Integrating Geospatial Technologies into the Right-of-Way Data-Management Process

DETAILS

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INTEGRATING GEOSPATIAL TECHNOLOGIES INTO THE RIGHT-OF-WAY DATA-MANAGEMENT PROCESS

This digest presents the key findings from NCHRP Project 8-55, "Integrating Geospatial Technologies into the Right-of-Way Data-Management Process," conducted by Kathleen L. Hancock, Center for Geospatial Information Technology, Virginia Polytechnic Institute and State University, Alexandria, Virginia.

INTRODUCTION

Right-of-way (ROW) issues commonly cause project delay and increased costs. While many state transportation agencies use technology such as computer-aided drafting and design (CADD) to draft ROW plans, the approved final plans are often manually recorded and filed on paper or mylar. Posting and storing such data by hand is obsolete, inefficient, and unresponsive to the demands of modern project management, encumbering multiple users from conveniently accessing real-time ROW information and resulting in undue delay and cost overruns. Moreover, paper and mylar records are more vulnerable to damage or destruction in the event of fire, flooding, or other catastrophic events.

Manually recorded ROW information includes agency ownership, appraisal information, acquisition status, and property management functions that are important for addressing real estate issues, utilities, environmental permitting and mitigation, access management, maintenance, and programming. Electronic management of this information improves the coordination and consistency of data, leading to reduced project delivery delays caused by ROW acquisition. In addition, the ability to retrieve these data electronically provides fast, convenient, and consistent access to all users, reducing the time and expense needed to ship documents, eliminating repetitive entries, minimizing data entry errors caused by multiple formats, and ultimately saving money for transportation agencies. Electronic management of real estate information could improve coordination with local jurisdictions and provide appropriate data to the public on agency ownership of property.

The automation of ROW functions and development of data-integration models using existing technology, including geospatial applications (generally referred to as geographic information systems or GIS), are needed to enable multiple users to access the ROW information quickly and easily.

Identifying the data elements needed to support the automation of ROW functions is the first step in the development of fully operational systems that integrate geospatial technologies into the ROW process.

The objectives of the research carried out in NCHRP Project 8-55 were to (1) identify the data elements that need to be included in a data model for a ROW information system that includes a geospatial component and (2) provide examples, if possible, of return on investment when geospatial capabilities are added to such systems.

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This digest describes first steps in automating the information technology process required for ROW acquisition and management. It will be of particular interest to those persons in state departments of transportation responsible for highway project planning and ROW management.

Contents of the Report

This digest is organized into three sections. The first section describes the research findings. The second section discusses the complexities involved in ROW activities that affect implementation of information management systems, how geospatial technologies are currently being used within state ROW agencies, and some considerations for incorporating geospatial technologies and information management systems within an agency. The third and final section presents the conclusions of the research.

The complete final report includes six appendixes. Appendix A provides the results of the literature review through an annotated bibliography. Six case studies demonstrating return on investment are presented in Appendix B. The data elements that are needed for a ROW information system are given in Appendix C. Appendix D provides the surveys used to collect information for this project, and Appendix E gives the results of these surveys. A summary of services related to information systems by vendors that attended the 2005 AASHTO/FHWA Right-of-Way and Utilities Subcommittee Conference is given in Appendix F. These appendixes are available in their entirety as *NCHRP Web-Only Document 95.*

FINDINGS

Literature Review

An initial literature review was performed for the Federal Highway Administration (FHWA) of past and ongoing efforts involving the application of GIS in ROW-related projects (Saka, 2004). The literature review for this project built on that work, incorporating additional information and providing an annotated component to produce a comprehensive bibliography. Annotated information includes the citation to the document, web page, or other resource followed by a brief descriptive and evaluative paragraph. In addition, key factors were noted about each source as listed in Table 1. The purpose of this annotation is to quickly inform the reader of the relevance, accuracy, and quality of the source and to identify specific information, as shown in Table 1, that is included in that document.

Table 1 Key factors used to annotate the literature review

Annotation Factors
Category of ROW functions addressed by document
-Planning & Management
-Engineering & Mapping
-Property Acquisition
-Property Appraisal
-Relocation Assistance
-Property/Asset Management
-Utility Relocation Management
-Outdoor Advertising
Type of article/study
Type of innovative system
Survey results included or not
Benefit/cost information included or not
Lessons learned included or not
Data elements included or not
Contact information included or not

In addition to GIS applications for highway ROW activities and land management systems, representative documents and related sources that present use of other technologies for ROW activities such as web-based services and enterprise database systems, ROW systems for utilities and communications infrastructure, and innovative uses of GIS in other transportation activities such as environmental streamlining and transportation planning were included as they were identified.

