E S R I

ARCNEWS

# Modernizing National Mapping Workflow

## *GIS Helps National Mapping Agencies Evolve Missions, Operations, and Service Delivery*

### Highlights

- Agencies are broadening their missions while improving efficiency.
- Map and chart production timelines are significantly reduced.
- Geographic data is more readily exposed and shared with customers.

*National mapping agency:* The name conjures images of legions of cartographers laboring away at familiar maps of their respective countries—political, transportation, geologic, vegetation, and topographic. In truth, national mapping agencies (NMAs) have a vital and often underappreciated role in national government. They provide timely, relevant, and accurate geospatial intelligence in support of

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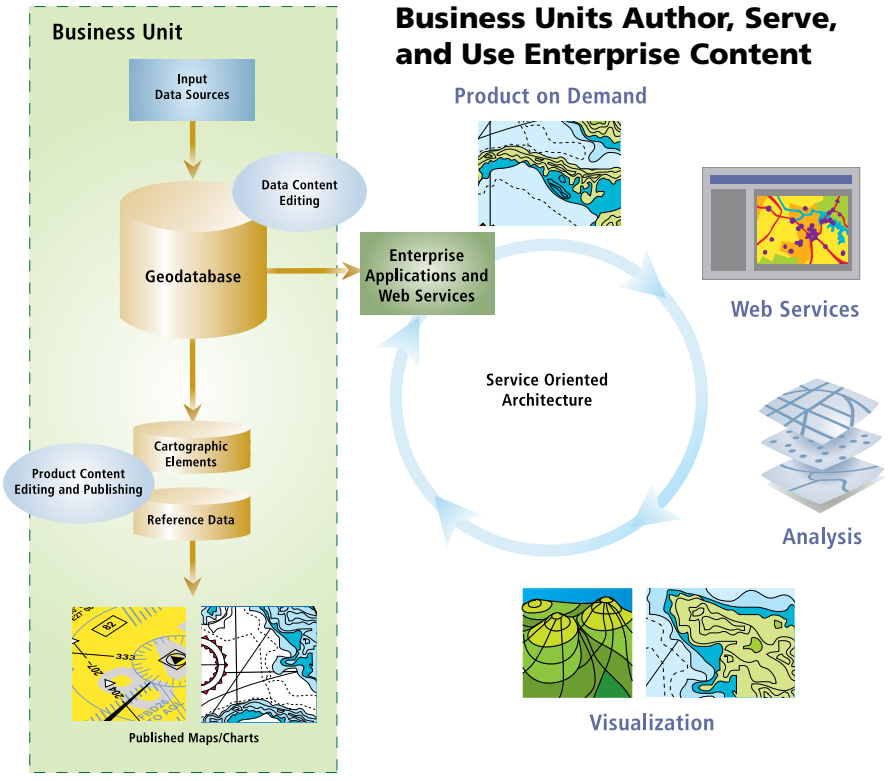


*Enterprise GIS-based workflows help national mapping agencies meet growing customer demand for more sophisticated products and greater access to data.*

# NOAA Modernizes Nautical Chart Production

## *Implementing Next-Generation Charting System with PLTS for ArcGIS—Nautical Solution*

The Marine Chart Division (MCD) at NOAA has embarked on an ambitious new deployment of GIS technology to create the next generation of its Nautical Chart System (NCS II). MCD has used GIS for many years to improve workflows and data management but wanted a commercial off-the-shelf enterprise-wide system for NCS II to gain efficiencies and streamline data management and product generation. With the new system, NOAA MCD will continue to be the world leader in hydrographic information management.

*See the complete article on page 4.*

# Aeronautical Transformation

## *From Paper to Digits at the National Geospatial-Intelligence Agency*

**By Charles L. (Chuck) McGaugh, Jr., Director, Office of Global Navigation, National Geospatial-Intelligence Agency**

Transformation involves "a major change in form, nature, or function," as defined by *Merriam-Webster's Collegiate Dictionary,* Tenth Edition. Starting in early 2002, the National Geospatial-Intelligence Agency (NGA) undertook a transformation in the way the agency does business and supports customers by moving from a productcentric to a datacentric organization. The goal, in the words of former NGA director and retired Air Force Lt. Gen. James R. Clapper, Jr., was to provide customers "instant access to specific geospatial intelligence."

Headquartered in Bethesda, Maryland, NGA is a U.S. Department of Defense combat support

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## Modernizing National Mapping Workflow

economic development, scientific research, natural resource management, navigation, safety, and national security. They are the leaders in collecting, managing, combining, and promoting the use of accurate and up-to-date geospatial data for use by government, business, and the public. Often, they are the only entity providing these services.

### Evolving Missions and Business Models

In many countries, there is more than one NMA, with different agencies dedicated to aeronautical, nautical, or topographic mapping. Most have focused on producing a limited number of standard products or series delivered either as hard-copy maps or digital files. Data was centered on the product sets and stored in a variety of databases and libraries while being processed by a disparate set of systems and tools. The specifications for these products were fixed, with production requirements established months or years in advance. The acquisition of source material followed similar timelines, and production processes depended heavily on manual operations. Customers ordered from an inventory of products and adapted them to their uses.

This business model is changing as the value of geospatial information becomes more widely recognized and customers demand more sophisticated products and greater access to the data. There is growing recognition that the product-centric system no longer meets customers' evolving demands nor is it efficient for the agencies. As geospatial information moves from the realm of map publishing and special projects to supporting mission-critical business functions, customers require more content and currency, on-demand accessibility, and application-ready formats.

This trend has led many NMAs to reevaluate how they interact with their customers. Many agencies have taken steps to adapt their business practices and production systems accordingly, but the demand for geospatial information


*GIS-based systems simplify and accelerate map and chart production by helping mapping agencies streamline business processes, consolidate data holdings across the enterprise, and standardize production workflows.*

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is outstripping their ability to keep up with the increasing sophistication of their customers.

**The Challenge**

To meet these demands, NMAs must achieve greater levels of performance and quality in all business functions at an enterprise level. Increasing staff or adding equipment resources can accomplish this in a limited way but are solutions with diminishing returns. To really improve, agencies must

- Streamline work processes.
- Increase accuracy and product quality.
- Eliminate data redundancy between functional business units.
- Facilitate collaboration between analysts from different business units.
- Expose the enterprise data holdings within the agencies, as well as among partners and external customers.
- Facilitate data exchange among aeronautical, nautical, and topographic agencies.
- Retire legacy systems gracefully.
- Maximize the use of standards-based commercial off-the-shelf (COTS) products.

**Common Business Functions Among NMAs**

There is no single technical solution for all mapping agencies. Each must adapt to the requirements of its particular domain. Each must work within its own special business and regulatory environment. But while they are each different in their specific data and map products and services based on whether their domain is aeronautical, topographic, or nautical, NMAs have common business functions and associated processes and procedures. These include

- Defining their geography of interest
  - Assembling information relating to the mapping task
  - Assessing existing information sources
  - Defining requirements for new geospatial solutions
  - Setting standards for new geospatial solutions

