GIS Applications in State Government

Report to the Joint Legislative Committee on Information Technology Oversight

Chris Estes

State Chief Information Officer

Office of Information Technology

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Legislative Request

The General Assembly in 2013 requested that the Center for Geographic Information and Analysis (CGIA) conduct a review of Geographic Information System (GIS) applications in state agencies. CGIA was further asked to identify instances of duplication, develop a plan for consolidating duplicative projects and issue a report to the Joint Legislative Oversight Committee on Information Technology and the Fiscal Research Division.

The full text of Section 7.9(c), Session Law 2013-360, can be found in Appendix A.

Report Focus

GIS applications organize and display geographic information for internal agency processes, for the public, or both. For this report, CGIA conducted a review of all GIS applications in state agencies. The report also provides background on GIS in state government, identifies policy considerations, presents a roadmap for progress, and provides next steps for the future.

The report concludes that state agencies do not have duplicative GIS applications or projects. Each GIS application supports specific business purposes in agencies, and GIS operations are embedded in business processes.

The report also finds that agencies have made progress in reducing duplicative data storage and GIS is underutilized in some state agencies.

Pursuant to the legislative requirements, this report focuses specifically on GIS applications and does not address governance or data duplication. Those areas will be addressed in future reports and studies.

Introduction

A geographic information system (GIS) is an enterprise technology tool that provides capabilities to spatially visualize data assisting in identifying patterns, trends and relationships. GIS applications are tools ranging from customized templates and routines using commercial GIS software to large custom online tools that enable interactive map composition and analysis.

GIS gives public sector managers and business leaders the power to understand complex relationships, craft well informed plans, and present data visually in clear and compelling ways. GIS technology is embedded in business processes in public agencies and private businesses. State government agencies use GIS for school bus routing, economic development, emergency response, tracking of sex offenders, transportation planning, and management and monitoring of natural resources to name a few of the prevalent uses.

The business case for GIS in North Carolina was first established in the 1970s and 1980s as state and local government agencies began to use geographic data for modernizing land records, for planning roads and other infrastructure, for evaluating the state of our natural resources and for other purposes. Since then, GIS has become a widespread, effective tool in improving service delivery to citizens and as a key element of economic development, emergency response and recovery, forest services, school bus routing, and the creation of voting districts.

In the 1990s and 2000s, state agencies created statewide digital base mapping datasets (e.g., roads, streams, county boundaries, municipal boundaries, state-owned properties, elevation, orthoimagery and geodetic control). At the same time, advances in GIS software enabled more state employees to apply the data content to public business processes. GIS applications made mapping and analysis more automated and more adaptable to problem solving and reporting. With extensive geographic data content and effective applications, state agencies are able to serve more customers in less time with higher quality. Applications help answer questions such as:

- From my point of interest, how many medical facilities are within 15 miles?
- What is the nearest interstate highway interchange to my point of interest?
- How far is it from a property of interest to the nearest public elementary school?
- What is the labor force within 25 miles of an industrial site of interest?
- How many buildings are within a flood hazard area?
- Where are the environmentally sensitive areas near a planned highway extension?

State agencies regularly collaborate and coordinate data creation, data sharing and distribution, and initiatives to improve data in terms of completeness, consistency, and currency. Effective collaboration relies on governance of geographic information systems and information. Since its creation by the Legislature in 2001, the Geographic Information Coordinating Council and an active group of committees have worked to collaboratively develop standards; coordinate the acquisition of geographic data layers; and leverage funding from state, federal, and local sources to the benefit of North Carolina. The council serves as an important forum that engages both public and private participants in GIS. The council submits annual reports to the General Assembly that summarize accomplishments and plans.

Policy Considerations

CGIA's review of GIS applications in state agencies included an assessment to identify duplicative applications and opportunities to consolidate these applications. The focus of this effort was GIS applications only. It did not include a review or assessment of governance, staffing, or other matters that were part a 2008 GIS Study prepared by the Office of State Budget and Management.

