

Enterprise GIS in National Security

Defense, Intelligence, and National Security Case Studies



Table of Contents

- 5 Naval Oceanographic Office Launches Enterprise Geospatial Data Services
- 9 CJMTK Geospatial Appliance Quickly Delivers Smart Maps to Warfighters
- 13 National Geographic Security System for the Bahrain Ministry of Interior
- 17 Brisbane City Council Flood Common Operational Picture
- 21 Enterprise GIS: Got Enterprise Architecture?
- 25 Fast Delivery of Imagery for the United States Air Force Air Combat Command
- 29 The NATO Core Geographic Services System

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Dear Colleagues:

I congratulate the organizations represented in this booklet. The projects described in the case studies herein took a giant leap forward, moving geospatial information from a few specialists' hands to where it's now available to everyone in the organization. They moved from stand-alone workstations or a client/server environment to transactional, enterprise-wide systems, enhancing collaboration and tradecraft within the defense, intelligence, and national security communities.

Through entrepreneurial efforts such as these and with the ability to push geographic information system (GIS) technology to the limit, the science of geography is

evolving from simple uses to networked environments involving servers, workstations, mobile devices, and the web. This has sparked the concept of sharing geospatial information throughout an organization and bringing about collective geographic understanding of the battlespace. This gives you the geographic advantage: the vital information required to first understand and then act.

Enterprise GIS in National Security reflects how GIS is part of the information technology (IT) infrastructure. The stories show how GIS is quickly becoming a dominant part of the IT used by military and intelligence organizations worldwide.

This collection of case studies includes stories about how Esri® technology is being used for enterprise-wide solutions for humanitarian and disaster relief (HADR) missions, maritime applications, and multinational forces. As examples, the North Atlantic Treaty Organization (NATO) implemented the ArcGIS® system as its core GIS, and the US Naval Oceanographic Office (NAVOCEANO) launched enterprise services for US Department of Defense and civilian use.

The NATO story is quite impressive, as the entire organization now has access to Esri technology to ensure that everyone in NATO "fights off the same map." Just as powerful a story is how NAVOCEANO implemented its GIS-based system on a modern service-oriented architecture (SOA).

The challenge for the future of geography in defense, intelligence, and national security is for organizations to move from observation and storytelling with GIS to a fully analytic force that acts responsively and decisively.

Warm regards,

A handwritten signature in black ink, reading "Jack Dangermond". The signature is stylized, with the first letters of the first and last names being large and prominent.

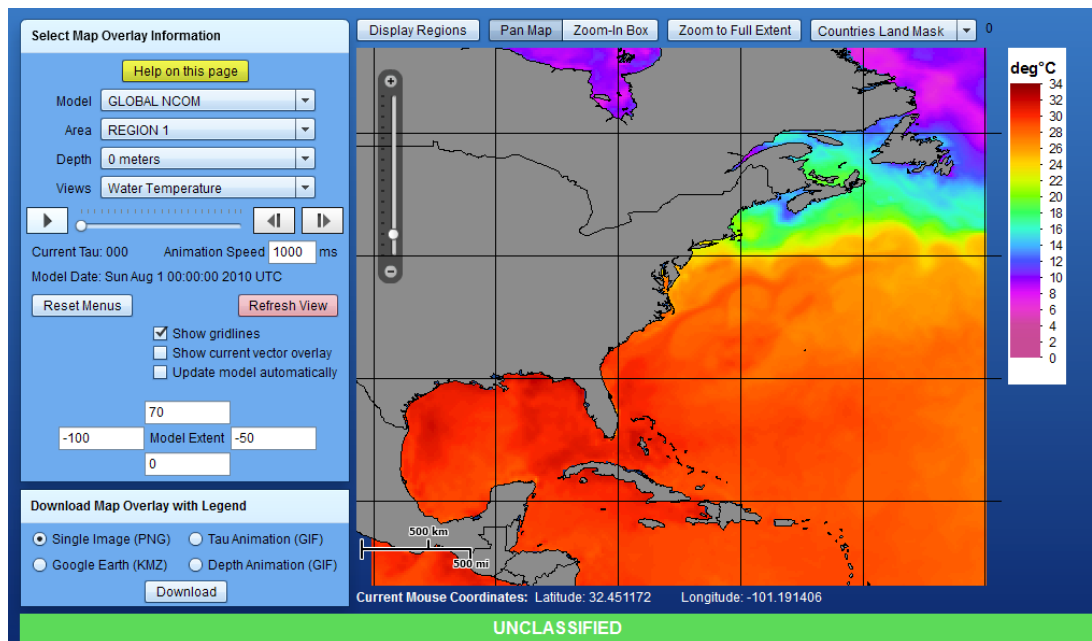
Jack Dangermond
Esri President



NAVOCEANO

Naval Oceanographic Office Launches Enterprise Geospatial Data Services

Geospatial Technology Delivers Oceanographic Information to Warfighters and Civilians



US Navy customers can generate coastal ocean model surface temperature via a customized web interface.

The Naval Oceanographic Office (NAVOCEANO), based at the John C. Stennis Space Center in Mississippi, continually collects oceanographic data around the globe. NAVOCEANO uses that data to produce a wide variety of oceanographic products and services for the United States Department of Defense (DoD), along with other US government and international customers including civilian organizations. NAVOCEANO's top priority, however, is to provide the best available oceanographic, coastal, and shoreline information to US warfighters.

Oceanographers, cartographers, and GIS professionals collect and analyze data from commercial and US government remote-sensing satellites and NAVOCEANO's fleet of ships, seaborne buoys, gliders, and lidar-equipped aircraft. They then turn the data into tailored oceanographic, hydrographic, bathymetric, geophysical, and acoustic products and services. These include bathymetric data for navigation; ocean measurements; and forecast properties such as tides, salinity, temperatures, wave height, swell periods, current direction and speed,

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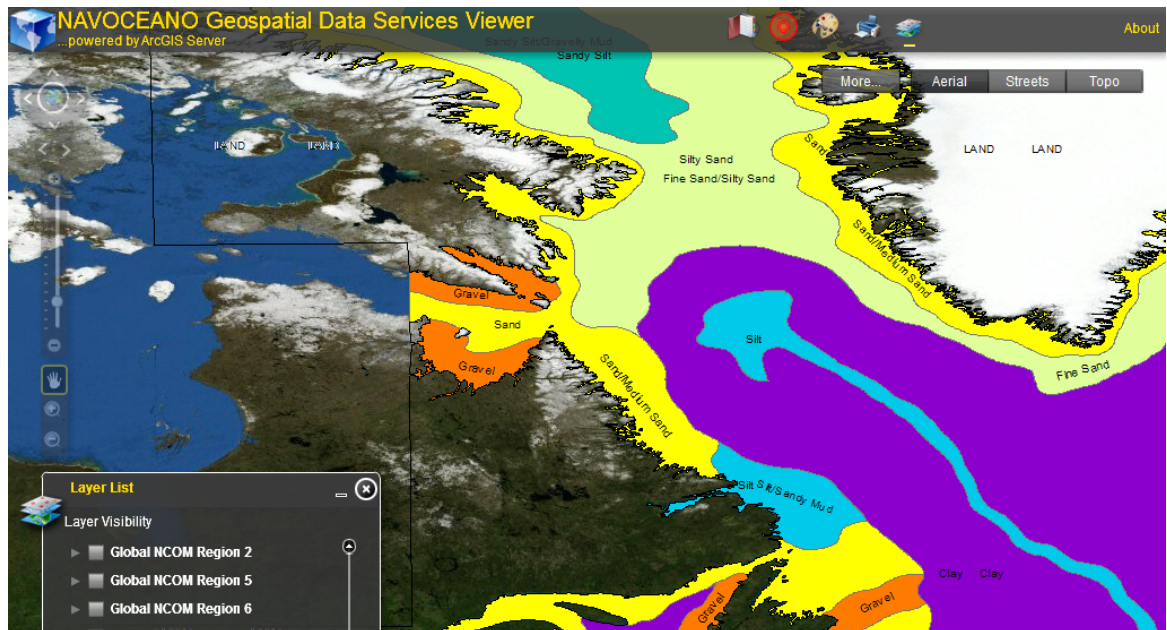
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Users can easily visualize bottom sediments data to aid in mine warfare missions.

optical visibility, mine detection, and acoustics. Warfighters, researchers, homeland security organizations such as the US Coast Guard, and many others, greatly depend on these products and data to safely navigate vessels through ports and the open ocean and effectively plan their strategic, operational, tactical, and humanitarian missions.

