GIS as an Enterprise Municipal System

BY GREG BABINSKI

In the past two decades, geographic information system (GIS) technology has become much more powerful, while costs have declined. GIS has become a common business tool, and many basic GIS capabilities are now used directly by government agency business users — including finance staff — elected officials, and the general public. As the technology has matured and applications proliferated, many government agencies now consider GIS a mission-critical enterprise system, along with financial, human resources, enterprise resource planning, and asset management systems.

King County, Washington — which comprises 2,000 square miles and has a population of 1.8 million — invested more than $10 million in its initial GIS development. On the other end of the spectrum, the City of Mercer Island — which comprises six square miles within King County and has a population of 22,000 and — invested barely $300,000 for its original GIS development. Both agencies rely on GIS for dozens of purposes, including managing their utility systems, providing a key tool for planning and permitting, and supporting public safety and emergency management. GIS supports many unique needs for each agency as well — such as protecting and managing the three bald eagle nesting sites on Mercer Island and helping King County assess how increases in sea level, related to global warming, will affect its waterfront.

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SUPPORTING BUSINESS NEEDS

GIS is not a single-purpose system, but an enabling technology that supports multiple business needs. It harnesses the power of framework geographic information by providing locational context for almost any municipal data. GIS software allows public agency data to be processed, analyzed, and displayed quickly and effectively to support better decision making.

Data Maintenance. Municipal framework data, the foundation for GIS, typically includes transportation (streets, highways, and street addresses), property ownership (tax parcels and land surveys), boundaries (city, district, census, zip, etc.), natural features (streams and topography), and imagery (digital aerial photography). Framework data, which provides the geographic context for other business data, was maintained for years before GIS was developed. For example, the assessor maintained paper tax parcel maps, the public works department maintained street paving maps, and the utility department maintained sewer maps. Traditional, paper-based map maintenance was labor intensive, prone to errors, and did not support agency-wide use. GIS allows technicians to maintain base maps with considerable time and costs savings, and automated processes within the software help reduce errors and improve accuracy. Network technology enables everyone in the organization to share framework GIS data for their own business needs.

Framework GIS data require constant updating as transportation, property ownership, boundaries, or other features change. Because GIS data is expensive to develop and maintain, it makes sense to pursue collaborative data sharing opportunities with other public agencies in order to minimize costs.

Business Process Improvement. GIS supports better business data management, which can lead to business process improvements. For example, a county with paper permit records could scan their records for system automation and improved records security. The scanned permit records could then be retrieved within GIS by street address, by owner, by type of property, or by many other geographic variables. A planner or permit technician could use GIS to retrieve and view other nearby permits, utility information, and even high-resolution digital aerial photography of the site. Permit applications could then be processed by the agency at reduced cost and in less time for the applicant. GIS helps put a wide variety of data and records into geographic context for informed decision making.

Natural and manmade disasters during the past decade have exposed a nationwide need for better management of local street address data. Most regions have multiple jurisdictions and even departments within jurisdictions that assign and maintain street addresses. In many regions, the U.S. Postal Service, county assessor, local permitting agency, fire department, and enhanced 911 each maintain separate street address databases. Multiple street address databases within a given location usually contain significant discrepancies and represent wasteful duplication of effort. This situation is of concern to the U.S. Department of Homeland Security, states, and local first-responder agencies, which need accurate street address data to deploy GIS for effective coordination of multiple agencies in response to any type of emergency.

Map Making. "Show me a map" is the most frequent request GIS staff receive, and map making is a powerful GIS application. GIS-based maps are easier to create and maintain than standard paper maps, and basic map-making ability can be put into the hands of almost anyone with access to a computer. GIS automates many basic map-making functions such as placing text and selecting standardized map symbols.

GIS also changes the way people think of maps. For many cities and counties, maps once meant expensive map books that were revised several times each year and issued to utility crews, meter readers, or fire crews. In other cases, maps were huge sheets to be mounted on walls or folded for use in the field (and never refolded quite the same way again). With GIS, a map of a city water system can be printed at full size for mounting on the wall of an operation center, and then printed as multiple map pages for field crew books, published as a PDF file for the city Web site, or loaded onto laptops or other portable devices for use by meter readers and maintenance field crews.