A survey of state agencies was designed to obtain information for each application about the business process or processes supported, consumers, sources of geographic datasets used, hardware and

software environment and hosting, any access restrictions, year and amount of initial and ongoing investment, staff support or contractual support, and status with respect to the Enterprise Project Management Office (EPMO) process. Regarding the EPMO process, CGIA monitors and approves all new GIS-related information technology projects and expansion budget requests. This report supplements CGIA's ongoing responsibilities in information technology project review in the Office of the State Chief Information Officer.

CGIA's goal is to maximize the value of state investments in information technology related to GIS. Value is realized through coordinated investments, state agency business processes, and in customer service that benefits statewide consumers of geographic information, including the citizens of North Carolina.

This report fits the purpose and goals of the Geographic Information Coordinating Council, where collaboration is imperative for GIS initiatives (e.g., statewide orthoimagery and NC OneMap) and GIS standards and policies. The council engages representatives of state agencies, county and municipal governments, regional organizations, federal agencies, private businesses, and educational institutions.

Findings

As directed by the General Assembly, the Center for Geographic Information and Analysis (CGIA) in the Office of Information Technology Services obtained information about geographic information system (GIS) applications in state agencies. The State Chief Information Officer sent a request to 31 agencies. Of the 24 agencies that responded to the request, 12 reported having GIS applications. Among the 12 agencies, a total of 30 GIS applications were identified and described. Of the 30 applications, 25 were identified by application owners as critical to business operations. The agencies with the most GIS applications:

- Department of Environment and Natural Resources (NCDENR) with ten applications; three of the applications serve multiple divisions and seven are specific to a division.
- Department of Transportation (NCDOT) with four applications, two of which serve multiple business units; NCDOT has taken on management of the application developed for the NC Ports Authority)
- Department of Public Safety (NCDPS) with four applications managed by the NC Division of Emergency Management.

The seven agencies that did not respond to the information request are unlikely to have any GIS applications, based on CGIA experience with state GIS events, working groups, professional organizations, online communication, information requests, and enterprise licensing. The list of respondents and summary information is displayed in Table 1.

Table 1. State Agencies and GIS Applications, 2013

AGENCY	Response	GIS Apps	# of Apps
Administration	Yes	No	
Agriculture and Consumer Services	Yes	Yes	1
Admin. Office of the Courts	NO		
Commerce	Yes	Yes	2
Cultural Resources	Yes	Yes	1
Division of Employment Security	NO		
Environment & Natural Resources	Yes	Yes	10
Health & Human Services	Yes	No	
Industrial Commission	Yes	No	
Information Technology Services	Yes	Yes	1
Insurance	Yes	No	
Justice	Yes	Yes	1
Labor	Yes	No	
NC Community College System	Yes	No	
NC Lottery	NO		
NC Housing Finance Agency	NO		
NC State Ports Authority	Yes	Yes	1
Office of Administrative Hearings	NO		
Office of the Governor	NO		
Office of the State Auditor	Yes	No	
Office of State Budget & Management	Yes	No	
Office of the State Controller	Yes	No	
Office of State Personnel	NO		
Public Instruction	Yes	Yes	1
Public Safety	Yes	Yes	4
Revenue	Yes	No	
Secretary of State	Yes	No	
State Board of Elections	Yes	Yes	1
State Treasurer	Yes	No	
Transportation	Yes	Yes	4
Wildlife Resources Commission	Yes	Yes	3
Number of Agencies Surveyed	31		
Total Number of Responses	24		
Total Number of Agencies with Apps		12	
Total Number of Applications			30

Applications identified by the 12 state agencies are listed in Appendix B.

CGIA analyzed the data to answer the following questions:

- Are applications duplicative or unique?
- Is GIS underutilized?
- Are there opportunities for consolidation?

Are Applications Duplicative or Unique?

Our analysis found that the GIS applications are not duplicative in terms of application development, business consumers, business needs satisfied, data development and data maintenance.

