2019 NASCIO Awards

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Project: Linear Reference System (LRS) Update Impacting Idaho Roads & Highways

Category: Enterprise IT Management Initiative

Start Date: 6/15/2016
Go Live Date: 1/23/2018
Burn-in period end: 5/30/2018

Executive Summary:

Despite being less populated, Idaho is currently the fastest-growing state in the nation. In order to meet the needs that growth brings, the state of Idaho and its agencies must work to create better and more efficient solutions to better use existing resources. There have been efforts to standardize technology and create comprehensive standards across state agencies. At a state level, the Idaho Technology Authority's IT Leadership Council seeks to provide better, more accessible, and more secure services and information to the public and foster collaboration among all state and private entities. While inter-agency cooperation is a key part of many ongoing and future initiatives, as one of the largest state government agencies, the Idaho Transportation Department (ITD), has often positioned itself as a leader in developing new practices and solutions and working to improve internal collaboration and efficiency.

The growth in population and accompanying infrastructure, the increase in data collection methods, and the expansion of government reporting requirements have led to escalating data quality and quantity needs by ITD. Processes and solutions that had existed for years and even decades were no longer sufficient to meet these needs, and were often far removed from the contemporary industry standard. The siloing of data into groups based on expertise and specialized software was not sustainable if ITD sought to better meet its goals of providing for the safety, mobility, and economic opportunity of the citizens of the state of Idaho. Integration of data, collaboration between business units and Enterprise Technology Services (ETS) can no longer be an abstract goal, it is an absolute necessity.

In this spirit of innovation and progress, the Geographic Information Systems (GIS) group at ITD sought to replace and upgrade the Linear Reference System (LRS) used by ITD. The LRS is where the rubber meets the road for ITD staff and the traveling public: this system is how everything — from signs, to speed limits, to pavement information — is located along a road using a route identifier and measurement. The process that ITD used for many years created a highly centralized data editing process inside customized and poorly-supported software. Data was often completely severed from the business unit responsible for it and subsequently had many issues in terms of quality. The replacement was a configured enterprise level system that empowered business data owners to interact directly with their data in one common, integrated, and decentralized system.

The project's implementation required the collaboration by a myriad of business units and IT staff, data cleaning and migration efforts across tens of thousands of miles of roads, and extensive work configuring the solution with the vendor. The benefits reaped have included hundreds of thousands of dollars and thousands of man hours saved, better integrated and higher-quality data, and the creation of a sustainable and scalable solution with great future potential. The system allows for improved data and analysis and increased efficiency, but above all, it makes a more modern transportation department better positioned to comply with modern federal reporting standards and better able to meet the needs of the people of Idaho.

Concept:

Background:

For 40 years, ITD has used an LRS along its 12,000 lane-miles highway system to locate various physical assets and road attributes. The system was cutting edge at the time it was developed but it showed many flaws as time passed. Due to how data was managed in the system, sharing and simultaneous editing of data was impossible and specialized software was required. This led to the creation of siloed business units and one centralized group responsible for editing data in the system. Additionally, any updates in one system were not carried over into the other systems. ITD's LRS system was built on customized software only employed by ITD that faced numerous support and longevity concerns. Finally, the system could not support having data on both sides of a divided highway - a reporting requirement mandated by the federal government.

Project Implementation:

Driven by federal and state reporting requirements, the need for better and more integrated data, and depreciation of the existing software, ITD decided to upgrade to ESRI's ArcGIS software suite. This includes ESRI's Roads & Highways, Workflow Manager, and Portal. This new system integrates with ITD's GIS and is an industry standard software that was configurable to our business needs. Starting this process required large data cleaning and migration efforts to ensure the data was seamlessly entered into the new system. In addition we worked with ETS to set up the supporting backend infrastructure. In terms of the human element, we had to build trust and gain buy in and cooperation from business units. Implementation required documenting and replicating business workflows, creating rules and behaviors for data, and finally training on the new system for users within and outside of the GIS/LRS team.

Based on the many longevity and support issues ITD has experienced with customized software applications, the department adopted a commercial-off-the-shelf, extensible, enterprise level solution. Additionally ITD discovered that many state transportation departments struggled implementing an LRS solution when they tried to do it on their own or have a 3rd party vendor do the implementation. Therefore ITD made the decision to work directly with their product vendor, ESRI, to implement the software. By working with ESRI directly and facilitated by extensive data cleaning efforts, we were able to transition smoothly between the old and new system. Finally, by gaining the trust and engagement of numerous business units, we were able to create a coherent and integrated data set. This relatively smooth and clean transition earned ITD ESRI's Special Achievement in GIS (SAG) award. The project was also notable for being delivered early and under budget.

