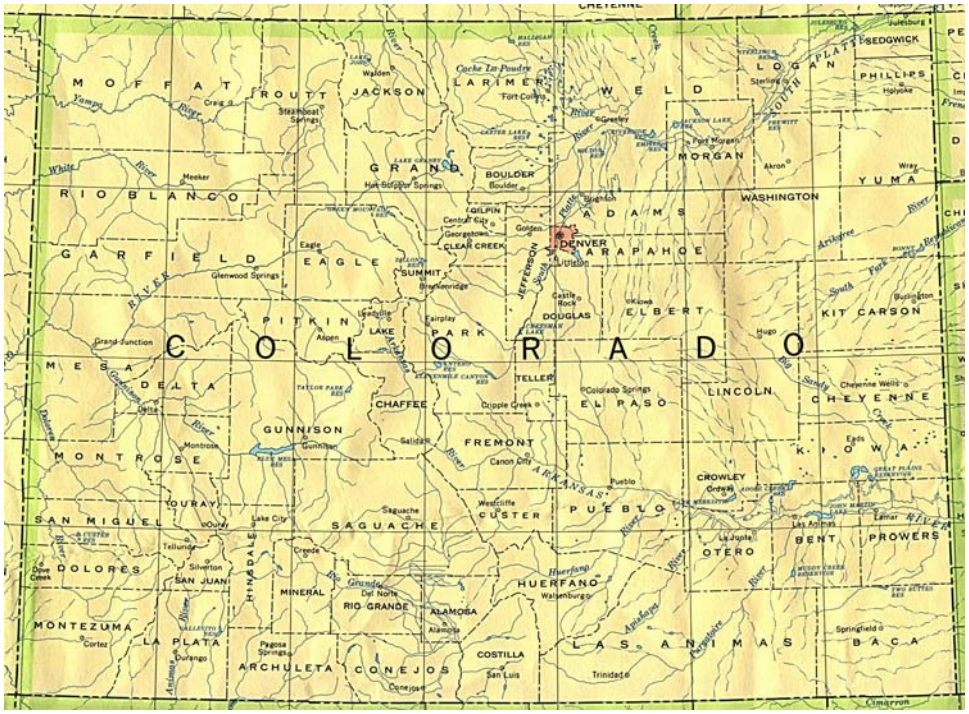
Final Report

Colorado Statewide GIS Coordination

Findings and Recommendations



Prepared for

State of Colorado Governor's Office of Information Technology

August 10, 2007

CH2MHILL

Table of Contents

Executive Summary

The State of Colorado has made significant investments in Geographic Information Systems (GIS) but so far, efforts at statewide coordination have been sporadic and under-funded. The state could benefit from increased GIS coordination based on four primary factors:

1. A broad cross-section of engaged participants
2. Legislative and executive support for the State GIS Coordinator and other coordinating entities
3. Consistent annual funding to sustain statewide coordination efforts
4. Alignment of GIS coordination activities with overall State information technology (IT) goals

The Colorado Office of Information Technology (OIT) requires an investigation of GIS coordination activities in the State, how GIS coordination is achieved in other states, and nationwide best practices for GIS coordination. This investigation is broken down into five sections:

- Environmental Systems Research Institute (ESRI) Software Licensing
- GIS Software Analysis
- Statewide GIS Governance Models
- GIS Software Inventory and Control
- GIS Data Dissemination

These sections will be discussed in order and some key recommendations will be highlighted.

ESRI Software Licensing

The State currently has between 400 and 500 licenses for ESRI products. These are all purchased at the state department level and there is no overarching coordination. Coordination could save the State money and better leverage existing ESRI software investments.

Key Recommendations

1. Negotiate a master pricing agreement (MPA) with ESRI.
2. Reduce the number of individual ESRI customer numbers in the State.
3. Reduce the total number of ESRI licenses in use at the State by pooling licenses. In
4. Improve the procurement process for GIS software and services.

GIS Software Analysis

The State uses ESRI software predominantly. In many cases, GIS software selection is not driven by business need. There are many instances where even the simplest ESRI product provides far more functionality than required by the business needs. In these cases, it would benefit the State to consider other options.

Key Recommendations

1. Assess how current GIS software investments (including ESRI) are being employed to support state business operations.
2. Let business needs drive software decisions.

GIS Governance Models

Currently there is no authorized governance model for GIS coordination in the State of Colorado. The current State GIS Coordinator has organized a Colorado GIS Advisory Council, the model for which can be employed to create an officially sanctioned body with defined responsibilities and authority. Some sort of GIS advisory board and the position of the State GIS Coordinator need to be supported by either legislative mandate or executive order to be truly affective.

Key Recommendations

1. Develop an impact-oriented mission and vision statement for GIS and spatial information resource management for the State of Colorado.
2. Establish GIS coordination responsibilities and authority through legislation or executive order.
3. The State GIS Coordinator should report to the CIO and be housed in OIT.
4. The new Colorado State GIS Advisory Council should be formally chartered.
5. Reframe the GIS paradigm in terms of spatial information resources.

GIS Software Inventory and Control

Currently the State does not have an accurate assessment of how many licenses of ESRI and other GIS software it possesses. In order to make the most of the investment made in GIS software, the State must determine some way to 1) inventory the licenses it actually owns and 2) ensure that the current GIS software portfolio best meets the State's GIS software needs.

Key Recommendations

1. Assess how current GIS software investments (including ESRI) are being employed to support state business operations.
2. Evaluate whether the total cost of ownership for GIS software (including ESRI) could be delivered and sustained more cost effectively through a centrally-hosted services environment.
3. Consolidate server-based ESRI applications in one place.
4. Conduct a non-invasive assessment of all IT systems in the state, including desktops and laptops.

GIS Data Dissemination

Currently, data is shared between state agencies and between the State and local communities in a piecemeal and haphazard fashion. Although efforts have been made by the current State GIS Coordinator to remedy this situation, his efforts have been limited due to lack of backing and authority. The first step to realize effective data dissemination and sharing across the State enterprise and throughout the State is to fully endorse the role of the State GIS Coordinator and empower him to negotiate both interagency and inter-governmental agreements. There are other ways to encourage data sharing between governmental entities. These include shared need, targeted state grants, and legislative

mandate. These should all be explored and applied where it makes sense to do so. The next step is to make the data available via the State GIS Data Portal which should be available late summer 2007.

Key Recommendations

1. Support the state GIS portal.
2. Increase data awareness and identify data gaps, redundancies, and stewards.
3. Establish data development policies and guidelines.
4. Establish data security standards.
5. Develop data sharing agreements.

Introduction

The State of Colorado has a significant investment in Geographic Information Systems (GIS) including hardware and software purchases, data development and acquisition, and staff training and development. Traditionally these investments have been made by individual state departments with little or no inter-departmental coordination. State coordination efforts to date have been haphazard and sporadically funded, limiting their effectiveness and longevity.

There have been several efforts to coordinate GIS activities in Colorado. Early efforts include a GIS coordinating group active in the early 1990s during the Romer administration. This group was supported by an executive order from then Governor Romer that mandated that state agencies participate in these activities. Governor Owens did not renew the executive order, and subsequent coordination efforts foundered.

More recently a similar group, the State Agency GIS group or SAGIS, was convened on a voluntary basis. This group was also active for a short time but then suffered from differences of opinion among the participants of the objectives of the group and the necessary governance to support it. Because the group was voluntary, agency personnel simply elected not to participate.

However, this group, led by a part-time, temporary state coordinator, did produce a coordination document that outlined several issues that the GIS staffs of state departments should address. These issues included standards, cooperative data development for specific themes, and the status of geospatial data among state agencies among other things. SAGIS drafted two standards. However, since this body had no authority and, in fact, ceased to exist, the standards did not become institutionalized. SAGIS also formed teams to manage some data sets critical to the National Spatial Data Infrastructure (NSDI). These teams followed the structure espoused by the Federal Geographic Data Committee (FGDC). Again, as SAGIS lost momentum, these teams also simply faded out of functional existence.

Jon Gottsegen has been the State GIS Coordinator for the last two years and has, despite limited funding and support, achieved several important milestones, including producing a GIS Needs Assessment for the Division of Emergency Management standing up a statewide GIS data portal hosted by the University of Denver, and chartering the Colorado State GIS Coordinating Council. Currently, Mr. Gottsegen is in the Department of Local Affairs (DOLA). In that position he lacks the authority, budget, staff, and other resources to perform extensive inter-departmental coordination activities. Coordination is presently achieved through informal networks and personal relationships.

The State of Colorado Office of Information Technology (OIT) has requested an investigation to provide information about best practices for GIS coordination, GIS software licensing, the GIS software market, and GIS data standardization and dissemination. This information will be used to develop a final report with recommendations and strategies for improving GIS coordination between state agencies initially and eventually with regional, county, and municipal governments as well as the academic community and the private

sector. This investigation will build on previous efforts, including work performed by Leah Lewis, Jon Gottsegen, various state departments, and the Governor's Office of Information Technology, to identify ways in which the state can be most effective in developing, managing, sharing, and utilizing spatial information resources.

Project Goals:

- The State of Colorado Office of Information Technology (OIT) desires a report or series of reports detailing how the State can:
    1. More effectively negotiate a volume licensing and maintenance agreement with Environmental Systems Research Institute, Inc. (ESRI) for all of the licenses currently owned by the State.
    2. Understand the GIS software marketplace, ESRI's role in it, and explore other options as far as GIS software, including open source alternatives.
    3. More effectively manage GIS state-wide in alignment with the National States Geographic Information Council (NSGIC) guidelines.
    4. Inventory and control all GIS licenses more effectively.
    5. Improve GIS data dissemination and identify shared services.
- The final report will provide broad strategies for the following:
    - Improving State-wide GIS coordination of:
        - GIS software licensing
        - Data collection efforts
        - Data dissemination efforts (e.g. through a state GIS data portal)
        - Hardware, software, data, and business process standardization
    - Improving return on investment (ROI) for GIS investments made by the state
    - Eliminating duplication of effort by coordinating and centralizing GIS investments across the state enterprise

The OIT would like to take advantage of best practices and lessons learned from other states where state-wide GIS coordination is more developed. NSGIC, an advocate for state interests that offers support, guidance, and technical assistance to state coordinating bodies, can provide recommended coordination methodologies based on successful efforts around the country.

Project Approach

Overall Approach

To perform this project, CH2M HILL gathered information from the following sources:

- Interviews with individuals from Colorado State government
- Interviews with GIS coordinators and planners from other states
- Interviews with subject matter experts in the local, Front Range GIS community
- Online research on various web sites, including the NSGIC and FGDC web sites, and various state GIS web sites from around the country

Persons Interviewed

Jon Gottsegen – State GIS Coordinator: Mr. Gottsegen has been the Colorado State GIS Coordinator for the last two years. He is currently in the Department of Local Affairs.

Leah Lewis – IT Director, Colorado Division of Water Resources: Ms. Lewis is the former part-time GIS Coordinator for the State of Colorado.

Mark Egbert – Colorado Department of Public Health and Environment (CDPHE): Mr Egbert is the GIS Coordinator for the Center for Health and Environmental Information and Statistics, a division of CDPHE.

Marv Koleis – Colorado Department of Transportation (CDOT): Mr. Koleis has been active in the Colorado state GIS community for over 20 years. Before moving to CDOT, he was the GIS Coordinator for the Department of Local Affairs.

Pete Van Ronk – Colorado Purchasing Department: Mr. Van Ronk has been working on negotiating a master purchasing agreement with ESRI for over seven years.