There is some duplication in storing data required by GIS applications but there is much less duplication in data storage than in previous years. State agencies share data through the NC OneMap Geospatial Portal (managed by CGIA) and through other data file transfers from agency to agency. In some cases, specific source datasets are stored locally in multiple agencies in support of geographic analysis applied with GIS software to derive custom products, provide custom mapping for specific business needs and support of users in the field via mobile devices.

Advances in GIS technology have improved the performance and applicability of map services and imagery services. Those services are images of geographic data, not the source files. Services go from a server (e.g., NC OneMap) to a user's GIS application, thereby reducing file transfers and redundant file storage. For example, the NCDOT GIS unit consumes imagery services from NC OneMap in internal applications instead of storing and serving copies of large source imagery files. The following sections offer more detail on application development, business users, business needs satisfied, development and maintenance of geographic data displayed in applications, and data transfer and storage.

Application Development

Of the 30 applications identified, all but two involve some custom application development. The common element for most of the applications is ArcGIS commercial software utilized for geographic data processing, map display, and web serving. In most GIS applications, agencies leverage the State of North Carolina's Enterprise License Agreement with Esri, the vendor for ArcGIS software. For example, NCDOT built a Spatial Data Viewer based on ArcGIS Server software, customized for internal NCDOT business units. Examples of exceptions are the web map viewer developed by a vendor for the NC Ports Authority, and the school bus transportation system developed by the Department of Public Instruction.

Business Users and Business Needs

Business users internal to state agencies have unique business requirements that shape agency GIS applications in terms of user interface, data content, functions, and products. For example, the Department of Public Safety's Floodplain Mapping Information System is driven by business requirements that inform the National Flood Insurance Program, the Federal Emergency Management Agency, state and local emergency managers, and hazard mitigation planners.

The Department of Transportation's Multi-User Geodatabase supports the internal maintenance of the NCDOT Linear Referencing System (LRS) and municipal boundaries. The Department of Agriculture's Multi-Hazard Threat Database supports a wide range of business processes that include the regulatory and inspection processes for the Food and Drug Division's Feed, Food and Grade A Milk sections; and the regulatory and inspection processes of the Liquefied Gas section and the animal health programs of the Veterinary Division.

Public-facing GIS applications have common consumers among private businesses, citizens, educators, students, and public agencies. Business needs among users of web applications vary widely. The GIS application designed for the widest audience is the NC OneMap Geospatial Portal that emphasizes online discovery of and access to statewide GIS data and web services. Businesses that consume imagery services from NC OneMap may also be interested in floodplain information. The approach of NC OneMap is to provide a first-stop location on the Internet for geographic information in North Carolina.

NC OneMap does not attempt to provide all possible views of the data. Instead, agencies develop complimentary online map viewers for specific business needs. For example, the Department of Public Safety's Flood Risk Information System includes a "General Public" interface that is designed to inform the public about flood risk in locations of interest. Another public-facing application, the Department of Environment and Natural Resources' Source Water Assessment Program map viewer, uses some of the same base mapping layers (e.g., roads, county boundaries, streams) with a focus on drinking water quality.

Source Data for GIS Applications

Geographic datasets (downloadable files and web services) provide vital content for the 30 GIS applications. The Geographic Information Coordinating Council and its active committees have provided regular opportunities for GIS professionals to discover and share geographic data produced by state agencies. NCDOT, NCDENR, Cultural Resources, and CGIA began collaborating on development of base mapping layers including streams, roads, boundaries, historic sites, and orthoimagery more than 20 years ago.

Data maintenance and public data access responsibilities are shared among multiple state agencies including NCDOT (roads, railroads, bridges, municipal boundaries), NC Geodetic Survey (county boundaries and geodetic control points), NCDENR (classified streams, waste management facilities, lands managed for conservation, and more), CGIA (statewide orthoimagery, master address database), Department of Agriculture and Consumer Services (agricultural imagery and soils), and Department of Public Safety (elevation and floodplains).