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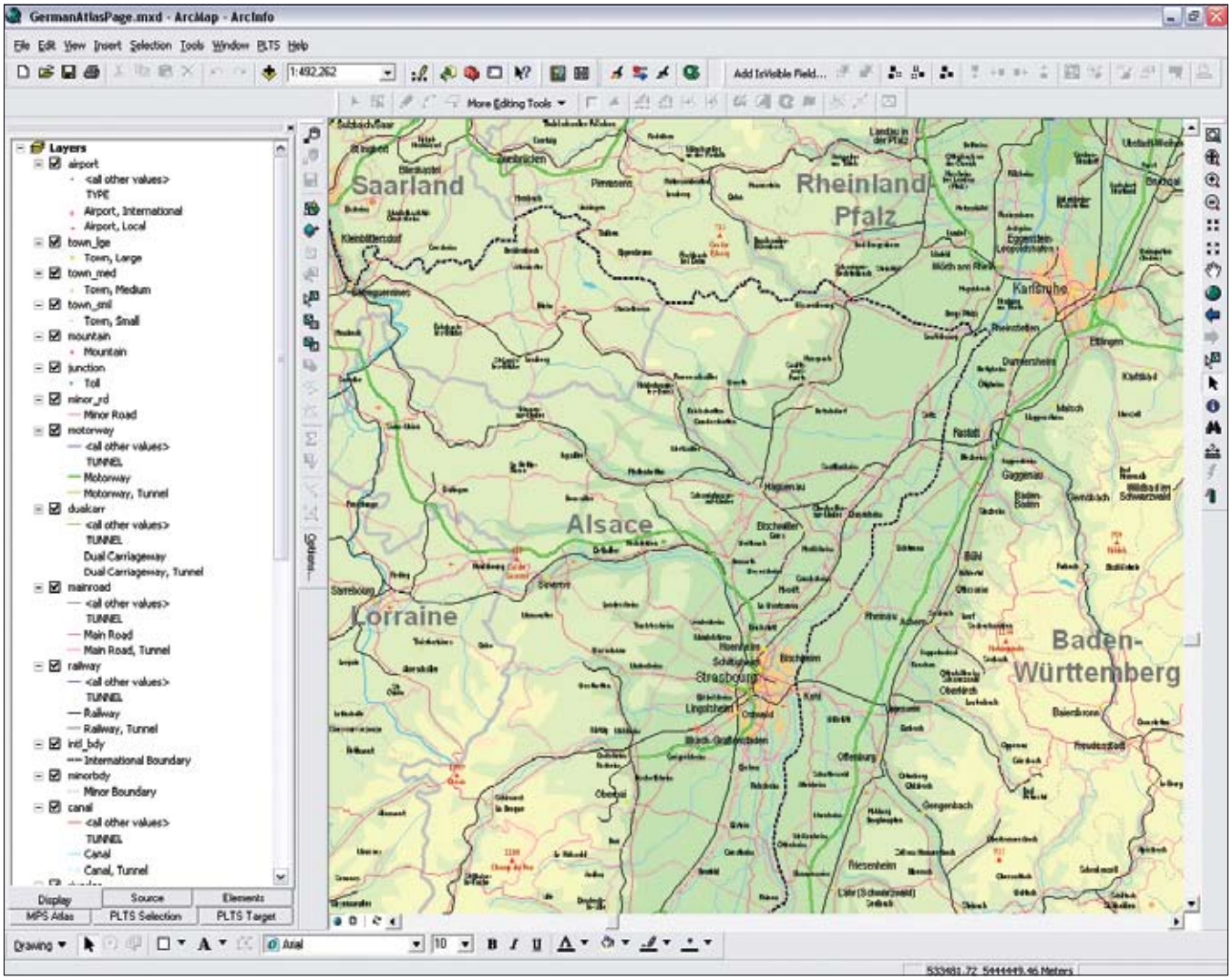


*National mapping agencies provide timely, relevant, and accurate geospatial intelligence in support of economic development, scientific research, natural resource management, navigation, safety, and national security.*

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## NOAA Modernizes Nautical Chart Production

### Highlights

- GIS will be used to manage production of nautical charts.
- Data is obtained from more than 50 entities.
- Project aims for gains in productivity and flexibility.

The Marine Chart Division (MCD) at the National Oceanic and Atmospheric Administration (NOAA) has embarked on an ambitious new deployment of GIS technology in the management of hydrographic information and the production of digital and hard-copy nautical charts. The result will be the next generation of the Nautical Chart System (NCS II).

MCD is a division in the Office of Coast Survey (OCS), which is part of the National Ocean Service (NOS), one of five NOAA line offices. NOS works to observe, understand, and manage U.S. coastal and marine resources, including navigation safety. OCS specifically oversees the Marine Transportation System.

NCS II will help MCD meet its critical challenge of providing navigation products that cover approximately 11 million square kilometers of coastal waters, including the Great Lakes (areas collectively called the United States Exclusive Economic Zone). Ninety-five percent of U.S. commerce, by weight, travels through these waters alongside 110,000 commercial and recreational fishing vessels.

A nautical chart is a graphic portrayal of the hydrographic navigation environment, showing the nature and form of the coast; the general configuration of the sea bottom, including water depths; locations of dangers to navigation; locations and characteristics of man-made aids to navigation; and other features useful to the mariner. In conjunction with supplemental navigational aids, the nautical chart is used by the mariner to lay out courses and navigate ships by the shortest and most economical safe routes.

To produce these complex products, MCD uses source data including hydrographic survey data, hazard updates, and navigation aid information. From this data, MCD maintains a suite of more than 1,000 paper nautical charts and is in the process of providing complete coverage in Electronic

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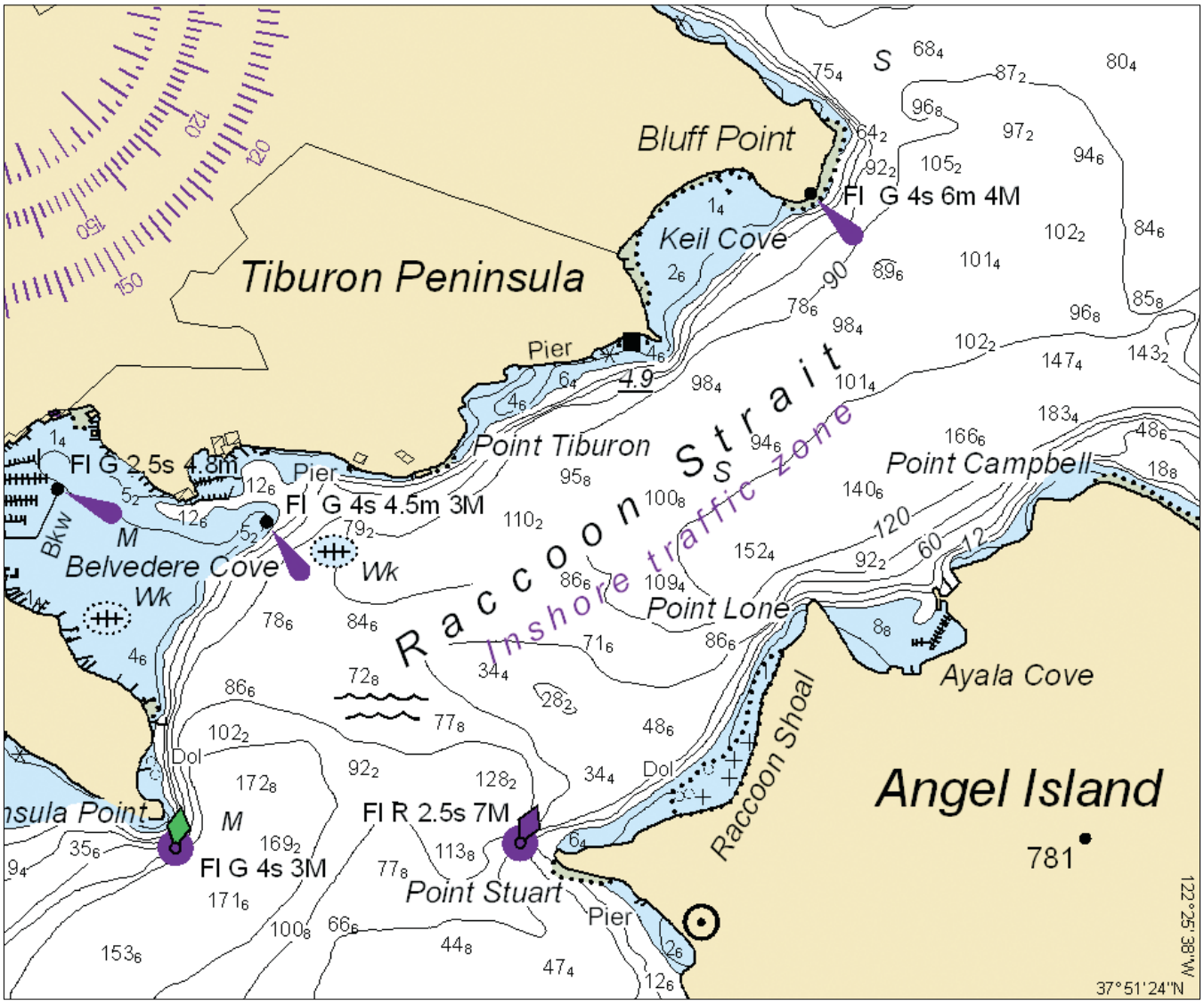


*The NCS II system uses PLTS for ArcGIS—Nautical Solution to create, manage, and publish hydrographic information in paper and ENC formats.*

# Technology Solutions for National Mapping Agencies

While no one solution can fit all the requirements of all national mapping agencies (NMAs), ESRI has worked tirelessly to ensure its product suite includes standards-based COTS solutions that provide the foundational tools and specific technology that mapping agencies need. These solutions are specialized applications built using ArcGIS. They are designed to model and support particular business functions and workflows with out-of-the-box tools that provide immediate business value. The following products have evolved out of repeated engagements between the ESRI Professional Services organization and key customers within particular application areas.