Carl Sylvester – ESRI: Mr. Sylvester is a Regional Manager for ESRI in Denver.

Tim Johnson – State of North Carolina: Mr. Johnson is the Director of the Center for Geographic Information and Analysis in North Carolina.

Stuart Davis – State of Ohio: Mr. Davis is the Administrator for Enterprise Shared Services for the State of Ohio and the President of the National States Geographic Information Council (NSGIC).

Jim Knudson – State of Pennsylvania: Mr. Knudson is the Geospatial Technologies Director for the State of Pennsylvania and is also on the NSGIC Board of Directors.

Shelby Johnson – State of Arkansas: Mr. Johnson is the Geographic Information Coordinator for the State of Arkansas.

Dennis Goreham – State of Utah: Mr. Goreham is the Manager of the Automated Geographic Reference Center for the State of Utah

Brian Timoney – The Timoney Group: Mr. Timoney founded The Timoney Group in 2005 with the mission of creating visual tools for managers and upper-level executives that enhance information access and data exploration.

Jill Saligoe-Simmel – State of Indiana: Ms. Saligoe-Simmel serves on the NSGIC Board of Directors and is on the NSGIC Homeland Security workgroup. She is the president of the Indiana Geographic Information Council, Inc (IGIC) and chair of the Indiana GIS Initiative since 1997.

Eric Svensen – City of Montrose: Mr. Svensen is GIS Coordinator for the City of Montrose in Colorado and also serves on the board of GIS Colorado.

Steve Hick – GIS Director, University of Denver: Mr. Hick is the GIS Director and a faculty member in the Department of Geography at the University of Denver. He also serves as a co-chair for GIS Colorado.

Mark Eaton – US Geological Survey: Mr. Eaton is the USGS Geospatial Liaison for the State of Colorado. As such he is tasked with working closely with the GIS Coordinator and any GIS coordinating bodies in the state.

Brian Cullis – CH2M HILL: Dr. Cullis pioneered the successful GeoBase program for the United States Air Force and later the Defense Installation Spatial Data Infrastructure for the Office of the Secretary of Defense.

Ed Riegelmann – CH2M HILL: Mr. Riegelmann is Global Director for CH2M HILL's Enterprise Spatial Solutions line of business. He previously pioneered the successful national Spatial Data Standards for Facilities, Infrastructure and the Environment, and has served as a representative on FGDC subcommittees.

Tim Hill – CH2M HILL: Mr. Hill is the National Practice Director for Geographic Information Systems for CH2M HILL. He served as the main negotiator for CH2M HILL in entering into an Enterprise License Agreement (ELA) with ESRI.

Tim Beerman – CH2M HILL: Mr. Beerman is a GIS Analyst and Developer at CH2M HILL. He is the on-site GIS Coordinator at the United States Air Force Academy. He is a leader in open source geospatial technologies, including MapWindow and Google Earth.

Shannon McElvaney – CH2M HILL: Mr. McElvaney is a spatial solutions consultant in CH2M HILL's Colorado Springs office. Before joining CH2M HILL he worked for The Nature Conservancy in Hawaii and was instrumental in establishing the Hawaii Geographic Information Coordinating Council.

Websites researched:

National

National States Geographic Information Council (NSGIC)

http://www.nsgic.org/

NSGIC 50 States Initiative Page

http://www.nsgic.org/hottopics/fifty_states.cfm

The Federal Geographic Data Committee

http://www.fgdc.gov/

FGDC 50 States Initiative Page

http://www.fgdc.gov/policyandplanning/50states/50states

National Spatial Data Infrastructure (NSDI)

http://www.fgdc.gov/nsdi/nsdi.html

The NSDI Framework

http://www.fgdc.gov/framework/

Geospatial One Stop

http://gos2.geodata.gov/wps/portal/gos

Methodology for Business Transformation

http://www.doi.gov/ocio/architecture/mbt/guidance.htm

The Federal Enterprise Architecture Geospatial Profile

http://www.cio.gov/documents/FEA_Geospatial_Profile_v1-1.pdf

Arizona

Arizona Geographic Information Council

http://agic.az.gov/

Arkansas

Arkansas GIS Gateway

http://www.gis.state.ar.us/

Arkansas GeoStor 5.0 – Arkansas' Official GeoData Clearinghouse

http://www.geostor.arkansas.gov/Portal/index.jsp

Indiana

Indiana Geographic Information Council

http://www.in.gov/igic/

IndianaMap Business Case – December 2006

http://www.in.gov/igic/policy/buscase.pdf

IndianaMap Law – state legislation passed May 2007

http://www.in.gov/igic/policy/IndianaMapLaw.pdf

New York

New York State GIS Clearinghouse

http://www.nysgis.state.ny.us/index.cfm

North Carolina

North Carolina Center for Geographic Information and Analysis

http://www.cgia.state.nc.us/

North Carolina Geographic Information Coordinating Council

http://www.ncgicc.com/

Oregon

Oregon GIS Utility Project

http://www.oregon.gov/DAS/EISPD/GEO/gisutility.shtml

Pennsylvania

Pennsylvania Mapping and Geographic Information Consortium (PaMAGIC)

http://www.pacounties.org/pamagic/site/default.asp

PaMAGIC GIS Legislation Workshop Materials

http://www.pacounties.org/pamagic/cwp/view.asp?a=2043&q=514363

Pennsylvania Spatial Data Access

http://www.pasda.psu.edu/

Texas

Texas Geographic Information Council

http://www.dir.state.tx.us/tgic/

Utah

Utah Automated Geographic Reference Center (AGRC)

http://agrc.utah.gov/index.html

Software

Environmental Systems Research Institute

http://www.esri.com/

Autodesk

http://usa.autodesk.com

MapInfo

http://www.mapinfo.com

Google Earth

http://earth.google.com/

Google Maps

http://www.google.com/apis/maps/gallery/mapsAPIProducts.html#utm_source=maps_home

Microsoft Virtual Earth

http://www.microsoft.com/virtualearth/default.mspx

Skyline Software Systems

http://www.skylinesoft.com
Oracle Spatial
http://www.oracle.com/technology/products/spatial/index.html
PostgreSQL
http://www.postgresql.org/
PostGIS
http://postgis.refractions.net/
MySQL
http://www.mysql.com/
AccuGlobe
http://www.accuglobe.net/
Manifold
http://www.manifold.net/
Quantum GIS
http://www.qgis.org/
User-friendly Desktop Internet GIS (uDig)
http://udig.refractions.net

ESRI Licensing

Introduction

The OIT wants to develop a strategy for more effectively negotiating a volume license and maintenance agreement with ESRI for all the licenses owned by the State. Although other GIS software is being used in a limited fashion throughout Colorado State government, ESRI software represents approximately 90-95% of the GIS software in use throughout the state. This does not include computer aided drafting (CAD) software such as AutoCAD or MicroStation, which is not considered GIS software, although products created using this software can be displayed in GIS. MapInfo software is being used by the Department of Corrections although that department also possesses several licenses for ESRI products.

Research and Interviews

Interviews were conducted in person and over the phone. Current State GIS Coordinator Jon Gottsegen and former State GIS Coordinator Leah Lewis were interviewed first to provide guidance and context for the remainder of the research and interviews.

Persons Interviewed

Jon Gottsegen – Colorado State GIS Coordinator

Leah Lewis – IT Director, Colorado Division of Water Resources

Carl Sylvester – ESRI

Pete Van Ronk – Colorado Purchasing Department

Tim Hill – CH2M HILL

Tim Johnson – State of North Carolina

Stuart Davis – State of Ohio

Jim Knudson – State of Pennsylvania

Shelby Johnson – State of Arkansas

Dennis Goreham – State of Utah

Websites Researched:

Environmental Systems Research Institute

http://www.esri.com/

Findings

Current State of ESRI Licenses in Colorado

Carl Sylvester from ESRI-Denver provided Jon Gottsegen with a report of all ESRI licenses currently owned by the State of Colorado. Currently the State has over 100 unique ESRI customer numbers for all its departments. More than 25 of these customer numbers have only a single license associated with them. In many cases there are multiple ESRI customer numbers within the same division.

Current State of the Colorado ESRI Master Pricing Agreement Procurement Process

The State has been attempting to negotiate a Master Pricing Agreement with ESRI for nearly 15 years. Due to changes in administration and attorney general these efforts have so far been unsuccessful. Additionally, there are sticking points in the respective contract language of the two parties that have yet to be overcome. The two major problems are:

- Indemnification – ESRI and the State cannot agree on appropriate indemnification language.
- Location of legal jurisdiction – the State wants to conduct all legal activities in the State of Colorado. ESRI wants to do so in California, where it is based.
- Limitation of Liability – ESRI's limitation of liability language includes blanket protections that are not appealing to the state.
- Protections from liability claims against the state – the State wants ESRI to protect it against claims related to software intellectual property rights, data licenses and other third-party components embedded in the ESRI suite.

These issues are by no means insurmountable. However, it is difficult to maintain momentum due to changes in administration, staff turnover, lack of executive focus, and limited staff bandwidth. All efforts must be directed from the state side, as ESRI has little incentive to change its current licensing relationship with the State. On a positive note, recent renewed efforts have resulted in significant movement toward reaching an agreement.

Current Colorado State Procurement Procedures

Currently the procurement process in the State represents a major roadblock to acquiring necessary GIS software. It can take up to a month to obtain permission to acquire a single license for GIS software and up to six months to get a signed contract for IT services. This is the result of a variety of factors, including:

- Lack of a standard contract for IT services considerably slows down the process. Better understanding of the differences between an end-user license agreement (EULA), a software purchase agreement, and a contract for services would result in a streamlined procurement process.
- Several layers of approval are required, which can include a departmental controller, state controller's office, and Attorney General's Office. This involves

numerous parties each taking significant time to review purchases and each with no motivation to complete the task in a timely fashion.

Best Practices from Other States

North Carolina Case Study

In 2005, North Carolina became the first state to enter into an Enterprise License Agreement (ELA) with ESRI. The state entered into a five-year contract with an annual fee that increases slightly each year. This agreement was the result of several years of contract negotiations. Software through the ELA is available only to state agencies. Funds to pay for the ELA are drawn from the North Carolina IT Enterprise Fund, which is controlled by the State CIO's office. While exact figures are not available, it is estimated that the State of North Carolina pays $400,000 annually for the ELA. Tim Johnson, director of the North Carolina Center for Geographic Information and Analysis (CGIA), estimates that before the ELA was put in place, his department of 20 users spent $50,000 annually on maintenance. He estimates that larger users, like NCDOT and the Department of Natural Resources, were each paying in excess of $75,000 annually. With over 30 departments and agencies statewide, most of them using GIS in some fashion, the cost benefit of negotiating an ELA becomes apparent.

One drawback of the ESRI ELA is that it is not extendable to the county and local governments in the state. However, ESRI did agree to make their rates for software for county and local governments competitive with the prices the State negotiated in the ELA. Training is also available to the county and local governments at a reduced rate. Another drawback is the fact that many of the ESRI extensions, specifically the extensions with third-party software such as the Interoperability Extension and GPS Analyst, are not available under the ELA and must be purchased separately.

For the State of North Carolina, an enterprise license agreement with ESRI has proved to be valuable and cost-affective arrangement. ESRI benefits as well. Before the ELA, licenses were often purchased and then allowed to lapse after one year. This is probably due to the fact that software is often purchased with grant money that disappears after one year. Now ESRI has a guaranteed annual revenue stream from the State of North Carolina for the duration of the agreement.