Data Transfer and Storage

The 30 applications use a wide range of geographic data including many datasets from several state sources. Regarding data used in the applications, state agencies share data through the NC OneMap Geospatial Portal and other data file transfers from agency to agency. Specific source datasets are stored locally in multiple agencies in support of geographic analysis applied with GIS software to derive custom products, do custom mapping for specific business needs, and in support of consumers in the field via mobile devices. Duplicative data storage by state agencies is most likely in the absence of statewide compilations of base mapping datasets. In the case of land parcel data, until this year, multiple state agencies were collecting copies of parcels from counties (the authoritative sources) and integrating the copies into multi-county datasets for application to a range of business needs. Through an initiative of the council to build an application to collect and integrate county parcel data and through collaboration among agency GIS coordinators in the State Government GIS Users Committee, state agencies save time in collecting source data for GIS applications.

A greater efficiency is being realized through web services that feed GIS applications. Advances in GIS technology have improved the performance and applicability of map services and imagery services. The NC OneMap Geospatial Portal now offers 80 live services for orthoimagery from multiple years and groups of map layers. In addition, NCDOT is preparing to publish over 40 services that will be consumable by all state agencies and the public. These services are accessible from servers and formatted for direct use in desktop and web applications, without any transfer of source data files, thereby reducing file transfers and redundant file storage. For example, the NCDOT GIS unit, instead of storing copies of large imagery files, consumes imagery services from NC OneMap in a mapping application that reaches 500 staff. Likewise, NC OneMap consumes services from other state and federal sources that become accessible to state agencies and the public (e.g., services for the locations of US Geological Survey stream gages). In addition, NC OneMap provides multiple formats so that consumers in private organizations are able to consume map services in a variety of software applications. For example, Duke Energy consumes imagery services for its internal GIS consumers in one format, and a small engineering company consumes a different format for its computer-aided design.

Where state agencies are storing copies of source geographic information for convenience and reliability of access, map services have the potential to reduce tendencies to download copies of source data and store it locally. Consumers expect published map services, managed by source data custodians, to represent the most current version of the data; the latest will stream to a consumer's device. An essential element in realizing the potential of map services is the reliability of servers. CGIA is in the process of increasing the reliability of map services available through the NC OneMap Geospatial Portal by establishing redundant servers in North Carolina's Eastern and Western Data Centers.

IS GIS Underutilized?

Of the 12 state agencies that responded to the survey and indicated no GIS applications (Table 1), at least two stand out as agencies that have underutilized GIS in information technology applications. The Department of Health and Human Services manages records about service providers and service recipients that in many cases have a geographic element (street address). A missing element appears to be geographic applications that that could reveal patterns of service delivery, offer a visual perspective to problem solving, and assist in data quality control.

A second agency that could benefit from one or more GIS applications is the Department of Revenue. The geographic origin of sales tax collection matters where sales tax revenue distribution to local governments is based on collections within those jurisdictions. The "Tag and Tax Together" system, serving the Department of Revenue and the Division of Motor Vehicles, is built on tables of addresses with jurisdictions without a GIS component to apply to maintenance of address locations and jurisdictional boundaries.

Among the other state agencies that do not have GIS applications, there may be business processes that could be more efficient and effective with a geographic information component. For all 12 of these state agencies, research would be needed to identify business and technical requirements and define GIS solutions. CGIA will continue to reach out to state agencies to explore potential applications of GIS.

Are There Opportunities for Consolidation?

As the technology of server software for geographic data has advanced, state agencies have developed applications that provide wider online accessibility to geographic data and mapping for internal business users and for the public. State agencies with numerous business units have found ways to consolidate storage of geographic datasets and make them available to internal consumers online. The notable examples are NCDENR's Portal Map Viewer and NCDOT's Spatial Data Viewer.

Are there opportunities for consolidation of GIS applications or GIS practitioners who manage and apply geographic information to business processes? The GIS applications reviewed are specific to agency business needs. GIS professionals who support and use the applications are embedded in agency business processes, assuring quality of the content and products of the applications, and meeting agency business needs in timely ways. The type of consolidation that would group GIS practitioners in an entity separate from the agency business processes is unlikely to save time, serve public and private customers more efficiently, or enhance quality of customer service.