ESRI has worked tirelessly to ensure its product suite includes standards-based COTS solutions that provide the foundational tools and specific technology that mapping agencies need.

**Production Line Tool Set for ArcGIS**

Production Line Tool Set (PLTS) for ArcGIS is a suite of applications that organizes, manages, and enhances productivity for a multitude of map, chart, and database production activities. These applications provide flexible workflow templates and data models that help organize data automation, cartographic production, and data management. The PLTS for ArcGIS suite includes specific solutions for aeronautical, nautical, topographic, and defense agencies. These solutions include the generation of map series and data products common to domains such as

- PLTS for ArcGIS—Nautical Solution leverages the PLTS for ArcGIS applications for creation, management, and publication of hydrographic information in hard-copy, Electronic Navigation Chart (ENC), and Digital Nautical Chart (DNC) formats.
- PLTS for ArcGIS—Aeronautical Solution provides end-to-end information management and support for standards-based aeronautical charts and data exchange.
- PLTS for ArcGIS—Mapping Agency Solution provides the database models, knowledge bases, and tools for topographic data and map production.

**PLTS for ArcGIS—Foundation and Components**

Each of the PLTS for ArcGIS solutions above comes with PLTS for ArcGIS—Foundation, which includes tools for database editing, quality control (GIS Data ReViewer), cartographic product generation (Map Production System—Atlas), and workflow management (Job Tracking for ArcGIS [JTX]). Foundation provides users with a consistent, repeatable, and well-managed production workflow.

**Standards and Interoperability**

Support for standards is an important part of enabling interoperability, a crucial requirement for NMAs. ESRI supports geospatial standards from the Federal Geographic Data Committee (FGDC); International Hydrographic Organization (IHO); International Organization for Standardization (ISO); Open Geospatial Consortium, Inc. (OGC); IT standards from Organization for the Advancement of Structured Information Standards (OASIS) and World Wide Web Consortium (W3C); and various GIS-related domain standards in its software. ESRI also offers various interoperability enablers, such as direct read/write of dozens of data formats; support for hundreds of projections and datums; support for openly published data models; and tools for spatial extraction, transformation, and loading (ETL) of data. ArcGIS also supports various metadata- and catalog-related specifications that provide practical ways to publish, discover, and bind to geospatial data and services.

ESRI leads and participates actively in many of the standards committees and works closely with many draft standards. As these standards are finalized, they are incorporated into the entire ArcGIS product suite as required, including the solution products mentioned above.

**Solutions for National Spatial Data Infrastructure**

Many NMAs are the sole champions for implementing a national spatial data infrastructure (NSDI) within their respective countries to promote the interoperability of digital geographic data between various suppliers, agencies, and users. To support content discovery for an NSDI, ESRI offers GIS Portal Toolkit, a metadata catalog server extension that supports metadata search services as a standard part of a GIS user's Web site. This product includes many capabilities to do advanced searching, viewing, metadata harvesting, and other functions and supports FGDC and ISO metadata standards as well as OGC specifications: Web Catalog Service (CS-W), Web Coverage Service (WCS), Web Feature Service (WFS), Web Map Content (WMC), and Web Map Service (WMS).

**Support for Service-Oriented Architecture-Based Implementation**

Service-oriented architecture (SOA) is a component-based software architecture model for enterprise application development and integration. A service is a reusable component used in a business process and generally defined according to Web service standards (SOAP, UDDI, WSDL, XML). Web services are registered and loosely coupled, meaning that they can be combined and integrated on demand, increasingly on the basis of an enterprise service bus integration and messaging platform.

SOA delivers flexibility and enterprise agility, fostering collaboration, enabling interoperability across new and legacy systems, substantially reducing the cost and time of development, and generally better positioning an NMA to adapt to changing business conditions. Using an SOA, users can author and publish a variety of geospatial services. These can be served to the larger enterprise, where users can flexibly integrate them with new or legacy application services and thereby create new knowledge that enriches the enterprise. ESRI is committed to ensuring that its products and solutions are fully compatible with SOA principles and standards.

**More Information**

For more information, visit www.esri.com/nmasolutions.

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# Aeronautical Transformation

## Highlights

- NGA moved from a productcentric to a datacentric organization.
- GIS changed the way flight information publications are produced and distributed.
- Geospatially enabled data enables fusion with other data for additional analysis.

agency and a member of the national intelligence community. The agency's mission is to provide timely, relevant, and accurate geospatial intelligence in support of U.S. national security.

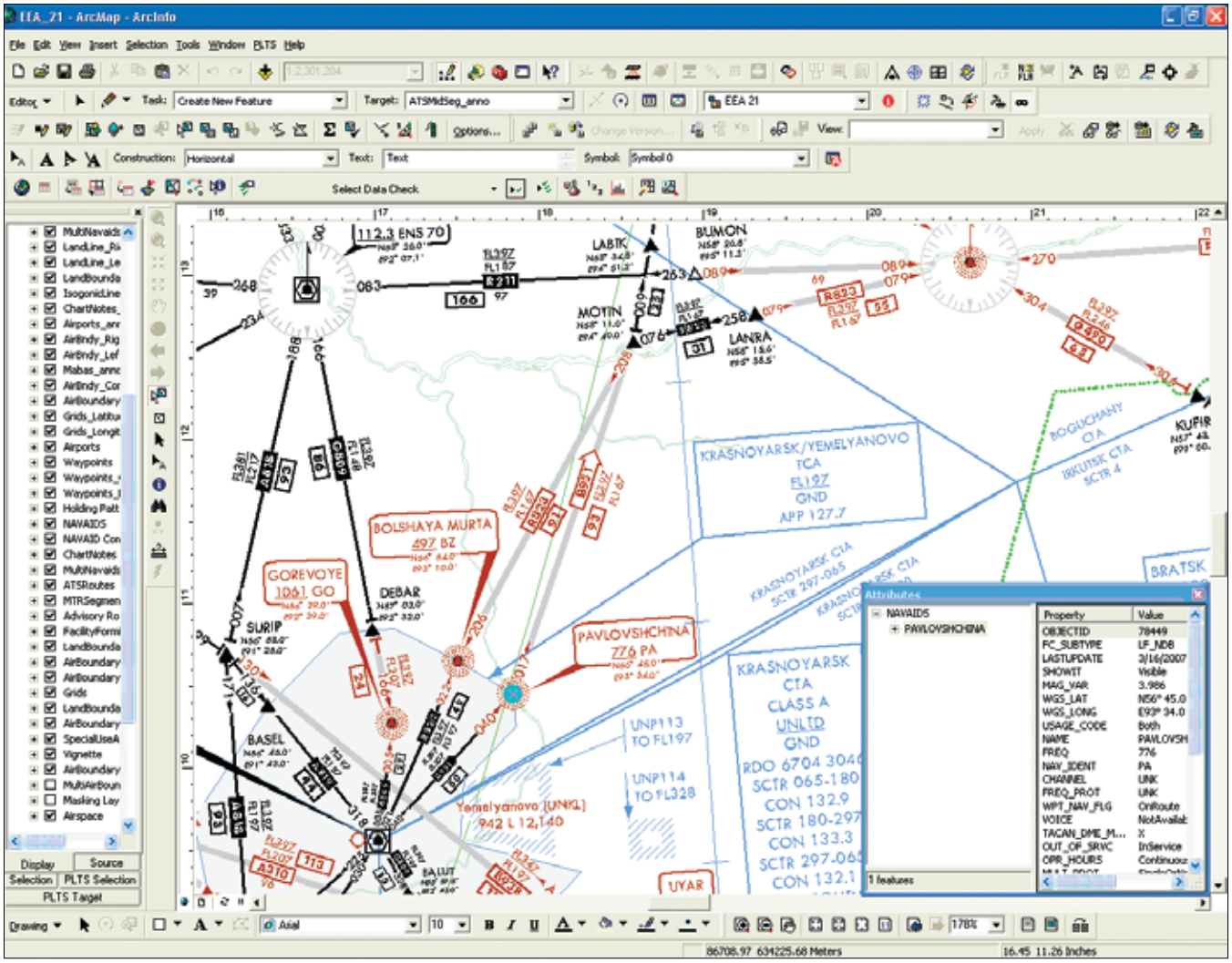
The agency's mission includes providing accurate aeronautical charts that are updated on a nationally and internationally mandated schedule. The transformation began with the implementation of GIS to change the way NGA Flight Information Publications (FLIPs) are produced and disseminated to customers.