What is a GIS?

In simple terms, a GIS is a computer system that manages data with a geographic component, including satellite data, aerial photographs, digital maps, and other sources, in an automated system that supports data analysis, modeling, and display. Other terms sometimes used in place of GIS include "geospatial technology" (in common use by the federal government) and "geomatics" (frequently used in Canada).

Geographic Data. GIS integrates non-map data sources that include geographic locations. Tabular data that contains geographic locations — a public utility customer database with service location and billing addresses, for example — can provide location data for GIS applications. As much as 90 percent of public agency data includes a geographic location component that can be used by GIS.

Geographic Information. Data on their own are facts without context. The power of GIS is its ability to combine data from multiple sources in order to provide useful information that supports decision making.

In a classic early example that illustrates what geographic data processing can do, Dr. John Snow compiled information on victims of the 1854 cholera epidemic in London, ultimately targeting the cause and stopping the epidemic. One of the pieces of data he collected was the victims' home addresses, which he plotted on a map, revealing a concentration of victims centered on Broad Street. Suspecting that the cholera was caused by contaminated drinking water drawn from a public well, Dr. Snow removed the handle of the Broad Street pump, which disabled the well and ended the outbreak.

Dr. Snow's Map of Cholera Victims

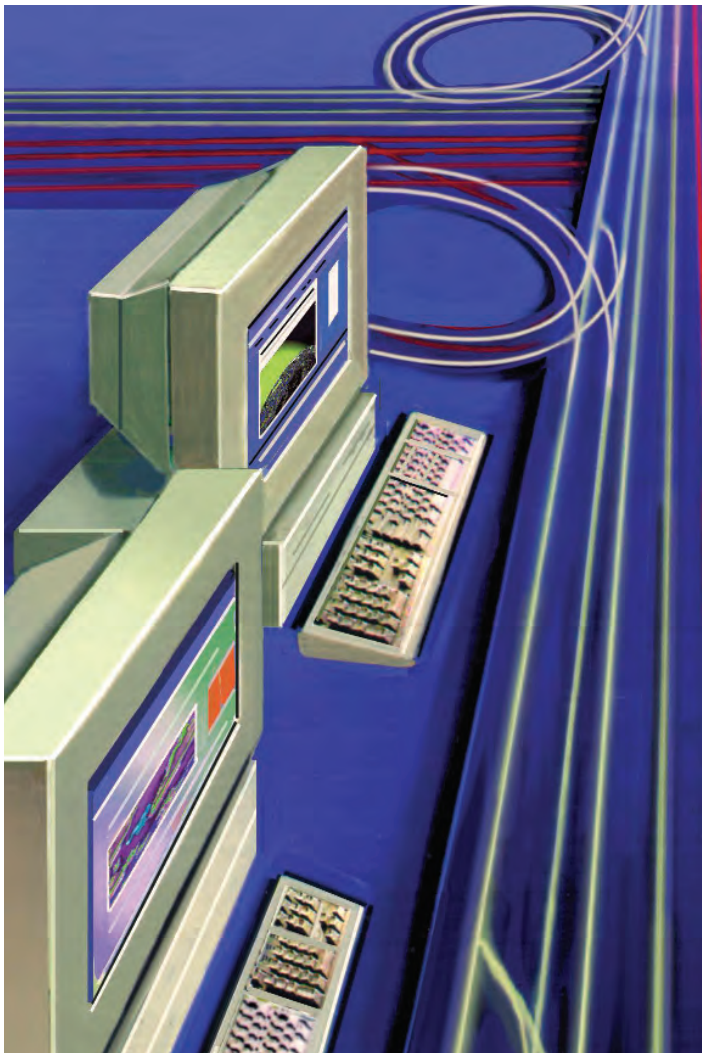
Geographic Information Systems. Specialized GIS software is used to combine geographic data sources for analysis and modeling, and to create, view, edit, and display maps. A GIS includes database software to manage tabular data, as well as software for programming and for publishing maps to the Internet.

GIS hardware includes servers to store, manage, and access data; computers to run the GIS software that edits manages, and manipulates the data; and specialized devices to scan or digitize data or to print large-scale maps. The hardware components must be networked together to function properly. Even medium-sized cities or counties require a terabyte or more of GIS data storage capacity.