Are there other opportunities for saving time, saving money, and improving customer service related to GIS applications? A common element of most of the GIS applications reviewed for this report is the application base mapping layers displayed in conjunction with business-related geographic data layers.

For example, in a map viewer developed for drinking water assessment areas, base mapping layers (roads, county boundaries, municipal boundaries, streams, orthoimagery) provide a visual reference and context for the unique dataset (assessment areas) created and managed by the NCDENR Public Water Supply staff. With further improvements in performance and functionality of map services and imagery services and GIS software, there is further potential for GIS applications to rely less on data file transfers and local data storage.

An important element was absent during the development of the 30 applications identified for this report—a formal research and development resource available to all state agencies. Governance of geographic information systems has been in place and effective in coordinating initiatives to develop data for base mapping (e.g., statewide orthoimagery, roads, streams and more) and in guiding initiatives to share data widely (e.g., NC OneMap). Concerning GIS application development, volunteers on committees and working groups of the council have shared technical knowledge at key times. Nonetheless, North Carolina has not had GIS subject matter experts dedicated to assisting state agencies in developing specific business cases, researching technical solutions, and advising on planning and design of GIS applications. The 12 agencies with 30 GIS applications would benefit from timely technical advice. Some of the 19 other agencies have unrealized potential to enhance their respective business processes with geographic information and analysis.

Roadmap

The roadmap for getting the most value out of state investment in GIS applications and geographic data has short term, middle term, and long term elements.

Short term

- CGIA and state agencies will continue to collaborate on development and maintenance of the most widely used geographic data, including the master address database for North Carolina, orthoimagery, roads, and land parcels. For example, CGIA will continue to collaborate with NCDENR to regularly update NCDENR-maintained geographic data for GIS applications and for public access as downloadable data and map services via the NC OneMap Geospatial Portal.
- As staff to the NC Geographic Information Coordinating Council, CGIA will support the State Government GIS Users Committee, a statutory component of the council, in carrying out the committee's work plan for data sharing and project collaboration.
- CGIA and State Archives will continue to archive datasets from NC OneMap, including compilations of statewide integrated data.
- Determine the most effective ways to share downloadable geographic datasets and map services among state agencies and the public to maximize the return on investment for the datasets such as elevation and building footprints.

Middle term

- Determine the most effective ways to develop and maintain complete, consistent, and current geographic data representing locations of medical facilities, public safety facilities, fire departments, emergency medical services, and public schools.
- Continue to update council-adopted standards for the content of base mapping datasets.
- Establish and sustain a staffing level in CGIA that will enable a technical advisory role that will
  - Assist state agencies in defining business requirements, technical requirements, and technical solutions, particularly in agencies where GIS is underutilized.
  - Assure that investments in GIS applications and geographic data are designed to generate return on investment and are not duplicative of other state agency applications and projects.
  - Research and develop solutions and test in the Innovation Center to provide a base of knowledge for GIS applications and related business processes.
  - Identify requirements for centrally hosted processing of geographic data for critical business needs of multiple state agencies, define business cases, identify solutions, and find the means for providing the services (e.g., address validation, geocoding, selection of features in an impact area, and others).

Long term

- Work with the council and with state agencies to bring GIS applications to more mobile platforms to take advantage of emerging and consumer technologies.
- Identify opportunities to integrate GIS applications in more state business processes where GIS adds value to operations and delivers improved customer service.

Issues & Cost

As stated earlier, state agencies do not have duplicative GIS applications, there are no apparent opportunities to consolidate GIS operations, and GIS is underutilized in some state agencies. Each GIS application supports specific business purposes in agencies, and GIS operations are embedded in business processes.

The two major challenges for GIS applications are to:

- Assure the quality of source geographic datasets that feed GIS applications across state agencies. For GIS applications, reliable access to complete, consistent, current and well documented geographic data enables satisfaction of business needs, public and private.
- Add value to state agency business processes where GIS applications are underutilized. Reasons for underutilization include agency budget priorities for information technology, readiness of data for internal application, sensitivity of data for public display, and specific technical expertise of staff.

