cape Town implemented an enterprise GIS based on ESRI's ArcGIS platform. This allowed extensive functionality within a multiuser environment and provided an effective spatial data management platform for its many users. Initially, the city concentrated on consolidating electricity and property geodatabases into the GIS and subsequently added the Water Services geodatabase to the GIS process. Since then, a number of other departments, such as Planning and Valuations, have started implementing GIS technology. ArcGIS was

successfully implemented in participating departments as the city focused on integration issues, such as user profiles, as well as standardized data capturing and maintenance of departmental geodatabases.



Cape Town's Water Services proved to be the ideal utility from which to continue its GIS integration initiatives. South Africa is located in a semiarid region without significant perennial rivers or lakes, and this reality requires extensive conservation and water control measures. The city of Cape Town also experiences a 3 percent annual growth in its population, placing an even greater strain on the city's limited water resources. Given these constraints, GIS provides one of the best possible means to collect, analyze, and model spatial data for optimization of water conservation and demand strategies.

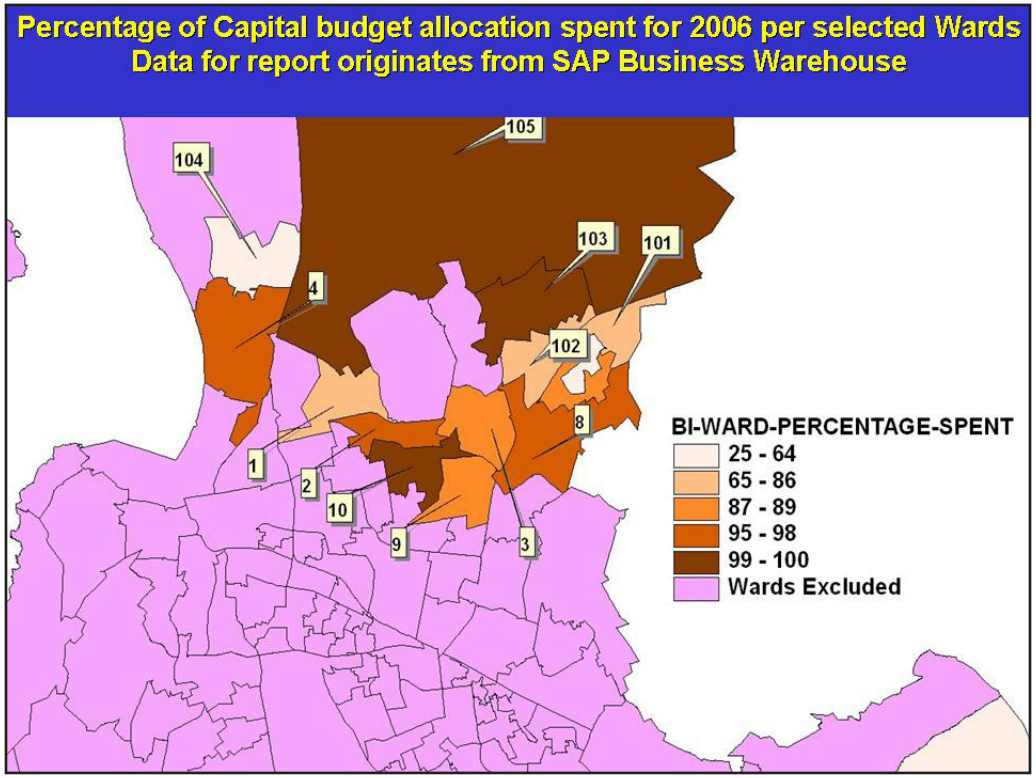
The implementation of SAP enabled the city to establish an effective link between the system's business information capabilities and its location-based asset information, such as pipes, meters, reservoirs, treatment plants, and associated attribute data stored in GIS. By taking advantage of this link, Cape Town is now able to extract the monthly maintenance costs for incidents, such as burst pipes and sewer blockages, as well as evaluate water consumption patterns based on tariff structures.



There is also a link to the asset register, which is a model that runs against the GIS infrastructure geodatabase and is used to calculate solutions, such as the life span of the various parts and components of the Water Services' infrastructure. GIS can, therefore, be used as a tool to plan medium- and long-term budgeting of infrastructure projects, such as replacing pipe infrastructure due to increased population demands or end of life cycle redundancy. Next, the city will apply the lessons learned from the Water Services implementation to the

development of a sewer and storm water geodatabase. Currently, the existing ArcEditor/ArcInfo 9.1 tools are utilized for multiuser editing in eight district offices, but the long-term vision is to develop a customized editing tool within the ArcGIS Server environment.

By developing a common data model for GIS use throughout the city, Cape Town has realized substantial savings in its operations and developed a GIS that promotes data sharing while minimizing data redundancy. The overall strategy is to implement a GIS completely integrated with the city's enterprise-wide information architecture and infrastructure, providing support to the city's private citizens and its local business community.



The Water Services Department has also implemented the Technical Operations Centre (TOC) that interfaces with the Corporate Call Centre to initiate operational responses and manage event tracking and logging. Currently, the Water Services Department is evaluating the available

technology and interfacing options to develop a fully automated, spatially enabled event management system (EMS), defining an event as any operational activity requiring a response. The EMS would be used to monitor and support the responsibilities of the city's employees to increase their efficiency. For example, the EMS would automatically record the exact location of an event occurring in the city and analyze it to determine its impact on the surrounding area. Using location as a reference, the system would then identify assets the city has at any particular location and dispatch work crews to respond to the event. Workflows developed within the EMS will allow the city to define and manage its standard operating procedures (SOPs) to support the EMS. The workflows would analyze the system's automated response to an event and escalate the response to a higher level, demanding greater urgency, if required.