To improve the reader's ability to locate documents related to specific interests or needs, "crosswalks"* were established for each of the factors listed in Table 1. In the crosswalks under each factor, all documents that included that factor are listed alphabetically by title. The list of references, the annotated bibliography, and the crosswalks are provided in Appendix A.

Case Studies

The purpose of the case studies was to provide tangible and easily understandable information for trans-

*Crosswalks are cross references between the items used for annotation and the list of references. For example, a reader looking just for survey results could look for that in the crosswalk, and under it would be listed all the documents that include survey results. The reader would then look in the list of references to get the full citation.

portation professionals in public agencies at the state or local level to use in support of implementing various levels and types of geospatial information technologies and/or innovative information management systems for ROW and related activities.

Identifying Systems to Be Included

A short screening survey, provided in Appendix D, was distributed to the attendees of the Right-of-Way Directors' meeting at the AASHTO/FHWA Right-of-Way and Utilities Subcommittee Conference in Austin, Texas, on May 16, 2005, to identify potential states that were currently using some type of GIS system. Thirty-five states and Puerto Rico responded. A summary of the responses is provided in Table E-1 in Appendix E.

From the screening survey, states that indicated the use of geospatial technologies were sent a more detailed survey, also provided in Appendix D. In addition, other states that were identified in the literature, suggested by panel members, or referenced by already-participating states as using geospatial technologies were also sent the detailed survey. The goal of this survey was to obtain more detailed information on each of the possible systems to determine the following:

1. Whether the system is actually being used in practice,
2. The extent of the activity and whether geospatial technologies or innovative information management and data integration are actually part of an operable system,
3. Whether information is readily available for determining some measure of return on investment,
4. Whether the systems selected represent a variety of applications related to ROW functions, and
5. Whether the systems represent the breadth and complexity of technical tools currently in use.

Twenty-six surveys were distributed, with 24 states ultimately responding. Table 2 provides a summary

Table 2 Summary of states receiving detailed survey

State	Agency	GIS in ROW	Innovative Data Integration	Case Study Candidate
AZ	Arizona Department of Transportation	YES	NO	Low
CA	California Department of Transportation (Caltrans)	YES	YES	Possible
DE	Delaware Department of Transportation	YES	YES	Strong
FL	Florida Department of Transportation	YES	YES	Strong
GA	Georgia Department of Transportation	YES	YES	Low
HI	Hawaii Department of Transportation	NO	NO	Low
IA	Iowa Department of Transportation	YES	NO	Possible
KS	Kansas Department of Transportation	YES	NO	Low
LA	Louisiana Department of Transportation	NO	YES	Low
MA	Massachusetts Highways Department	YES	NO	Possible
MD	Maryland State Highway Administration	YES	n/a	Strong
MI	Michigan Department of Transportation Real Estate Office	YES	n/a	Low
MN	Minnesota Department of Transportation	YES	YES	Strong
MO	Missouri Department of Transportation	n/a	n/a	No response
MS	Mississippi Department of Transportation	YES	YES	Possible
NC	North Carolina Department of Transportation	n/a	YES	Low
NJ	New Jersey Department of Transportation	NO	NO	Possible
NM	New Mexico Department of Transportation	YES	n/a	Strong
NV	Nevada Department of Transportation	n/a	n/a	No response
NY	New York State Department of Transportation	YES	NO	Possible
OH	Ohio Department of Transportation Office of Real Estate	YES	n/a	Strong
OK	Oklahoma Department of Transportation	YES	n/a	Strong
SC	South Carolina Department of Transportation	YES	NO	Low
TX	Texas Department of Transportation	YES	YES	Strong
VA	Virginia Department of Transportation	NO	YES	Strong
WI	Wisconsin Department of Transportation	NO	YES	Low

of each state's indication of use of GIS or innovative data integration. Of the 24 responses, 18 indicated use of GIS. Detailed summary tables of the additional information from the survey are provided in Appendix E.

When selecting systems for the case studies, the decision was made to exclude systems focusing on planning activities because several case studies already exist for this activity (see annotated bibliography). Florida was also excluded because the GIS in ROW Scan (performed by FHWA in 2004) provides detailed descriptions and presentations of the systems it uses (FHWA, 2004).

Based on survey results and follow-up discussions with states, only a very few have an operational ROW information management system that incorporates geospatial technology for one or more business activities. Although many states have strategic plans that include incorporating GIS capabilities into an enterprise ROW system, none currently have one in operation. Therefore, the case study selection was expanded to include consideration of innovative enterprise information management systems. Ultimately, six systems were selected for case study development.

Summary of Case Studies

The final case studies include two enterprise information management systems not geospatially enabled, two geospatial applications, one use of GIS to generate routine information, and one project-based use of a geospatially enabled information management system. One of the enterprise information management systems was modified by another state, and a supplemental section to that case study was developed to present their experience with the process. Case study information is summarized in Table 3.

