

Tallahassee–Leon County, Florida Topographic Partnering Group/LIDAR Project (2003—Single Process)

System Summary

In 2001, when the Tallahassee–Leon County GIS (TLCGIS) Interlocal Project was implementing the 2001 Flyover Project to update orthophotography and planimetric data sets previously gathered in 1996, concerns were voiced about the accuracy of contour data initially captured in 1996, especially in those areas of the county that had heavy tree canopy. Some users preferred contour data created in 1988 rather than the 1996 data. Users were concerned that if the same photogrammetric methods used in 1996 to collect data were used again in 2001, the accuracy of the new data would not meet their needs.

Rather than simply moving forward with the 2001 Flyover Project, the TLCGIS staff called together all the potential users of the data and formed the Topographic Partnering Group to discuss accuracy issues, and the pros and cons of available methods used to collect data and create contour data sets. The Partnering Group decided to have a prototype study of LIDAR-based terrain mapping conducted in four pilot test areas. The Tallahassee–Leon County GIS Interlocal Project diverted funds from the 2001 Flyover Project to complete the prototype study. Thus, a Digital Terrain Model (DTM), vector contour data, and vector spot elevation data were delivered and evaluated. Based on these results, the LIDAR DTM data and derived contour data had accuracy levels of ± 1.5 feet in heavily wooded areas, in comparison to 1996 contour data accuracy levels of ± 30 feet in heavily wooded areas. The group determined that the prototype study was a success and recommended LIDAR data be acquired countywide.

The Topographic Partnering Group/LIDAR Project is exemplary for several reasons. First, it brought together critical users from multiple agencies—many of whom had never worked together before—to discuss their concerns and needs about data accuracy. Second, users learned about LIDAR, a cutting-edge technique for mapping terrain data in heavily vegetated areas with high accuracy. Third, the Tallahassee–Leon County GIS Interlocal Project diverted funds from an existing project to acquire

LIDAR data. Finally, because some members of the Partnering Group required a turnaround time of one year for finished data sets, members assisted in securing funding for the project, and, therefore, ensured that more accurate data would be developed so that every user's needs would be met.

Motivation for System Development

The Tallahassee–Leon County GIS is an Interlocal Project funded by three local governments: the city of Tallahassee, Leon County, and the Leon County Property Appraiser's Office. One of the duties of the Interlocal GIS is to maintain GIS data, including orthophotos and planimetric data, for use by staff in these three governments. As such, every five years, the Interlocal GIS arranges for a flyover of the entire county, to acquire orthophotos from which data sets, including contours, are derived using photogrammetric techniques.

In the course of the 2001 Flyover Project, however, it came to the attention of project personnel that some of the critical users of the data from city and county local governments, especially engineers who rely on data for infrastructure projects, had concerns about the accuracy of contour data initially captured in 1996, especially in those areas of the county that had heavy tree canopy. Because Leon County has such a dense tree canopy—more than 60 percent of the county is covered by a heavy tree canopy—traditional photogrammetric techniques cannot provide accurate elevation information for the ground underneath the tree canopy. This often resulted in inaccurate elevation data in those obscured areas. Additionally, the finished data required extensive field surveys to verify elevation to facilitate preplanning for large community improvement projects. Based on these factors, users were concerned that if the same photogrammetric methods used in 1996 to collect data were again used in 2001, then the accuracy of the new data would not meet their needs.