According to Pieta le Roux, GIS coordinator for the city's Water Services Department, because events will be spatially referenced, engineers will be able to interpret trends and patterns visually, which will allow them to be proactive in their response to events. In addition, the TOC will coordinate responses to water/wastewater emergencies by integrating the notification and work order processes of SAP with mobile GPS/GIS and communication technologies. This integration will allow the city's supervisory control and data acquisition (SCADA) and telemetry systems' alarm components to be part of the central IT network and information infrastructure for quicker response to any malfunctions or anomalies occurring within the city's utility networks.

Le Roux further states that Cape Town has a mature GIS, which is commonly viewed as central to the city administration's plans for a tightly integrated and service-oriented IT architecture, supported by a modern infrastructure, for a seamless enterprise information management capability. The GIS production and geodatabase server environments form a major part of this integration process.

Commenting on the future, le Roux says, "Cape Town will be implementing strategies and processes toward the transactional integration of GIS and SAP to provide the necessary life cycle views and real-time feedback of its asset maintenance environment."

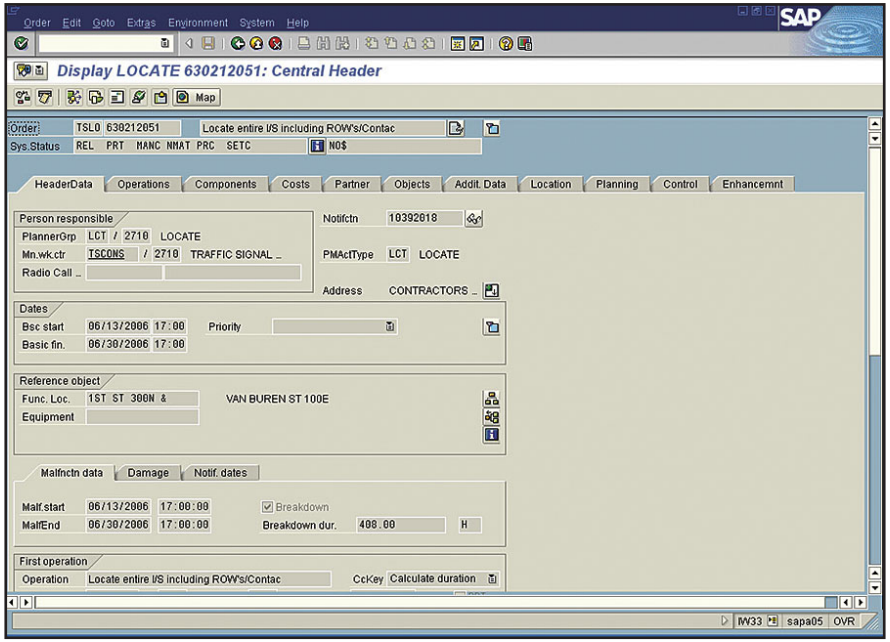
(Reprinted from the Summer 2007 issue of *ArcNews* magazine)

Enterprise Resource Implementation Through ESRI GIS and SAP ERP

City of Phoenix Street Transportation Department Invests Significantly in GIS Technology

By Gordon Guge, IT Manager, Street Transportation Department, City of Phoenix; Tom Rieckhoff, SAP Team, Finance Department, City of Phoenix; and Mike Youngs, GIS Analyst/ Programmer II, Street Transportation Department, City of Phoenix

The City of Phoenix, Arizona (like its legendary namesake), has risen from the ashes of the ancient Hohokam Indian settlement to become the fifth largest city in the United States. It is one of the nation's three fastest-growing cities with a population of nearly 1.4 million anchoring a surrounding population base of 3.5 million.



SAP Plant Maintenance Model screen with the custom map button.

Managing the transportation needs of a large population base is difficult at best in any environment. In Phoenix, it is more than challenging. The City of Phoenix contends with its own unique characteristics, which to Phoenicians make Phoenix like no where else to live, unless of course you are the city's Street Transportation Department and are responsible for a host of challenges in the desert environment. In addition to Phoenix's rapid population growth, its more than 300 days of sun each year attract more than 12 million tourists annually. Snarled traffic, ongoing pollution alerts, extended commutes, and significant new construction combined with older infrastructure all add to the pressure. The City of Phoenix Street Transportation Department is meeting the challenge head-on through a complex proactive initiative that will allow Phoenix to continue to evolve with the changing needs of the city. As part of that initiative, the Street Transportation Department has implemented an asset management system that integrates enterprise resource planning (ERP) with GIS.

Following a detailed selection process, the Street Transportation Department chose ESRI Business Partner CyberTech Systems and Software as the city's consultant in integrating ESRI's GIS with SAP ERP and in helping create a road map for an implementation of ESRI software as an enterprise resource. This plan included the study of legacy systems that would be replaced by SAP and ESRI technologies. Working with the Street Transportation Department IT team led by Gordon Guge and the city SAP team led by Susan Perkins, CyberTech submitted a three-year road map for implementing SAP and ESRI software in the Street Transportation Department. The road map highlighted the importance of implementing SAP and ESRI software across the department and integrating the two powerful technologies to help improve the department's operational efficiencies, leveraging each technology for the value that it provides. ArcGIS Desktop, ArcIMS, and ArcSDE software products were used to develop custom applications for the collection, conversion, maintenance, and analysis of data.