Case Study Format

The purpose of the case studies was to provide information to ROW professionals about current information systems that either provide them with a system they could use or with information they can offer to decision makers in support of the implementation of a system. Therefore, the format was developed to inform readers about the activity/activities that are supported by the system and about the environment that the system is used in, specifically the general structure of the transportation agency, how the ROW agency fits into that structure, and what role an information technology office played in the implementation of the system. Then the technical specifics of the system are provided. Table 4 gives the general format. However, this was adjusted as necessary depending on the system and how it is used.

Issues Associated with Return on Investment

As anticipated, obtaining quantitative measures of return on investment for incorporating GIS and information management systems into ROW processes is difficult, if not impossible, particularly after the systems have been implemented. Generally, the cost of hardware and software is readily available. Also, the cost of developing software applications is usually obtainable. However, costs associated with generating and/or converting data to the new system and maintaining that information are not readily available. Neither are specific values in dollars or labor associated with the savings that these systems generate. Qualitatively, most states have been able to describe what use of the system has achieved in general terms, but only Pennsylvania provided specific overall savings related to their performance measure. In part, this is a function of the fact that implementation of information management systems does not have an end date while the systems are being used. Another factor is that many of the savings are measured in reduced redundancy and errors that traditionally are not tracked in normal business practices. Return on investment, for these case studies, was defined in the terms provided by the managers and users of the systems, not in a benefit-cost type of analysis.

Benefits

Although specific return on investment was difficult to quantify, a number of benefits were identified and are summarized in this section. In general, benefits included the following:

- Reduced staffing and/or improved staff efficiency;
- Improved scheduling;
- Improved access to information both internally and by the public;
- Improved customer service/relations;
- Improved documentation and reporting uniformity;
- Reduced time to perform specific tasks;
- Increased management flexibility;
- Reduced redundancy, primarily in data/information entry; and
- Improved oversight capabilities.

Table 3 Summary of case studies

State	System	Type	Description
Illinois	Aeronautical Land Acquisition System (ALAS)	Project using geospatially enabled information management system	Geospatially enabled information management system used for a state airport project.
Maryland	MdProperty View	Geospatially enabled system	Geospatially enabled tool to view and access parcel information.
New Mexico	Non-Right-of-Way (NRW) Parcel & Improvement Inventory	Use of GIS to perform routine business activity	Use of standard GIS and GIS templates to generate information page of excess parcels for public sale
Pennsylvania	PennDOT ROW Application	Enterprise Information Management System	Vendor-based enterprise information management system (no GIS)
Texas	San Antonio ROW Application	Geospatially enabled system	Web-based geospatially enabled tool to access and view final ROW maps using point and click location
Virginia	ROW and Utilities Management System (RUMS)	Enterprise Information Management System	Internally developed enterprise information management system (no GIS)
Minnesota (supplement)	ROW Electronic Acquisition Land Management System (REALMS)	Purchased RUMS from Virginia and modified	Modified information management system (GIS to be incorporated in Phase 2)

In Illinois, a single person is able to oversee the ROW activities associated with a multimillion dollar airport project. Without the use of the information management system, this would be impossible. Because the system is web based, this person has desktop access to near real-time information about the project and can quickly generate the summary reports necessary for effective project management. The public has access to a limited amount of information related to the project, which improves relations and reduces the number of interactions required between citizens and transportation staff.

The use of a single application within Maryland's Office of Real Estate has allowed them to cut their research staff in half because researchers have desktop access to parcel information without having to physically go to the courthouse, locate the appropriate parcels, and manually extract the necessary information. Use of this system has improved employee efficiency, reduced the time needed to perform this function, and provided better quality data.

New Mexico uses a GIS-based template to generate a summary document of excess property for sale to the public. They have realized a substantial reduction in the amount of time required to provide this information to the public via the web. What once took several hours to prepare is now generated in several minutes and almost immediately posted to the web. Because the document includes a map with an image background in addition to standard sale information, questions from the public have been dramatically reduced.

Pennsylvania established performance measures when they began implementation of their information management system. Based on the internal tracking of the costs associated with ROW activities, they have reduced annual operating costs by $679,000 resulting in a return on investment of 21%. They have also realized improved product delivery, reduced payment