The TLCGIS organized a Topographic Partnering Group consisting of critical users from various departments. Based on

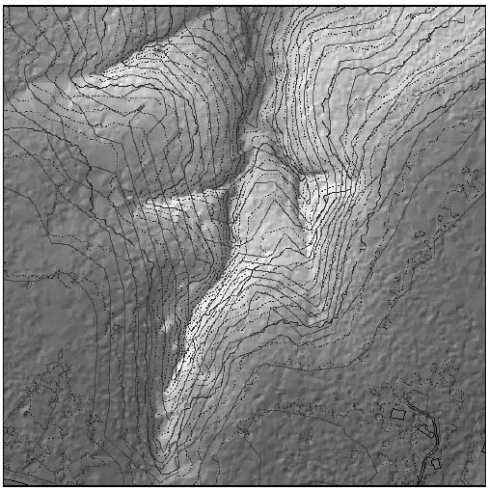


Figure 1. LIDAR Surface-Derived Contours Versus Photogrammetric-Derived Contours.

members' discussions, it appeared that the finished data sets that would result from the 2001 Flyover Project would fall short of the needs of all users. In addition, the users expressed diverse views about the value of past efforts of obtaining finished contour data sets completed in 1988 and 1996. Although each data set was dated, each had pros and cons relating to their effectiveness in the members' business processes.

Specialists presented a seminar for the Partnering Group describing the methods used to produce the 1988 and 1996 topographic data sets and comparing the photogrammetric method with a new technique using Light Detection And Ranging (LIDAR) for mapping terrain. LIDAR is similar to radar but uses a laser instead of microwaves, and it can "see" gaps through heavy tree canopy to the ground below. The LIDAR technique proved that not only can it penetrate the tree canopy, but it also can provide accurate elevation information of the ground below. With LIDAR, accuracy levels of +/-1.5 feet in heavily wooded areas were obtained for contour data.

System Benefits Achieved

This project brought about several unexpected benefits, including:

- Higher-than-expected data accuracies and greater detail of the Digital Elevation Model (DEM) in heavily vegetated areas; also higher accuracy than photogrammetric methods at scales of 1:1,200 or smaller.
- Amazing detail in microterrain features (e.g., small ravines, roadside swales, karst depressions, etc., that had never been mapped before).
- Better working relationships among different governmental departments.
- Cost sharing by the different departments.
- First customer to retain access to Merrick and Company's proprietary software used to capture and create data. TLCGIS used this software to conduct quality control on the data.

- A "National Recognition Award" from the American Council of Engineering Companies.

The overwhelming benefit of using the LIDAR technology to acquire data is the higher level of accuracy it provides. For example, the 1996 contour data, which was derived using traditional photogrammetric mapping techniques, could have a level of accuracy of +/-30 feet in heavily wooded areas. In comparison, contour data derived from LIDAR had an accuracy of +/-1.5 feet in heavily wooded areas. This information was field-verified by staff. Figure 1 illustrates the differences that are apparent in the two data sets. The brown lines are LIDAR Digital Surface Model (DSM) with surface-derived contours. The blue lines are the photogrammetric-derived contours. The four-foot interval contours are shown at a scale of 1:2,400.

Because of this higher accuracy, local government staff are able to minimize the time they spend in the field collecting data to verify elevations. Users can have confidence in the data when they use it to complete their projects.

Also, as part of the group's discussions, the group determined that this highly accurate data could be used as part of the planning and preplanning for Blueprint 2000 Projects. Blueprint 2000 is a public/private partnership to direct additional sales tax revenue to infrastructure improvement and environmental protection projects. The high accuracy of the data can help speed up the planning stages for these projects by eliminating predesign field surveys.

This project has also resulted in better working relationships among different governmental departments. Some of the members had never worked together before. They now have become better acquainted with each other and are comfortable working together as needed.

Additionally, the different departments shared the costs of this project, with each department assisting in securing funding for the project. Each department, therefore, ensured that more accurate data would be developed so that every user's needs would be met.

A final unexpected benefit is the national recognition this project has received. The TLCGIS Topographic Data Partnering and LIDAR Project was a finalist in the American Council of Engineering Companies/Colorado 2003 Engineering Excellence Awards and received an ACEC National Recognition Award.