The city has been using SAP, an enterprise resource planning software package, to manage its finances and assets since 1998. The SAP Plant Maintenance module was selected by the Street Transportation Department for asset maintenance management because it provided specific construction, maintenance, and tracking functionality. A geographic interface was incorporated because street assets are maintained as part of the public right-of-way, and GIS offers a uniquely efficient way of searching, viewing, and analyzing data. The literal translation of an old Chinese proverb states that "a picture is worth 10,000 words." Similarly, integrating SAP software with ESRI software provides the ability to view, query, and analyze asset information and produce graphs, maps, charts, and so forth. Analysis of SAP data is further enhanced by presenting the information via a map, facilitating the geographic analysis of data.

Custom intranet application for the signal shop division.

A major objective of the Street Transportation Department is to provide a means for the integration of disparate right-of-way and street data. Using a variety of ESRI software products and these interfaces, the right-of-way objects and events are located relative to a position along the street network. Using this integration framework, applications can be developed to track department infrastructure and operations, as well as facilitate improved workflows and decision-making activities.

The Street Transportation Department's SAP integration with ArcIMS software makes spatial information accessible and useful to users across all business areas of the department. This department-wide GIS is a collaboration of project, divisional, enterprise, and public access GIS implementations and is organized into five application areas including bridge management, street management, traffic signal management, storm drain management, and streetlighting management. These application areas provide a general business context for accessing spatial data using the ESRI GIS functions.

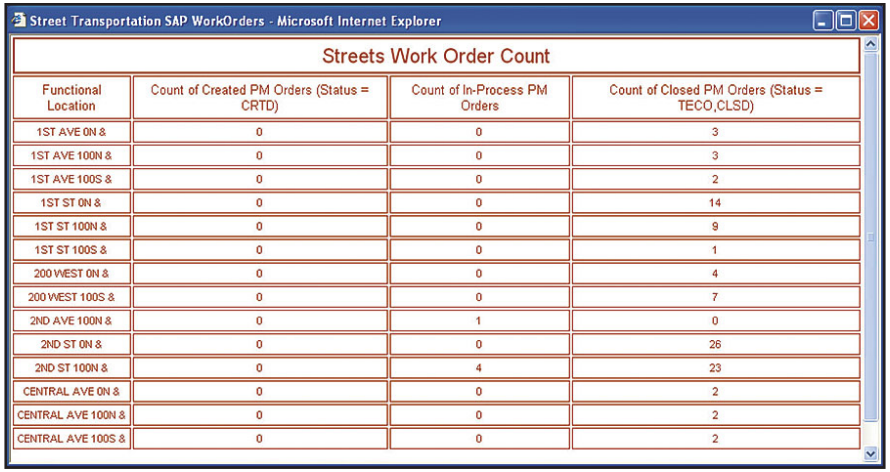
The SAP Plant Maintenance implementation for maintaining the nearly 1,000 traffic signals in Phoenix is operational. Users can immediately view the location of a signal work order on a map through SAP. Construction and maintenance SAP work order data can be accessed through the ESRI GIS. Additionally, functionality has also been added to the department's ArcIMS intranet application, allowing users to retrieve work orders directly from SAP.

Robust City Data Architecture

ESRI GIS database and integration capabilities are uniquely suited to this application, as the synthesis of data in this project is complex. For example, any single piece of data may be recognized in many disparate databases. The collection, along with the maintenance, of spatial data is the largest single cost associated with the GIS implementation. The spatial data of interest to the city falls into four logical groups; for example, storm drain data may need to be captured as geographic data, which is the common reference framework and includes right-of-way, street centerlines, natural features, and political boundaries; infrastructure and utilities data; operational data, which provides spatial locations for various types of installation and maintenance activities; and land-use and development data, which provides information for the management and utilization of land and natural resources within the city. It includes zoning designations, development boundaries, city-owned lands, and environmentally significant features.

Pragmatic Implementation Approach

Highly cognizant of the city's fiscal responsibilities and limited budget, a prudent and flexible implementation approach was developed, balancing key business drivers with available resources while allowing the city to meet its obligations to the public. To shorten the timeline and increase efficiency, the implementation schedule overlays three parallel efforts consisting of data collection and conversion of the Street Transportation Department's GIS database; data maintenance application development that will allow the city to maintain the GIS database; and GIS application development, design, and implementation that apply the GIS database to the department's business processes.



Streets Work Order Count

Functional Location	Count of Created PM Orders (Status = CRTD)	Count of In-Process PM Orders	Count of Closed PM Orders (Status = TECO,CLSD)
1ST AVE 0N &	0	0	3
1ST AVE 100N &	0	0	3
1ST AVE 100S &	0	0	2
1ST ST 0N &	0	0	14
1ST ST 100N &	0	0	9
1ST ST 100S &	0	0	1
200 WEST 0N &	0	0	4
200 WEST 100S &	0	0	7
2ND AVE 100N &	0	1	0
2ND ST 0N &	0	0	26
2ND ST 100N &	0	4	23
CENTRAL AVE 0N &	0	0	2
CENTRAL AVE 100N &	0	0	2
CENTRAL AVE 100S &	0	0	2

Count of SAP Work Orders corresponding to area specified on the map.

Components of each of these efforts, together with the implementation of SAP, are allocated in stages. Each stage delivers a part of the asset management application set that applies the data model and is incremental, building on the work done in the prior stage.