### Outdated Processes

Until 2002, the process of producing NGA FLIP global charts required a large staff of aeronautical analysts, quality assurance specialists, and contractor personnel. Significant effort and expertise were required for chart maintenance. Geographic area analysts used drafting tools to create chart overlay lithographs to meet precise standards. For less complex chart changes, the analyst crafted textually descriptive directions called data abstracts using detailed format standards. Due to the complexity of the work and technical writing involved, all information received a second level of review by quality assurance specialists to ensure that it met NGA standards and was similar across all overlapping charts.

The contractor used the data abstracts and/or the hand-drawn lithographs to create sticky-backed strip waxing ("stick-up") film overlays for text and/or graphic symbols. Each change was applied manually by scraping off old annotations and graphics and replacing them with the modification for the master versions of each chart.

With more than 1,000 changes per month, this tedious process required great skill. Each of the four colors used on charts required a separate master layer, and screened colors required additional layers. The stick-up overlays were then used as the positive in a photo process to create negatives for each layer for every chart. In the busiest cycle, contractors produced more than 145 charts with an average of six layers each. Accuracy was imperative to ensure the layers merged to form the completed Enroute Chart when printed.




*NGA has replaced its manual process for creating aeronautical charting products with a completely GIS-based process. Shown is an Enroute Chart being created using GIS.*

With so many changes and the possibility of human error at many stages of production, consistent quality required great effort. Review and rework prior to publication expended many work hours and required substantial lead time to ensure the charts were finished before the next cycle began.

**Sticky Crisis**

While the GIS and mapping community might have been ready to support digital aeronautical charting long before, it took a stick-up crisis to force a change. The world's only manufacturer of stick-up stopped producing the material in 2001, and a new supplier could not be found. All remaining stock was purchased, but the clock started ticking. There were no suitable substitutes for the strip waxing film. A new method for correcting the charts had to be found before all the stick-up was gone.

A GIS solution was an obvious choice, but there were many obstacles, most notably the lack of data. An aeronautical database did exist, it was kept current, and the attribution was robust. The data quality was exceptional, but it was not geospatial.

**The Solution: Digital Enroute Charts**

NGA's Aeronautical Division turned to ESRI for help in solving this critical problem. Together they worked on an ambitious program to create a completely GIS-based process to produce NGA aeronautical charting products. The foundation of the approach was Production Line Tool Set (PLTS) for ArcGIS—Aeronautical Solution, which allowed NGA to develop a database-driven system to support digital aeronautical chart production. The NGA aeronautical database is imported into a geodatabase, and data is preformatted for charts during the data ingest. On a weekly basis, NGA provides database updates, and these transactions are loaded into the geodatabase, which has been optimized for cartographic output. Quality is ensured through several steps, and a Web-based scheduling tool monitors job progress, tracking every chart in every phase of production.

Using this foundation, NGA is able to produce charts of any scale, orientation, and projection, in addition to the standard NGA series of aeronautical charts. PLTS for ArcGIS—Aeronautical Solution manages the chart series design and incorporates intelligent elements that are automatically updated based on the content in the geodatabase.

The database-driven system makes update management many times more efficient than in traditional manual chart production. Onetime data entry allows greater accuracy by eliminating the possibility of errors in the production chain. When a feature update is transferred from the NGA database to the geodatabase, the change is automatically and immediately reflected on all associated charts. Text associated with modified features is automatically updated as well, using feature-linked annotation capability.

As a direct result of the automation, digital data is synchronized with the paper product, and product quality has dramatically improved.

NGA continues to deliver hundreds of thousands of Enroute Charts to aviators every 28 days without delay, and the output product is so similar to the manually prepared charts that customers never noticed. The digital Enroute Chart process supports direct-to-plate printing, completely eliminating the need for film overlays and stick-up.

**Success Transforms NGA to Datacentric Organization**

With NGA's traditional methods, a large percentage of energy was focused on the format and appearance of products, rather than on the depth of knowledge behind the data. Through this effort, its processes were transformed. Today, analysts devote their energy to creating and maintaining quality aeronautical information. Technology then transforms that quality data into a representation that the customer can utilize.

The database-driven system also enables NGA to give customers a variety of new product options, from various digital formats to various printing options. And now that the data has been transformed into geospatially referenced digits, the data can be fused with other information for additional analysis, portrayals, and applications that have yet to be conceived. Using the geospatial knowledge of NGA's contracted experts, the aeronautical expertise of NGA analysts, and the power of GIS, even the sky is no longer the limit.

**More Information**

Excerpted from "Aeronautical Transformation: Paper to Digits—Changing the Way the National Geospatial-Intelligence Agency Creates Aeronautical Products," presented by Charles L. (Chuck) McGaugh, Jr., at the 2004 ESRI International User Conference, available at **gis2.esri.com/library/userconf/proc04/docs/pap2215.pdf**. For more information, contact the NGA Office of Corporate Affairs, Public Affairs Office (Web: **www.nga.mil**), or Brian Cross, ESRI (e-mail: bcross@esri.com; tel.: 909-793-2853, ext. 1-1158).

## A Brief History of Aeronautical Charting

To understand the change that GIS has brought to the National Geospatial-Intelligence Agency (NGA), it is helpful to be familiar with the history of aeronautical charting.

Shortly after the Wright brothers made their historic first flights, the skies began to fill with aircraft. Visibility was the key navigational tool at that time. Aircraft were limited to short flights in clear weather and used transportation routes to navigate by, flying low to the railroads during reduced visibility. Early pilots began making personal notes to help them navigate to and land at increasingly distant airports, and enterprising pilots sold these notes to other pilots, but air travel remained limited by visibility.

In the 1930s, radio technology made it possible for pilots to navigate farther distances through unfamiliar surroundings in reduced visibility. In 1941, the first instrument approach and landing charts were developed, serving pilots with the need to land in low visibility.

By this time, aviation was a matter of interest worldwide. Many organizations began drafting standards for aviation-related maps, charts, and information. During World War II, the demand for charts increased dramatically. By 1943, production had increased from around 500,000 per year to more than 11 million. The U.S. Army and Navy air forces each built their own custom charts to fit their wartime needs.

By the end of the war, it was clear that standardized products and symbology were needed to support international air travel. The following years saw the establishment and maturity of many of the aeronautical- and aviation-related agencies and associations that we see today, such as the U.S. Federal Aviation Administration and the United Nations International Civil Aviation Organization (ICAO), each mandated to ensure the safe, efficient, and orderly evolution of international civil aviation.

Today, these organizations and others drive the look and feel of aviation products worldwide. They have also mandated an update cycle to ensure that all aircraft are flying on the same data. Depending on the region of the world, this cycle is effective every 28 days or multiples of 28 days. It is easy to see how a map of the world's airports and airways, updated every 28 days and limited by international standards, can become a huge challenge. This challenge is the mission of NGA's Aeronautical Division.

# GIS for National Mapping and Cartograp

## Modernizing National Mapping Workflows

### The Challenges

National mapping agencies face new and increasingly sophisticated customer demands, along with expanded responsibilities. To meet these challenges, they need to

- Implement work processes that are simple, flexible, and measurable.
- Increase accuracy and product quality with more automation.
- Eliminate data redundancy between functional business units.
- Facilitate collaboration among analysts from different business units.
- Expose enterprise data holdings within the agencies and among partners and external customers.
- Reduce life cycle costs through the use of standards-based COTS products.
- Plan for the orderly retirement of legacy systems.