Significance:

Engaging and Integrating Business Users:

The most important step forward for this project was giving users the ability to edit their own data instead of being forced to rely on an inefficient and centralized process of data editing. The prior process relied on email and phone communication between business users and the LRS/GIS team, and had the LRS/GIS team editing business information when they often had less involvement or knowledge than the business users. Miscommunication and lack of business knowledge led to huge data quality issues in information that was distributed internally and publicly, leading to a loss of trust, productivity and time. The new system was designed to ensure that business users could directly edit their data, cutting out the middle man and leading to better accuracy and trust, among other things.

While the project was an IT initiative, implementation of the new LRS system required the buy-in and cooperation of seven distinct business units. While some business units decided to keep their business data in their own native systems, others used the new Roads and Highways system to update and maintain both the location and business data. Regardless of where the business data was stored, all units would have a location component integrated with the new LRS providing a significant reduction of redundant data. This required configuring the LRS system to best ensure business needs were met, as well as providing user training and support.

Configuration over Customization:

As previously mentioned, the support and longevity issues experienced by ITD while using customized software solutions in the past, we decided to keep the deployment of Roads and Highways as close to configured out of the box as possible. Instead of shaping the software to completely fit existing processes, we decided to modify business process to better fit the new system. This was done to ensure better vendor support and to avoid issues with being locked into a version of software due to dependencies built in through customization. We tried to model process and meet needs using the configured Roads and Highways software rather than relying on third-party software or additional customized tools on top of the software. This process differentiated us from most other transportation departments and facilitated a smoother transition to the new system.

Formalizing Processes:

Roads and Highways and the accompanying software suite allowed ITD to incorporate existing business processes and workflows to ensure the behavior of the software would best fit the needs of business users. Roads and Highways also allowed for the creation of rules regarding auto-updating data when changes were made to road shape. Data associated to the roadway could be set to move or stay in place as shape changes were made to the road; so data attached to crashes and bridges would remain in the same geographic location, data like corridors could move location but remain at the same measure on the road. Implementing this new system allowed us to document workflows and incorporate them into another ESRI product, Workflow Manager. This ensures the workflows are reflected accurately in the data-editing process. This provided another benefit in documenting business processes, some of which only existed informally. Workflow Manager also allowed for the automation of configurable email notifications to be sent to users upon completion of tasks and ensured that all edits were traceable to a

user and timestamp, ensuring accountability and transparency. Instead of ad hoc processes and sporadic edits made by a centralized core group, the new system ensured documented process with full integration of business users in a more streamlined and decentralized environment.

ArcGIS Portal and Identity Management:

ITD implemented ArcGIS Portal as an internal-facing identity management and content delivery system. Portal can be branded and configured to fit the needs of an organization. It is also used to manage user identity and roles within an organization. Due to Portal's inherent nature, there is both increased security and access control and the interface can be better optimized for our needs. This identity management is needed to ensure that users have access and edit capabilities for their business data but are unable to affect the road location or the data of other business units. This allowed us to create a versioned decentralized editing environment of Roads and Highways while ensuring data integrity.

Unlocking the Full Potential of Data through Spatial Intelligence:

While the prior LRS system could be leveraged spatially, it was primarily a system based on tabular logic. The new system is not designed with that limitation and is therefore fully spatially-enabled which unlocks additional potential for using the data. While traditional data at ITD lacks a common key linking it to other data, spatial data is joined together using location and proximity boundaries. Whereas culverts, pavement, and roadway projects exist in separate systems and have no common key fields and things like geological data, watershed info, and census data, which exists externally, all of these things can be brought together spatially for viewing and in-depth analysis. Furthermore while data could be brought together in a tabular format using its position along routes in the previous system, this interface was far less intuitive than a map interface. Tying data to location ensures that the data in the system more closely mirrors reality. It is easy to see when data does not line up with reality through use of aerial imagery and GPS coordinates.

Leveraging the Web Environment:

Roads and Highways is integrated with other ESRI tools which allow for easier sharing of data in internal and external environments. As the new system is enterprise-supported and does not rely on data extraction but instead web-based services, we are able to leverage the system to make internal and external published data reflect edits near real time. The previous system was only able to publish data on an annual basis due to the arduous editing, updating, and extraction procedure required to push data to a web environment. We will leverage these enterprise-level, web-based capabilities within the system to allow external partners to make edits to relevant data that was previously an entirely paper-based process.