Expected Benefits

As a result of the teamwork between the City of Phoenix, CyberTech, SAP, and ESRI, the city expects to improve the management of the right-of-way assets through the geospatial coordination of the location of the growing infrastructure, and associated elements and attributes assist in ensuring that these assets are properly maintained. Enhancing the analysis of changing traffic and infrastructure demands will help the Street Transportation Department identify and prioritize construction and maintenance efforts.

Most important to the City of Phoenix is improved citizen services. With integrated street and services information that incorporates displays and reports enhanced with maps, the city can more effectively provide quicker and more coordinated responses to queries from its citizens. By analyzing service requests within geographic areas, the Street Transportation Department will better match services to community needs.

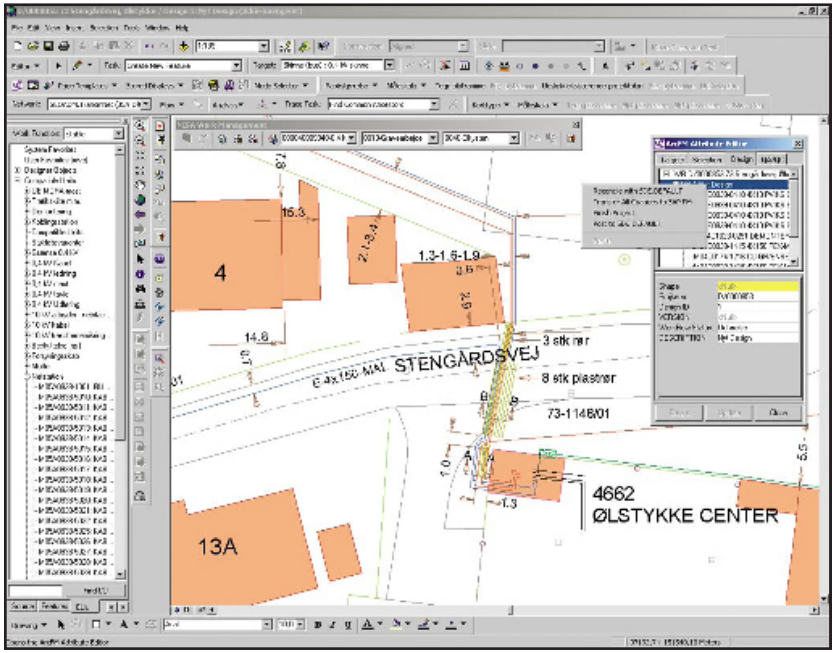
(Reprinted from the Fall 2006 issue of *ArcNews* magazine)

Denmark's Largest Electricity Company Implements Enterprise GIS

NESA Deploys a Complete Business Solution

By Osnat (Osi) Arbel, Business Analyst, Miner & Miner

In Denmark, the deregulated electricity market allows customers to have free choice of electricity suppliers. This encourages utilities to improve customer service and cut costs. NESA, Denmark's largest electricity company, is focused on strengthening its competitiveness to attract significantly more electricity consumers and grid supply customers. Thus, key priorities in NESA's corporate culture are enhancing, sharing, and exploiting knowledge to expand its existing business.



Miner & Miner's Designer was integrated with SAP's Project, Plant Maintenance, and Material Management systems.

NESA is a lead player in the Danish power market. From power generation to electricity supply to customers, NESA is involved at every link along the chain. NESA strives to provide customers with excellent service and has a long-standing tradition for reliably supplying electricity.

Serving a population of nearly one million, NESA has approximately 550,000 customers around greater Copenhagen. NESA distributes approximately 6,000 GWh to customers on a yearly basis and manages transmission and distribution, fiber optic cables, and communication lines. In 2001, NESA supplied 6,347 GWh of electricity through a total of approximately 533,000 connection points along its electricity grid. Approximately 471,000 of those were residential units; the remainder were business enterprises, shops, schools, etc.

Extensive GIS Implementation

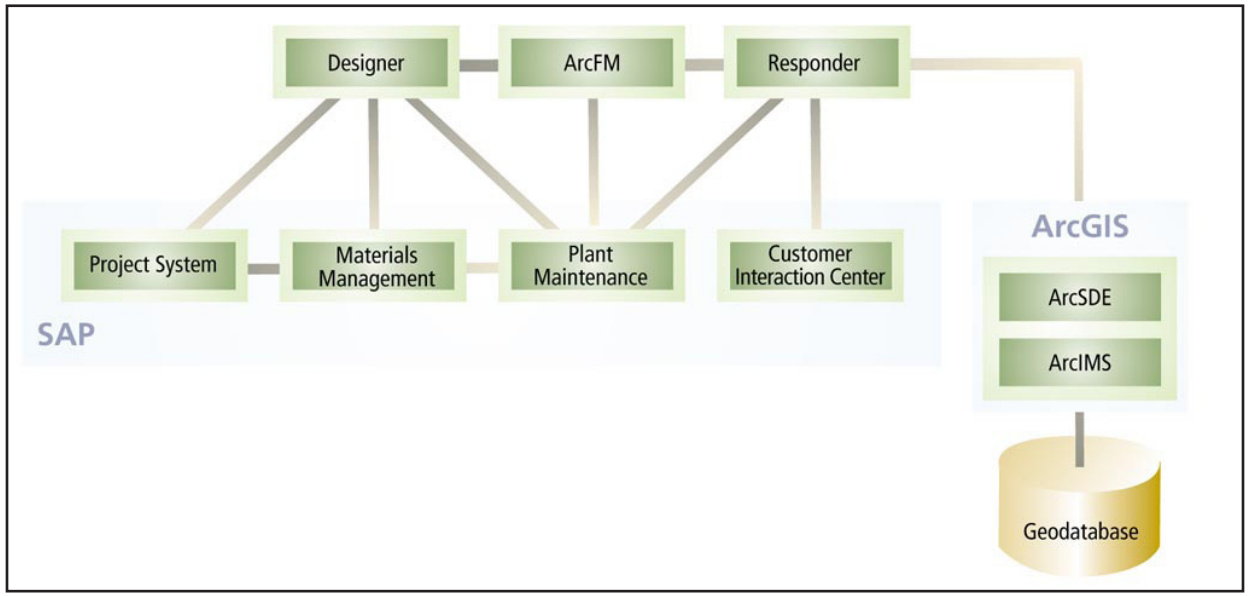
To support NESA's core business processes and leverage its existing expertise and competitive advantages, NESA invested in an enterprise GIS solution. Since 1995, ESRI Business Partner Miner and Miner, Consulting Engineers, Inc. (M&M), and Informi GIS A/S, ESRI's Danish distributor, have provided implementation services for NESA's distribution and transmission network system using ArcGIS software-based applications. Over the last three years, NESA, working with M&M and Informi, has completed the enterprise solution implementation. By using the best-of-breed approach, the three companies have chosen technologies and built interfaces to support NESA's workflow and leverage its investment in GIS.