Table 4 General case study format

Heading	Purpose
Cover Page	One-page "brochure" of summary and benefits with a statement about return on investment
Case Study Objective	Description of why this system is unique and was included as a case study
System Overview	Brief description of the system to let readers know whether they should continue to read this case study
Agency Overview Organization Information Technology Support	Provides the organizational context in which this system was developed and is used including a brief description of the transportation agency, how the ROW agency fits into the organization, and what role, if any, an information technology office played in the system development/management.
System Description Background Development System Goals System Requirements Activities Managed User Interface Technologies Used Geospatial Data Extensions and Future Plans	More detailed description of the system including any formal development/acquisition procedures that were followed. Screen captures of the system are provided here if available.
Estimated Cost of System	Any cost information that the agency could and was willing to provide is included.
System Benefits	Qualitative information about benefits that the agency has recognized with the implementation of this system is provided. None of the agencies were able to provide quantitative benefits in terms of dollars.
Lessons Learned	Lessons that the agency learned during the process of developing the system or in current use are included. Any comments that the representative wanted to pass on to others are also provided.
References	Any documents or web pages that were used to develop the case study are listed. Consultants and software vendors involved in the system are also included.
Contacts	The agency contact for the system, case study sponsoring agency (NCHRP), and consultant developing the case studies are provided.

processing time, reduced data entry, reduced security access management, and improved uniformity in reporting and documentation.

Electronic access to project drawings in Texas has increased employee efficiency by eliminating the manual locating and reviewing of large drawing sets. The geospatial interface allows staff to obtain information by clicking on the desired section of road on a street network as opposed to looking up the project number and then extracting the appropriate drawings.

Virginia measures the benefits that it has realized from its information management system through improved schedule commitments, reduced staffing costs, and increased productivity. Electronic access to information has improved public relations because any staff member can respond to a query through the ability to access the complete customer file.

DATA REQUIREMENTS

Several hundred—potentially several thousand—data elements are part of an enterprise ROW information management system depending on how the enterprise is defined. Agencies need an understanding of these data requirements and potential sources for obtaining, collecting, or accessing these data. To ensure that the results of this research present a clear and comprehensive understanding of data requirements and to provide the foundation for the next step of building an interoperable enterprise system, the extent of the enterprise was established, process activities were identified within ROW process flows, and data elements were associated with those activities.

For this phase, no work was performed to identify elements and flows across the enterprise boundary or to identify elements that are common to different activities or that cross activity boundaries, with the exception of unique parcel and project identifiers. Also, when viewing process flows, the order of activities should not be implied by the order in which activities are placed in the flow. The arrows and connecting lines are only used to show a connection between these activities. Different agencies perform these activities in different ways and with different priorities based on their own business needs.

Defining the ROW Enterprise

Ultimately, the definition of the enterprise for an information system is determined by the needs of the specific agency that is implementing the system. Because every state defines their ROW office and its activities differently, a single uniform system is impossible to establish. However, a core of ROW functions is common to almost all ROW agencies. These functions include appraisal, acquisition, relocation, and property/asset management. For the purposes of this study, the activities associated with these functions were considered to be within the enterprise. Although often part of ROW activities, the following functions were not included: comprehensive and project planning, construction, ROW engineering and mapping, utility relocation and management, corridor management, and outdoor advertising.

Developing Process Flows and Identifying Process Activities

To provide a more useable format than having a single comprehensive (and continuous) table of data elements, a decision was made to create a series of tables of elements associated with tightly coupled activities in the ROW process. To understand and locate these tables, a series of process flow diagrams were developed showing activities within each ROW function area in the enterprise. Appendix C provides both the process flow diagrams and the corresponding tables. The geospatial data elements were placed in a separate table and are linked to processes and their corresponding attribute data through the *project ID* or *parcel ID*.

Identifying Data Elements

Specific data elements were identified and extracted from the literature review, case studies, and discussions with representatives of several state agencies. For geospatial data elements, information provided in the tables includes the following:

- *Category:* federally recognized geospatial layer category;
- *Feature class:* federally defined class of information associated with the geospatial category;
- *C/C+*: core or core-plus element within the class of information;
- *Data type:* metadata, geospatial, attribute, primary key (link between data tables), or transactional;
- *Data element description:* generic name or description of what the data element represents;
- *Data source:* creator/manager/owner/provider of the data element; and
- *Source of data element:* document or resource that identified this data element as important during the course of this research.

For business process attribute data elements, information provided in the tables includes the following:

- *Function:* the ROW functional area included in the enterprise—appraisal, acquisition, relocation, or property management;
- *Activity:* closely coupled tasks within a function area;
- *Data type:* geospatial (link to geospatial data elements), attribute, primary key (link between data tables), transactional;
- *Data element description:* generic name or description of the data element;
- *Data format:* number, string, date, BLOB (binary large object) for scanned images and photographs;
- *Application using this data element:* case study system(s) that include this data element;
- *Element source:* creator/manager/owner/provider of the data element; and
- *Source of data element:* document or resource that identified this data element as important during the course of this research.

The geospatial data element and attribute data element tables are presented in Appendix C. Data elements associated with legal activities, particularly condemnation, were not included because each state is unique in this respect.

ADDITIONAL INFORMATION

During this research, some resources were identified that could benefit ROW agencies. One of these resources is the Bureau of Land Management's National Integrated Land System (NILS).