TAKING AN ENTERPRISE APPROACH

An enterprise GIS approach enables public agencies to increase efficiency by sharing the cost of GIS technology and of framework GIS data to meet the specific information requirements of every department. It eliminates overlap and avoids the limitations caused by a narrow focus on a given project or problem. GIS technology allows organizations to develop business applications that would not otherwise be possible, but the best technical solution will be a failure if it is not first and foremost a business solution. The following examples show how enterprise GIS capability allows organizations to create business solutions that are inexpensive but highly effective.

Property Appraisal. Many county assessors have been developing GIS-based computer-aided mass appraisal systems (GIS/CAMA), resulting in fairer assessments and potentially increased tax revenue. CAMA systems improve staff efficiency by combining recent high-resolution aerial photography with tax parcel maps to compare assessor records with the actual extent and condition of the property. The technology also makes it easier for staff to discover previously unnoted developments or additions; GIS/CAMA systems can use digital aerial photography from multiple years to automatically identify possible structure modifications or additions. These systems make appraisals more defensible by providing extensive data for objective analysis.



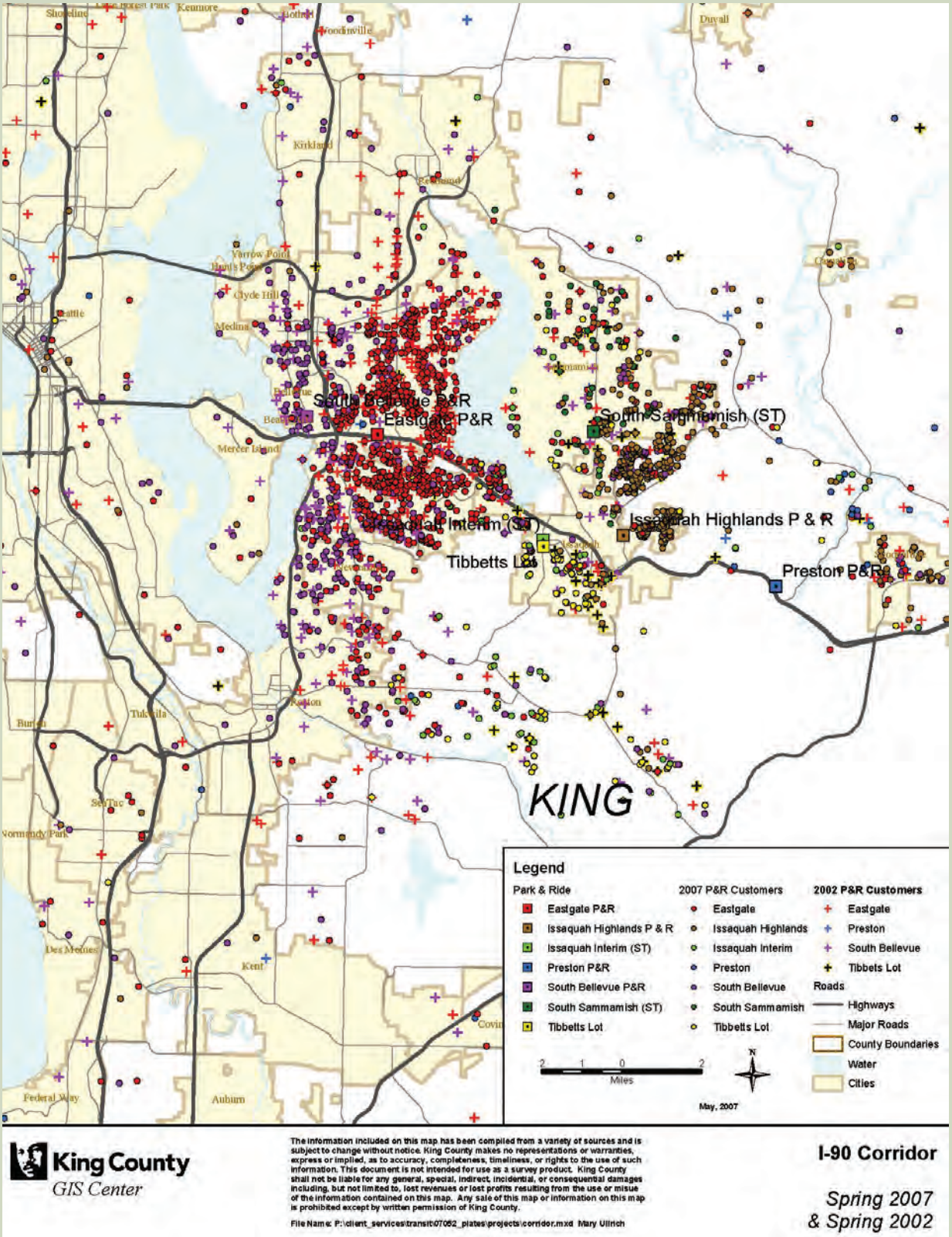
GIS changes the way people think of maps.