NESA uses ESRI's ArcGIS and Miner and Miner's ArcFM to handle the management and presentation of its facility data such as transformers and circuit breakers. Using ArcSDE on a central server, together with ArcEditor/ArcFM, facility data is managed in a central geodatabase. The user community can access the geodatabase and maintain its network assets, issue trace results, support map production, and initiate reports and queries. With ArcIMS, users can also access this data in Web browsers.

Integration With SAP R/3

ArcFM and SAP's R/3 Plant Maintenance system were integrated to link features in the GIS to objects in R/3 to support maintenance and other activities. M&M's Designer was integrated with SAP's Project, Plant Maintenance, and Material Management systems to support design engineering and costing. In addition, NESA uses M&M's Responder and Responder/System Operations Management (R/SOM) applications to manage outage and switching operations in

the control room. Responder is integrated with SAP's Customer Interaction Center and Plant Maintenance system to support trouble call operations.



The overall system is composed of facility data stored in a geodatabase, GIS applications for maintaining the facility data and for design and trouble call applications, and SAP for storing business attributes on facility and network features stored in the geodatabase. Geographic features, such as transformers, are linked to corresponding technical objects with unique IDs in SAP, and data is shared between the two systems using SAP's Business Application Programming Interfaces (BAPIs).

Integration With ArcFM

ArcFM is used within GIS to support the creation and maintenance of facility, asset, and equipment features. To create and maintain corresponding objects in SAP, ArcFM was integrated with SAP's Plant Maintenance system. Users can create, update, and delete objects in SAP that correspond with the evolving network infrastructure within the GIS. Since features are linked, users can access additional information using ArcFM to display SAP asset master data and maintenance status. ArcFM and Plant Maintenance are kept in sync through the integration and consistently reflect the as-built state of the network. Other GIS and SAP applications can then leverage the currency of the data.

Integration for Design

NESA needed an integrated design solution to manage the design process and interface with its core enterprise resource planning (ERP) system, SAP R/3. Leveraging a unified solution platform, Designer links with various applications within R/3 including Plant Maintenance, Material Master, and Project Scheduling. These integrated applications support the entire design process including work request display, design, construction, material identification, costing, and as-built updates.

NESA's designers can easily view the work requests generated by SAP's Project Scheduling within GIS. They can also create designs within GIS and access a list of materials that have been downloaded from the Material Master. In the design process, they can generate a cost report and bill of materials for the customer.

The goal was to optimize the process of network engineering at the company. NESA is now able to produce cost quotations faster and more accurately with the integration of the applications to provide its customers with better service. The fully automated process also secures a high level of data quality, making it possible for NESA to document the network precisely and consistently. This is critical for the company to support the integration of GIS with the Outage Management system and Switch Operation Management.

Trouble Call Analysis

Industry deregulation and competition make it more important than ever for utilities to maximize their electric distribution network's reliability as well as minimize service outages to improve customer satisfaction. Analyzing outage calls is essential for dispatching and resolving problems. NESA is using M&M's Responder Trouble Call Analysis (TCA) Engine to support and manage the analysis of outage calls.

NESA's dispatchers are able to use the outage database and TCA Engine to analyze customer calls with respect to the GIS network and create incidents—locations of suspected failures in the network. SAP manages the call information within its Customer Interaction Center application. The TCA Engine periodically queries SAP for this call information before beginning its analysis. The calls are associated with transformers, and then the transformers are aggregated into probable incident locations. The call and incident locations are stored in an ArcGIS geodatabase to be displayed on the Intranet via ArcIMS. Users can then select specific incidents for work crews to investigate. These incidents are then passed back to SAP and forwarded for crew dispatching. When the crews finish the repair, they log this information via remote terminals,

which pass data back to SAP and from there to Responder for removal from the open-call and incident queue, allowing the map display to only show those calls and incidents that are open.

System Operations Management

NESA has been using R/SOM to run its 10 kV control room operations. The application is an integrated switch order and operations management system that operates in a high-performance distributed architecture, providing a convenient graphical environment while utilizing data maintained by GIS. The product is based on MapObjects, utilizing coverages and shapefiles that are extracted from the geodatabase on a periodic basis. The application is run in the control room on dual monitors to display the geoschematic data and switch forms. NESA initiated the implementation of the system in early 1999, going live in December 1999 just in time to resolve Y2K problems.