Bureau of Land Management's National Integrated Land System (NILS)

A federal geospatially enabled web-based information management system was identified that could provide state ROW agencies with information about federally owned land and serve as an example of an interoperable information management system for parcels owned by several federal agencies. NILS is a joint project between the Bureau of Land Management (BLM), the United States Forest Service, and state, county, and private organizations (BLM, 2004). The goal of NILS is to provide land managers with a tool to access land records for performing increasingly complex transactions.

NILS consists of two environments: *transactional* where cadastral data and land records data are captured, analyzed, edited, and committed to permanent record; and *publication* where the public can view and access information in a web-based system. GeoCommunicator (www.geocommunicator.gov/GeoComm/index.shtm) is the web-based geospatial publication tool that allows users to search, locate, and map federally owned parcels of land. It also provides access to land and mineral use records, as well as Public Land Survey System (PLSS) and other survey-based data. Locating federal lands of interest is accomplished by zooming into the online map or searching by name.

GeoCommunicator includes an ESRI-based map service that allows users to view or "stream" live data as a base map link directly to their own GIS applications. Data include federal management agency boundaries and information layers. The map server is located at www.geocommunicator.gov with the Map Service Name "BLM_Surface_MGT_AGY." Figure 1 shows the initial screen when GeoCommunicator is launched for Federal Land Stewardship. The Map Service Name for PLSS and survey based data is "BLM_LSIS_wms." Data download capabilities are also available from this application. Figure 2 shows the initial screen when GeoCommunicator is launched for the Land Survey Information System.

Vendor Information

AASHTO/FHWA hosted their annual Right of Way and Utilities Subcommittee Conference concurrent with the initiation of this research. As part of the information gathering phase, literature was obtained from the exhibitors that paid for space in the exhibit hall. A summary of this information, categorized by type of technology provided by the exhibitor, is provided in Appendix E.

COMPLEXITIES AFFECTING ROW ACTIVITIES

From the literature review, case studies, and discussions with members of several state ROW agencies, some key dimensions of complexities have emerged that affect the level and way that an agency approaches incorporating technology, particularly at the enterprise level, into their business practices.

A fundamental consideration is the laws and policies at the state level. From the legal side, this mostly affects condemnation and associated activities. However, a few other factors, such as the legal definitions associated with mobile homes and the authorities granted to state agencies, also affect activities performed by ROW agencies. Other factors include whether the taxing authority is the state, county, or local government. This affects who has responsibility for parcel information and whether it is available through single or multiple sources. Maryland has a centralized taxing authority and information for the entire state is available from a single source. Tax authority for Massachusetts is local, meaning that obtaining parcel information for the state would require establishing agreements with over 350 entities.

Another dimension of complexity exists with the state transportation agency. The structure and polices of the state agency directly affect how ROW offices do business. Issues that impact business activities include whether the state transportation agency is strongly centralized or delegates activities to the regions, how much work is performed by employees and how much is contracted, how aggressively the agency embraces new technologies, and whether or to what extent an