The Challenge

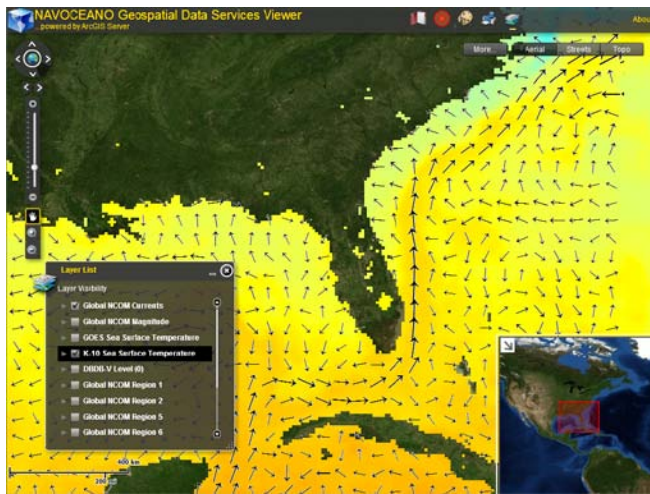
Facing a rising tide of data and a growing demand for dynamic, time-sensitive information about specific areas of the world, NAVOCEANO decided it needed a modern service-oriented architecture (SOA)-based system to speed delivery of data and products to mariners and give them the best tools to build custom products themselves.

Examples of NAVOCEANO's various products and services include nautical charts, ocean temperature forecasts, ocean drift and surf forecasts, port approach maps, and advanced geophysical and acoustic analyses. The organization realized that traditional methods of delivering products and services using HTML-based web pages either took too long or did not dynamically generate data detailed enough for a small area.

The Solution

NAVOCEANO contracted with Radiance Technologies, Inc., an Esri partner headquartered in Huntsville, Alabama, to develop NAVOCEANO Geospatial Data Services (NGDS). The geospatial technology-based enterprise SOA quickly serves oceanographic data, models, and products and provides an easy-to-use interface for finding information and requesting advanced analysis. The geospatial technology used was Esri's ArcGIS Server. The NGDS also manages workflow processes, enforces DoD metadata standards, and stores data in a centralized geodatabase.

NAVOCEANO can now provide US Navy coastal ocean models (NCOMs) on demand through a customized web interface that accesses Open Geospatial Consortium, Inc.® (OGC®), Web Map Services (WMS). These services now replace the generation of 15,000 soft-copy regional NCOM maps daily. This saves valuable high-performance computing time, allowing NAVOCEANO to run its complex ocean models more often. Using these web services and interfaces, DoD warfighters, researchers, and customers can customize the ocean model output display by defining their area of interest, selecting the desired ocean properties by depth and time period, and generating a



Quick and easy tools in the viewer can be used to calculate and visualize global NCOM data.

product image. Using this interface, they can also download the image in various formats, including .png, .gif, animated .gif, or .kml. The final output of ocean current direction vector arrows overlaid on a surface temperature model image can then be incorporated into briefing presentations or GIS technologies.

Using the NGDS secure web-based system, warfighters and others can find and retrieve this environmental data using OGC WMS, Web Feature Services (WFS), and Web Coverage Services (WCS) clients such as Esri's ArcGIS Explorer.

The Results

The ArcGIS Server software-based NGDS is hosted on both unclassified and classified networks. It delivers oceanographic information to NAVOCEANO production centers and authorized organizations through the use of OGC web services. This gives NAVOCEANO staff the ability to create, manage, and distribute GIS services over the web to support desktop, mobile, and web mapping applications, something they previously could not do. An added benefit of implementing an SOA based on ArcGIS Server is that authorized users can obtain NAVOCEANO oceanographic data from the National Geospatial-Intelligence Agency's (NGA) Geospatial Visualization Services (GVS).

NGDS Services Available Now

The new NGDS disseminates more than 80 services that include

- Deep ocean forecasts of temperature, salinity, current direction and speed, and sea surface height
- Wave forecasts of significant wave height, mean wave direction, mean wave period, peak wave period, and height (tides)
- Sea surface temperatures derived from satellites
- Digital Bathymetric Database—Variable resolution (DBDB-V)
- Bottom characteristics important for mine warfare such as sediments, seafloor clutter, and bottom type

Services currently being developed include

- Nearshore ocean forecasts of temperature, salinity, currents, and tides
- Derived acoustic properties from NCOM
- Ocean drift and surf forecasts
- Ocean horizontal and vertical visibility
- Acoustic performance surfaces

The NAVOCEANO Esri ArcGIS Server software-based NGDS system proved to be integral in planning the navigation routes during the US government's massive response to deliver aid to the victims of the earthquake in Haiti in January 2010. NAVOCEANO production teams tapped into their geospatial databases to produce ingress/egress navigation routes for US hospital and supply ships that needed to deliver care and supplies to Haiti.

"It took four hours to produce one [navigational aid] product simply because the data was already in the system," said one production manager. He simply had to pull out and reuse existing data that was required for analysis and navigation planning. Without the system, it would have taken one or two days to produce the same navigational aid product.



CJMTK Geospatial Appliance

Northrop Grumman's CJMTK Geospatial Appliance Quickly Delivers Smart Maps to Warfighters

Preloaded and Ready to Use, the Appliance Serves Maps for Defense and Intelligence Missions

Training, reconnaissance, combat, logistics, intelligence gathering, and other missions, demand quick, simple access to extremely accurate geographic information: high-resolution imagery from government sources; the most up-to-date maps available; and geospatial data such as topographic features, shaded relief, terrain elevation, and nautical charts. Northrop Grumman's Commercial Joint Mapping Toolkit (CJMTK) Geospatial Appliance (CGA) supplies it all.

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NORTHROP GRUMMAN



The Challenge

The global war on terrorism (GWOT) drove up demand for National Geospatial-Intelligence Agency (NGA) data, with requests coming from the United States Department of Defense (DoD) organizations. Multiple groups within these organizations were taxing NGA resources, asking for the same world maps and map data for a particular area of interest (AOI). NGA also collects and updates more data than ever before due to the war on terrorism. However, data maintenance did not keep pace because of the sheer volume of information the agency needed to validate.

The data being sought by US federal organizations needed to be mission ready for military or intelligence operations. But some of it was outdated; did not work optimally on network-centric systems; or was not in the proper formats, such as those needed for web services. Another complicating factor was the lack of available personnel to maintain the data servers and data services and ensure that the data was accurate and accessible to multiple groups within the same organization.