Switch Operation Management of the 10 kV network is an important function at NESA and R/SOM makes it possible to plan and carry out network switching very efficiently. This ensures that the customer receives better service in terms of continuous power supply availability and reduced outage time in the event of a network fault. The scalability of the system fits well into NESA's strategic plans for a growing number of customers. The product is based on an open architecture, which helped leverage the integration of the Outage Management System and Switch Operation Management.

By introducing the latest technology, NESA improved its process efficiency and enhanced its customer service and supply reliability. As a result, NESA is now better able to handle a growing number of customers, providing them with sustained and reliable service.

NESA's Business Benefits

Implementing this extensive GIS infrastructure at the utility was part of NESA's goal to create an environment in which it can expand its customer service, introduce streamlined working procedures, improve its earnings potential, and secure greater value for its owners. This fully automated process provides a high level of data quality, making it possible for NESA to document the network precisely and consistently. NESA recently recorded both a net increase in customer numbers and increased sales of electricity.

"The NESA implementation of ESRI's ArcGIS and the ArcFM solution, including Designer and Responder, may be one of the most advanced enterprise deployments of GIS anywhere in the world," states Jeff Meyers, Miner and Miner's president.

NESA recently relocated to its new headquarters building in Vangede, Denmark. In addition, the company has undergone a considerable organizational restructuring including information technology and personnel. Ensuring the utility could provide products and services at competitive prices drove NESA to recently deploy a broad GIS solution. NESA focused on business benefits and competition.

(Reprinted from the Spring 2003 issue of *ArcNews* magazine)

Editor's Note In 2006, NESA was part of a large-scale merger with DONG Energy in Denmark, which now has more than one million customers.

GIS and Beyond

By Rene Horemans, Project Manager and Chief GIS Editor, Pidpa; Bart Reynaert, ICT Project Lead, Pidpa; and Patrick Vercruyssen, Director of Customer Relations, Pidpa

Integration with SAP Improves Business Processes

Pidpa, a Belgian water utility, uses a complete ArcGIS-based solution to maintain a large amount of data relating to the company's water distribution network. An ArcIMS software-based viewer called GeoLink allows every employee to easily access related geographic data in a Web browser. GeoLink also contains interfaces to important company-wide information systems such as SAP, CIS, Supervisory Control and Data Acquisition (SCADA), and an intranet document archive. GIS is a portal to all kinds of location-linked corporate data.

In a utility company, most data has a location attribute so the ability to link detailed data to a location with only a mouse click has many benefits. The ArcGIS and SAP integration implemented by Pidpa demonstrates the value of the integration of business processes in the utility world.

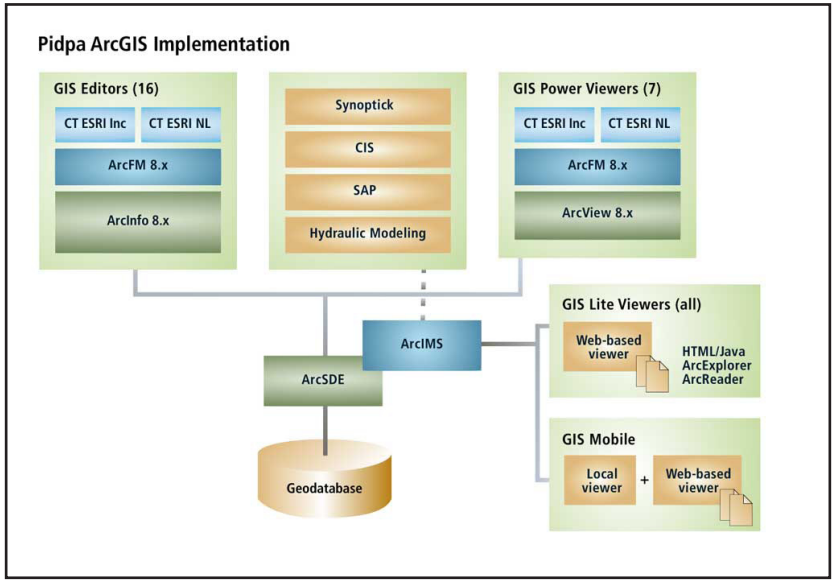


Figure 1: Pidpa ArcGIS implementation.

Pidpa, one of the largest drinking water companies in the Flanders region, produces and distributes high-quality drinking water throughout the Antwerp province in Belgium. It serves an area of approximately 2,581 square kilometers and continuously provides more than 1.1 million people with drinking water. The company is committed to distributing high-quality drinking water to its customers at an affordable rate. To accomplish this, Pidpa maintains a network of more than 12,000 kilometers of water distribution mains in urban as well as rural areas. Its 26 water production centers annually produce more than 65 million cubic meters of water.

The company works with groundwater. Water quality throughout the network is checked by the company laboratory on a daily basis. Water samples from different points in the network are checked to quickly detect any problems. In the event of a problem, its origin can be isolated in the network to minimize the number of customers affected. Pidpa has developed alternate ways for distributing drinking water to affected customers. Small water bags or bottles, created on an emergency production line, are distributed to customers.

Water seems like a simple product, but it is actually very complex and requires high standards. Pidpa wants to be the best, not only in water production and treatment but also in water distribution, quality control, customer service, and sustainable management of water resources.