Site Analysis. Local governments analyze sites for a variety of purposes. A city may need to determine the best place for a clinic to serve the maximum number of nearby clients. A utility may need to decide on the best location for a new pumping station. A transit agency may need to analyze customers of their park-and-ride lots. In each case, GIS provides an effective tool for combining data from multiple sources, processing the data, and presenting the results in tables, statistics, or maps. In King County, Washington, for example, license plate numbers recorded from each park-and-ride lot are used to determine the addresses of the vehicle owners, which are then plotted on a map to depict the distribution of the lot users (see Exhibit 1). Transportation planners then use the maps to plan for new lots or to adjust bus service.

Web Mapping Applications. One of the most significant recent GIS developments is putting basic, user-friendly GIS capability in the hands of everyone in the agency, and the public as well. While desktop GIS software requires significant computer capability, GIS-based Web mapping applications use Internet mapping system (IMS) software that performs the map request and display processing on a central server and then displays the results on any computer with a Web browser.

Web mapping application costs are basically fixed, so there is no additional cost involved in making the application widely available — even to the public. Of the 39 counties in Washington, 30 have public Web mapping applications, along with seven cities and one regional agency. For context, King County, Washington maintains a suite of Web mapping applications that collectively had 2.2 million user sessions in 2007. This represents more than 6,000 public user sessions per

Exhibit 1: Home Locations of Park-and-Ride Lot Users in King County



day. The result has been fewer people visiting county offices or calling county staff for basic information about the county, its services, or their property.

Data Processing and Reporting. Some GIS-based applications do not rely on maps. A utility department may need to know per capita water consumption by city council district, or the police department may need to know crime rates by zip code. With appropriate data, GIS processing provides these types of reports quickly. GIS can also generate property owner or business mailing lists easily, based on location-based queries.

Other GIS-based applications include crime mapping, emergency dispatch and routing for e911, maintenance and work order management systems, flood plain mapping, natural resources management, and real estate portfolio management.