For example, the US Army has command, control, and intelligence (C2I) systems in geographically disparate locations that need the same data for a mission. The G3, a plans and operations group in a division's main Tactical Operations Center (TOC) located in the continental United States, requires the map data for mission planning. The company S3, a plans and operations officer, is working in Afghanistan and needs the same data to refine the division plan for the company's role in the operation. And the warfighter, driving a HMMWV through an Afghani provincial village, depends on the information to execute the mission.

The G3, S3, and warfighter require the same basemaps but may need different hardware solutions to deliver the data. Since the mission is paramount, time is of the essence, and much of the environment is rugged, the solution has to be easy to maintain and the geospatial data easy to access and update.



The rack-mounted CGA supports hundreds of users. (Image courtesy of Iron Systems).

The Solution

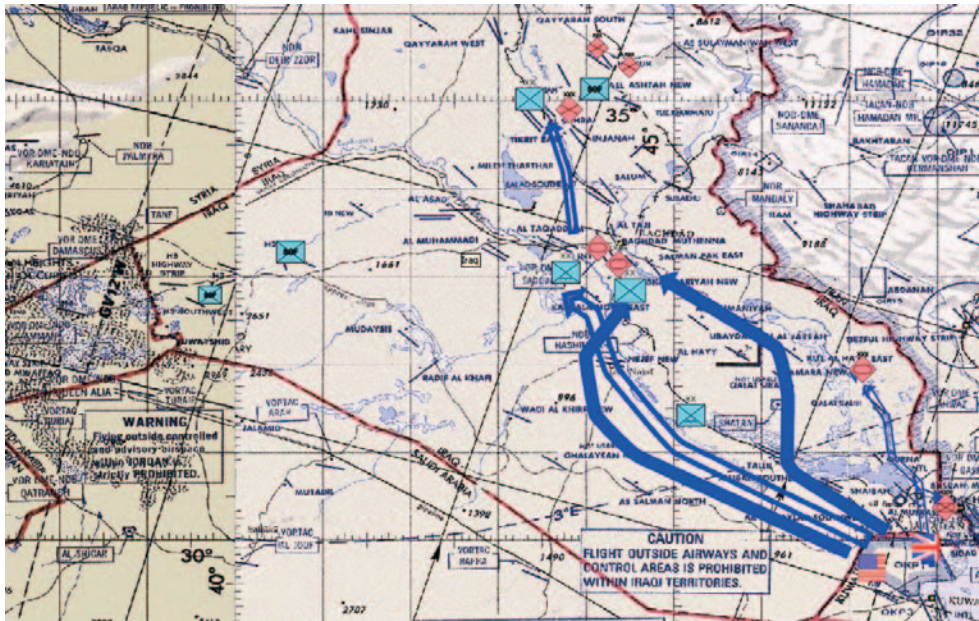
Northrop Grumman Corporation, using Esri technology, produced CGA to give organizations an integrated solution to easily acquire NGA data and receive regular updates of the data. This is beneficial to groups using CJMTK-based C2I and legacy systems.

The appliance provides the geographic content from NGA. CGA, a high-performing server loaded with geospatial data and software, comes configured with the latest Esri geospatial technology to ensure that users can deliver what Northrop Grumman calls "fast, smart maps."

Warfighters needed a map server capable of serving NGA's entire catalog of digital geospatial data and maps in a variety of formats. It had to serve web mapping services, such as those compliant with the Open Geospatial Consortium, Inc. (OGC), Web Map Service (WMS) standard, REST, SOAP, Keyhole Markup Language (KML), geodatabase flat file, and FalconView. This enables military personnel to use the data in CJMTK-based C2I systems such as the All Source Analysis System-Light (ASAS-L) and legacy systems such as FalconView.

The CGA software includes

- Microsoft® Windows Server
- Esri ArcGIS Server
- Esri ArcGIS Server Image extension
- Esri ArcGIS Desktop, with extensions
- Northrop Grumman's Geospatial Management and Provisioning Suite (GMPS)
 - » Content management tools
 - » Data provisioning
- Application-ready data (WMS v1.1.1, KML v2.0, SOAP, REST, mapping, Gazetteer place finding)



Analysts using ASAS-L can use and display data from CGA.

Some of the preloaded NGA data includes

- Controlled image base (CIB) orthorectified imagery at 10-, 5-, and 1-meter resolutions
- Digital Terrain Elevation Data (DTED) at 30 arc second (nominally one kilometer) and 90- and 30-meter resolutions
- Shuttle Radar Topography Mission (SRTM) digital elevation models
- Vector Product Format (VPF) vector map data
- Automated air facility information file (AAFIF)
- Compressed ARC Digitized Raster Graphic (CADRG) data that includes
 - » Global Navigation Chart (GNC)
 - » Jet Navigation Chart (JNC)
 - » Operational Navigation Chart (ONC)
 - » Tactical Pilotage Chart (TPC)

Northrop Grumman provides updates of NGA data three times per year. CGA comes in two versions: the rack-mount server, for large organizations, supports hundreds of users, and the tower unit can be easily deployed for use in a forward operating base.

The Results

CGA enables US defense and intelligence organizations and groups to immediately deploy and field a complete geospatial dataset for any international contingency including combat, intelligence, and emergency operations; humanitarian assistance and disaster relief; and special operations, as well as many other defense and intelligence missions. Service members can concentrate on the mission rather than on whether the data is up to date or in the proper format.



The CGA tower unit is easily deployable for use in a forward operating base. (Image courtesy of Iron Systems).



Bahrain Ministry of Interior

National Geographic Security System for the Bahrain Ministry of Interior



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The Kingdom of Bahrain's strategic location in the Arabian Gulf has given it the chance to broaden its cultural perspective and increase its prosperity through trade and travel. However, its location has made it desirable not only for traders but also for those seeking to establish control over shipping in the gulf.

Among its many duties, Bahrain's Ministry of Interior (MOI) is responsible for the country's homeland security and natural resources as well as the maintenance of safe and secure passage in and around the kingdom. The MOI is the first line of defense in managing threat attacks; hence, the ministry's ability to quickly and effectively access spatial data that can minimize damages and save lives is essential.

The Challenge

The MOI required a nationwide solution that would be used to enforce public security and achieve tight control, leverage data sharing between the various MOI departments, and allow effective emergency response planning and efficient emergency management.



The GSS common operational picture can display multiagency geographic information.

The Solution

After several intensely competitive bid rounds, ESRI Northeast Africa was selected to provide a national-scale, state-of-the-art solution, the Geographic Security System (GSS).

- At the core of GSS, a unified geodatabase was established to host the spatial and tabular data of the MOI.
- GSS is built on industry standards based on service-oriented architecture (SOA) to overcome issues concerned with data isolation and the lack of integration among various MOI departments.
- It integrates with and spatially empowers automated vehicle location (AVL) and other existing surveillance systems, and it enables users to visualize incidents.
- The solution is composed of several modules. All the modules provide resource management, analysis, and report generation functionalities.