Recommendations

1. **Negotiate a master pricing agreement (MPA) with ESRI.** Currently the State gets federal government pricing even though ESRI is not obligated to provide this. Under an MPA, the State would have fixed pricing on ESRI software products over the length of the agreement. The agreement would have to be renewed periodically, and terms and conditions can be revisited and renegotiated if necessary. With an MPA in place, signature authority up to a certain dollar amount could be given to purchasing agents for individual departments. This would dramatically speed up the process for obtaining ESRI software licenses. Another advantage of an MPA is that it can be used by all tax-levying political subdivisions in the State, including counties and municipalities. This will facilitate greater GIS coordination throughout the State, another stated goal of the OIT. To succeed this process must have executive support and focus. There are issues that, while not insurmountable, require a great deal of coordination and discussion. This

can probably best be achieved by a face-to-face meeting with all concerned individuals from both ESRI and the State. Sticking points can be addressed directly and resolved without months of delayed response times by carefully tracking and recording progress and maintaining the proper focus.

2. **Reduce the number of individual ESRI customer numbers in the State.** Currently the State is paying more in annual maintenance then necessary due to the high number of distinct ESRI customer numbers. By consolidating customer numbers the State can likely save thousands of dollars per year by transferring existing primary maintenance to secondary maintenance. More research is required to provide a better estimate of the savings. ESRI allows up to nine secondary maintenance licenses per primary license. Further investigation could provide a better estimate for the return on investment by reducing the number of unique ESRI customer numbers.

3. **Reduce the total number of ESRI licenses in use at the State by pooling licenses.** In Many cases stand-alone licenses can be exchanged for floating licenses. Floating licenses can be managed collectively on a server and accessed whenever a user has need. The State would not require as many floating licenses to support the same number of users currently operating stand-alone licenses.

4. **Improve the procurement process for GIS software and services.** As a longer-term goal, the process by which the State acquires GIS software and services needs to be improved. This is one part of a larger issue that is outside the scope of this study. Some of the recommendations provided here are applicable to this larger problem. Some steps that should be taken to improve the process for procuring GIS software and services include:

    - A standard contract for GIS services should be developed, vetted with the proper representatives from the Attorney General's office, and used for all GIS services provided to the State. Signature authority should be given to appropriate representatives from interested State departments up to a certain dollar amount. This will dramatically reduce the time required to obtain GIS services for State projects.

    - Training should be provided to procurement staff at the State and Department level for processing GIS software and services contracts.

    - Anything that can be done to mitigate the bottleneck in the Attorney General's office. This can include contract templates, distributing signature authority through the use of same, and greater executive pressure to focus efforts on processing agreements and contracts more efficiently.

5. **Take advantage of data center consolidation.** Another option for reducing ESRI licensing costs may occur if the State decides to consolidate its existing 38 data centers for the 23 state agencies. The data center consolidation will enable server consolidation, virtualization of shareable services-oriented applications such as ESRI, and a reduction in the number of ESRI licenses. In addition, the State could outsource the management of the ESRI licenses, and bypass all of the above issues which have prevented the State from effectively managing ESRI license costs in the past.

6. **(For future consideration) Negotiate an enterprise license agreement (ELA) with ESRI.** At some future data it may become desirable to the State to negotiate an ELA with ESRI. There are numerous advantages in having an ELA. Some of the advantages include:

   - Better pricing for the State for all ESRI products covered under the ELA.
   - Since an ELA would be administered through one central location, it would enable better control of ESRI products in use around the State.

   There are hurdles to be cleared before an ELA can be administered at the State level. Funding sources and mechanisms need to be secured. Typically, ELAs are for a 3-year duration, with the cost escalating each year. The State must secure budget for all 3 years of an ELA or determine how to fund an ELA over multiple budget cycles. There are also some disadvantages of an ELA, including the following:

   - An ELA is not immediately usable by political subdivisions of the State, as an MPA would be.
   - An ELA must be administered through a central location, which, although providing more control over license use and distribution, could sever the contact between ESRI and representatives of the various State departments.
   - Staff and resources would have to be allocated to administer the ELA on a continuing basis.

GIS Software Analysis

Introduction

The OIT wants to collect information on GIS software available in the market today. The resulting report will contain information on market share for ESRI and their competitors, and recommendations on a future course for GIS software standardization for the State of Colorado.

Research and Interviews

Interviews were conducted in person and over the phone. Current State GIS Coordinator Jon Gottsegen and former State GIS Coordinator Leah Lewis were interviewed first to provide guidance and context for the remainder of the research and interviews.

Persons Interviewed:

Jon Gottsegen – Colorado State GIS Coordinator

Leah Lewis – IT Director, Colorado Division of Water Resources

Brian Timoney – The Timoney Group

Ed Rigelmann – CH2M HILL

Tim Johnson – State of North Carolina

Stuart Davis – State of Ohio

Jim Knudson – State of Pennsylvania

Jill Saligoe-Simmel – State of Indiana

Websites Researched:

Environmental Systems Research Institute
http://www.esri.com/
Autodesk
http://usa.autodesk.com
MapInfo
http://www.mapinfo.com
Google Earth
http://earth.google.com/
Google Maps
http://www.google.com/apis/maps/gallery/mapsAPIProducts.html#utm_source=maps_home

Microsoft Virtual Earth
http://www.microsoft.com/virtualearth/default.mspx
Skyline Software Systems
http://www.skylinesoft.com
Oracle Spatial
http://www.oracle.com/technology/products/spatial/index.html
PostgreSQL
http://www.postgresql.org/
PostGIS
http://postgis.refractions.net/
MySQL
http://www.mysql.com/
AccuGlobe
http://www.accuglobe.net/
Manifold
http://www.manifold.net/
Quantum GIS
http://www.qgis.org/
User-friendly Desktop Internet GIS (uDig)
http://udig.refractions.net

Findings

Current State of GIS Software in Colorado

As is typical in most states, ESRI software is the primary spatial information management software suite in use throughout Colorado. A report generated in 2002 estimated that the State possessed over $1.5 million of ESRI software. To maintain all this software from year to year, the State likely has to pay upwards of $500,000 annually. This has undoubtedly increased in the last five years. A Master Pricing Agreement with ESRI will help to reduce this cost but as more and more state departments want to make use of spatial information, the cost will only increase. Despite the costs involved, there are numerous advantages to be gained from adopting an "ESRI-centric" approach. These include:

- Large, well-educated user community
- Uniformity when it comes to functionality, support, and development
- Capacity for integration with other State business systems across the enterprise
- "One-stop shop" for all your spatial information software requirements
- Large amount of existing State map data stored in ESRI formats
- Academia typically educates new spatial labor force in ESRI products

ESRI offers software products that span the entire spatial information management lifecycle, from data development to visualization. There has always been competition from companies such as Intergraph, Autodesk, and MapInfo. In recent years, however, there has been an increase in the number of companies offering spatial information products, and the range of spatial information software has been expanding to include "consumer mapping" products such as Google Earth, Google Maps, Yahoo Maps, and Microsoft Virtual Earth. These products have the potential to cut into ESRI's market share toward the end of the spatial information management lifecycle, as seen in Figure 1.

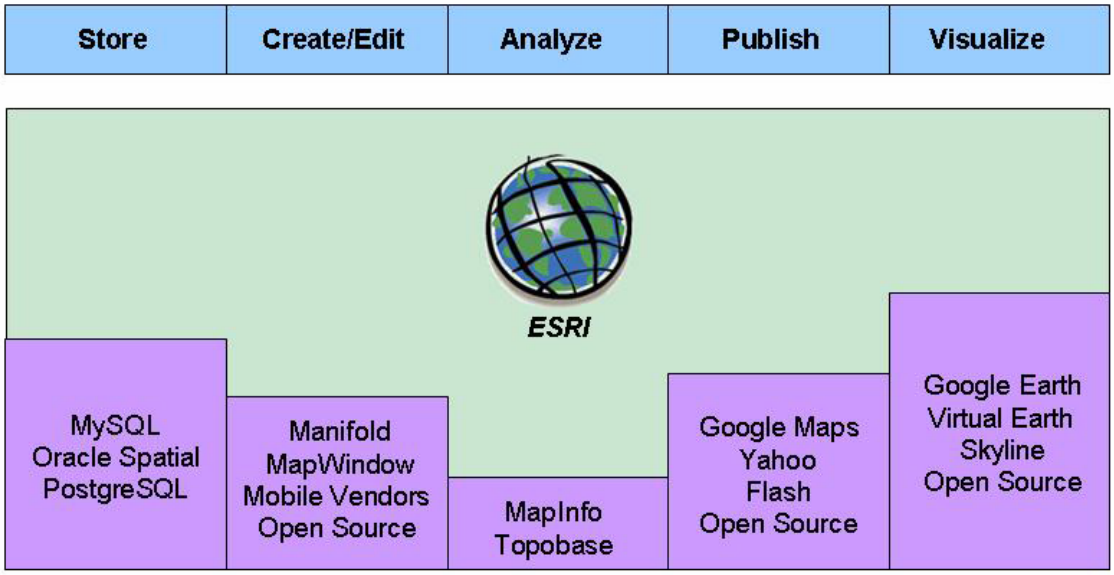


Figure 1. Spatial information management lifecycle and competition to ESRI

These products are more suited for viewing spatial information and lack most of the customary functionality of a true GIS. At the other end of the spatial information management lifecycle, spatial data storage solutions such as Oracle Spatial (at the high end) and PostgreSQL PostGIS (open source) are providing alternatives to ESRI's ArcSDE and ArcGIS Server suite of products. Where ESRI still holds a commanding market edge and where it is unmatched in functionality is in the area of spatial analysis.

Spatial Information Management Software Market Share

GIS Vendor	Full-Use Seats	View-Only Seats
Autodesk	8%	25%
Bentley	4%	4%
ESRI	81%	39%
GE Network Solutions	1%	0%
Intergraph	4%	24%
Looking Glass	0%	7%
MapInfo	2%	1%

Table 1. 2006 Public Sector SIMS Market Share (GITA 2006 Geospatial Technology Report)

ESRI dominates the government sector in terms of market share. Autodesk, Intergraph, and Bentley also play a role but with a much smaller market share. Of note is the fact that the

percentage of public sector entities using ESRI products for "view-only seats" dropped from 65% to 39% from 2005 to 2006. The bulk of that difference was picked up by Autodesk and Looking Glass. The effects of the rise of "consumer mapping" products like Google Earth and Microsoft Virtual Earth remain to be seen, although it is evident that these products are occupying a niche that until recently was served exclusively by GIS web-based mapping applications. For example, Google Earth is used (often in violation of its license agreement) throughout state, county, and local governments to perform daily tasks. Before 2005, this need would have been served by, for example, an ESRI ArcIMS-based web site that would have to be created, populated with current data, and maintained. With KML (Keyhole Markup Language – the "language" of spatial data in Google Earth) becoming an (Open Geospatial Consortium) OGC-compliant spatial data standard, it may develop into a means through which spatial information can be shared among a wide variety of geospatial applications. In other words, organizations will be able to export their spatial information in one format and let the end user decide what application they want to use to view it. While this methodology certainly has its limitations, the needs of a certain subset of users, both internal and external to government organizations, can likely be met in this fashion.