Land

Top

### The Solutions

ESRI offers standards-based COTS solutions to help mapping agencies transform their operations and missions. These include

- A suite of applications that enables efficient, streamlined data, map, and chart production with increased quality at a lower cost
- A workflow management solution that offers standardization, better communication/collaboration, consistent reporting, project tracking, and considerable cost savings in typical GIS workflows
- A technology and services solution that provides all the tools and templates needed to implement local, regional, national, and global spatial data infrastructure portals

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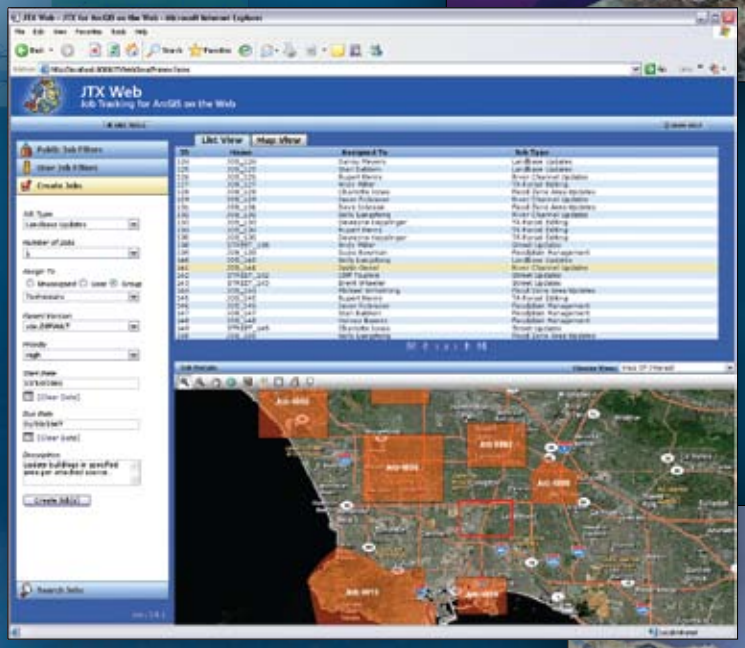
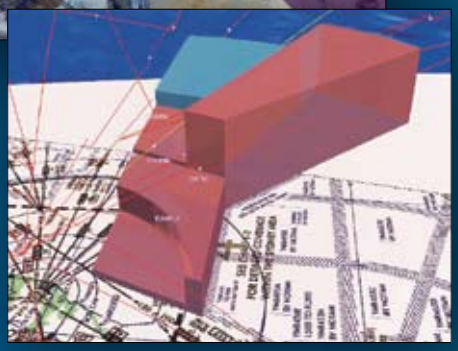
## Air

## Aeronautical



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## Nautical

SRI solutions for mapping agencies at www.esri.com/nmasolutions.

ESRI

# Innovative Solution for Road Data Maintenance at Gila National Forest

## *PLTS for ArcGIS a Crucial Tool for Cooperation and Communication on Dual-Agency Project*

**By Joe Encinas, GIS Coordinator, Gila National Forest, and**

**Phil Watts, Jr., GIS Specialist, Las Cruces BLM District**

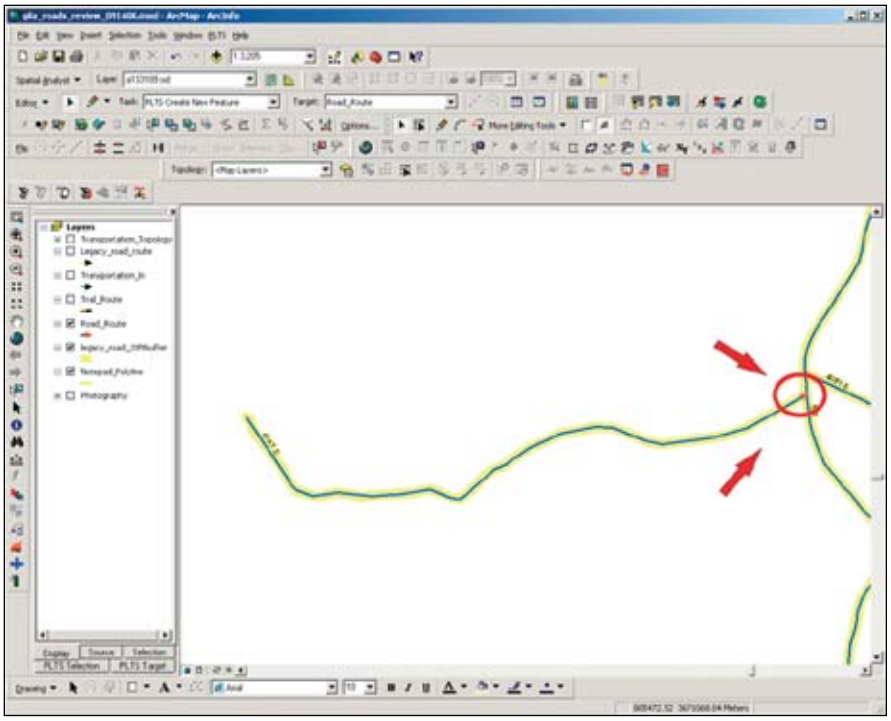
### Highlights

- A new rule requires all national forests to correctly map and classify their road networks.
- More than 45,000 features were reviewed for about 6,000 miles of road.
- PLTS was key to achieving cross-agency goals.

Located in southwestern New Mexico, the Gila National Forest comprises 3.3 million acres of rugged beauty, with spectacular scenery ranging from high, cool mountains with aspen and Douglas fir to warm semiarid lowlands with juniper, oak, and cactus. It is one of the more remote and least developed national forests in the Southwest and is the sixth largest in the continental United States. The forest is also home to the first designated wilderness area, the Gila Wilderness, which was established in 1924.

On November 9, 2005, the U.S. Department of Agriculture Forest Service (USFS) published a new Travel Management Rule, governing off-highway vehicles (OHV) and other motor vehicle use in national forests and on grasslands. The new rule requires each national forest to designate those roads, trails, and areas open to motor vehicle use. This resulted in the need for all national forests, including Gila National Forest, to correctly map and classify their road networks.

***GIS Data ReViewer became an essential mode of communication between the Gila and BLM teams. Since both had the tool, it was possible to review the edits and provide guidance when course correction was necessary to complete the project.***



*Routes can be flipped to point in the right direction. In this case, the route should end on the left side of the route. At present, it appears to end at the road junction, which is incorrect.*

Gila National Forest Southwestern Region managers needed to update their road data in a cost-effective manner with limited labor costs. They wanted to integrate locally collected field data with existing data provided by the Geospatial Service and Technology Center, the USFS mapping center. The project would require integration of multiple data sources, compliance with regional and national GIS standards, and establishment of a regional geodatabase schema.

To achieve these goals, the GIS program managers for Gila established a joint project with the Las Cruces, New Mexico, Bureau of Land Management (BLM) District Office in keeping with the USFS Service First Initiative, which allows USFS and BLM offices to combine resources to improve public land management. The initiative legally paves the way for coordinating and streamlining project implementation and costs in multiple disciplines, including GIS.

Together, the agencies selected ESRI's Production Line Tool Set (PLTS) for ArcGIS—Foundation as the common platform for the project. PLTS for ArcGIS—Foundation offered the necessary tools for editing the data within the geodatabase and for quality assurance/quality control (QA/QC), allowing them to perform maintenance of road data in an integrated fashion. The Las Cruces BLM also provided experienced student workers as affordable labor for the project. The Gila GIS Program provided the program management.

### Establishing Data Standards

One of the first steps in the project was to establish a regional geodatabase schema designed to

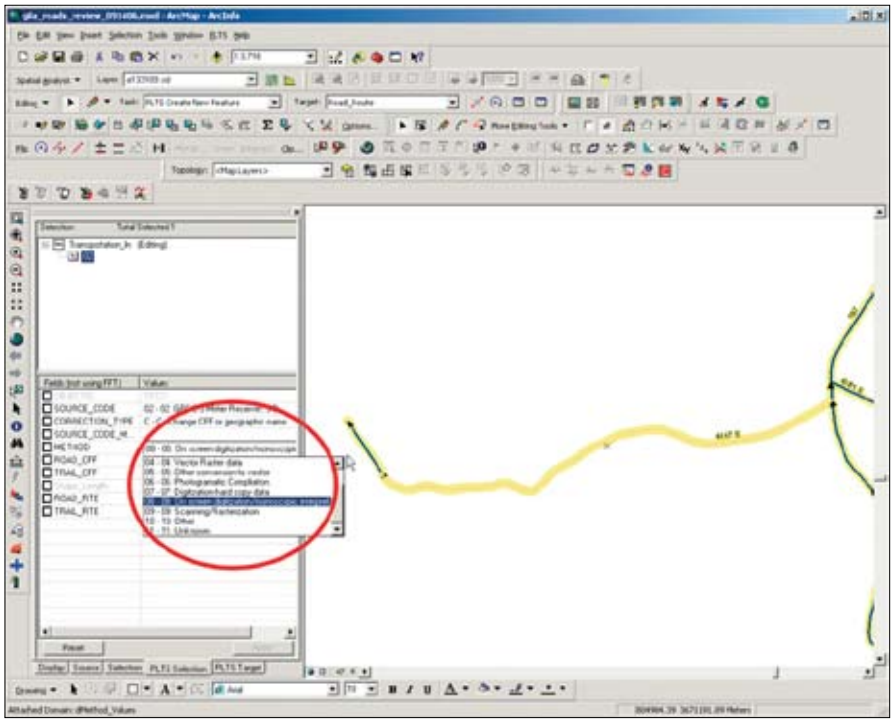
data standards for 11 national forests between New Mexico, Arizona, and the National Grasslands in Oklahoma and Texas. This schema was designed from regional input by GIS specialists and data stewards, as well as specifications from the regional Data Automation Contract with the Tennessee Valley Authority. These specifications were later compiled into the geodatabase schema as standard values, or domains, which could be edited using PLTS for ArcGIS.