The modules are as follows:

Emergency Response System

- Handles all issues related to receiving calls about incidents and dispatching units accordingly
- Coordinates between field officers and the control room dispatchers using the in-vehicle devices

Traffic GeoManager

- Aids traffic control room staff in viewing traffic status and controlling traffic flow by manipulating street properties and exit and entry points

Mission Planning System

- Permits users to put forth a suitable plan for dispatching units and allocating them, defining the ideal route for the units, and identifying the nearest medical facilities to the site of an incident
- Allows selection of the most appropriate live feed sources to acquire immediate feedback from the scene

Crime GeoAnalyzer

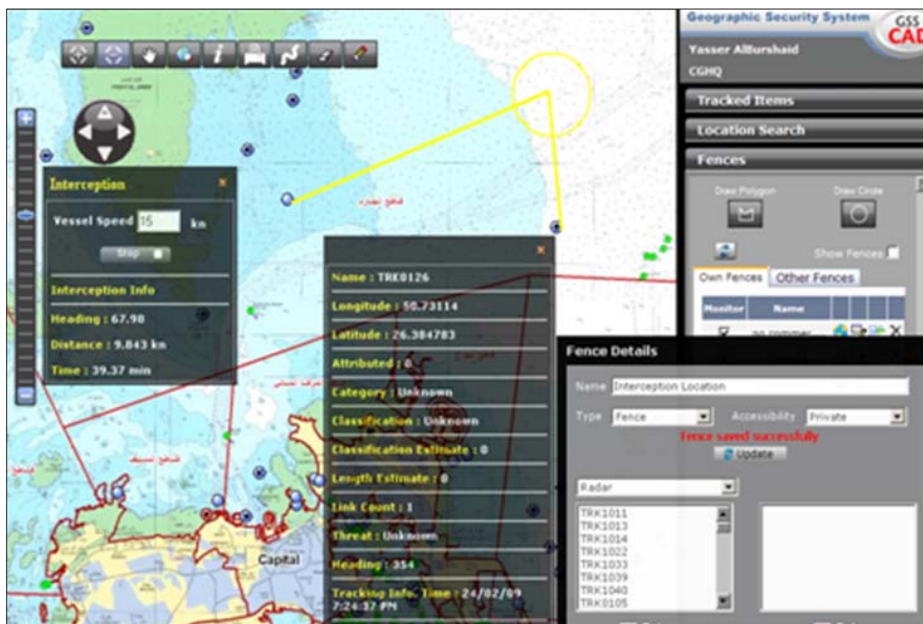
- Allows users to conduct advanced analysis on crime incidents recorded in the system's database
- Allows the highest crime activity areas to be located on the map, and investigation to be enhanced, since users can view the coverage of police vehicles in these areas and identify reasons behind the prevalence of such incidents

Coastal Surveillance System

- Allows users to effectively survey all marine activities, displaying the various locations of outgoing and incoming ships by connecting to radar and other external information systems in other marine-affiliated entities

Task Force Management System

- Allows users to fully control their fleets and assign tasks based on preplanned missions or developing incidents
- Useful for any entity requiring a fleet management system
- Allows decision makers to track and visualize the movement of vehicles on interactive maps
- Identifies a patrol vehicle of interest by displaying its available information



The GSS coastal surveillance capabilities include radar tracking, automated information system (AIS) plotting, and interception analysis.

Esri Software Used

ArcGIS Server 9.2 and ArcGIS 9.3 (Network Analyst and Spatial Analyst extensions)

- ArcGIS Desktop 9.3 (Network Analyst, Spatial Analyst, 3D Analyst™, and Tracking Analyst extensions)

Other Software Used

Windows® 2000/2003 Server

- Windows 2000 Professional

Hardware Used

IBM® Blade Servers

Results

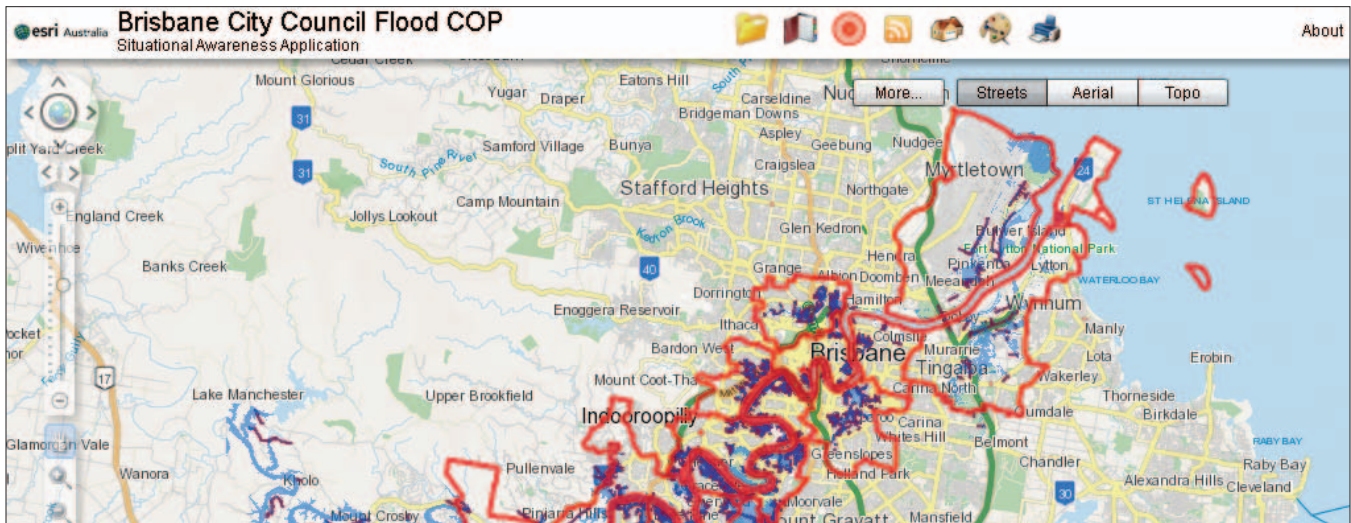
- Enabling of various system users to visualize data, thus ensuring efficient and effective resource allocation and utilization
- Increased response time
- A single common operational picture (COP) for top managers
- Seamless integration between GIS and imaging and radar systems
- Availability of presorted procedures for incident handling
- Seamless communication with mobile units
- Enhanced data sharing between MOI directorates
- Full seamless integration with government databases
- Live situational maps providing a real-time view of the current situation
- Efficient and accurate management of day-to-day operations
- Critical infrastructure information (documents, images, videos, etc.) and location management
- Enhanced response time and analysis capabilities



BCC Flood COP

Brisbane City Council Flood Common Operational Picture

Application Gave Responders a Web-Based Tool to Prepare for and Respond to Massive Flooding



The BCC Flood COP shows the flood extent and BCC operational sectors on top of a basemap provided by Map Data Services (MDS).