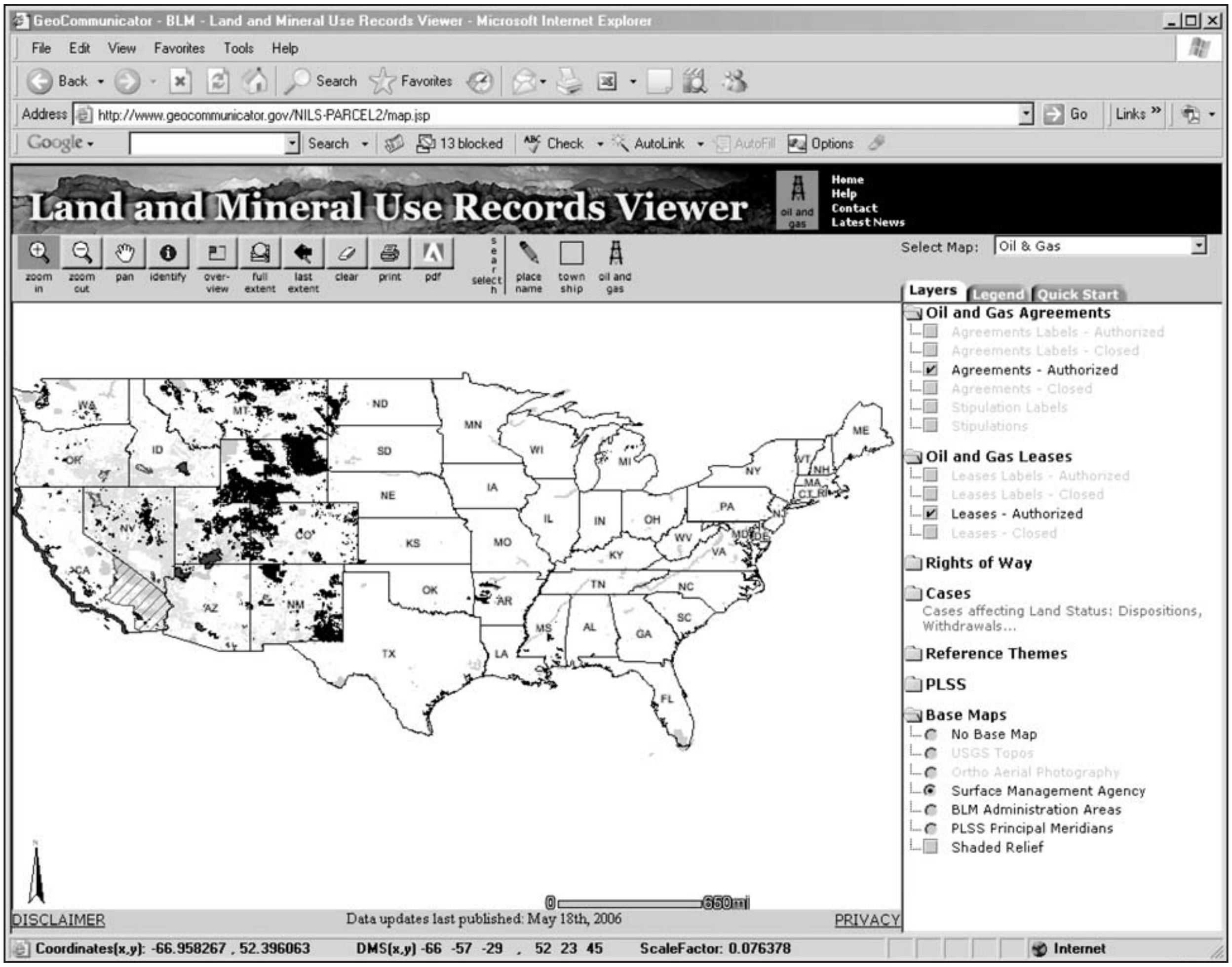

Figure 1 GeoCommunicator showing federal land stewardship.

agency has adopted other information management systems.

Physical characteristics of a state also impact activities performed by ROW agencies. Whether a state is mostly urban or rural, coastal or inland, relatively young or old, includes a large proportion of federal lands, or needs to consider mineral or water rights, all affect how business is done. Performing a title search in Texas can include as many as six different countries of origin, the United States, the Confederate States of America, the Republic of Texas, Mexico, France, and Spain.

DISCUSSION OF GIS IN ROW ACTIVITIES

Geospatial technologies are primarily used for three types of activities: managing information, displaying information, and analyzing/modeling with that information. For ROW agencies, the first two functions are most commonly used or anticipated to be used. GIS can be used for analysis and modeling activities like predicting archeologically sensitive sites, mitigating hazardous materials sites, and evaluating social justice related to property acquisition and management. However, for day-to-day activities, managing and tracking information is of primary importance. The unique capability that GIS brings is the use of location as a method of finding, combining, and viewing information. Selecting a location on a map is more intuitive and faster than looking up an ID or name. Seeing the status of parcels shown as a theme on a map is easier to assimilate and more informative than looking at a table of textual facts.

Geospatial Transportation Layers

Because transportation, by its very definition, is geospatial, almost all activities within a transporta-