System Design Issues Encountered and Overcome

The Topographic Partnering Group effort had to overcome the typical "turf" issues that occur in many areas of local government. The group's decision about how to proceed had to meet a variety of needs for a variety of users (stormwater engineers, public-works engineers, land-use planners, permitting reviewers, environmental planners, emergency-management planners, and GIS users) from two government agencies, and they all had expectations defined by the various business processes they use in their work. Eventually,

the Partnering Group reached consensus on issues and solutions so that everyone's needs would be met.

What Differentiates This System from Other Similar Systems

The Topographic Partnering Group united a variety of participants from different governments, with the group establishing a comprehensive approach to resolving concerns and issues. The group determined common needs and goals, which provided for common oversight and resulted in a formula for success for all.

Additionally, by pooling financial resources, a solution was obtained that otherwise no one or two participants could have afforded. The following are alternatives that were considered by the Topographic Partnering Group before it decided on Alternative B.

Alternative A: 2001 Flyover Project

Alternative A was based on completing the 2001 Flyover Project under the original scope of the project for updating the 1996 DTM and planimetric data using traditional photogrammetric techniques. If the 2001 Flyover Project was pursued to completion, then finished contour data would still have been needed in FY 02/03 to complete the effort. Therefore, GIS Central would have requested an additional \$100,000 in the FY 02/03 budget cycle for acquisition of the finished contour data. However, this option did not resolve the issue of higher accuracy, which LIDAR data would have provided, as discussed by the Topographic Partnering Group.

Alternative B: Diversion Plan

Alternative B was to suspend the current updating efforts of the 2001 Flyover Project and divert the remaining funds to the LIDAR Acquisition Project. This alternative effectively met both the timing and improved accuracy needs of the Topographic Partnering Group. It would have allowed for the acquisition of more accurate finished data by March of 2003. Under this alternative, the initial acquisition of the LIDAR data and the required supporting aerial photography would have been captured by mid-February of 2002. A prototype project would then have been completed to define the final deliverable procedures.

To fund the effort under this plan, GIS Central would have recommended suspending all further updating of the 1996 DTM and planimetric data. The unused funds budgeted for these updates (\$208,951) could have been added to other diverted GIS funds (\$41,750). This would have resulted in a total of \$250,701 available to fund the initial LIDAR acquisition and prototype project. The remaining funds required to complete the analysis and establishment of a new DSM, to replace the 1996 DTM, would have been pursued through the CIP budget process at both the city and the county levels during the FY 02/03 budget cycle. Under the separate CIPs, each jurisdiction would have been required to fund \$375,992 in FY 02/03 for the final completion of the LIDAR Acquisition Project and restore the initial funding for the 2001 Flyover Project.

Alternative C: New Flyover Project

The final alternative was to complete the current effort and pursue the LIDAR Acquisition Project later in FY 02/03. The final products from the project would meet the accuracy needs of the Topographic Partnering Group, but the completion of the project would have been delayed until March of 2004. The initial data acquisition could not have occurred prior to January of 2003 and, therefore, would have required additional funding of approximately \$110,000.

System Hardware, Software, and Data

Hardware:

Common GIS Server

- IBM RS/6000 S70
- AIX 4.3.3 operating system
- 8 CPUs (64 bit, 330 MHz)
- 10 GB memory
- 400 GB disk storage (fiber channel/RAID)
- GB network adapter

Seven Web and Map Servers (for deployment of Internet and intranet GIS Web sites)

- All have similar configurations
- Dual Intel Pentium 900+ MHz CPUs (server-class)
- 1 to 2 GB memory
- 50 GB disk storage (SCSI/RAID)
- 100 MB network adapters
- Windows NT/2000
- Microsoft IIS Web Server

Plotters

- Large Format (HP650C and HP1055cm Plus)

PCs

- Intel Pentium IV 2.0 GHz
- 1 GB memory
- 36 GB disk storage
- 100 MB network adapter
- Windows 2000

Software:

Merrick and Company Product

MARS (proprietary software) used to capture and create data, to process Leica Geosystems LIDAR files directly, and to export the data into various file formats (such as shapefiles and grids). As part of the contract with Merrick and Company, Tallahassee–Leon County GIS became the company's first customer to retain access to this software; TLCCGIS used it to conduct quality control on the data.