BUDGETING AND FINANCE

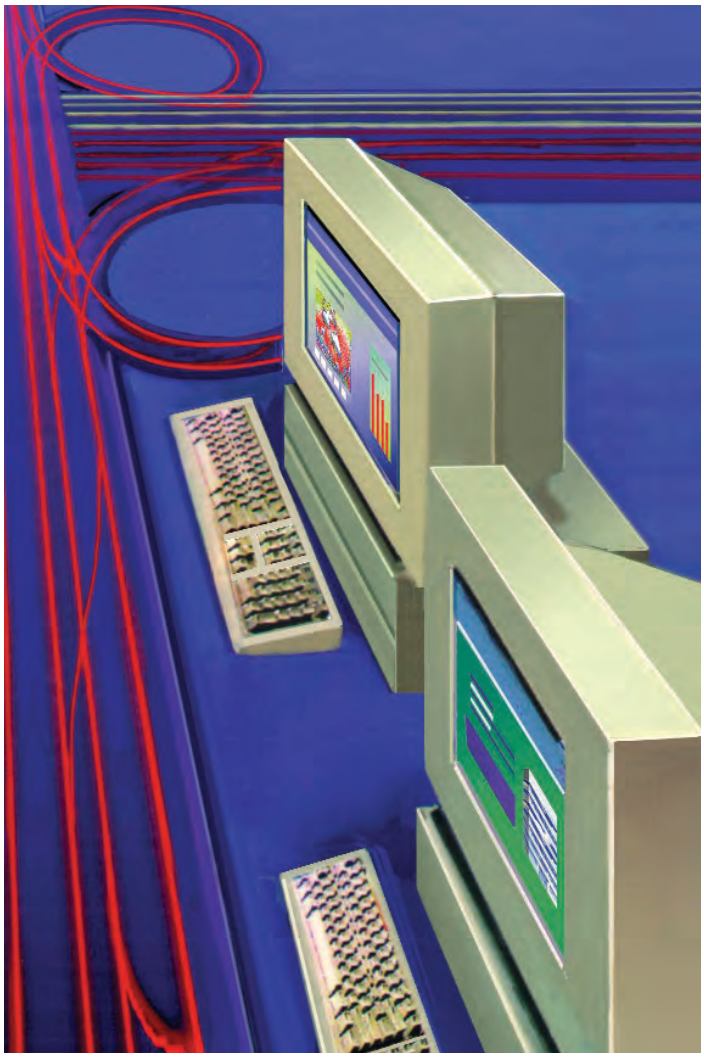
As GIS capability has matured, applications to support public budgeting and finance business needs have become common. In King County, the Finance and Business Operations Division accounted for 1.65 percent of staff in 2007, but 1.75 percent of Web mapping application user sessions. The county's Office of Management and Budget represented 0.65 percent of total staff, but 1.14 percent of total user sessions. The county's budget and finance staff use GIS at a rate comparable to or greater than departments. Specific examples of budget- and finance-related GIS applications include looking up property tax histories, analyzing tax and utility payment delinquency, and mapping capital improvement projects for budget development.

Many states have implemented GIS-based online applications to look up tax rates. The state of Washington Department of Revenue's Online Tax Rate Lookup Tool (at http://dor.wa.gov/content/findtaxesandrates/salesandusetaxrates/lookupataxrate/) allows residents or businesses to determine the appropriate sales tax rate for a specific location based on a city name, street address, or zip code, or by indicating a location on an interactive online map. This, like all web-mapping applications, reduces calls to agency staff while providing residents and businesses with a more useful service.

Another finance-related business use for GIS is complying with Governmental Accounting Standards Board Statement No. 34, *Basic Financial Statements — and Management's Discussion and Analysis — for State and Local Governments*. GASB 34 requires that local governments establish mechanisms to report on their infrastructure value, depreciation, and management practices. Even without GASB 34, the aging infrastructure of cities and counties is a financial challenge and a political problem that will only grow with each passing year. GIS has proven to be an effective tool for managing municipal asset inventories, modeling valuations, and planning maintenance or replacement of assets.

FUNDING FOR MUNICIPAL GIS

Most agencies implement GIS as a capital project, based on a needs assessment, cost-benefit analysis, and strategic implementation plan. Start up costs typically include acquiring hardware and software, developing or acquiring framework GIS data, system integration, and assembling a small staff to operate and maintain the system.



URISA

The Urban and Regional Information Systems Association (URISA, at www.urisa.org) provides extensive educational resources for managers who are responsible for implementing enterprise GIS or managing its ongoing operation. Many of these resources can be of value to finance and budget officers who would like to learn more about the benefits of implementing GIS and strategies to minimize start-up and operational costs.

A source for additional examples of GIS applications is the URISA Journal (http://urisa.org/urisajournal), which contains refereed articles and reports about GIS research and state-of-the-art GIS applications. Many URISA chapters publish online newsletters (for example, the Washington State chapter newsletter, *The Summit*, at http://www.waurisa.org/thesummit/) with articles that describe local agencies GIS applications and enterprise GIS case studies.

URISA holds an annual conference that attracts GIS professionals and users from around the world, as well as a GIS Street Addressing Conference that focuses on street addressing standards and integrated emergency dispatch. Other URISA specialty conferences focus on topics such as GIS/CAMA, GIS for public health, GIS for transit, and public participation GIS. In addition, URISA chapters in many states and provinces hold their own annual conferences. The association also provides workshops and publications on the use of GIS for asset management.

URISA's new flagship educational offering is the URISA Leadership Academy. This week-long program, the only geospatial technology leadership training program of its type, is tailored for agency leaders and managers.