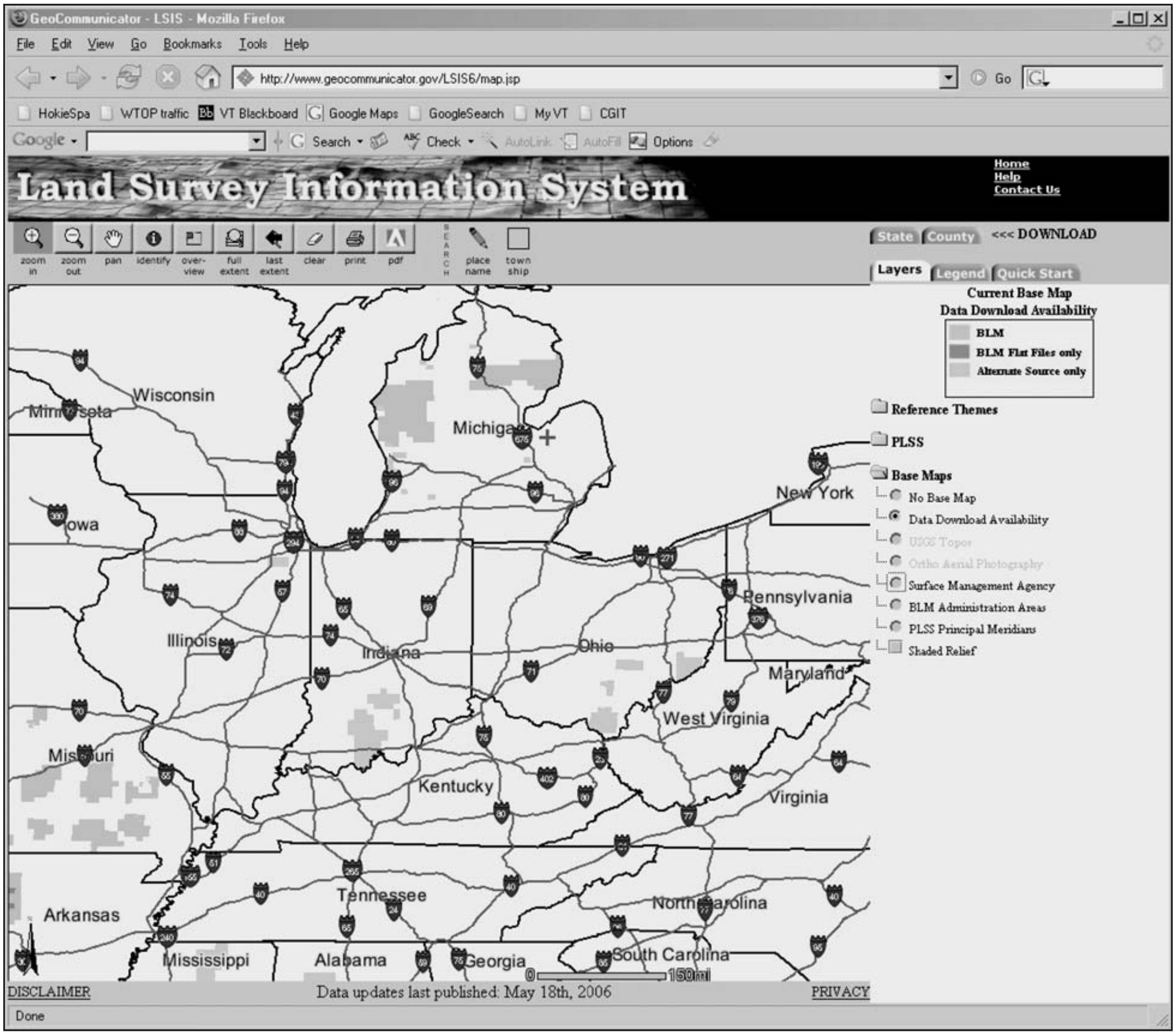

Figure 2 GeoCommunicator showing land survey information system.

tion agency can be referenced back to physical location. The primary locational "layers" that transportation information is associated with are *roads,* usually provided as centerlines, and *projects,* which provide the location of proposed new or modified facilities. Almost every state agency now maintains a GIS-based centerline road layer. Although all states prepare project drawings within computer aided design and drafting (CADD) software, not all states geospatially reference these CADD files so that the digital information can be integrated with GIS. Many states have decided to incorporate this capability in their strategic planning. Others, like Texas, are scanning plans and geospatially referencing the scanned images. How a state addresses this issue will affect how a state incorporates functionality into an enterprise system.

Cadastral or Parcel Layer

A third key layer of interest to ROW agencies is the cadastral or *parcel* layer, which is used primarily for project delivery and excess property management. As a geospatial layer, this is more problematic for transportation agencies because typically this layer results from work by surveyors, abstractors, title attorneys, zoning organizations, and courts outside of transportation agencies and is typically managed by the state-defined taxing authority, which is most commonly at the local county level. The need for an improved land information system is well established, primarily because of its role as a title and assessment records system (National Research Council, 1980; Cowen and Craig, 2003; Minnesota, 1997; and FGDC, current). There is an increasing need for information in a standardized format for resource management, environmental and transportation planning, emergency management, municipal functions, and citizen access.

With the exception of property owned by the state transportation agency, maintenance and possible creation of parcel records within a comprehensive parcel layer will exist with other entities—either local, state, or federal—and will usually exist across multiple jurisdictional entities at each level. How a comprehensive layer is developed for a state will directly impact the ability and method that a ROW office uses to implement an enterprise system that includes geospatially represented parcels (i.e., each individual community may maintain their own parcels). Although transportation agencies are not the entry point for this information, they are definitely a user or potential user and should work with any groups developing cadastral data standards.

For states currently using GIS, some transportation agencies establish agreements with the agency/agencies responsible for parcel information while others generate their own layer of pertinent parcels from project drawings. Ideally, the latter activity will be eliminated over time as states establish base layers. However, until that happens, this activity results in a layer that is only used within the agency and, thus, has a lesser degree of standardization than one used by other entities.

BARRIERS TO IMPLEMENTING GEOSPATIALLY ENABLED INFORMATION MANAGEMENT SYSTEMS

Several factors affected the ability of states to implement or attempt to implement systems in their ROW offices. These factors are detailed in Table E-21 and the case studies in Appendix B under "Lessons Learned" and are summarized below.