Once established, all existing GIS layers for the Gila National Forest were migrated into the new schema.

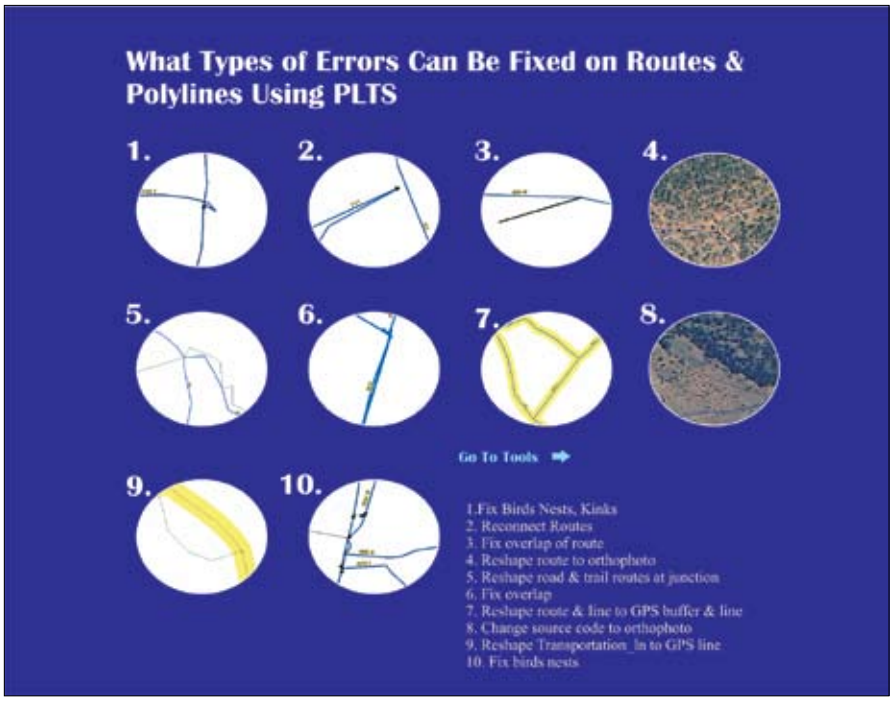
**GIS Data ReViewer Is Key Communication Tool**

The main focus of the project for BLM was the editing phase. This was initiated with the assistance of ESRI Professional Services, which provided a customized two-day training session of PLTS for ArcGIS, focusing on each of the features needed to edit the Gila road layer. The project then proceeded for three months in which both agencies reviewed, edited, corrected, and accepted all roads using the Foundation tools.

One of the most important PLTS for ArcGIS tools for the project was GIS Data ReViewer, which allowed workers to identify errors, provide instructions to fix those errors, then distribute them to the GIS technician. This Foundation tool creates a personal geodatabase that tracks essential tasks within multiple error tables for the GIS technician. These tasks include spatial location of the error, the feature class requiring editing, the GIS technician user name, date, and status of the corrections and resolution.



*The use of domains allows the GIS user to edit and standardize a spatial layer without incurring redundancy and spelling errors.*




*These types of errors are typically found in a transportation layer during the editing session.*

GIS Data ReViewer became an essential mode of communication between the two agencies. Since the Gila and BLM teams both had the tool, it was possible to review the edits and provide guidance when course correction was necessary to complete the project. Additionally, both agencies could share spatial bookmarks, a unique feature of PLTS for ArcGIS, which further aided the location of errors in an efficient and timely manner. Overall, this technical solution was monitored through weekly conference calls to discuss questions and resolve obstacles to keep the project on track.

The magnitude of work accomplished on this project was colossal. More than 45,000 features were reviewed for about 6,000 miles of road. In GIS Data ReViewer, 400 roads were physically edited for both spatial location and attributes. All unsatisfactory edits were flagged as unacceptable until a satisfactory correction could be achieved. Employee performance was easily measured as the BLM GIS technician performed editing tasks on a two- to three-day rotation based on the complexity of the errors. The project was essentially paperless. Major cost centers included salary for the GIS technician and oversight provided by BLM.

This project served as a showcase of the USFS Service First Initiative, demonstrating the use of PLTS for ArcGIS as an innovative

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# Countrywide Mapping Made Possible with GIS at the Colombia National Mapping Agency

Agustín Codazzi Geographic Institute (IGAC) is Colombia's national mapping agency responsible for producing the official map and base cartography of Colombia. It supports geographic studies in the form of land development support and professional training and education in GIS technology and coordinates the Colombia Spatial Data Infrastructure.

In addition, IGAC's mission is to "carry out the constitutional mandate that refers to the production and updating of the official map of the Republic and develop the policies and execute the plans of the National Government with respect to cartography, agronomy, land registry, and geography through the production, analysis, and dissemination of survey and environmental georeferenced information with the goal of supporting land planning and zoning processes."

**The Challenge**

For the past 70 years, IGAC has produced georeferenced cartographic maps at several scales using the most modern technology available at the time. The maps that were developed provided the nation with basic spatial information tools.

In 1994, IGAC began producing digital cartography using Infocam software. In 2003, the cartography branch initiated a process to update the production system and generate additional products, such as spatial maps and orthophotos. Furthermore, one of the principal purposes was to implement a new, comprehensive GIS that would allow IGAC to administer and standardize its cartographic production system. The challenge for the four-year project was to consolidate the 1:100,000-scale digital database, obtain 100 percent of the cartography for urban areas, and achieve 80 percent coverage for 1:25,000-scale cartography.

**The Solution**

During initial planning for digital information capture and responding to the agency's stringent cartographic requirements, IGAC chose available off-the-shelf GIS tools, selecting ESRI software technology as the most robust, functional, widespread, and interoperable for the project. In 2003, Procálculo Prosis S.A. (PPSA), the ESRI solutions distributor for Colombia, signed a contract to replace the existing system with a new one.

Since then, participants have proceeded to implement the tasks of project requirements analysis, hardware and software system design, and development and implementation of the IGAC cartographic database.

Continuing with the implementation, ArcGIS Desktop (ArcInfo, ArcEditor, and ArcView) and ArcSDE were installed. ArcScan for ArcGIS, ArcGIS Spatial Analyst, and ArcGIS 3D Analyst extensions were also installed to provide versatile tools for updating existing cartography and creating new data that would comply with IGAC requirements. All information is stored in an Oracle database that, together with ArcSDE, permits the storage, administration, and maintenance of the information in a way that is centralized, secure, and transparent to the user.

Production Line Tool Set (PLTS) for ArcGIS—Foundation, GIS Data ReViewer, and Maplex for ArcGIS were also installed to perform data upload and quality control functions and generate a high-quality map series. The new implemented system integrates several tools that PPSA built in Visual Basic to execute specific tasks used by IGAC to produce the national base cartography.

**The Results**

In November 2004, the model for the map series (at a variety of scales, all derived from the same basemap) was developed, reviewed, and implemented. Several months of evaluation followed, with the added objective of training production group professionals charged with generating basemaps and thematic maps. As a result of this study, the model for cartographic production was refined to include all the different map scales with the advantage of maintaining everything on just one single GIS platform.

Through the collaborative work of ESRI, PPSA, and the cartography branch, IGAC now has a basemap data model implemented on a single continuous geographic database.