IT Strategy: Choosing Standards

Pidpa has evolved from a company with many in-house developers and proprietary mainframe-based information systems to a company that uses a standard software approach that can be summarized in one sentence with "buy what you can find and build what you can't find." This approach is based on the typical enterprise resource planning (ERP) business model that stresses the availability of rich generic software, limits the programming required, and shifts efforts to customizing applications to meet company needs.

In the long term, this strategy also ensures the company of continuously improving base products due to a large user base. Implementing SAP company-wide is indisputably a cornerstone of Pidpa's corporate IT strategy. The implementation of the ArcGIS family of products from ESRI provides a solid GIS foundation that is complemented by the ArcFM solution from Miner & Miner. This database-centric GIS environment for water distribution network management has been operational for more than two years and is still expanding to additional departments. GIS is an important information system at Pidpa. The integration of GIS with other key IT systems provides the organization with new strategic, tactical, and operational opportunities.

Information Systems at Pidpa

Information systems at Pidpa include GIS, ERP, CIS, SCADA, and LIMS. Over the last two years, GIS implementation has expanded its focus from GIS editing to making information accessible to a nearly unlimited number of users who can benefit from geoinformation about the water distribution network.

All customer information is still maintained in a mainframe-based information system that was developed in-house. It is complemented by an intranet environment that contains day-to-day information and provides a portal to archived information. This allows efficient handling of all customer-related activities. The decision whether to bring this system under the SAP umbrella will be made at a future date.

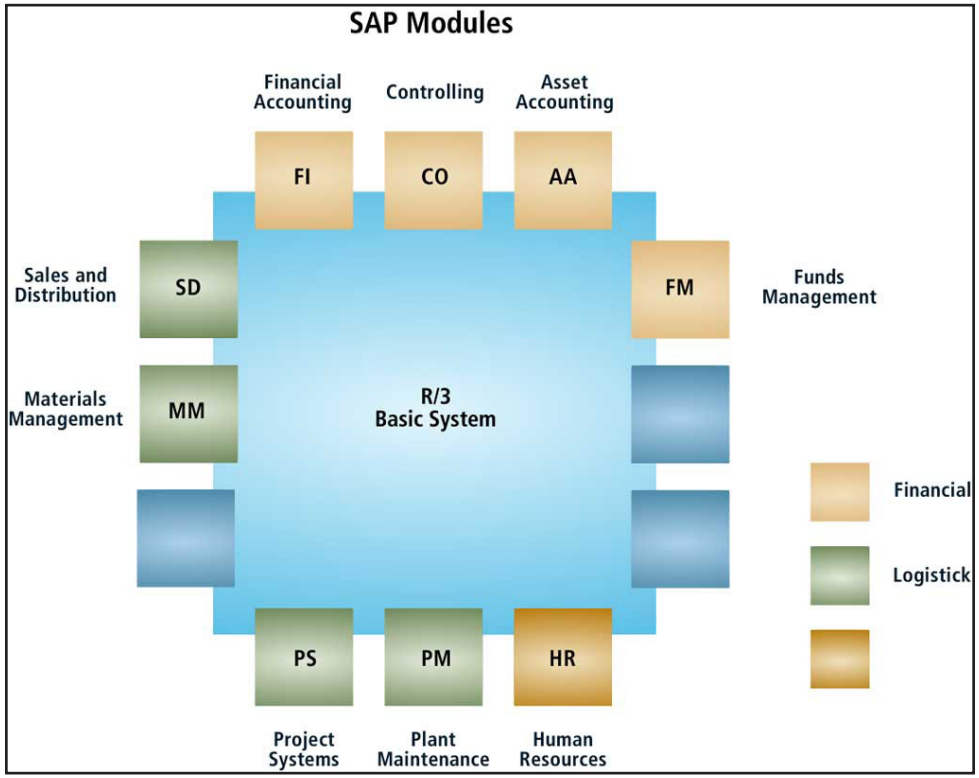


Figure 2: Relationship of SAP modules implemented by Pidpa.

Pidpa has a SCADA system for remotely controlling the function of equipment at water production sites. The SCADA system was developed in-house and stores readings from water towers, pumps, and valves and other necessary information to support decisions and provide necessary input to other parts of the system such as pumps. Pidpa also has a fully equipped laboratory that uses a Labo Information Management System from COMPEX-Unilab to manage all results.

What Is GeoLink?

GeoLink is a flexible intranet GIS viewer that provides easy access to geographic information for anyone in the company. It was developed and implemented in cooperation with ESRI Nederland B.V. and is based on the out-of-the-box ArcIMS 4.1 HTML viewer. The basic viewer layout—with toolbar, table of contents, and a large data frame for optimal viewing—was retained.

Standard, powerful GIS functionality was used when possible to limit the need for additional code development in JavaScript and ASP. From the Pidpa intranet home page, a user can start this viewer and access geoinformation. Functionality is very straightforward so there is no need for extensive training. A couple of two-hour demonstrations and good documentation were all that was needed to show users the available functionality. ArcIMS software's central licensing structure is a huge advantage because it limits licensing costs and adds flexibility for the user base of more than 100 viewers.

GeoLink accesses data from the central ArcSDE database which is also used by the GIS editors, so GeoLink users always have the most up-to-date GIS data. This environment runs smoothly and doesn't require much maintenance. GeoLink provides the flexibility to tailor the viewer to different types of information. GeoLink Distribution shows all water distribution network data. The same basic structure is also used for a site that focuses on water production and gives users an overview map displaying features such as water production centers, water towers, and pumping stations.

In using ArcIMS functionality for viewing company data, Pidpa faced challenges in three areas—symbology, raster data, and printing.