A current example of a state agency utilizing some alternative to ESRI software is the AquaMap application being developed by the Division of Water Resources. AquaMap is based on SVG, or scalable vector graphics, technology. SVG is a language for describing two-dimensional graphics and graphical applications in extensible markup language, or XML. The application functions inside of a standard web browser such as Microsoft Internet Explorer. The purpose of the application is to replace twelve stand-alone licenses of ESRI's ArcView. The application will cost less to maintain annually than the ESRI licenses it replaces and can be made available to a wider audience limited only be web server capacity. The technology is open source, so there are no licenses to buy and maintain. SVG is a fairly mature technology, having been around since 2001. There is a large user community and many online resources for support. SVG is a web standard fully supported by the World Wide Web Consortium (W3C).

Recommendations

1. **Assess how current GIS software investments (including ESRI) are being employed to support state business operations.** A "best practice" repeatedly cited by the Federal CIO Council and the General Accountability Office prior to making further software investments is to ensure that ***current*** investments are appropriately aligned with strategic business priorities.

2. **Let business needs drive software decisions.** It is vital to identify critical business needs and separate groups of users when determining where to make spatial information software investments. In many situations, an ESRI solution is required. For example, if an application is being developed that needs to integrate data from the Department of Homeland Security (DHS), it would be best to utilize an ESRI solution, as the data model for homeland security used by DHS is based on the ESRI geodatabase model. However, for many applications and user communities, it is not necessary to provide fully functioning GIS software on the desktop. Specific user requirements can be met using server-based products or any one of the "consumer-based mapping" products

mentioned above. This will become increasingly important as more non-traditional users of spatial information, like the business community, begin to develop applications for the spatial information they already collect and store.

3. **Focus on the areas where other GIS software may be used most effectively to supplement existing ESRI capabilities.** These areas are listed below, with a selection of alternatives to ESRI software that may be employed.

    - **Publish and Visualize:** Web-based mapping applications

        - MapServer - MapServer is an open source development environment for building spatially-enabled internet applications. MapServer is not a full-featured GIS system, nor does it aspire to be. Instead, MapServer excels at rendering spatial data (maps, images, and vector data) for the web.

        - MapGuide Open Source - MapGuide Open Source is a web-based platform that enables users to quickly develop and deploy web mapping applications and geospatial web services. MapGuide features an interactive viewer that includes support for feature selection, property inspection, map tips, and operations such as buffer, select within, and measure. MapGuide includes an XML database for managing content, and supports most popular geospatial file formats, databases, and standards.

        - Microsoft Virtual Earth - The Virtual Earth platform is an integrated set of services that combines unique bird's eye, aerial, and 3D imagery with best-of-breed mapping, location and search functionality. By combining comprehensive support for feature customization, richer features for end users, and new levels of control and flexibility in the platform, Virtual Earth allows you to create unique environments to support a variety of applications.

        - Google Maps – Google Maps is a free web mapping service application and technology provided by Google that powers many map-based services including the Google Maps website and embedded maps on third-party websites via the Google Maps API. As the Google Maps code is almost entirely JavaScript and XML, some end-users reverse-engineered the tool and produced client-side scripts and server-side hooks which allowed a user or website to introduce expanded or customized features into the Google Maps interface.

        - Google Earth - Google Earth is a virtual globe program that was originally called Earth Viewer and was created by Keyhole, Inc. It maps the earth by the superimposition of images obtained from satellite imagery, aerial photography and GIS 3D globe. It is available under three different licenses: Google Earth, a free version with limited functionality; Google Earth Plus, which includes a few more features; and Google Earth Pro, intended for commercial use. Spatial data is rendered in Google Earth using Keyhole Markup Language, or KML. Users can export data from standard GIS software packages into KML format and view their data in Google Earth.

        - (Scalable Vector Graphics) SVG-based applications - SVG is a platform for two-dimensional graphics. It has two parts: an XML-based file format and a

programming API for graphical applications. Key features include shapes, text and embedded raster graphics, with many different painting styles. SVG is used in many business areas including Web graphics, animation, user interfaces, graphics interchange, print and hardcopy output, mobile applications and high-quality design. SVG is a royalty-free vendor-neutral open standard developed under the W3C Process. It has strong industry support; Authors of the SVG specification include Adobe, Agfa, Apple, Canon, Corel, Ericsson, HP, IBM, Kodak, Macromedia, Microsoft, Nokia, Sharp and Sun Microsystems. SVG viewers are deployed to over 100 million desktops, and there is a broad range of support in many authoring tools. SVG builds upon many other successful standards such as XML (SVG graphics are text-based and thus easy to create), JPEG and PNG for image formats, DOM for scripting and interactivity, SMIL for animation and CSS for styling.

- **Store:** GIS data storage applications
    - Oracle Spatial - Oracle Spatial forms a separately-licensed option component of the Oracle Database. Oracle Spatial aids users in managing geographic and location-data in a native type within an Oracle database, potentially supporting a wide range of applications — from automated mapping/facilities-management and geographic information systems (GIS), to wireless location services and location-enabled e-business.
    - PostgreSQL/PostGIS - PostGIS adds support for geographic objects to the PostgreSQL object-relational database. In effect, PostGIS "spatially enables" the PostgreSQL server, allowing it to be used as a backend spatial database for geographic information systems (GIS), much like ESRI's ArcSDE or Oracle's Spatial extension. PostGIS follows the OpenGIS "Simple Features Specification for SQL" and has been certified as (Open Geospatial Consortium) OGC-compliant.
    - MySQL - MySQL is a key part of LAMP (Linux, Apache, MySQL, PHP / Perl / Python), a fast growing open source enterprise software stack. More and more companies are using LAMP as an alternative to expensive proprietary software stacks because of its lower cost and freedom from lock-in. MySQL is owned and sponsored by a single, for-profit firm. They offer the software for free and make money on services and support.

One way that a centralized GIS coordinating organization can add value is to provide training and expertise on these different applications.

State GIS Governance Models

Introduction

The OIT desires a report proposing a governance model which will enable GIS to be more effectively managed state-wide.

Research and Interviews

Interviews were conducted in person and over the phone. Current State GIS Coordinator Jon Gottsegen and former State GIS Coordinator Leah Lewis were interviewed first to provide guidance and context for the remainder of the research and interviews.

Persons Interviewed:

Jon Gottsegen – Colorado State GIS Coordinator

Leah Lewis – IT Director, Colorado Division of Water Resources

Marv Koleis – CDOT

Mark Egbert – CDPHE

Brian Cullis – CH2M HILL

Shannon McElvaney – CH2M HILL

Tim Johnson – State of North Carolina

Stuart Davis – State of Ohio

Jim Knudson – State of Pennsylvania

Shelby Johnson – State of Arkansas

Dennis Goreham – State of Utah

Websites Researched:

Pennsylvania Mapping and Geographic Information Consortium (PaMAGIC)

http://www.pacounties.org/pamagic/site/default.asp

PaMAGIC GIS Legislation Workshop Materials

http://www.pacounties.org/pamagic/cwp/view.asp?a=2043&q=514363

Pennsylvania Spatial Data Access

http://www.pasda.psu.edu/

New York State GIS Clearinghouse

http://www.nysgis.state.ny.us/index.cfm

Utah Automated Geographic Reference Center

http://agrc.utah.gov/index.html

North Carolina Center for Geographic Information and Analysis

http://www.cgia.state.nc.us/

North Carolina Geographic Information Coordinating Council

http://www.ncgicc.com/

Texas Geographic Information Council

http://www.dir.state.tx.us/tgic/

National States Geographic Information Council

http://www.nsgic.org/

The Federal Geographic Data Committee

http://www.fgdc.gov/

The Federal Enterprise Architecture Geospatial Profile

http://www.cio.gov/documents/FEA_Geospatial_Profile_v1-1.pdf

Findings

Current Situation in Colorado

Currently in Colorado there is very little organized GIS governance. Jon Gottsegen has created a Colorado GIS State Advisory Council which had its third meeting on July 13, 2007. This new forum comprised of GIS representatives from state agencies, regional alliances, city and county governments and the private sector, offers new potential as a more formal means for securing consensus on GIS efforts, especially if it is bolstered with either legislative or executive support or both. The lack of formal governance of GIS coordination activities results in numerous problems, including the following:

- **Lack of uniform policies among state agencies regarding spatial data handling and structures –** Agencies within the state and organizations working with the State should be aware that geospatial data and applications adopted by the State will comply with specific guidelines. Extra time and money has been spent integrating data because of this lack of guidance.
- **No single point of contact for entities who want to interact with the State in the area of geospatial technologies –** It is difficult for a separate jurisdiction, such as a federal or county agency, to exchange data with the State, collaboratively develop geospatial data or applications, or otherwise work with the State on any geospatial-related effort that spans several State agencies.
- **No consistent policy for sharing data among state agencies –** Obtaining data from state agencies often depends on the unique policies established by each individual division within state departments.
- **Inability of some state agencies to provide access to data for parties outside of their department –** Although some departments are interested in disseminating their

geospatial data, they consider developing the means for access to their data outside of the purview of their department's business needs. They cannot spend resources that should be dedicated to supporting their regulatory activities or other programs on developing the mechanisms for data dissemination.

- **Loss of potential grant funds –** There have already been instances where the State has not received grant money that was available from federal programs because it does not have coordinated GIS efforts. In addition, other grant programs, such as those from the US Department of Homeland Security, require that the State indicate its commitment to a coordinated approach to developing a statewide repository of geospatial data.
- **Lack of a single source for identifying State geospatial data that are available or for acquiring state data –** It is difficult for people inside and outside of state government to obtain a comprehensive picture of the data that is available from the State or to obtain data from several different departments individually.
- **No comprehensive awareness or record of geospatial activities occurring within the State –** The State lacks a single location where entities in the state, including state, federal and local agencies, can discover the activities that other entities may be undertaking or interested in undertaking. This constrains GIS organizations from collaborating on GIS projects.

Best Practices from NSGIC

NSGIC has published the following nine criteria that its members believe are essential for effective statewide coordination of geospatial technologies. They serve as a guideline for assessing the maturity of statewide coordination activities. It is important to note that the NSGIC agenda was developed by state GIS representatives with assistance from the Federal Geographic Data Committee which is charged with responsibility for building the National Spatial Data Infrastructure or NSDI. Thus, these criteria should be seen as a compilation of measures submitted by various states that have individually (not necessarily collectively) been self-reported as contributing factors to realizing enhanced performance from GIS investments across the respective states. Last year, the State GIS Coordinator, Jon Gottsegen, reported the status of the Colorado GIS program per each criterion in the 2006 NSGIC survey. Notable changes in status since 2006 have been included in each criterion discussion.

1. *Full-Time, Paid Geospatial Information Coordinator*. A full-time, paid coordinator position is designated and has the authority to implement the state's business and strategic plans. Colorado reported progress has been made with expectations to be fully implemented within the next 12 months, with the greatest need for more implementation authority.

2. *Authoritative Charter for Geospatial Information Coordination*. A clearly defined authority exists for statewide coordination of geospatial information technologies and data production. Colorado reported plans to implement this within the next 12 to 18 months and the Colorado GIS Advisory Council is evidence of this progress.

3. *State Geospatial Information Coordinator Alignment with State CIO*. Statewide coordination is enabled through teaming with the state's CIO (or similar office). Colorado had reported no plans for implementing this criterion in 2006. However, May 2007 legislation led by the new cabinet has now fully satisfied this criterion.

4. *Executive Champion for Geospatial Information Coordination*. A champion (politician or executive decision-maker) is aware and involved in the process of coordination. Colorado reported progress has been made with expectations to be fully implemented within the next 12 months. However, this criterion has now been reinforced with the enhanced executive support for GIS from the OIT.