"Establishing the digital capture of georeferenced data with GIS has become an example of successful technological innovation that Colombia is holding up for the rest of Latin America to see," says Miguel Angel Cárdenas, deputy director of geography and cartography, IGAC.

The single cartographic database is used as the standard for information storage and management, saving time and money during map production and in maintenance. The database can be adjusted and improved according to current needs. The system makes it possible to efficiently create printed maps at different scales—1:2,000, 1:10,000, 1:25,000, 1:100,000, and 1:500,000—and of individual departments (Colombian states).

Finally, the cartography branch continues to work toward its ideal of making IGAC the most advanced and efficient center of cartographic production in Latin America.

**More Information**

For more information, contact Helena Gutierrez, Procálculo Prosis S.A. (e-mail: hgutierrez@prosis.com), or Dewey Marino, ESRI (e-mail: dmarino@esri.com; tel.: 909-793-2853, ext. 1-1913).

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**Innovative Solution for Road Data Maintenance at Gila National Forest**

template for establishing cooperation and communication between the two agencies. PLTS for ArcGIS was a key tool in achieving cross-agency goals, improving customer service, and meeting the public expectations of the two land management agencies.

**About the Authors**

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**More Information**

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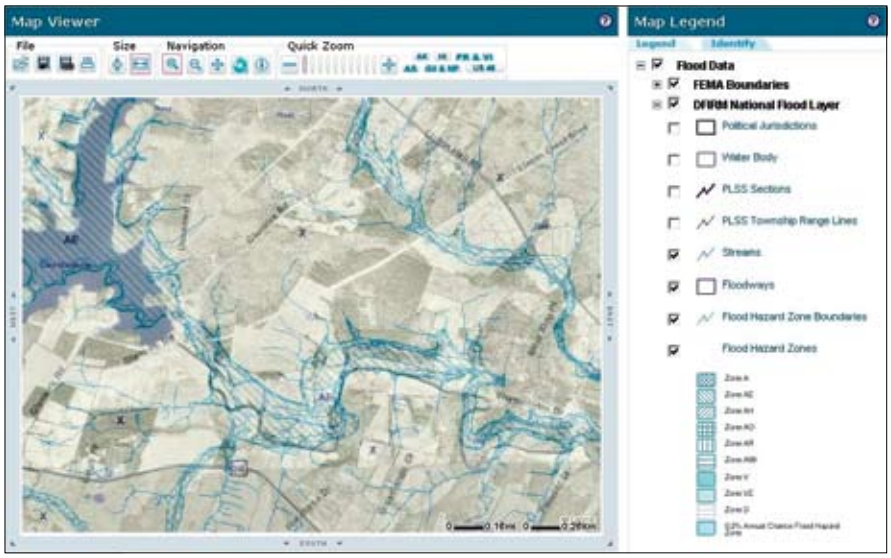
# Flood Map Modernization at the U.S. Federal Emergency Management Agency

The U.S. Federal Emergency Management Agency (FEMA) manages federal response and recovery efforts after any national incident. In 2003, FEMA became part of the U.S. Department of Homeland Security (DHS). More than 2,600 full-time employees work at FEMA headquarters in Washington, D.C., and around the country. FEMA also has approximately 4,000 standby disaster assistance employees who are available for deployment after disasters.

FEMA initiates proactive mitigation activities, trains first responders, and manages the National Flood Insurance Program (NFIP). NFIP currently serves more than five million policyholders and provides coverage for nearly $1 trillion in insured assets to more than 20,100 communities.

Often, FEMA works in partnership with other organizations that are part of the nation's emergency management system. These partners include state and local emergency management agencies, federal agencies, and the American Red Cross.




*FEMA flood hazard maps are integrated with a GIS database that makes data available over the Internet.*

**The Challenge**

FEMA developed a five-year plan, Flood Map Modernization (Map Mod), to update the NFIP's digital flood insurance rate maps (DFIRMs). DFIRMs depict potential flood hazard risk for communities throughout the United States and its territories. FEMA uses DFIRMs to delineate a community's special flood hazard areas and risk premium. Because flood hazard conditions are dynamic, DFIRM data needs to be continually updated. FEMA contracts with state, local, and regional mapping partners to keep flood hazard maps current and to produce maps. FEMA needed an integrated software solution that could manage these updates and changes.

**The Solution**

FEMA chose to manage data for the DFIRMs by integrating flood hazard maps with a GIS database that makes data available over the Internet. The tools used are based on Production Line Tool Set (PLTS) for ArcGIS, which was specifically developed for high-volume database production, maintenance, quality control (QC), and cartographic production projects such as this.

The development of DFIRMs begins with Job Tracking for ArcGIS (JTX), a workflow management application designed to improve the efficiency of multiuser GIS projects. Through Job Tracking for ArcGIS (JTX), FEMA mapping partners create flood hazard products by progressing through a FEMA-defined set of best practices workflow steps. The ability of Job Tracking for ArcGIS (JTX) to facilitate the assignment of work among users allows mapping partners to efficiently manage their DFIRM projects.

Many of the DFIRM workflow steps require the use of ArcMap, an application within ArcGIS Desktop, for data development and review. Upon launching ArcMap via Job Tracking for ArcGIS (JTX), the user can get the toolbars and layers necessary to perform FEMA-specific tasks. FEMA manages symbology requirements with ESRI GIS Data ReViewer, which is part of PLTS for ArcGIS. GIS Data ReViewer allows users to employ a set of predefined complex attribute checks to review both spatial layers and business tables. These checks mimic FEMA's independent QC process because users can detect and correct errors early in the DFIRM production process. These checks also help ensure that FEMA-compliant data is created.

The GIS Data ReViewer Error Table tools allow different critics within the mapping partner group (including QC, engineering, and mapping) to review the spatial data. The engineers and QC analysts use notepad features and comments in the Error Table tools to indicate areas in need of revision, which the mapping analysts then correct. The GIS Data ReViewer Error Table tools also facilitate the spatial integration of engineering data.

**The Results**

FEMA is now able to easily track the mapping process for its flood hazard mapping projects and create the final DFIRM database through best practices using PLTS for ArcGIS. PLTS for ArcGIS streamlines the product development process and allows FEMA mapping partners to work together by project reassignment using Job Tracking for ArcGIS (JTX) within the DFIRM tools environment.

PLTS for ArcGIS also facilitates the spatial and attribute validation process. Using GIS Data ReViewer, FEMA can effectively highlight attribute errors. The GIS Data ReViewer Error Table tools allow QC analysts to locate areas in need of revision in the flood hazard database, track the mapping process of projects, and revise the database.

Once updated, DFIRMs are stored digitally on FEMA's Mapping Information Platform (MIP), which can be viewed on the agency's Web site at **hazards.fema.gov**.

**More Information**

For more information, contact Melis Mull, FEMA, Mitigation Division (tel.: 202-646-4135), or Glenn Berger, ESRI (e-mail: gberger@esri.com, tel.: 678-417-1883).

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## NOAA Modernizes Nautical Chart Production

Navigational Chart (ENC) format based on the International Hydrographic Organization S-57 transfer standard. Data is obtained from more than 50 entities, including the Army Corps of Engineers, NOAA survey ships, and the U.S. Coast Guard.