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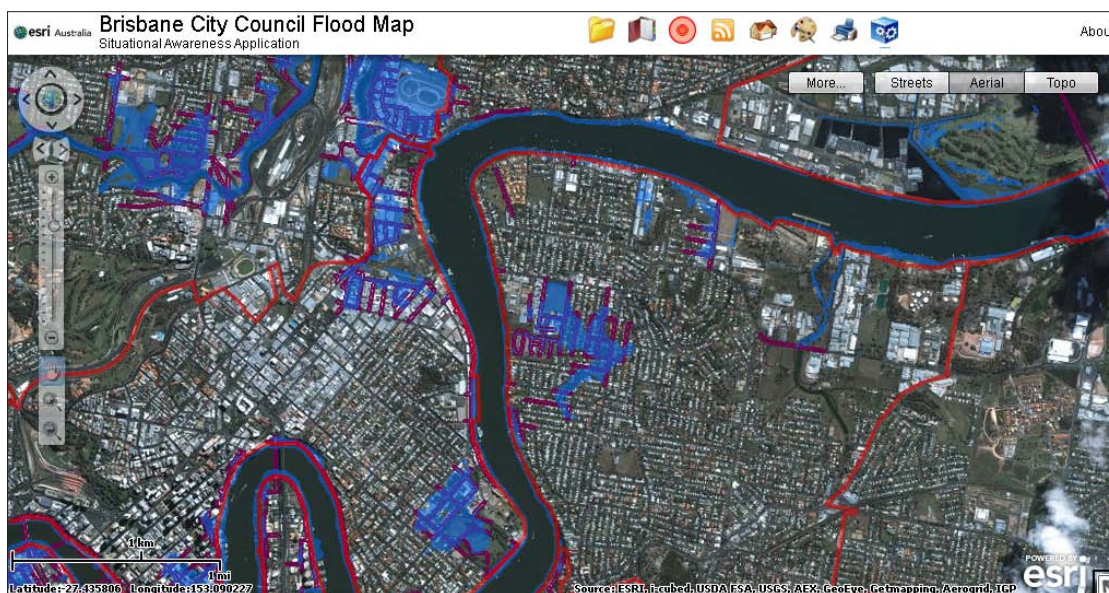
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After years of devastating drought, torrential rains caused by the La Niña weather phenomenon drenched Queensland, Australia, in late 2010. The constant rains triggered deadly flooding in Brisbane and dozens of other communities in January 2011. More than 35 people were killed, and damage to property was extensive.

By the evening of January 10, it became apparent Brisbane was about to experience serious flooding and damage such as had not been seen since 1974, when three weeks of rain caused the river that runs through the city to overflow and flood more than 6,000 homes.

The latest flooding took an even heavier toll. In Brisbane alone, almost 33,000 homes, businesses, and properties were damaged or destroyed as a result of being inundated with mud and water. Coal mines, vital to Queensland's economy, were flooded. Insurance claims have topped 1.5 billion Australian dollars (A\$). Damage to the country's economy is estimated at more than A\$30 billion.

"In many ways, it is a disaster of biblical proportions," Queensland treasurer Andrew Fraser told the media during the worst of the flooding.



BCC placed the flood map on a public-facing website. This view shows aerial imagery from Esri and areas inundated with water shaded in blue.

Australia's prime minister and cabinet approved the activation of 1,600 members of the Australian Defence Force (ADF) to assist in the disaster recovery operations. The ADF airlifted food and supplies to outlying communities and conducted search and rescue missions.

The federal, state, and local governments, as well as numerous volunteer organizations, launched disaster recovery operations. Brisbane City Council (BCC) mobilized more than 50,000 local residents to do everything, from volunteering at the evacuation centers to cleaning up mud- and water-damaged homes and businesses. The magnitude of the logistics to manage and coordinate this operation was the largest in Brisbane's history.

The Challenge

BCC needed a way to share vital information with the many recovery teams, ADF, work units, and community volunteers. Disseminating information about the flood peak and where roads, bridges, and other infrastructure were flooded would help decision makers in both the command center and the field best coordinate and utilize the workers. The solution needed to be simple and fast.

The Solution

While heavy rain continued to fall, an engineering contractor worked with BCC to produce numerous hydrology models based on flow rates. The results of the models were used as part of a GIS analysis. Information produced by the GIS analysis was used to report the effects of the flood on critical infrastructure, such as what was destroyed and damaged.

BCC contacted ESRI Australia Pty. Ltd. for assistance. BCC and ESRI Australia decided to use ArcGIS Viewer for Flex™ and ArcGIS Server to create the BCC Flood common operational picture (COP). The intent was to initially create an online mapping application for the council and state and federal agencies that needed to dispatch and coordinate resources to best deal with the crisis. A second application, the BCC Flood Map, would then be made for disseminating information to the wider, public audience.

Separate websites were created for each web application so the government and the public would not be competing for computing resources. The internal-facing web application gave officials at BCC and state and federal agencies their own decision-making tool.



Floodwater reaches waist level on Mark Wallace, GIS manager at Queensland Fire and Rescue Service. He was conducting preliminary flood damage assessment in Ingham. (Photo courtesy of Richard Gory)

Citizens used the public-facing BCC Flood Map to see which roads were affected by the flooding, find evacuation centers, and view the modeled flood peak layer. As the flood peak passed and the waters started to subside, BCC wanted to use the public-facing map to communicate how the council was going to manage the huge task of cleaning up the city.

However, the initial map on the BCC site that was meant for use by the government agencies was overwhelmed quickly as the word spread through social media channels about a flood map website. By using the Amazon® Elastic Compute Cloud (EC2), ESRI Australia was able to quickly scale the infrastructure behind the application to meet the demand. Had conventional infrastructure been used, scaling the site would have been a slower, more labor-intensive task and probably would have resulted in the public being unable to get the information it needed due to poor response times.

The Results

The Esri-based web viewer proved to be an ideal solution for BCC. It was similar to defense COPs, and in many ways, the BCC Flood COP was designed around the same principles. Map Data Services (MDS) supplied the basemap, MDS Foundation Map, a ready-to-use cached map service with authoritative street and property information for Australia.

As the floodwater continued to rise, the internal and external websites were constantly updated with new operational overlays. Planning layers, such as operational sectors and emergency waste disposal sites, were established. Multiple agencies used the BCC Flood COP to respond to the emergency. The mapping application benefited not only BCC staff but also other emergency responders such as members of the fire and rescue services, police, and ambulance units as well as various ADF personnel that assisted in the operations.

The BCC Flood Map was also launched using Esri's ArcGIS Viewer for Flex. People who wanted to know if their house was possibly going to be damaged by the flood could visualize the areas already inundated and bring up flood prediction maps. A Microsoft Bing™ locator was added to allow the public to search for an address and then easily navigate to that address. Evacuation centers, often located in stadiums or churches, were placed on the map. People could click the Evacuation Centres button on the application's toolbar to add those sites to the map. They could then zoom in to their neighborhood to find the center closest to them. An Australian Broadcasting Corporation (ABC) GeoRSS feed was also added to provide constant news updates from the field. At the flood's peak, the BCC Flood Map received about 1.5 million hits.

Mobile users, however, could not view the online flood maps because they lacked the support for Flash® that was needed to access the BCC's sites. To combat this limitation, a web map was created using the flood-related services from ArcGIS Server and the Bing basemap. This web map was created in ArcGIS™ Online and made available through a public group called Queensland Floods. Creating web maps using ArcGIS Online exposes mashups and functionality to a range of end users through many devices. In this case, it allowed iPhone®, iPad®, and Windows Phone users to see the same flood-related content on their mobile devices.

Queensland is a large state in area but a small one when it comes to community. Despite its size, people came from far and wide to assist in the cleanup and recovery process. Additional mapping efforts using ArcGIS Viewer for Flex can be seen on the Queensland Reconstruction Authority's website at www.qldra.org.au.



USMC GEOFidelis

Enterprise GIS: Got Enterprise Architecture?