Symbology—In addition to a complex set of symbols and classifications, the water distribution network is represented with rotated symbols, annotation, and dimensioning. Initially, the ArcMap Server extension was used because the edit environment included more than 60 layers.

However, once a basic .mxd file was generated, maintenance became easy. View settings were adjusted in ArcMap, saved to a new .mxd file, and used to refresh the ArcIMS service.

Raster data—Because the company's GIS environment consists of a seamless combination of raster and vector data, it was not always easy to get data displayed correctly. Now the ArcMap Server extension uses the same image catalogs as ArcMap.

Printing—Despite encouraging users to access data on-screen as much as possible, field crews still need paper maps. The amount of raster data limits printing in ArcIMS to A4 or A3 sheets. Larger printouts ran into an ArcIMS limitation with one-bit raster data, but as the company moves more to vector data, this problem is diminishing.

GIS-Centric Strategy

GIS can help immediately pinpoint an exact location while creating a new SAP maintenance order or quickly determine the location of a problem in the network, such as a ruptured main, and subsequently create a list of the customers who will be affected. These two examples show how users can benefit from GIS in everyday work. GeoLink makes GIS functionality available to both technical and nontechnical departments and links geographic information to corresponding information within many other company information systems such as SAP, CIS, SCADA, and the company intranet archive.

Although linking GIS and SAP was envisioned years ago, the actual development was postponed until 2003. It began with an intensive search for a generic interface between GIS and SAP, specifically for the SAP PM and PS modules. This research led to solutions for integrating GIS and ERP environments using commercial products such as ArcFM Designer from Miner & Miner. However, after discussions with SAP, ESRI, and independent consultants, Pidpa decided this could become complex and costly in the long term and the focus returned to creating records in SAP from GIS and vice versa. This solution could be used by GIS editors and many users who would benefit greatly from viewing geographic data with data from other information systems.

Starting a large-scale GIS and SAP integration project that would require completely redrawing work flows was not possible at that time due to limited resources. Consequently, the company looked at the problem from a pragmatic point of view and decided to implement incrementally to get quick returns on the project.

The first step was defining the business scenarios by talking to key SAP and GIS users in the distribution department. The work processes that linked GIS with other information systems that could generate almost immediate benefits were identified. Eight business scenarios were selected for development. A small team of IT and end users developed interfaces for these scenarios.

The link between GIS and SAP was the most complex. It required extensive research by one of Pidpa's technical SAP specialists. These efforts resulted in SAPGui, a generic interface for passing parameters. Instead of trying to implement custom SAP interfaces, components in ArcMap and the GeoLink ArcIMS application were used as a portal environment from which the SAPGui could be started.

Challenges Faced in the GIS-SAP Link

The challenges faced by developers of the GIS-SAP link were associated with permissions issues, the requirement for rapid rollout of software to users, initialization of the interface, and the security and control issues associated with interfacing an application for a Web browser with a client-server application.

SAP Permissions

GeoLink is available company-wide, without restriction or risk of uncontrolled data changes. On the other hand, SAPGui allows users to access and change information. This powerful functionality required good permission management. When calling the SAPGui, a method was needed for users to log on to SAP with an individual user ID and get the correct permissions based on the user's clearance level. The difficulty was making this happen automatically through a single sign-in that used the Windows login to access SAP. This approach would make the interface fast and straightforward. While security is important, users can't be bothered with too many login screens.

Rollout

The interface between GIS and SAP was effected using the SAP DCOM connector. However, this component had to be installed locally on every client PC. It was a challenge to push both the connector and the interface to more than 200 client PCs on the network in just one night.

SAPGui Initialization

When called, SAPGui defaults to the user menu so a transaction can be chosen. However, when accessing SAPGui from GeoLink, the user wants to go directly to a transaction based on the parameters obtained from GIS to display the desired data. This functionality is a major benefit of the GIS-SAP interface so it was included in the interface code.

Browser Application/Client-Server Application

GeoLink runs in a Web browser, while SAPGui is a regular client-server application. From a technical point of view, these two very different environments raise security and application control issues when calling one application from the other. Because this is a closed intranet environment, rather than a more complicated Internet setting, security can be managed with a fair amount of flexibility. There are plans for eventually creating a Web browser implementation of the SAPGui, which will make the interfacing easier.

The Road Ahead

Many of Pidpa's goals for the project have been met. The company has created a powerful GIS edit environment and a flexible viewing environment that links GIS to other company information systems. However, this system runs only on the company intranet so field crews must still rely on paper documents. The next challenge will be to get these powerful tools to field crews in a manner tailored to their work processes.

In the future, the goal will really be to integrate the work processes of field crews with the current work flow in the office by equipping field-workers with mobile devices, either handheld or Tablet PCs. It is especially important for maintenance crews to easily retrieve water network information. The link with SAP is also very important because it contains all work order information.

Pidpa began an offline test project for field crews that offers new possibilities for accessing data. The real added value will be when these workers can receive new maintenance orders online, with links to GIS that allow zooming to the pertinent location, and immediately supply administrative feedback in SAP once the job is done. Bandwidth had been the limiting factor, but new technology is becoming available that will make standard applications in the field a reality.

But this isn't all. Increased availability of GIS data in vector format offers more possibilities for analysis and support for decision making by management. More nontechnical departments are discovering what GIS has to offer, not only for water network management but also for other applications.

The keyword for the future is integration—integration that respects the strengths and specific functionality of every information system but makes this information available to users quickly via an intuitive connection between information systems. GIS can be the glue to make this happen for a utility company.

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