URISA also publishes books, quick study guides, and conference proceedings, in addition to its flagship URISA Journal.

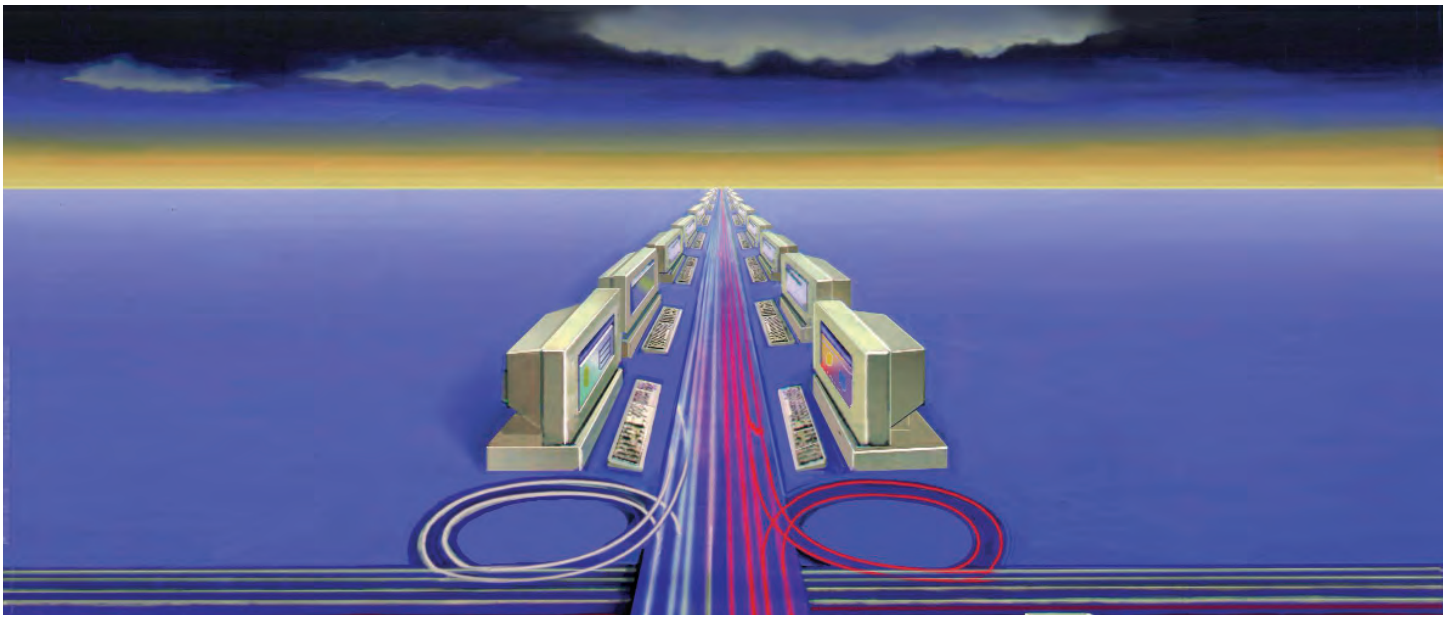
Recently, URISA helped to form the Coalition of Geospatial Organizations (COGO) with other GIS-related professional and industry organizations. The primary purpose of COGO is to formulate policy positions and to coordinate the development of strategies to address key GIS-related issues at the federal, state, and local levels.

A single sponsor department such as planning or public works often provides GIS operation and maintenance. But as GIS use spreads outside the sponsor department, many agencies recognize that GIS should be organized as an enterprise service and funded by the individual departments that benefit from the services. The current trend is for municipal GIS to be organized as a stand-alone division, or as a section within the agency's information technology division. Often, a GIS oversight committee provides ongoing strategic direction and funding support, and a GIS technical committee represents the needs of GIS end-users and business clients.

The largest component of a GIS management office budget is labor. A small city or county GIS may have a staff of just one or two people, while a large city or county with a population of more than one million might have more than 20 people in its GIS management office. GIS managers and other senior staff typically have at least a bachelor's degree from a university GIS program. Some schools now offer a master's degree in GIS management programs. The GIS Certification Institute (at www.gisci.org) also provides a GIS Certified Professional designation for those who have demonstrated a defined level of education, experience, and professional involvement.