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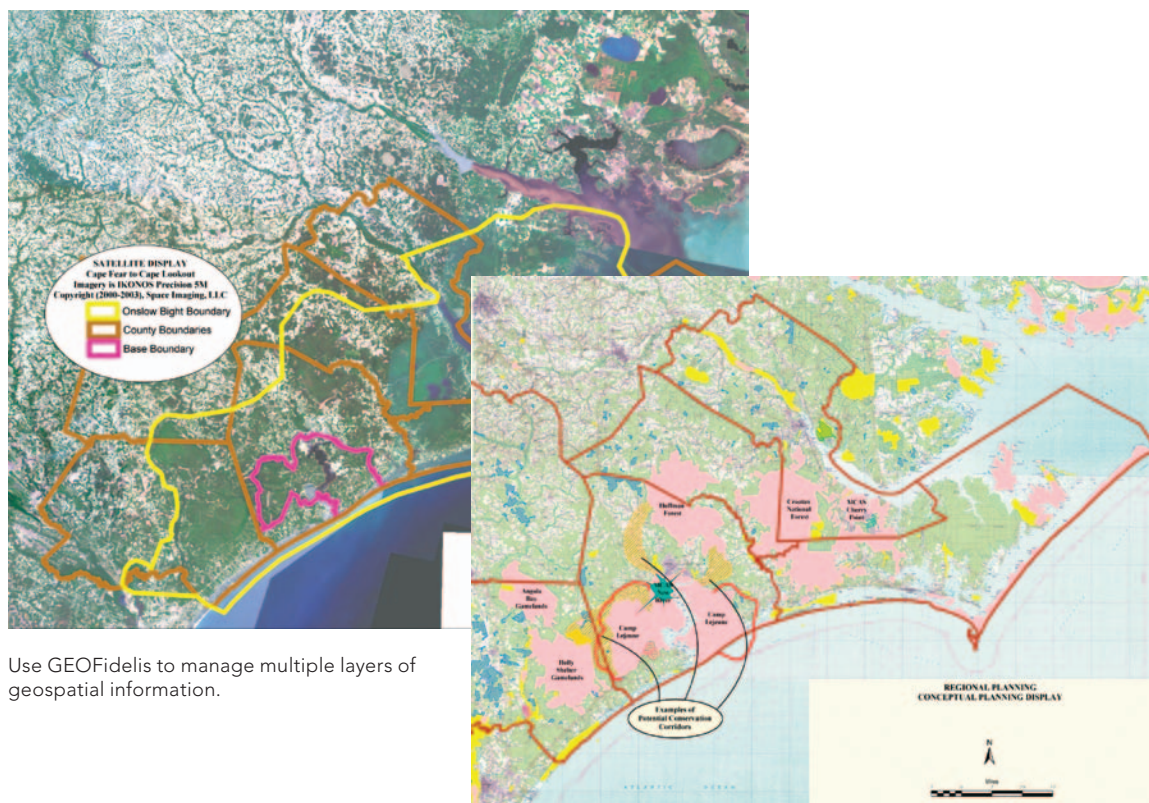


Within the Department of Defense (DoD), installation geospatial information and services (IGI&S) have become a critical component of the installation management mission. The Marine Corps IGI&S program, better known as GEOFidelis, has established an enterprise geographic information system capability that spans regions and installations worldwide. GEOFidelis is leveraged every day as a tool to manage thousands of facilities, dozens of threatened and endangered species, countless miles of utility lines and shorelines, and thousands of acres of military training ranges. GEOFidelis employs a family of systems that utilizes Esri ArcGIS products to deliver IGI&S capabilities to multiple users and use cases. It would be a misconception to assume that an enterprise GIS such as GEOFidelis just happens without a plan, design, governance structure, or architecture. The tool that encompasses all those facets is an enterprise architecture (EA).

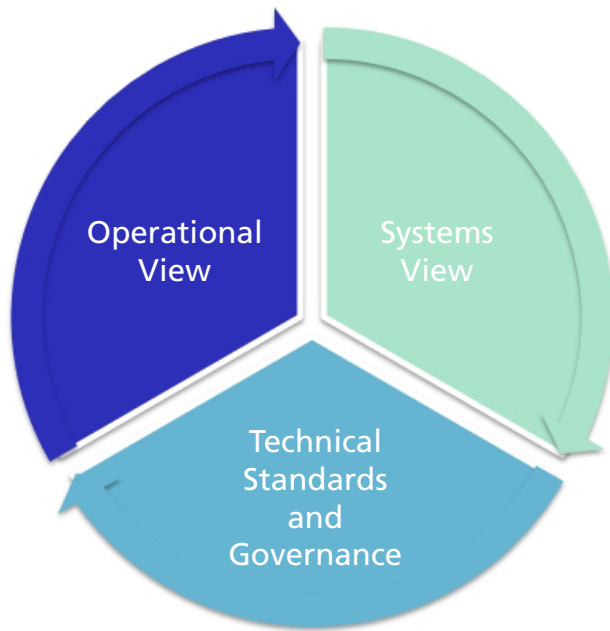
The GEOFidelis enterprise architecture is nearing completion, with expected publication by the end of fiscal year 2010. This EA will be an effective tool by which the program can be managed as it ties together existing GEOFidelis standards, policy, and governance. The GEOFidelis EA follows the Department of Defense Architecture Framework (DoDAF), which consists of operational, systems, and technical views (OV, SV, and TV). The views will provide textual, tabular, and graphic definitions of the components that make up the GEOFidelis family of systems (FoS). Establishing a DoDAF-compliant architecture is a growing requirement and trend throughout DoD.

	Requirements (Why)	Data (What)	Process (How)	Network (Where)	Role (Who)	Timing (When)
Operational Views (As-Is)	Identify business goals/strategy and how it fits in the Operational View As-Is	What data or services are impacted in the Operational Views (OV-1, OV-7)	What processes or workflows change between Operational Modes (OV-2 and OV-6)	Logistics-Where in the Operational Views will this proposed change take place/impact? (OV-1, OV-2)	What operational roles are impacted? Where does this impact? (OV-2)	What are the timing/estimated project milestones to implement?
System Views (As-Is)	What are the required technical systems components of the proposed change? What are the system requirements (HW/SW)? (SV-1)	What specific databases, data architecture, formats and data exchanges will this proposed change impact? (OV-7, SV-2, SV-4)	What system related components or workflows will be impacted? (SV-1, SV-4, SV-6)	Where in the GEOFidelis System architecture, network, etc. will this impact? (SV-1, SV-4, SV-6)	Who in the system or which operational nodes will this impact? What roles will need to be added or changed? (SV-1, SV-4, SV-6)	What are the estimated technical milestones/timelines for the proposed change?
Technical Views (To-Be)	Do the requirements align with or include changes to technical forecasts and To-Be Operational View goals? (Review To-Be Views: OV-1 and TV-2 technical forecasts)	Does the proposed solution impact or align with any data related goals or forecasts? (Review To-Be Views: OV-7, SV-2, TV-2)	Are there any impacts to or is there alignment with the operational or system processes? (Review To-Be Views: OV-1, SV-1, SV-4)	Will the proposed change impact or align with the system components architecture, data exchange or network goals? (Review To-Be Views: SV-1, SV-2, SV-4, SV-6)	How does the change impact operational or systems goals for users and operational nodes? (Review To-Be Views: OV-2, SV-2)	When or what timing is impacted for future goals or objectives of the GEOFidelis Enterprise architecture or portfolio?

GEOFidelis Technical Insertion Framework



Use GEOFidelis to manage multiple layers of geospatial information.



Developing an enterprise architecture with its many views can initially be a daunting task. However, there are many benefits to establishing an EA for an enterprise GIS program like GEOFidelis. The EA consists of as-is and to-be views that were developed simultaneously. As-is views provide a current baseline of the existing portfolio of technology, services, and capabilities for GEOFidelis. The to-be views serve as a reference model for future development of the program to address gaps and inefficiencies identified during development of the as-is views. Together, these views provide the overall program with a framework to help guide and manage the GEOFidelis portfolio as it evolves.