5. *State Stewardship for NSDI Themes*. Responsibilities for developing the National Spatial Data Infrastructure and a State Clearinghouse are assigned. Colorado reported full compliance with this criterion. However, the specific responsibilities associated with state agencies assuming stewardship needs further clarification.

6. *State Geospatial Information Coordination Infrastructure*. The ability exists to work and coordinate with local governments, academia, and the private sector. Colorado reported full compliance with this criterion. Further formal clarification of the role of the new Colorado GIS Advisory Council, however, will help reinforce this coordination infrastructure.

7. *Sustainable State Funding for Geospatial Information Coordination*. Sustainable funding sources exist to meet projected needs. Colorado had reported no plans for implementing this criterion in 2006 and like many other states, effective, sustainable funding sources for GIS coordination remains a top challenge.

8. *Obligation Authority for State Geospatial Information Coordinator*. Coordinators have the authority to enter into contracts and become capable of receiving and expending funds. Similar to the sustainable funding criterion, Colorado did not anticipate being able to satisfy this criterion in 2006.

9. *State Geospatial Information Coordinator Interface to Federal Operations*. The Federal government works through the statewide coordinating authority. Colorado reported full compliance with this criterion in 2006 and the State GIO continues to have a healthy, working relationship with the regional USGS/FGDC representative.

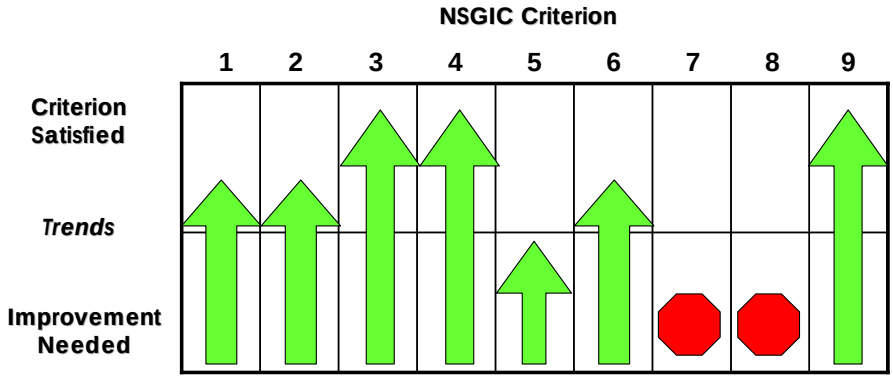


Figure 2. Current Trends in Colorado Using NSGIC Maturity Criteria

Best Practices from Federal Agencies

Assimilate Spatial Information Resources into Enterprise Business Architecture Initiatives

Many of the services provided by government agencies can be tied to a geographic location. Providing, tracking, and improving the delivery of these services require that information about locations be collected and managed. Given that multiple agencies, as well as private sector entities, provide a variety of services over the same geographic areas and/or provide geospatial information and services in support of business, there are efficiencies to be realized through collaboration.

Subsequently, the Federal Enterprise Architecture (FEA) Program Management Office (PMO), the Federal Chief Information Officers Council's Architecture and Infrastructure Committee (AIC), and the Federal Geographic Data Committee (FGDC) have collaborated to produce a Geospatial Profile to the Federal Enterprise Architecture (FEA). The FEA is the overarching architectural guide for considering IT investment strategies. FEA Profiles are frameworks about a particular subject area that crosses many subject areas or programs within agencies. The Geospatial Profile joins the Security and Privacy and Records Management Profiles in providing cross-government guidance intended to promote common, consistent enterprise architecture practices that improve business performance.

Position Spatial Information Resources as Business Enablers in the State Enterprise

The Department of the Interior (DOI) has been a successful pioneer in demonstrating how the FEA and geospatial profile can be effectively implemented. The DOI CIO uses an internally-developed Methodology for Business Transformation which has earned praise from both the Federal CIO Council and the Office of Management and Budget. The MBT uses proven EA workflows to sequentially identify prioritized business needs, inventory current IT assets through portfolio management practices, optimize business workflows prior to enlisting requisite IT capabilities, and measuring IT value to DOI business goals. Figure 3 depicts the comprehensive DOI business blueprint to include the enabling role of geospatial services.

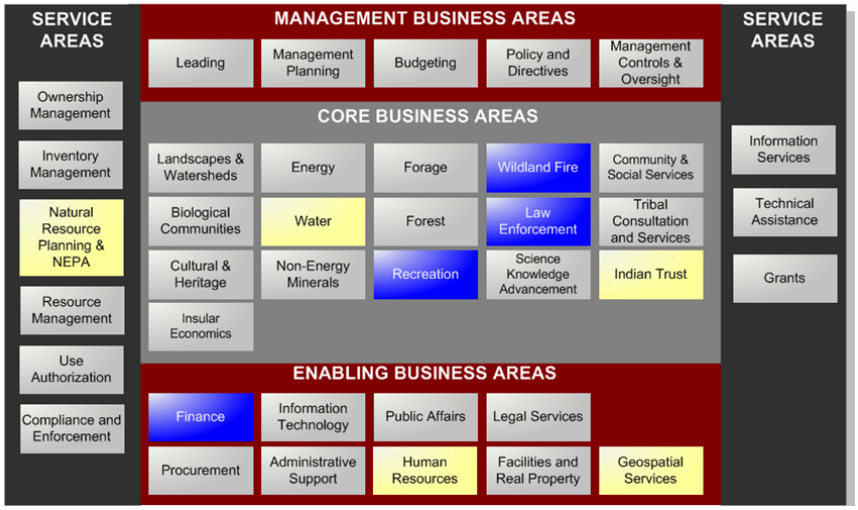


Figure 3. Role of Geospatial Services in the Department of Interior Business Architecture

Reframe GIS as Spatial Information Resources Integral to the Enterprise Information Infrastructure

The passage of the 1996 Information Technology Management Reform Act mandated federal agencies establish CIOs to oversee and bring accountability to the rampant investments in IT that had been discovered by the General Accountability Office. The worldwide US Air Force installations and environmental business mission was one of the most aggressive investors in GIS software and were eager to work with the new Air Force CIO to better align their many spatial information investments with the Air Force business enterprise portfolio.

The USAF GeoBase program's practical vision of "one installation, one map" and guiding principles known as the GeoBase Foundations have achieved remarkable success in a short period of time. Through close cooperation with the Air Force CIO office, costly redundant investments on defense installations have been eliminated and existing commercial GIS licenses have been optimized so that required GIS services can be 'acquired once, shared many'. Incredible cost savings have been recorded with regard to shared use of high-resolution digital imagery as well as GPS technologies and servers.

Best State GIS Practices from Other States

Gleaning GIS 'best practices' from across the states is an arguable venture since every state information environment presents a different array of business priorities, fiscal tradeoffs, and political dynamics inherent to any bureaucracy. However, in-depth reviews of GIS programs in Pennsylvania, North Carolina, Texas, and Utah all share common hallmarks that are well known precursors to successful IT innovations. Establishing an inarguable, principle-based vision and premise for pursuing spatial IT initiatives, aligning spatial IT innovations with business priorities, demonstrating success in an incremental basis by realizing near-term benefits for high visibility projects, gaining credibility for the spatial IT by enabling business success across a variety of agencies, and securing an enduring, sustainable role within the many new state enterprise architecture initiatives by helping to

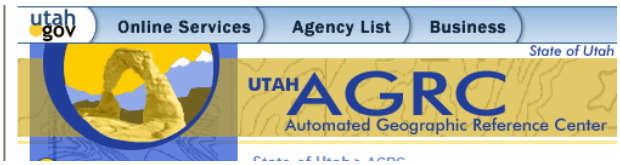
spatially-enable state operations in a tangible, effective manner are but a few of the means being used by various state GIS programs.

For example, despite many advances and even more challenges over the past decade, the State of Pennsylvania's Bureau of Geospatial Technologies has succeeded in enhancing the Commonwealth's geospatial preparedness, coordinating Executive agency and enterprise geospatial initiatives, and facilitating geospatial interoperability and data sharing across all levels of government in support of defined Pennsylvania priorities. A succinct enabling vision and guiding principles such as "Improve government services", "Leverage every dollar spent for the extended enterprise", "Maximize sharing of ideas, knowledge, data and applications", "Remain agile and open to new ideas, always guided by a long-range plan" and lastly appreciating that "Relationships and communications trump technologies" has served as a solid foundation on which they continue to extend their influence and business impact.

North Carolina has been a recognized leader in statewide geospatial implementation and coordination for over twenty-five years thanks due largely to strong leadership, empowering legislation and cross-agency cooperation. Their Center for Geographic Information and Analysis (CGIA) was established in 1991 under an executive order which also established and authorized the North Carolina Geographic Information Coordinating Council (GICC). Today, the CGIA is a division within the Department of Environment and Natural Resources (DENR) and serves as the GIS coordinating agency for North Carolina, administers the state's GIS data portal, and provides technical support to the GICC. The Director of the CGIA serves as Secretary of the GICC and provides staff resources as necessary. The CGIA and GICC are models of what GIS coordinating bodies can achieve, and are recognized statewide and nationally. In fact, the CGIA is unique in that it has three to four staff members devoted full time to coordination activities. The GICC is comprised of members from a wide range of organizational backgrounds, and can provide a comprehensive strategy for GIS activities in the state. The linkage between the CGIA, GICC, State Legislature, and Governor's office help to form a cohesive vision for the future of geospatial technology in North Carolina.

The Texas Geographic Information Council (TGIC) is a superb example of a collaborative approach among agencies to advance the mission of the state through a common technology architecture and data standards. With 46 member organizations composed of agencies, universities, and regional organizations, TGIC serves as the state coordinating council for geographic information systems (GIS) technology in the state. The council provides guidance to DIR on GIS standards and best practices and provides legislative recommendations on improving the state's GIS technology. Today, Texas has 24 digital base maps under development; for example, satellite imagery maps, digital road maps, and census maps. For a state the size of Texas, these maps can cost millions of dollars to develop and maintain collectively. Collaboration among TGIC agencies allows geographic data created and maintained individually to be shared among all agencies throughout the state, avoiding greater costs associated with

individual development. This kind of collaboration is applicable in many other areas within the state, such as electronic forms management and criminal justice data exchange.



Finally, Utah has made remarkable progress in spatial data sharing despite numerous fiscal, legislative and political challenges. They have secured widespread cooperation through a small group of state employees who have established strong relationships with various federal, tribal, county, and local entities. Roughly 64% of Utah is owned by the federal government. This fact has forced the state to develop and maintain strong relationships with numerous federal agencies, including the Bureau of Land Management, the National Park Service, and the United States Air Force, among others. After seeking a formal champion and executive sponsor for several years, the Utah Automated Geographic Reference Center (AGRC) was re-authorized in 2005 under the Utah Technology Governance Act, and moved into the Department of Technology Services, under the direction of the Chief Information Officer (CIO). The AGRC has instituted groundbreaking Memorandums of Understanding (MOU) with dozens of participants from all levels of government that were some of the first of their kind in the country. Today the AGRC is the primary GIS coordination agency for the State of Utah and the manager of the State Geographic Information Database (SGID). The primary GIS coordinating council for the State of Utah is the GIS Advisory Council (GISAC), which was authorized as a stand-alone council by an administrative ruling, issued by the CIO. The council has representation from federal, state, local, and tribal members, as well as private interests, although they are unable to vote.