SocetSet Product

Softcopy photogrammetric package used to view LIDAR data in a stereo model and to conduct statistical accuracy assessments (“soft copy” means everything is viewed digitally in 3-D—using special glasses—on-screen versus “hard copy,” which relies on two printed copies of orthophotos viewed with stereoscopic glasses).

ESRI Products

- ArcSDE 8.3 (Unix)
- ArcGIS 8.3 (Windows 2000)
- ArcInfo 8.1 (Unix)
- Grid, TIN, COGO, and ArcPress Extensions
- ArcView 3.x (Unix and Windows)
- Network, Spatial, and 3-D Analyst Extensions
- Map Objects 2.1
- Map Objects IMS 1.x and 2.x (Windows NT and IIS 4.0)
- ArcIMS 4.0.1 (Windows 2000, IIS 5.0, and Servlet Exec 4.2)

Oracle Products

- Standard Server, Version 8.1.7 (Unix)
- WebDB Web Interface (Unix)

Data:

The topographic data (contour lines and spot elevations) are distributed in ESRI software-supported coverage and shapefile format. TLCGIS additionally has the capability to create DXF files of the data set for external CAD users. Also, TLCGIS has the ability to export the LIDAR data in a variety of file formats using the MARS software package. Additionally, the digital orthophotos flown in 2001 are at 0.5-foot resolution and are available in TIFF, JPG, and MrSID formats.

Where Are We Now?/Future Direction

Since 2003, when the “Tallahassee–Leon County GIS Topographic Partnering Group/LIDAR Project” won the ESIG Single Process Award, the Partnering Group has continued to be a user-driven group devising the overall direction of and implementation strategy for affected base map data sets. The group is now working on three new primary projects:

Incremental Update Process

In the past, TLCGIS would hire a contractor to produce digital orthophotography and planimetric data (road edges, building footprints, hydrography) for the entire county every five years (e.g., in 1996, in 2001). The problem with the five-year schedule is that the data sets become outdated and do not meet the needs of GIS users who want to see current data in areas of the county

that have experienced high growth. In response, the Topographic Partnering Group has implemented the Incremental Update Process. Now, photography, planimetric, and LIDAR data will be collected simultaneously on a three-year basis for the urban areas of the county (where most of the growth is occurring) and on a six-year basis for the rural parts of the county, with TLCGIS having the option to request data for ten “hot-spot” areas of growth that are outside of the regularly scheduled area.

Environmentally Sensitive Areas Refinement

Using contour data collected in 1996, GIS staff members from TLCGIS and other departments created data sets pertaining to Environmentally Sensitive Areas (ESAs). These data sets include severe and significant slopes, drainage basins, watersheds, and catchments. Engineers in the stormwater-management departments and planners in the growth-management departments use these data sets in their daily tasks. With the availability of more current, more accurate contour data (derived from LIDAR), members of the Partnering Group are now updating these ESA data sets.

Coordinating with the Northwest Florida Water Management District, the Local Coordinating Technical Partner (CTP) for FEMA’s Map Modernization Project

According to its Web site, FEMA has “developed the Cooperating Technical Partners (CTP) Program as an approach to creating partnerships between FEMA and participating National Flood Insurance Program communities, regional agencies, and state agencies that have the interest and capability to become more active participants in the FEMA Flood Hazard Mapping Program.” For northwest Florida, the CTP is the Northwest Florida Water Management District. Because of the high quality and high accuracy of the GIS data produced and maintained by Tallahassee–Leon County GIS, the Topographic Partnering Group is working with the water-management district to provide it with information to be utilized in updating the local Flood Insurance Rate Maps.

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