Much like a comprehensive plan where the foundational development goals and objectives are established for a community, the GEOFidelis EA will serve as a guideline for technical progress and improvements to the program.

As a framework, the EA will provide technical forecasting and standards that can be reviewed in a technical insertion process. This will enable GEOFidelis to make informed decisions about changes that will have impacts on the architecture as a whole.

Throughout the process of developing the GEOFidelis enterprise architecture, there have been many lessons learned that can be shared with any organization considering an EA. The wrong approach is to simply develop an EA to be in compliance with a mandate. The result will be a compliant enterprise architecture document that serves little purpose.



USAF ACC GeoBase

Fast Delivery of Imagery for the United States Air Force Air Combat Command

ACC GeoBase Program Improves Its Ability to View and Serve Geospatial Information

The United States Air Force (USAF) Air Combat Command's (ACC) primary mission is to provide combat air power to America's warfighting commands. The ACC GeoBase program supports geospatial operations for more than 2,000 airfields and furnishes the infrastructure and tools for users to collect, manage, analyze, and distribute their geospatial content to a global audience.

The Challenge

USAF ACC customers worldwide need geospatial data of their regions of interest. They must have the ability to view the data easily and quickly over low-bandwidth, secure Department of Defense (DoD) networks. They also need to gain access to the data and computing power for analysis anytime, anywhere, with zero downtime for network and data access. Some of the geospatial data that airmen access is fairly static such as historical imagery and vector data of country boundaries. Other data, such as current imagery of a targeted location, is collected regularly.

The ACC GeoBase team, which builds, manages, and maintains base and expeditionary geospatial information, tried different approaches for serving and viewing static and dynamic geospatial information. The existing server technology was unable to handle an increase in users, which caused the speed at which the data could be retrieved to slow down due to increased server loads.

The team reviewed requirements for data handling, viewing, and analysis. This analysis revealed that the operational architecture was changing and applications were transitioning to the Content Delivery Network (CDN), or "Fed Cloud." The team also determined that Esri's ArcSDE®, used for geospatial data management, was no longer adequate to manage ACC GeoBase's imagery holdings.

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The Solution

ACC GeoBase required a data viewer that was easy to install. Additionally, the viewer needed to use data services to display static and dynamic geospatial information and offer the ability to work on the CDN. ACC selected Esri's ArcGIS Server and other Esri technology for the solution.

The team developed a map viewer using Esri's ArcGIS Application Programming Interface (API) for Flex. Based on Adobe® Flex, this API is an open source application for building web, mobile, and desktop applications. ArcGIS Viewer for Flex was chosen because the team wanted a solution that was easy to develop and configure for the web; end users now find the viewer intuitive and easy to use and navigate. It's also fast and interoperable with ArcGIS Server. ArcGIS Viewer for Flex also can be cached on the CDN, and its built-in logic can determine which prerendered map content, also known as cached tiles, is needed based on extent.

When a customer uses the Flex-based web client, the CDN's built-in logic locates the requested data nearest that client based on the user's geographic location and the network speed. If the DoD's Global Information Grid (GIG) Content Delivery Service (GCDS) is unable to locate the data on one of its nodes, or edge servers, it then sends the request to the origin (host) server and gets the data to the client. Simultaneously, GCDS copies the data to its nodes for use when a web client requests the same piece of data. It will then be pulled from the most logical edge server. By leveraging this technology, the speed at which the data requests going between the requester and the main server and edge servers is greatly improved.

ArcGIS Server with ArcGIS Image Server (now the ArcGIS Server Image extension) was used to handle the imagery. Part of the problem the team faced was how to better manage the volumes of imagery streaming into the server. The team used the ArcGIS Server Image extension to load, catalog, and create the cached tiles of static data such as for historical imagery.

In the past, ACC GeoBase used Esri's ArcSDE to manage its imagery. Using ArcSDE, it managed over 450 separate raster datasets in a storage footprint of just under two terabytes. Managing imagery this way was difficult, because the storage footprint was so large. Loading raster data and managing the database was time-consuming and labor intensive.

The ACC GeoBase team conducted research and testing to help select the most appropriate technology to implement to serve dynamic imagery. The ArcGIS Server Image extension was tested and evaluated. This server-side, file-based image management system leveraged the existing imagery archive. Analysts did not need to preprocess the imagery to use it. The ArcGIS Server Image extension supports many image formats and can be consumed by multiple clients, whether GIS, CAD, or web based. This kept the storage footprint small, streamlined image processing, and increased the rendering speed in the client's applications. ACC GeoBase has the ability to serve the entire imagery archive of over five terabytes easily and quickly.

The Results

ACC GeoBase and its customers now have a fast and better-performing web viewer for geospatial information. The technologies increased performance while decreasing demand on the GCDS and reduced the data transfer load on a low-bandwidth network.

ACC GeoBase's number of users jumped from an average of 100 a week to 5,000 a week due to new standard operating procedures (SOPs) for using geospatial information for ACC missions such as for planning forward-operating bases. Implementing ArcGIS Server, the ArcGIS Server Image extension, and ArcGIS Viewer for Flex prepared ACC GeoBase to handle nearly triple the number of user requests during the USAF relief operations in Haiti after a magnitude 7.0 earthquake rocked that country in January 2010. Emergency responders leveraged the dynamically served imagery of Haiti, giving them access to historic and newly collected imagery so they could monitor changing conditions on the ground.

Prerendered cached tiles were updated weekly and, in some cases, daily. Historical and current imagery was used to display the before- and after-earthquake situation in Haiti and rapid changes such as newly repaired airfields and roads throughout the country. This enabled USAF and other emergency responders to be more effective in moving relief supplies during the humanitarian assistance and disaster relief (HADR) operations.



Prerendered cached tiles of imagery are delivered quickly to analysts.

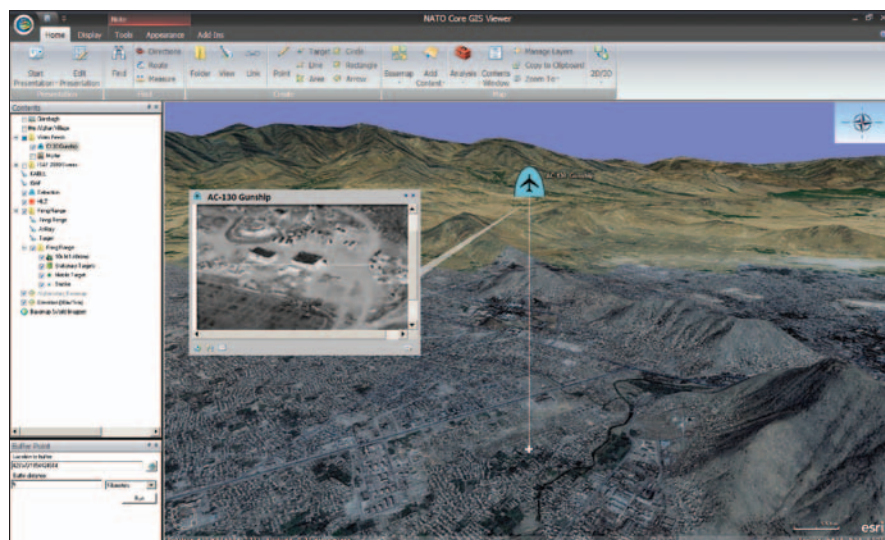


NATO



The NATO Core Geographic Services System

Enterprise GIS for Defense Provides Strong, Centralized Geospatial Capabilities



ArcGIS Explorer provides an easy way to access local desktop data sources and online NATO Core GIS web services and analysis capabilities when connected to the NATO LAN.