Recommendations

1. **Develop an impact-oriented mission and vision statement as well as guiding principles for GIS and spatial information resource management for the State of Colorado**. State and federal GIS initiatives have been hampered by pursuing a very broad change agenda (e.g. geospatial data sharing). The ubiquitous nature of spatial IT and its relevance to virtually all lines of state business will require any statewide GIS coordination to have a very focused goal (or set of goals) that can align itself with the State's larger IT strategic plan which is aimed to achieve the Colorado Promise stated by Governor Ritter. Any new GIS initiative should seek to explicitly align its purpose with the larger business goals of the State. The majority of the objectives of the current Colorado IT Strategic Plan all carry significant relevance to any GIS or spatial information resource initiative as noted in Table 2 below.

	Relevance to Spatial IRM Governance		
OIT Major Strategic Objectives	Major	Minor	NA
1.0 Secure and Protect IT Assets			
1.1 Conduct Enterprise Asset Management Inventory	●		
1.2 Create New Asset Management Policies & Standards	●		
1.3 Continue to Improve Cyber and IT Security	●		
1.4 Continue to Standardize Enterprise Architecture	●		
1.5 Begin Enterprise Service Consolidation	●		
2.0 Optimize Spending for IT Decisions, Projects, and Technology			
2.1 Establish New Budgeting Process	●		
2.2 Reform Enterprise Licensing & Buying	●		
2.3 Improve Contracting Oversight		●	
3.0 Effectively Manage IT Projects			
3.1 Continue to Implement Project Management Certification			●
3.2 Expand the Enterprise PMO	●		
3.3 Provide Enterprise Reporting on Large IT Projects	●		
4.0 Improve Enterprise Service Delivery			
4.1 Help Enable Statewide Broadband Connectivity	●		
4.2 Complete Statewide Communications System	●		
4.3 Better Leverage of the Statewide Internet Portal	●		
4.4 Improve Service Delivery to Customers	●		
5.0 Improve Collaboration & Innovation			
5.1 Continue Strategic Planning	●		
5.2 Establish Centers of Excellence for Key Competencies	●		
5.3 Build an Executive Policy Board	●		
5.4 Involve the Private Sector in Developing Innovative Solutions	●		

Table 2. Relevance of Colorado 2007 IT Strategic Plan to Spatial IRM Governance

2. **Establish GIS coordination responsibilities and authority.** Currently, there is no explicit specification of the responsibilities and authority for any of the participants in a statewide GIS coordination process. For any coordination effort to be successful in the long term, such organizational definitions must be developed and institutionalized through some governance mechanism, either an executive order or legislation. Both of these options are possibilities, and have advantages and disadvantages.

   - Legislation would clearly have the most impact in terms of solidifying GIS coordination. However, it would also be extremely difficult to accomplish because of the generally decentralized political climate in Colorado and the objection to legislation on the part of other agencies. The process of passing legislation is extremely arduous, and the resulting law rarely looks like the bill that was originally introduced. Problems with defining and passing legislation notwithstanding, legislation would be useful for authorizing and directing a State GIS Coordinator and State coordination body. It could also help ensure that agency activities are compatible with statewide GIS strategies. Examples of legislation authorizing GIS coordinating bodies can be found at the websites below:

     IndianaMap Law
     http://www.in.gov/igic/policy/IndianaMapLaw.pdf
     North Carolina Geographic Information Coordinating Council
     http://www.ncga.state.nc.us/enactedlegislation/statutes/pdf/byarticle/chapter_143/article_76.pdf

   - Formulating an executive order is adequate for the most important initial goals in the coordination process, and it is more palatable to GIS staff from other agencies. While it does not carry the same weight in ensuring participation and consistency among agencies, it will reflect an executive level commitment to GIS coordination. This indication of commitment will be enough to support agency participation in the coordination process, especially early on as the process gains momentum. An executive order needs to be renewed with each new governor so effort must be expended potentially every four years to see that it is renewed. However, it is considerably easier to implement than legislation, and can often serve as a stepping stone to legislative action. Examples of executive orders authorizing GIS coordinating bodies can be found at the websites below:

     North Dakota GIS
     http://www.nd.gov/gis/about/enabling/execorder200106/index.html
     Montana Geographic Information Council
     http://itsd.mt.gov/policy/councils/mgic/exord21.pdf

   Such mechanisms will mandate participation in coordination among state agency GIS personnel, and will also ensure that agency GIS staff are empowered to speak for their respective agencies regarding GIS activities.

   There are several suggested objectives for an executive order or legislation:

- **Authority –** There are several types of authority that should be explicitly given to the coordination process:
    - Mandating and authorizing participation in the coordination effort – Currently coordination of State agencies depends on voluntary participation. A process based on such discretionary input will founder as disagreements arise. In addition, some participants will benefit from knowing that there is executive level endorsement of the coordination effort. This support should percolate down through the CIOs of the agencies enabling the GIS staff to commit to the process. Additionally, decisions on statewide procedures and policies made through the coordination process should bind the state agencies. This is only possible through an executive order or legislation.
    - Negotiating and implementing purchases of data or services – the State GIS Coordinator can enhance the GIS capabilities of the state by entering into license agreements or purchasing data and services for the State as an enterprise. Individual agencies could take advantage of these enterprise-wide agreements, which would make access to the information and services easier and lest costly.
    - Developing conditions/MOUs for interaction with and within the state – Predefined agreements among all of the state agencies and between the State and other jurisdictional levels will expedite the flow of information among state agencies and between state agencies and other jurisdictions. However, the State GIS Coordinator cannot do this meaningfully unless the authority exists.

- **Enhance the State GIS Coordinator Role –** Currently the State GIS Coordinator position exists simply because the Department of Local Affairs (DOLA) had a spare FTE with which to hire him. This will not suffice in the long term, because buy-in and recognition of the position from state, local and federal as well as non-governmental entities is based on implied status and services provided by the coordinator position. That is, these entities will only interact with the coordinator position as long as these entities believe that the coordinator position can accomplish something for them or can influence their activities.
- **Budget –** The most successful coordination efforts in other states have a budget that they can direct independently. In the current fiscal environment in CO, the chance of securing dedicated budget for a state GIS coordinating office is low, but may be a long-term goal.
- **Defining roles of agencies –** The lack of explicitly defined roles of the state departments and the GIS coordinator leads to some confusion about what is appropriate and reluctance on the part of some agencies to participate. Thus a mechanism that defines these roles and a minimum level of participation will clarify the possibilities as well as empowering state department personnel to participate.

3. **The State GIS Coordinator should report to the CIO and be housed in OIT.**
    - There are both positive and negative aspects to this organizational structure. One disadvantage of this arrangement is the fact that the CIO can change every four

years, requiring the GIS Coordinator to communicate ongoing GIS coordination efforts to a new CIO and hope for continued support. However, for many reasons, including the following, this is the preferred alternative:

- There is no other state department or agency that has shown the desire to be the coordinating body for statewide geospatial information and initiatives.
- Spatial information resources and GIS technologies are an integral component of any state's information infrastructure. As the Colorado CIO leads continuing development of a statewide enterprise architecture, positioning the GIS coordinator within the OIT will provide the best opportunity to leverage location information critical to improved government business operations.
- To advance the concept of statewide GIS coordination for the benefit of all state departments and the people of Colorado, the GIS Coordinator benefits from the executive sponsorship associated with being in the office of the CIO.

4. **The new Colorado State GIS Advisory Council should be more formally chartered and empowered through executive order, legislative mandate, or OIT operational protocol.** It may be necessary to revisit the make-up of the council to better represent GIS interests statewide as well as consider how the council could be aligned within the present OIT governance model. The inclusive nature of the council should be maintained by continuing to include representatives from the county, local, academic, and private sector communities.

    - Initially, the council must be focused on a handful of prioritized tasks. These tasks must be 1) widely understood and supported, 2) identified as high-priority, and 3) attainable under the current level of legislative and executive support.
    - A state department working group should be the first (and for an initial period, only) working group formed to immediately address issues specific to GIS coordination at the state department level. There are issues that need to be addressed at the state government level before the challenges of true statewide GIS coordination can be overcome. Executive orders and legislative action have a direct impact on state departments. Initial coordination efforts should be focused where there is a clear authority to direct those efforts.
    - Many states have allocated budget to cover travel expenses for coordinating council members. While still technically a voluntary position, participation is encouraged by this reimbursement.
    - Other working groups should be created on either a permanent or ad hoc basis to address key challenges such as those found in other states and noted in Figure 4. These working groups would be tasked with making recommendations for the GIS Coordinator to take to the CIO for appropriate action.

5. **Reframe the GIS paradigm in terms of information resources.**
    - The persistent challenge facing state GIS coordinators lies, in part, in the title itself. The desired business outcomes for state business stakeholders are larger than any specific technology. Specific reference to GIS should be relegated to the similar role served by other enterprise IT solutions such as ERP or CRM. As the State of Colorado OIT embarks on a more comprehensive integration imperative, reframing

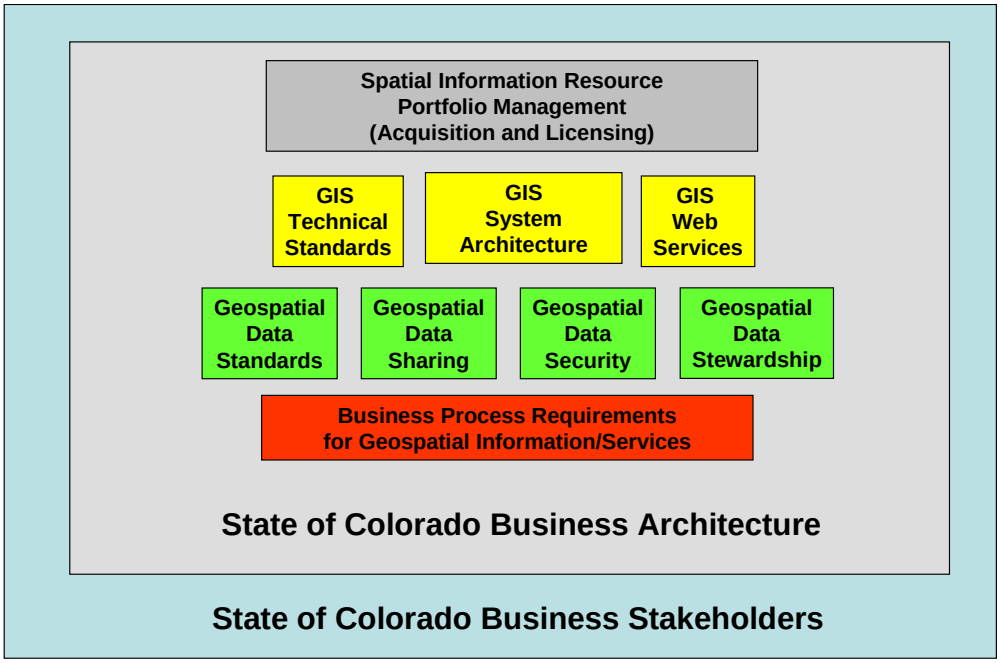


Figure 4. Potential Colorado GIS Working Groups

GIS in new terms of ***spatial*** information resource management would draw more attention to the more important information resource sharing goals.

- Framing GIS as spatial information resource management would also lend stronger rationale for assimilating the many facets of GIS (hardware, software, imagery, web services, licensing) within the existing OIT governance framework and enterprise transformation.