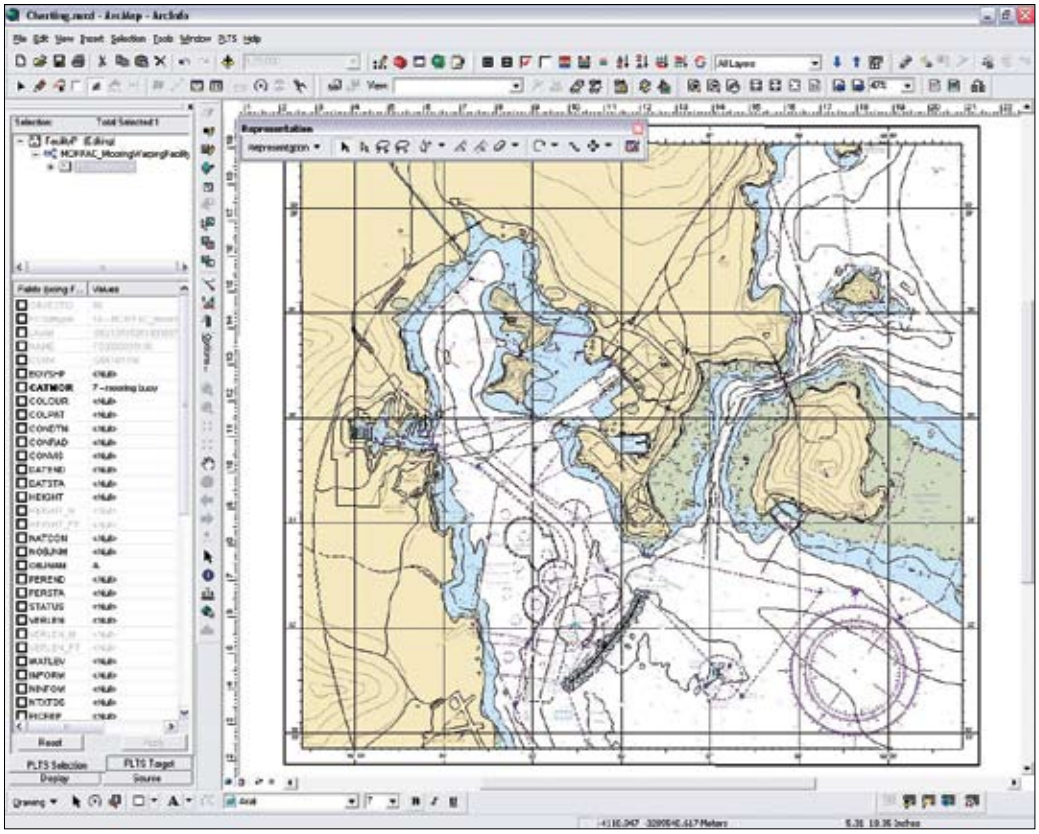
In the current system, critical updates for paper and electronic charts are published weekly. However, the noncritical update cycle for paper charts ranges from every 6 months for areas of high commercial traffic to as infrequently as 12 years for remote areas. The average revision interval per nautical chart is about 2 years. Data must be applied multiple times, stored in multiple applications, and processed through several production lines to either an ENC or a paper chart, which is a major factor in the amount of time, effort, and quality control needed for updates.

MCD has used GIS for many years to improve workflows and data management but wanted a COTS-based enterprise-wide system for NCS II to gain efficiencies and streamline data management and product generation. NOAA MCD contracted with McDonald Bradley, Inc., an information technology solutions provider, to integrate, operate, and maintain NCS II. After a rigorous selection process, McDonald Bradley selected ESRI as a subcontractor on the project due to ESRI's expertise and experience working on GIS projects. In particular, the team wanted to leverage PLTS for ArcGIS—Nautical Solution, which provides production-oriented applications and end-to-end workflows tailored specifically to the needs of hydrographic offices.

With the implementation of NCS II, McDonald Bradley is creating a system that compiles source data from the myriad of providers, stores the information in a single database, and is able to extract information to produce various paper and electronic charts.

MCD expects NCS II to decrease production time for charts significantly, allowing more frequent updates. The streamlined workflows and improved data management will increase the agency's ability to respond to coast-altering events, as well as improve the accuracy of charts and ensure greater navigational safety and better coastal management. Because MCD will manage data centrally, integration with ancillary legacy systems will be centralized and optimized. Furthermore, MCD will have the capability to offer new products and Web services within NOAA or to end users of the data.

The NCS II project is in the integrate and test phase, with initial system capability acceptance planned for mid-2008. Following system acceptance, MCD will conduct an extensive operational test and a multiyear transition plan based on charting priorities. With NCS II, MCD expects to realize significant gains in productivity, data management capability, and flexibility once the transition is complete. With this move to a next-generation GIS-based system, NOAA MCD will continue to be the world leader in hydrographic information management.



*The NCS II will help the Marine Chart Division meet its critical challenge of providing navigation products that cover approximately 11 million square kilometers of coastal waters.*

### More Information

For more information, contact Julia Powell, Marine Chart Division, NOAA (e-mail: Julia.Powell@noaa.gov, Web: **chartmaker.ncd.noaa.gov**), or Brian Cross, ESRI (e-mail: bcross@esri.com; tel.: 909-793-2853, ext. 1-1158).

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**Modernizing National Mapping Workflow**

- Primary data collection
  - Planning the data acquisition program
  - Performing or contracting field data collection
  - Performing or contracting remote data collection
- Data processing
- Extracting and compiling digital information
- Performing quality assurance
- Instituting "one-touch" data maintenance across the enterprise
  - Defining enterprise data workflows
  - Centrally managing data workflows
- Finalizing information products
- Information dissemination
  - Cataloging information
  - Storing information
  - Developing dissemination mechanisms (digital and print)
- Ensuring interoperability among all enterprise business systems
- Providing access to, and integration with, other agencies, commercial organizations, and public offices

**Common Strategies to Improve Business Functions**

There are common GIS-based strategies that all NMAs can employ to improve these business functions:

- Maximizing the use of standards-based COTS products minimizes operational costs and production schedules while leveraging best practices for each domain. COTS-based solutions allow workflows, business rules, desktop applications, and Web services to be built on a common framework.
- Adopting a service-oriented architecture (SOA) framework lets agencies leverage legacy data during transformation and provides flexible alignment of functions with business units, interoperability between working databases with various geospatial technologies, and extensive reuse of applications when provided as registered services.
- Approaching change by business unit allows each unit to adapt and adopt workflow improvements, new applications, new services, and data model refinements independently while collaborating with other business units through the SOA.

**Conclusion**

NMAs are no longer just about mapping and charting. The increasingly sophisticated demands of their customers, which now include communities of users in the government and private sectors, and their own institutional requirements have changed their missions to providing leadership in geospatial data collection, management, and dissemination through a greater variety of products and solutions.

Thus, their situation has changed from stovepipe departmental GIS/processes/procedures for developing static map products to maximizing the value from the investment in digital information across the enterprise. Their systems must meet broader strategic goals, including

- Providing accurate and timely geospatial products and services
- Demonstrating the capabilities to adapt to new requirements and technologies
- Extracting maximum value from geospatial information
- Allocating resources effectively
- Promoting collaboration throughout the organization, as well as through interdepartmental and interagency partnerships and collaboration with commercial/private organizations
- Ensuring the effective planning, development, and administration of core business functions

NMAs worldwide must achieve these goals within the context of their particular national policies, markets, budgets, and assets. They need cost-effective COTS-based solutions that can integrate systems and databases and standardize business functions while providing maximum flexibility to adapt to their particular needs and situations. ESRI ArcGIS solutions are used to meet the challenge of true integration of geodatasets, maps and globes, metadata, and process and workflow models.

**More Information**

For more information about how ESRI software addresses these critical challenges, read the article on page 5, "Technology Solutions for National Mapping Agencies."

For more information about GIS for national mapping and cartographic production, please visit www.esri.com/nmasolutions.

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*For more than 35 years, ESRI has been helping people make better decisions through management and analysis of geographic information. A full-service GIS company, ESRI offers a framework for implementing GIS technology and business logic in any organization from personal GIS on the desktop to enterprise-wide GIS servers (including the Web) and mobile devices. ESRI GIS solutions are flexible and can be customized to meet the needs of our users.*

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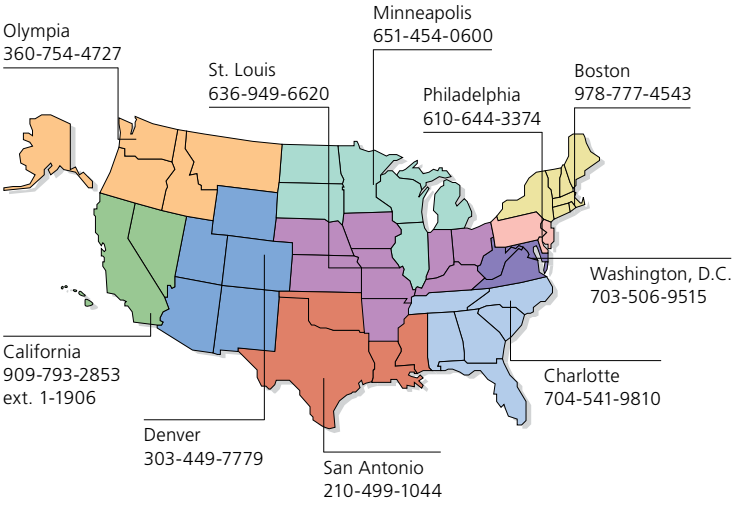


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