Peacekeeping and security missions take North Atlantic Treaty Organization (NATO) forces to remote regions of the world, from the rugged mountains in Afghanistan to the choppy seas off the Horn of Africa.

NATO personnel who work in these diverse environments, often under dangerous conditions, need fast and easy access to accurate and up-to-date geographic information for planning missions, evaluating terrain, navigating ships and other vessels, analyzing intelligence, and managing logistics. In short, they require maps, imagery, and other geospatial data, along with GIS technology, to manage, analyze, and visualize data and create web-based GIS services and applications.

NATO Consultation, Command, and Control Agency (NC3A) provides a technical solution for these types of geospatial products, services, and software to NATO's operational commands in Allied Command Operations (ACO), the International Security Assistance Force (ISAF) in Afghanistan, and other missions through the NATO Core Geographic Services system.

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The Challenge

NATO needed a next-generation GIS to provide centralized geospatial capabilities throughout the organization. The abundance of disconnected and barely connected legacy systems for collecting, managing, analyzing, and disseminating geospatial information no longer sufficed. The existing systems could not handle the full volume of incoming data. Built on outdated technology, these systems were often incompatible with each other, too.



The NATO Geo staff creates map products and makes them available via web services for NATO Core GIS users and systems.

NATO required a modern, enterprise-level information technology (IT) infrastructure built on IT standards for handling and working with geospatial information. Recognizing GIS as a fundamental technology, NATO wanted the new geospatial solution to provide

- Improved commercial off-the-shelf (COTS) tools and hardware
- Decentralized geospatial data management at each NATO headquarters, with centralized quality control by Allied Command Operations
- Standardized GIS production and dissemination tasks
- An improved interface with NATO Functional Area Services (FAS), which manages logistic and operational information within the common operational picture (COP)

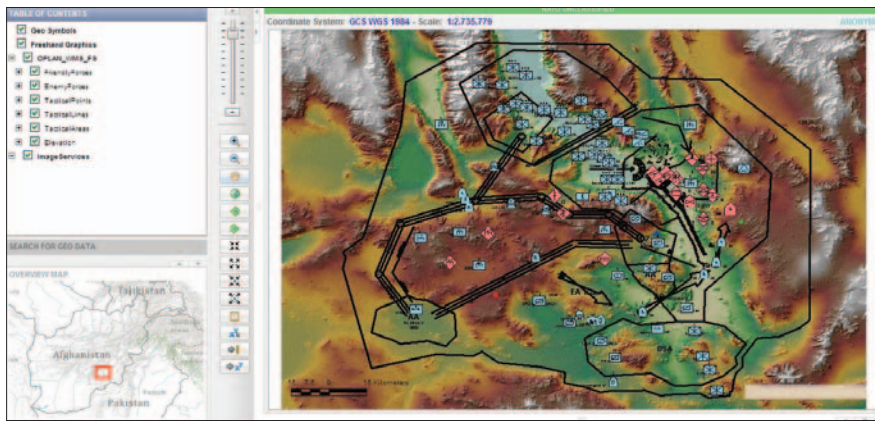
The Solution

In 2006, NATO contracted with Siemens Enterprise Communications to implement the NATO Core Geographic Services system (NATO Core GIS), an enterprise-level geospatial data and services infrastructure. Siemens brought project management, communications, security, site rollout, hardware, and many other assets to the project. Esri joined the team to provide all the geospatial capabilities for the solution. Other team members include ESRI Nederland B.V. and Belgium company GIM, brought on for training and technical support, respectively.

NATO Core GIS provides centralized geospatial services to NATO headquarters staff and command and control (C2) systems. The system delivers the following:

- Cartographic services are available through a high-end GIS desktop and server environment. NATO's geospatial staff will use desktop and server-based applications to acquire, manage, produce, maintain, and publish all geospatial data, products, and web services.
- Core GIS services, such as web map services and other geospatial capabilities, are centralized in one location at each headquarters and available through a variety of web services. Staff in every NATO headquarters can access these maps and services through the Core Geo Viewer, a simple GIS viewer. Access is also available using ArcGIS Desktop or other applications that can use Open Geospatial Consortium, Inc. (OGC)-compliant web services.
- NATO FAS project teams now have access to a GIS developer toolkit called the Component-Based Framework (CBF) to build custom GIS viewers and services for specialized user communities such as intelligence, logistics, and land C2.

These services and the toolkit are deployed on each of the local area networks (LANs) at 18 NATO headquarters in 12 countries. This means that all NATO staff will have access to the same strategic geospatial information and products, whether they are at ACO or ISAF headquarters in Afghanistan, ensuring that everyone in NATO "fights off the same map."



The Core Geo Viewer provides access to NATO geospatial assets, readily available via standards-based web services.

NATO Core GIS services are available using many OGC and International Organization for Standardization (ISO) standards, integral to promoting interoperability among NATO systems and member states. Any system that can connect to the NATO network and consume OGC services can use the geospatial information. NATO Core GIS will provide this open framework via OGC web services, such as Web Map Service (WMS), Web Coverage Service (WCS) and Web Feature Service (WFS). This enables other systems to ingest and use geospatial data for further analysis, visualization, and planning such as C2 and logistics.

NATO also mandated a solution that uses 80 percent or greater commercial off-the-shelf products, guaranteeing all the benefits of mature, stable, maintained software that will continue to be updated as the project develops.

The Esri ArcGIS system underpins the solution, which is based on the following products:

- ArcGIS Desktop plus several extensions for the high-end cartographic workstations
- ArcGIS Server, with the Spatial, 3D, and Image extensions, which are critical to supporting server-side GIS capabilities within the system
- ArcGIS Workflow Manager to manage all GIS tasks such as map updates and requests for special geospatial analytic products
- ArcGIS Engine and ArcGIS Web Mapping APIs for the developer toolkit
- Core Geo Viewer, a customized 2D web GIS viewer, in addition to Esri's ArcGIS Explorer, an advanced 2D and 3D GIS viewer

NATO Core GIS uses a modern hardware and software infrastructure to support the GIS technology, including

- A multiterabyte and centralized storage environment for imagery and other geospatial products
- Oracle® 11g as the database technology to store geospatial information such as vector geodata
- Scalable servers capable of supporting a large and distributed user community

The server, workstation, and networking hardware components come from Dell®. Siemens is responsible for configuration management of the Oracle database and all the hardware. Once accepted by NC3A, NATO CIS Agency (NCSA) will take ownership of the systems and be responsible for life cycle system maintenance.

Training is a key element of any complex system. For NATO Core GIS, ESRI Nederland B.V. is responsible for conducting training at NATO CIS School (NCISS). Training courses have been developed and delivered to GIS specialists, IT staff, and database administrators.

The Results

NATO staff around the world can now access geospatial data throughout NATO's command structure, to add mission-specific overlays and use powerful geoprocessing tools.

Commanders, their staff, GIS analysts, and other NATO network users will fuse geospatial content from NATO Core GIS with other forms of information to use in C2, intelligence, logistics, and many other applications. This was a challenging system development project for everyone involved. It stretched the limits of technology, tested the NATO procurement system, and—like any major project—had its ups and downs. However, all agree that the result is a world-leading defense GIS that will save lives on the battlefield, make NATO planning and operations more efficient, and allow NATO to deliver more geospatial capabilities over the system's life cycle.