Software Inventory and Control

Introduction

The OIT wants a report recommending a strategy to inventory and control all GIS licenses more effectively. This strategy is closely tied with the strategy discussed earlier for managing ESRI licenses. Again, ESRI software is not the only GIS software in use at the State, but represents 90-95% of that category. Control of other GIS software types is relatively easy to manage, given the low absolute numbers.

Research and Interviews

Interviews were conducted in person and over the phone. Current State GIS Coordinator Jon Gottsegen and former State GIS Coordinator Leah Lewis were interviewed first to provide guidance and context for the remainder of the research and interviews.

Persons Interviewed:

Jon Gottsegen – Colorado State GIS Coordinator

Leah Lewis – IT Director, Colorado Division of Water Resources

Carl Sylvester - ESRI

Tim Hill – CH2M HILL

Tim Johnson – State of North Carolina

Stuart Davis – State of Ohio

Jim Knudson – State of Pennsylvania

Shelby Johnson – State of Arkansas

Dennis Goreham – State of Utah

Websites Researched:

Environmental Systems Research Institute

http://www.esri.com/

Citrix Systems, Inc.

http://www.citrix.com/lang/English/home.asp

Findings

Current State of Colorado GIS Software Inventory and Control

Currently there is little to no statewide tracking of GIS software. Efforts have been made in the past (and have been made in the course of research for this report) to obtain information from ESRI on the quantity and makeup of the ESRI software portfolio owned by the state. Other GIS software in use around the state (again, not including CAD software) should be relatively easy to generate given the low numbers of other GIS software packages. The ESRI assessment is more difficult to perform, particularly given that there are over 100 unique ESRI customer numbers in use around the state.

Best Practices from the Federal Government

Air Mobility Command ESRI Software Management Tool

The United States Air Force Air Mobility Command (AMC) provides airlift and aerial refueling for all of America's armed forces. The AMC is based at 12 Air Force bases around the country. Each of these bases is supported by the Geobase program, a geographic information system tailored for the US Air Force's particular needs. The general concept is that of "one base – one map" with one set of spatial data supporting all the different activities on the base. The AMC bases had a combined ESRI maintenance bill of just over $200,000 per year. As part of a cost reduction strategy, they were instructed to reduce their maintenance costs by 10%. By developing a tool with which they could better manage their ESRI license portfolio, they were able to meet and exceed this goal without losing any capabilities and in some cases even adding capabilities.

The first step was to consolidate their ESRI customer numbers to one per base. Since funds to pay for GIS software come from different source for different squadrons on each base, each squadron was provided with its own maintenance terms under the same customer number. Next, with ESRI's help, each base determined exactly what ESRI software they possessed and verified that it corresponded with ESRI records. When the software inventories were synchronized, a web-based planning tool was created that allowed each base to enter and track all the necessary information about each ESRI software license in use at that particular base. This tool allows users to link to ESRI and periodically verify that base records correspond to ESRI records. Some of the additional information tracked includes the individual the license is assigned to, if it is a stand-alone license, or the server on which it resides if it is a floating license. By tracking additional information and synchronizing license information automatically on a scheduled basis, the AMC is able to ensure that it always has the licenses necessary to perform its mission and that every ESRI license is used to its fullest extent.

Best Practices from Other States

Pennsylvania Case Study

Pennsylvania currently offers a variety of ESRI products in a Citrix access environment for GIS practitioners from around the state government. Users can log into the Citrix server and access any one of the following ArcGIS 9.1 applications:

- ArcView

- ArcEditor
- ArcInfo
- 3D Analyst
- Data Interoperability
- Geostatistical Analyst
- Network Analyst
- Publisher
- Spatial Analyst
- Tracking Analyst

Users simply log on to a Citrix "desktop" and they have access to all the ESRI software and extensions listed above. Users can upload their data to the Citrix server and work with it "locally" or leave it in their department data server and access it over the network using the Citrix desktop. This arrangement allows the state to house and manage a significant percentage of their ESRI licenses in one place. This approach allows the state to keep track of usage, keep maintenance agreements up to date, and provide GIS capabilities to departments that lack budget to set up a stand-alone GIS.

Recommendations

1. **Assess how current GIS software investments (including ESRI) are being employed to support state business operations.** A "best practice" repeatedly cited by the Federal CIO Council and the General Accountability Office prior to making further software investments is to ensure that ***current*** investments are appropriately aligned with strategic business priorities.

2. **Evaluate whether the total cost of ownership for GIS software (including ESRI) could be delivered and sustained more cost effectively through a centrally-hosted services environment.** The rising costs in infrastructure and personnel to simply operate and maintain the numerous and diverse IT applications common to most enterprise organizations are motivating many CIOs to evaluate how such core services could be more cost-effectively delivered through a hosted environment. Such an alternative could also lead to a more automated, efficient means to share GIS software licenses and reduce variances in annual IT expenditures.

3. **Consolidate server-based ESRI applications in one place.** In Utah, all server-based ESRI applications – applications operating on ArcIMS and ArcGIS Server platforms – are housed in the AGRC. State agencies can build applications and host them in a central location. This allows the State of Utah to make the best use of its GIS server investments. State agencies with applications on the central server(s) can access and administer their applications remotely. AGRC takes care of server maintenance, patches, upgrades, and licenses.

4. **Reduce the number of ESRI customer numbers in use around the State.** It is not anticipated that the State will be able to gather all ESRI GIS software products under one ESRI customer number. There are political and budgetary considerations which make this highly unlikely. However, it is probably possible to reduce and cap the number of ESRI customer numbers. One possibility is that individual State departments can have

their own ESRI customer number. All ESRI software products ordered for that department will go under that number. If the customer numbers can be reduced from over 100 to around 20, it will make them much easier to track.

5. **Identify a single point of contact for each ESRI customer number.** This individual will be responsible for tracking all ESRI software activities under their customer number and reporting that activity on some measured basis to the OIT and State GIS Coordinator. In this way, the State will be able to maintain an inventory of all ESRI GIS software in use month to month or quarter to quarter, and will be able to determine the possible benefits of negotiating an ELA for the State at some future date.

6. **Using the license list generated by ESRI as a starting point, conduct a survey of all state departments using ESRI software.** Compare what they think they have with what ESRI says they have. In many instances it may be the case that they have more licenses than they know about. These licenses can be utilized or traded in for licenses of other ESRI applications that the department needs.

7. **Conduct a non-invasive assessment of all IT systems in the state, including desktops and laptops.** In order to determine the actual number of licenses of any particular type of GIS software, some type of electronic assessment must be performed. Although ESRI can provide a list of all licenses currently owned by the state, many of them or out of date and, in all likelihood, not even installed and on state systems. An IT assessment would provide information not only on the actual ESRI software licenses in use in the state, but also other types of GIS software such as MapInfo, Erdas Imagine, and AutoCAD Map.

GIS Data Dissemination Strategy

Introduction

The OIT wants to develop a strategy for improving GIS data dissemination and developing shared services at the state level.

Research and Interviews

Interviews were conducted in person and over the phone. Current State GIS Coordinator Jon Gottsegen and former State GIS Coordinator Leah Lewis were interviewed first to provide guidance and context for the remainder of the research and interviews.

Persons Interviewed:

Jon Gottsegen – Colorado State GIS Coordinator

Leah Lewis – IT Director, Colorado Division of Water Resources

Marv Koleis – CDOT

Mark Egbert – CDPHE

Steve Hick – GIS Director, University of Denver

Brian Cullis – CH2M HILL

Ed Riegelmann – CH2M HILL

Tim Johnson – State of North Carolina

Stuart Davis – State of Ohio

Jim Knudson – State of Pennsylvania

Mark Eaton – US Geological Survey

Shelby Johnson – State of Arkansas

Dennis Goreham – State of Utah

Websites Researched:

New York State Orthoimagery Web Map Service

http://www.nysgis.state.ny.us/gateway/mg/webserv/

Arkansas GeoStor 5.0 – Arkansas' Official GeoData Clearinghouse

http://www.geostor.arkansas.gov/Portal/index.jsp

Pennsylvania Spatial Data Access

http://www.pasda.psu.edu/

Utah Automated Geographic Reference Center (AGRC)

http://agrc.utah.gov/index.html

The NSDI Framework

http://www.fgdc.gov/framework/

MassGIS Geospatial Web Services

http://lyceum.massgis.state.ma.us/wiki/doku.php

Indiana Geographic Information Council

http://www.in.gov/igic/projects/indianamap/webmap.html

North Dakota GIS

http://www.nd.gov/gis/mapsdata/web/

Findings

Until recently, unlike most other states in the US, Colorado has not had anyone or any office coordinating the development of geospatial data and efforts within the state. Colorado has not implemented statewide enterprise GIS architecture, nor is there a systematic approach to sharing digital geospatial data between state agencies. This has resulted in state agencies pursuing GIS activities in an independent fashion with perspectives limited to the narrow confines of the business needs of each department. An enterprise-wide perspective that could identify overlaps in department GIS efforts and suggest possible commonalities in data development efforts does not exist.

Currently in Colorado there is no statewide policy regarding GIS data organization, steward assignment, and dissemination. While some sharing of geospatial information does take place, it does so in an ad hoc fashion that varies greatly from department to department. Departments simply provide the data they wish to share, with no thought for redundancy and data conflicts. There is no "pushing" of data from one department to another. Rather, individual departments and the State GIS Coordinator must actively seek out data from other departments and maintains that data separately in another physical location. This process is highly inefficient. The Colorado Department of Transportation (CDOT) provides data on their website. This serves as an important data source for other state agencies but must be manually downloaded and replicated elsewhere on the state network to be usable. The current GIS data dissemination environment does not provide State users with authoritative datasets that are regularly maintained by willing, assigned data stewards.

The current state GIS coordinator is standing up a geographic data portal which should be ready late summer 2007. This portal is being housed at the University of Denver. Initially, only raster, or grid-based, data will be available. The initial data sets will include data that is already freely available from other sources such as the U.S. Geological Survey (USGS). The goal is to ultimately host data, both raster and vector, from a wide variety of sources around the state.

Currently in the state there are the "haves" and "have-nots." Those who have spatial data and those who do not. Those who have the capabilities to make use of their spatial

information and those who do not. Since the development of GIS in the State of Colorado has been driven at the department level, there are various departments around the state who have spatial information (addresses, districts, etc.) but lack the capability to derive any benefit from it.

Benefits of Data Sharing and Dissemination

After conducting interviews with GIS coordinators from other states where GIS data sharing and dissemination are well-established, the following list of benefits of GIS data sharing was developed:

Data Access – It will become increasingly easy for government agencies, citizens, and commercial entities to determine what GIS data sets are available and who is the primary steward by visiting the Colorado GIS Data Portal. This will save time for state employees who provide data to other state agencies, businesses, and the public.

Data Accuracy – Each data set should have a designated steward, the agency which originated the data and remains responsible for its quality. This can be mandated by legislation or executive order. In this way, all state agencies (as well as other users) know that the data they are accessing is as current as possible.

Improved Data Quality – As use of provided state data sets increases, users will pass updates, corrections, and revisions back to the data stewards. The result is increasing data quality. All state agencies, as well as the public and private sector users of the data, benefit from these improvements in data quality.

Standards and Consistent Practices – In working together to create a standardized data sharing agreement, participants from across the State can also develop standards for metadata, data exchange formats, and other characteristics.

Savings – Ideally, state agencies have access to all other available state agency data sets at no cost. Therefore, duplication of effort and investment in creating data sets already available from other agencies are minimized.