- **Resources:** The most commonly mentioned factor was cost and lack of available resources. Unlike roads and other transportation facilities, information is typically not recognized as a tangible resource in its own right. Related to this, states mentioned a lack of awareness and understanding of how information management systems could benefit their activities.
- **Champion:** When considering any type of new technological change, a highly positioned advocate or "champion" is important to aid its smooth and successful implementation. For many states, this champion has been difficult to identify.
- **Data:** Securing accurate and up-to-date data and maintaining those data have proved difficult for many states, particularly if they do not have a strong centralized IT capability. In addition, the ability to effectively integrate data requires an understanding that is often not available from existing staff.
- **Coordination:** Transitioning to an enterprise approach to data management requires coordination among multiple offices and, possibly, agencies. Because resources are already scarce, many states have found that coordination is difficult to establish and maintain.
- **Connectivity:** Accessing information and using information management systems requires networking capabilities that are fast, reliable, redundant, and secure. Providing this capability is resource-intensive and outside the scope of ROW offices.
- **Inertia:** Moving to a new way of doing business is often difficult because of the built-in inertia of being comfortable with how things have always been done. Bureaucracy reinforces this inertia by establishing procedures that are difficult to change. Resources to effectively educate employees in new methods are often not included in cost estimations and are thus not allocated, again reinforcing the lack of willingness to change.

SOME CONSIDERATIONS FOR INCORPORATING INFORMATION MANAGEMENT SYSTEMS WITHIN STATE ROW AGENCIES

Defining the enterprise is probably the first consideration that needs to be addressed. Enterprise boundaries are defined by control over resources for activities within an organization and successful negotiations with cooperating organizations for activities outside the organization (Fletcher, 1999). For public agencies, and transportation in particular, what is considered inside and outside an organizational entity can be quite fuzzy and is often dynamic depending on the activity. Some activities, such as acquiring title to a piece of property, are clearly within a single organizational structure. On the other hand, estimating the cost of a parcel could be performed in a planning department for the early stages of project planning and appraising a parcel could be done in the ROW appraisal section for project delivery. Are both of these activities part of the enterprise or are they separate? A benefit to enterprise systems is that they are scalable and the boundaries can be defined to meet the needs of the agency. The challenge of an enterprise system is to effectively define the boundaries so that the necessary information crosses the appropriate organizational boundaries.

The International Standards Organization defines interoperability as "the ability of systems to provide and accept services from other systems and to use the services so exchanged to enable them to operate effectively together" (Fletcher, 1999). Because of the federated nature of transportation agencies, interoperable systems are the only effective mechanism for obtaining data integration across activities. To be successful, interoperability depends on all stakeholders agreeing on the desirability, validity, and portability of information across organizational boundaries. Fletcher establishes three design aspects for interoperability to occur as summarized in Table 5 (Fletcher, 1999). To design an effective system, each aspect must be addressed and coordinated.

CONCLUSIONS

This project accomplished three tasks. The first task was to develop a comprehensive annotated bibliography of literature about the use of geospatial and innovative information systems primarily for transportation agency ROW activities. The second task developed six case studies of systems used by state agencies, spanning the current state-of-the-practice in information systems with and without geospatial technologies, ranging from a simple automated process to an enterprise information management system. The final task was to compile a list of data elements required for a geospatially enabled enterprise-wide information management system.

ROW activities are extremely information intensive. Almost every activity requires documenting what was done, collecting parcel or owner or lease information, or tracking the large volume of required paperwork. Even a simple information system can provide substantial benefits to those responsible for that information. A comprehensive enterprise-wide system, once in place, could easily result in more efficient project delivery, substantial savings in resources, and improved interactions with the public.

Although the tasks and resulting products from this project are straightforward, the underlying com-

Table 5 Interoperability design aspects

	Type	Description
Scope	Global level	Ability to consistently function or operate across national, state, or county boundaries
	Regional level	Ability to consistently access systems within a predefined region or between multiple cooperating agencies
	Enterprise level	Ability to deploy efficient services and systems within and across a single enterprise
	Product level	Ability of products from different vendors to communicate
Categories	Institutional	Formal agreements between institutions
	Procedural	Information exchange and operational procedures
	Technical	Ability of heterogeneous software and hardware components to communicate meaningfully
Dimensions (Technical)	Horizontal	Information exchange among similar components
	Vertical	Information exchange from one component to complementary components
	Temporal	Information exchange between successive generations of components

plexities involved in the business processes associated with transportation ROW activities are substantial. Technology is no longer the stumbling block to implementing enterprise information systems. Organizational structure, communication lines, and moving the behemoth of the status quo are often the more difficult challenges to overcome. This project took the first steps to surmounting these factors.

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