Costs associated with data quality assurance include database management, data maintenance, and technical infrastructure. Costs related to greater utilization of GIS in agency business operations include definition of business requirements, development of business cases, definition of data models, definition of technical solutions and designs, development of specific geographically referenced datasets, application development, and operation and maintenance. Investment is needed in time and in dollars for technical assistance.

Next Steps

- CGIA will complete an update of the Master Address Database in collaboration with NC Commerce and other state agencies.
- CGIA will continue the statewide orthoimagery program in collaboration with the NC 911 Board and state and local government stakeholders.
- NCDOT will complete a statewide integrated street centerline database.
- CGIA and project partners will complete the NC Integrated Cadastral Data Exchange project for land parcels.
- CGIA will continue to collaborate with state agencies to regularly update geographic data discoverable and accessible through the NC OneMap Geospatial Portal.
- As staff to the NC Geographic Information Coordinating Council, CGIA will support the State Government GIS Users Committee, a statutory component of the council, in carrying out the committee's work plan for data sharing and project collaboration.
- CGIA and State Archives will continue to archive geographic datasets based on the NC OneMap Data Retention Schedule, including compilations of statewide integrated data.

Appendix

Section 7.9(c) of Session Law 2013-360.

SECTION 7.9.(c) All State agencies shall coordinate any Geographic Information System (GIS) initiatives through the Center for Geographic Information and Analysis (CGIA) in the Office of Information Technology Services, as well as the Office of the State CIO, to ensure that existing capabilities are not being duplicated. The CGIA shall monitor and approve all new GIS-related information technology projects and expansion budget requests. By January 1 of each year, the CGIA shall submit a written report on GIS duplication to the Joint Legislative Oversight Committee on Information Technology and the Fiscal Research Division.

The CGIA shall conduct a review of all GIS applications in State agencies, identify instances of duplication for existing applications, and develop a plan for consolidating duplicative projects. By November 1, 2013, the CGIA shall provide a report on the review to the Joint Legislative Oversight Committee on Information Technology and the Fiscal Research Division.

Appendix B: List of GIS Applications

AGENCY	# of Apps	Name(s)
Agriculture and Consumer Services	1	Multi-Hazard Threat Database (MHTD) for agriculture.
Commerce	2	AccessNC (economic development), NC Broadband Online GIS Map.
Cultural Resources	1	Enterprise Geodatabase for cultural resources.
Environment & Natural Resources	10	Source Water Assessment Program map viewer, Groundwater Decision Support System, Division of Marine Fisheries BioGIS, Permit Application Tracker, Shoreline Mapping, Conservation Planning Tool, Drinking Water Assessment Areas Viewer, Ecosystem Enhancement Program Geodatabase, IBEAM Viewer, and Portal Map Viewer.
Information Technology Services	1	NC OneMap Geospatial Portal.
Justice	1	Sex Offender Public Website map viewer.
NC State Ports Authority	1	ConnectGIS map viewer for NC Ports.
Public Instruction	1	Transportation Information Management System (TIMS)
Public Safety	4	North Carolina State Preparedness And Response Tracking Application (NC SPARTA), Flood Risk Information System (FRIS), iRISK is a spatially enable web-based application providing data, models, methodologies, analysis and digital mapping associated with all natural hazards, and The North Carolina Flood Inundation Mapping and Alert Network (FIMAN).
State Board of Elections	1	State Elections Information Management System (SEIMS) for Voter Registration and State Board of Elections Audits.
Transportation	4	Attribute Road Inventory Data (ARID), Multi User Geodatabase (MUG), Spatial Data Viewer (SDV), NCDOT Highway Stormwater Environmental Sensitivity Maps (SESM).
Wildlife Resources Commission	3	NC Wildlife Resource Commission (WRC) Maps, WRC Locators, WRC Fusion Tables.
TOTAL	30	