Community Building – Statewide GIS coordination can encourage members of the GIS community to share information about their projects, education programs, conferences, and experiences. Groups such as the Colorado GIS Advisory Council can provide a venue for long-lasting professional relationships built around common interests and mutual goals.

National Presence – The emergence of a state GIS coordination program can make it possible for Colorado to participate actively in national efforts to create and promote a national spatial data infrastructure. It will make it easier for Colorado to apply for and receive federal funds to enhance the program and create opportunities to work with and learn from other states on issues of mutual concern.

Best Practices from Other States

Utah Case Study

In the State of Utah data sharing between various state agencies, counties, and local jurisdictions has been taking place for a number of years. While a portion of the success of the data sharing agreements and MOUs that Utah has in place are attributable to the

continued support and funding of the Automated Geographic Reference Center (AGRC), there are three primary ways that the AGRC is able to effectively share geospatial data with others in the State:

Shared Need – In order to get the necessary data for the State Geographic Information Database (SGID), the AGRC has developed numerous agreements based on shared need. An example of this is the statewide street centerline dataset available on the SGID. This data is collected from local and county governments and aggregated into a common data model developed by the AGRC. Because there is interest across all levels of government – county, tribal, and local for E911 applications, federal for TIGER modernization – the AGRC has been able to depend on support and cooperation at a variety of levels.

Funding Programs – In some cases it is necessary to provide funding to get access to the data needed for the SGID. An example of this is cadastral or parcel data. The State has established a funding program to help rural counties maintain and update their parcel data layer on an annual basis. In many cases, the money provided is as low as $25,000 per year. This is not much, but in most cases it is enough to provide the counties in question the funds to pay a GIS technician one-third to one-half time to maintain the county's parcel data layer. A stipulation is that the county shares its parcel data layer with the SGID.

Legislative Mandate – In some cases it is necessary to require a county or local community to share specific data sets. An example of this is the case of municipal boundaries. Counties and local communities are required to pass any boundary changes, including county, municipal and special district boundaries, through the Office of the Vice-Governor for approval. As a function of this process, the entities must provide up-to-date digital copies of the boundary layers for inclusion in the SGID.

Recommendations

Data Dissemination

1. **Support the state GIS portal.** A statewide GIS data portal has proved to be very effective in other states for sharing data and serving as a single point of information for GIS coordination activities around the State. More and consistent funding is required for the Colorado GIS Data Portal that the current State GIS Coordinator has established and will be rolling out later this summer. Currently this portal is supported exclusively by grants. As with all GIS coordination activities, executive and legislative support would help to solidify the role of the portal in statewide coordination efforts and provide the consistency required to make it a success.

   The State GIS Data Portal can also serve as a "one-stop shop" for information concerning GIS coordination activities statewide. Concern has been raised about the ability of state employees to obtain information about coordination activities such as data-sharing agreements, new statewide datasets available, best practices from other states, council meeting minutes, and other news and information. An information website linked from the GIS Data Portal would provide the State GIS Coordinator a venue to provide information to a variety of stakeholders.

2. **Increase data awareness and identify data gaps, redundancies, and stewards.** One of the first tasks of a fully authorized Colorado State GIS Coordinating Council should be to undertake a study to determine the best way to increase data awareness in the State. The first step will be to identify data development overlap in the State and identify data stewards for framework datasets to avoid this in the future. A good place to start would be the National Spatial Data Infrastructure (NSDI) framework layers. These are listed below with possible data stewards:

   - Geodetic Control – CDOT
   - Cadastral – Counties
   - Orthoimagery - DNR
   - Elevation – CDOT
   - Hydrography – Division of Water Resources
   - Administrative units – DOLA
   - Transportation – CDOT

   Once stewards are established, the process should begin to develop these framework data sets for the State. Once developed, these data sets should be made available on the State GIS Data Portal and in web map service format.

3. **Establish data development policies and guidelines**. In order to share data more effectively, a well defined set of policies for spatial data development should exist to promote spatial data consistency and interoperability. These policies can be best on national best practices and modified for the unique needs of the State. The State GIS coordinator can work closely with the data stewards and establish standards that make the best use of existing investments while adhering as closely as possible to national best practices. Where long established data standards already exist, methodologies can be investigated for translating between them and proposed statewide standards. Where GIS capability is less well-established, standards can serve as a jumping-off point for state agencies, counties, and local communities, enabling them to stand up a functional GIS more quickly.

4. **Establish data security standards.** An issue closely related to data sharing is that of data security. Many state agencies and local entities are hesitant to share their data due to security concerns. The State must investigate data security standards from other states and the federal government (for example, the FGDC) to establish its own standard that reflects the needs of the contributing state agencies and local governments. All GIS data security standards should be an extension of existing state data security standards for non-spatial data.

5. **Develop data sharing agreements.** The State GIS Coordinator should develop memoranda of understanding (MOUs) with state agencies and inter-governmental agreements (IGAs) with county and local jurisdictions to facilitate data sharing across the State. To that end, a template for such agreements should be created and vetted by the State Controller's Office and Attorney General's Office so that if county and local representatives agree to the boilerplate terms and conditions, the GIS Coordinator can enter into the agreement with his signature without further review.

6. **Investigate and incorporate internal and external web map services**. Web map services are a way to provide GIS data that can be incorporated into a variety of spatial information management applications. The data is hosted on a central server and available to applications via the State intranet or the Internet. The State can develop its own web map services based on the framework data layers described above. There are also external web map services, both free and fee-based, that the State can make use of. The State should investigate and identify potential internal and external web map services that fill data gaps and eliminate redundancies. Instructions for accessing these web map services should be made available to users through the State GIS data portal. Many states have already created web map services for the use of state agencies and the general public. These include:

    - MassGIS Geospatial Web Services
      http://lyceum.massgis.state.ma.us/wiki/doku.php
    - Indiana Geographic Information Council
      http://www.in.gov/igic/projects/indianamap/webmap.html
    - North Dakota GIS
      http://www.nd.gov/gis/mapsdata/web/

Shared Services

7. **Leverage existing executive support.** Executive Order D 016 07 gives the OIT oversight over all IT purchases and projects costing more than $10,000. This oversight can be used to encourage state agencies to coordinate and make use of shared services. In many other states, this has had a real impact on the development of shared capability.

8. **Build out the capabilities of the state.** A well-funded and supported geographic information office can provide capability build-out for both state agencies and county and local governments who have the desire to make use of spatial information, but lack the means. This assistance could take the form of grants for parcel data update, as in Utah, training for agency, county, or municipal staff in required spatial information technologies, or professional services in the form of data or application development. This can benefit the State in a number of ways, including:

    - By helping rural counties develop and maintain their cadastral (parcel) and other data sets, the State can improve the quality of its own data repository when the counties provide that information back to the State.

    - Services can actually be a revenue-generating activity for a GIS coordination office. With a small staff, a geographic information office could provide services to other state agencies or local governments and charge fees for those services.

    - By providing geospatial information management expertise to state agencies that currently don't make use of the technology, the State GIS Coordinator can identify areas where those agencies can make use of spatial information to enhance their effectiveness in serving the public and increase their revenue stream by performing their business functions more efficiently.

    - Statewide GIS coordination specifically benefits from assisting local communities. By generating goodwill in local communities the State GIS Coordinator can ask for help

from local State Representatives in promoting GIS coordination initiatives and funding in the State Legislature.

9. **Gather support with targeted projects.** A project or projects should be identified which can provide exposure and generate interest in GIS at the statewide level. These projects should be relatively low-profile initially, with low risk of failure and relatively high reward. A good example is to develop a web map service that provides access to all the US Geological Survey 1:24,000 scale topographic maps in digital format. These maps are something that almost every department uses in one form or another. Another possibility is to create a similar service providing the aerial photography from the National Agricultural Imagery Program (NAIP) that the State purchased last year. The state has made this data available for free but the files are large and unwieldy. A better way to provide this data would be in web map service format. Another possibility is to provide a geocode service. A geocode service can be hosted on a central server and accessed by all state agencies who have the business need or performing address locates, that is, automatically creating spatial data from the location of street addresses. The State could use the rollout of such services as a means to educate the statewide GIS community about coordination efforts and as case studies to demonstrate return-on-investment (ROI) for future budget requests.

General

10. **Communicate the advantages of GIS coordination.** There is resistance, both at the state and local level, to statewide GIS coordination. Many around the state see coordination efforts as attempts to either get local data "for free" or to place restrictions on local autonomy. It is recommended that the State create a report outlining the benefits of statewide GIS coordination from the perspective of the state agencies and local communities. Much of the information from this report could be used to make that case. Sustained participation from all key stakeholders is essential in maintaining GIS coordination efforts from year to year. Many of those key stakeholders will come from state agencies and county and local government. Executive and legislative support will help to rally people to the cause, but a case for GIS coordination is essential for garnering and maintaining long-standing support and involvement from key stakeholders. An example of such a document was prepared by the States of Oregon and Indiana. The web addresses for these reports can be found in the Websites Researched section at the beginning of this report.

Conclusion

The success of any effort at statewide GIS coordination in the State of Colorado depends on four primary factors:

1. **A broad cross-section of engaged participants**

   Colorado has tremendous resources in spatial information management. Numerous state agencies have been making use of geographic information systems and related technologies for nearly twenty years. The goal of any statewide GIS coordination effort should be to leverage these prior investments wherever possible and make use of the wealth of GIS experience across the State. This experience is found at all levels: state agencies, county and local governments, the private sector, and academia. All should be engaged in improving statewide GIS coordination. Specific groups can be formed to address specific issues, such as coordination between state agencies.

2. **State support for the effort in the form of legislation or executive order**

   In order to effectively direct GIS coordination efforts at the state level, all coordinating positions (State GIS Coordinator) and bodies (Colorado GIS Advisory Council) need support from either the State Legislature or the Governor's Office. By codifying the authority and responsibilities for all coordinating entities in the State, the State Legislature and/or Governor's Office can speed up the process of GIS coordination substantially. Without authority, the State GIS Coordinator will not be able to get all stakeholders to come to the table and discuss data sharing, shared services, and standards. Without clearly defined responsibilities, stakeholders will instead focus on those tasks they are required to perform by state statute. This is as it should be. Leadership is required to direct the state agencies in their responsibilities and contributions to overall statewide GIS coordination.

3. **Consistent and adequate funding**

   In all states where GIS coordination is well-developed, adequate funding is provided to support coordination activities. Not all funding has to come from legislative funding must be provided to begin the process and sustain it from year to year. Additional funding can be generated in other ways, including dedicated funds, cost recovery, and mission-driven funding, including federal grants. Another option is to develop some type of "GIS Trust Fund" where end-of-year monies can be deposited and accumulated to support development of some application or data set that will provide benefits for all contributors. The State of Arkansas has done this and found it to be very successful.

4. **GIS efforts are aligned with statewide information technology goals**

   Geographic information systems are just another of the State's many information systems. As such they should not be sequestered away as a separate system but rather integrated into the whole. In this way the State can be assured that spatial information system standards are in keeping with statewide IT standards and that the maximum benefit can be derived by including spatial information in the everyday business of the State government. Similarly, the State GIS coordinating entities can be assured that their

vision for statewide GIS coordination will be supported as an integral part of the State's information technology infrastructure.

These are the four pillars on which the State can build a successful statewide GIS enterprise. Where other states have been successful, there has been some combination of participation, support, funding, and alignment. These can be achieved in different ways, but elements of all four must be present.