The typical GIS budget may include the purchase of new software and should always include software license maintenance to ensure that GIS staff and users have access to software updates and vendor support. GIS desktop software typically requires a license for each user. IMS software is relatively expensive, compared with desktop software, but it enables basic GIS capability to be provided to many business end-users without the cost of individual licenses. Another way to control the cost of desktop GIS software is enterprise license management — pooling software licenses, with users "checking out" licenses only when they need them. Because many users access GIS software only a few hours each week, enterprise license management allows an agency to meet its needs with a smaller number of licenses and at reduced cost.

The GIS budget will also include hardware costs. Desktop computer capability has increased, and most office computers can now run GIS software. However, GIS staff will still benefit from computers that have higher processing speeds and greater storage capacity because of the intense processing involved with data maintenance, application development, and analytical processing. Many organizations replace GIS desktop computers every two or three years, and then allo-



cate them to other staff. Other hardware will also be needed, including application and data servers, data storage devices, plotters, scanners, and sometimes laptops and GPS equipment for field data capture. The GIS management office should develop a plan that designates equipment replacement cycles with projected future costs. This plan can be used to spread out replacement of expensive items over multiple years to minimize budget cost spikes.

Once GIS has been developed, most of the data is maintained within the agency, with one major exception: aerial imagery. Aerial imagery is a key component of municipal GIS, providing locational context for other GIS data and visual detail that supports many users. However, aerial imagery must be replaced at least every two to three years to provide coverage of new subdivisions and infrastructure, and changes to natural features, a well as enabling GIS/CAMA change detection. The GIS budget should include an imagery replacement plan to coordinate these costs with the equipment replacement plan, or to set aside funds in an imagery replacement reserve.

GIS funding varies from agency to agency. Some organizations fund GIS within the budget of a sponsor department. These departments are usually early adopters of GIS and have stable funding sources. Other agencies treat GIS as a general government function supported by the general fund. Because many agencies have structural limits to the growth of their general funds, GIS competes with many general government services in this scenario. A growing number of agencies treat GIS as an enterprise or internal service fund, with support from all departments based on a funding formula tied to the level of service provided.

There are many innovative examples of local governments applying concepts such as costing government services, alternate service delivery, and intergovernmental service sharing to minimize GIS costs and to create more GIS capability. For example, Chester County, Pennsylvania (at www.chesco.org/ gis), and Pierce County, Washington (at http://matterhorn.co. pierce.wa.us/gis/), each provide basic GIS services to towns and cities within their jurisdictions to generate revenue for the counties and to reduce the cost of GIS capability for smaller jurisdictions. Chester County manages a GIS consortium that provides GIS services to townships, utilities, and school districts for a tiered annual fee. Pierce County provides local public agencies with secure access to its GIS

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data and applications for an annual subscription fee. The King County GIS Center in Seattle (at www.kingcounty.gov/gis) operates on an entrepreneurial basis, generating 5-10 percent of its annual revenue by providing a wide variety of GIS services to outside agencies. King County GIS services include Web application hosting, application development, custom mapping, and GIS training for cities, counties, regional agencies, and the state of Washington.

CONCLUSION

The U.S. Department of Labor lists geospatial technology as one of 14 high-growth industries for the next decade. GIS will be integrated into industry, commerce, and education, paralleling the continued spread of enterprise GIS capabilities throughout city, county, and regional agencies. This mission-critical enterprise tool can be used in many ways to manage operations and to maximize the benefits of an organization's unique geographic assets.

Note

1. U.S. Department of Labor, "The President's High Growth Training Initiative," http://www.doleta.gov/BRG/JobTrainInitiative/#TargetedIndustries.

GREG BABINSKI is the finance and marketing manager for the King County GIS Center in Seattle, Washington, where he has worked since 1998. Before that, he was GIS Mapping Supervisor for the East Bay Municipal Utility District in Oakland, California. Babinski holds a master's degree in geography from Wayne State University, and he is a certified GIS professional (GISP). He is also treasurer of URISA, the association for geospatial professionals, as well as serving on the City of Mercer Island, Washington, Utility Board. or more of GIS data storage capacity.