Impact:

Data Integration:

A problem around enterprises that has developed over time is that many departments created custom IT solutions specific for their needs, without taking into account the overall enterprise needs. This meant it was common to find out-of-date data in separated silos or data that is believed to be up-to-date but obtained from other sources that are not the real source of truth and therefore either incomplete or also out of date. With incorrect and/or bad data, incorrect and/or bad decisions get made. The LRS solution allowed ITD to create a source of record for all their location/spatial data. Now, all departments can come to the GIS group to obtain the most accurate data to conduct their analyses correctly and trust the results, whether they need to know where assets are, where roadways are, where accidents occur, traffic statistics, or more.

Greater Efficiency:

Consolidating location data into the new LRS systems provides significant time and cost savings.

- It was estimated that at least four full time employees (FTE's) time annually was spent manually updating the same location data in their disparate systems.
- The integration of the new LRS system saves $100,000 to $200,000 per each new system integrated with Roads and Highways in annual support. The cost savings with the initial "go live" is more than $600,000, with continued cost savings in additional years as more systems are integrated.
- End users can now edit their own data directly in the GIS database using online web mapping provided with the new LRS system. Upon project go-live, over 30 users were trained on the new system; 25 of whom are from business units outside of the GIS department.
- There have been over 800 edit sessions in the new system; 40% of which have been completed by business users.
- The system can be interfaced more quickly from other systems due to modern Application Programming Interfaces (APIs) that allow faster, cleaner development for data integration.

Improved Data Quality:

A major factor to a business' ability to run effectively and efficiently is driven by its data. Traditionally, the most accurate and well-maintained data is found in the business units that own the data. Our new LRS system allows these units to keep and maintain their primary business data while consolidating the location aspects into the central repository. This provides the best-case scenario where the business units continue to own their specific data, with data available from the entirety of ITD's organization.
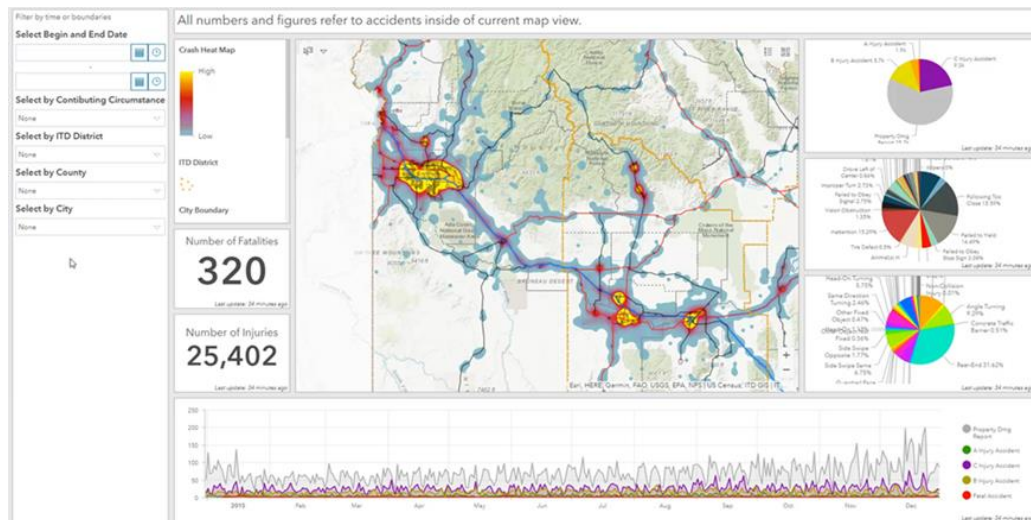
Along with the Roads and Highways LRS, we also implemented another ESRI extension with this project called Workflow Manager. Workflow Manager gives ITD a means to define repeatable processes for editing and maintaining data. Working with business units, guidelines were created for how they want to interact and update their data. These guidelines then became the standard for how that group would interact with some or all of their data. Not only does this enforce governance within the data, but it also standardizes how to interact with the data. This provides stability and consistency to processes in an ever-changing, dynamic environment.

Better Reporting:

The previous LRS system only tracked assets on one side of the roadway. The new LRS system allows for tracking on both sides of the road. Tracking information on both sides of the road allows ITD to accurately report information to the federal government, in compliance with new federal standards including: MAP-21, FAST Act, MIRE and HSIP. Additionally, the new LRS system provided accurate collection and reporting of data for the Highway Performance Monitoring System (HPMS), which directly ties into federal funding for the organization.

Our new LRS system allows performance dashboards to be created that can track work, report progress, highlight successes and deficiencies, as well as anything else you may want to report on. These can be used on an executive or management level, or by front line employees for everyday tasks. Below are examples of dashboards that are currently being used at ITD:

Accident Heat Map

Culvert Status