GIS for Patrick Air Force Base meets SDSFIE standards and provides the flexibility and functionality of an ESRI/Oracle geodatabase

By Michael Gilley and Rene Rodriguez

GIS officials at Patrick Air Force Base in Brevard County, Florida, wanted the flexibility, functionality, and location-specific optimization that the non-military world has come to expect from customized geodatabase models based on ESRI and Oracle products.

But the GeoBase architecture mandates that they follow the Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE), so they can maintain the interchangeability and interoperability of data throughout the Department of Defense.

Officials at Patrick AFB teamed with Woolpert LLP to bridge the gap, giving the base the best of both information worlds.

In 2003, Patrick contracted for field inventory and GIS implementation for sewer and storm water systems, as well as airfield lighting structures.

Data collection posed its own challenges. First, the contract team reviewed as-builts, field reports, valve tie sheets, and shop drawings. These documents were categorized and related to a spatial location. The contract team created an ArcGIS map document depicting all areas where good, fair and bad documents existed, with annotation as to the documents used to categorize each area. This visualization tool helped the contract team and the base personnel identify holes in the data. When they identified an area of missing data, base personnel checked again for mislaid maps. If no data could be found, then the contractor expected to spend additional time surveying that area — collecting sufficient information for the correct assembly of the system and taking special care to maintain connectivity and flow direction as close as possible to reality.

That system worked well when surveyors are gathering data about storm sewers near buildings, but collecting airfield lighting structures at a busy air base can be a major problem. Woolpert devised two schemes — one to gather data using real-time kinematic (RTK) surveying techniques which is quick and efficient, but requires time at the structure; one to use conventional techniques and triangulate data from a distance, more costly, but possible when the airfield is busy. After reviewing the two methods, airfield personnel developed schedules that permitted on-the-spot RTK data collection.

Other data collection challenges included conduits with multiple types of wiring, or multiple culverts converging on a single headwall. This problem was solved by modeling the structure as a single culvert with multiple lines.

Woolpert assigned two data collection crews — one for sewer and storm water assets, the other dedicated to airfield lighting. The crews collected the majority of the data in a single sweep, using scanned plan views as a guide; then compared their data to the more detailed source documents in the office and collected any missing assets in a second sweep.

Woolpert used a suite of proprietary tools called SmartSurveyor™ and SmartMapper™which allow collection of field data and subsequent data conversion straight in the native geodatabase environment. After agreeing on the geodatabase design, all domains and rules were defined and enforced through the conversion process.

Collecting the airfield lighting structures required several special procedures. First, before accessing the airfield, survey crews completed specialized safety training provided by base personnel. Next, the survey crews coordinated radio frequencies with the airfield command to avoid conflicts between the airfield's communication frequencies and the frequencies used by Woolpert's GPS and communication equipment. Also, survey times were dictated by the availability of the airfield. Since survey crews were not allowed on the airfield grounds when military activity was underway, the survey time was limited. To accommodate the limited time, crews predefined much of the data on assets from source documents and historic information, so they had only to locate the structures and verify the attributes.

But the project's most important challenge came from implementing the SDS while optimizing the benefits from the data gathered and the functionality of the software and technology in question. The military has standardized on SDS naming and structure conventions, while GIS users are still building on utility models to obtain the maximum benefit of treating infrastructure assets as objects.

Traditionally, GIS models for utilities have been based on ArcFM models. These were developed by the GIS community, working with GIS software vendors and consultants, to account for the infrastructure itself and all the information about the relationships and connectivity of various structures.

Within the ESRI-oriented geodatabase world, those models have been the standard for the GIS community in municipalities and counties. And, in fact, ESRI dominates the municipal geodatabase world.

But the military is just as committed to its own Spatial Data Standards, a massive database schema that includes everything related to the Facilities, Infrastructure and Environment of military compounds — from buildings and surrounding trees to storm water, manhole covers and electrical structures. The creators of the SDSFIE standards have also created a tool for entering geodatabase schemas straight from the SDS schemas. This tool allows a user to select a subset of the SDSFIE standards and create an empty geodatabase with all of the objects and attributes selected. The process is not as straightforward as it sounds, however.

It was a challenge to start with two different models and see whether they could mesh. Could the SDS standards accommodate all the attributes generally included in a custom utility GIS database — data gathered from source documents and from field inventory? And could the SDS standards accurately reflect the data hierarchy? Would the SDS hierarchy make the best use of the ESRI ArcGIS suite of products?

Since there was no option but to meet SDS standards, the challenge became finding creative solutions to make the two work together — to maintain the integrity of the data collected in a geodatabase model when it was used within the SDS model.

It wasn't possible, either, to start with the SDS model and work back to the geodatabase model, because the CADD-based SDS standards lacked the hierarchy of concrete classes and subtypes used in the geodatabase and because it would not address the overall need for normalization of the resulting database. For example, we found that entities that needed to be represented as subtypes were identified by attribute values. Some concrete classes were further identified by an attribute value as well. In a sense the non-normalized nature of the SDS standards created a setback that partially offset the advantages of using a geodatabase model and the capabilities of the new ArcObjects engineered GIS software. SDS schemas did not have any place to enter some standard field-collection attributes but included duplicates for other attributes.

GIS experts from Patrick AFB and Woolpert toyed with the idea of simply modifying the geodatabase model resulting from the SDS standards tools without affecting the interoperability of the data, thereby creating a new model that incorporated SDS standards and maintained the hierarchy and integrity of Geodatabase. Instead, they developed both the modified geodatabase model and a purely SDS model. The two models, working together, meet all three of the project's basic criteria:

- ✓ the local data needs on the base
- ✓ the military standards for interchangeable data
- ✓ the ability to communicate with each other

For example, attributes that have no home in the SDS standards are stored in relate tables so they can be accessed later if the SDS model data users so choose. Meanwhile all maintenance, analysis, and production chores are carried out against a sound and normalized geodatabase.

All datasets were delivered in two formats — CADD and GIS. The GIS environment was implemented in an ArcSDE-accessed Oracle geodatabase. The SDS compliant data was loaded and accessed directly through Oracle. Woolpert is in the process of developing automated routines for synchronizing both datasets on a quasi-real-time mode.

The first data has been delivered, demonstrating clearly that the two types of data access — ESRI ArcFM Geodatabase models enforced by the SDS standards — can co-exist and provide the best aspects of both systems.

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