

Title: Navy's GIS Solution for Decision Support and Service-wide Data-Sharing, Paper 1889

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Abstract

The Navy's GeoReadiness Repository builds on a Web services, using ArcObjects 9 and open standards, and provides the Navy with the following:

- Authoritative source of geospatial data for Navy Real Property in support of Critical Infrastructure and Force Protection, Shore Installation Management, and Environmental Protection
- Baseline architecture for a network of Regional Repositories
- Portal that integrates functional applications and databases
- Security controls limiting access to specific data layers
- Quality control by automating the SDSFIE Standards and IVT Quality Assurance Plan compliance check function, and
- Access between authoritative geospatial databases

1. Introduction

The Commander, Navy Installations required a strategic-level geospatial data repository to support executive level decision making, facilitate inter-agency data sharing, and improve the efficiency of installation and range operations. The Naval Facilities Engineering Command (NAVFAC) created the GeoReadiness Repository to provide geospatial information relative to the Navy's Real Property Inventory to support Functional Areas including Facilities Management, Environmental Management, Antiterrorism/Force Protection (AT/FP), Base Development/Planning, Regional Planning, and Range Management.

The Navy faces many challenges as it goes through its current transformation including the lack of an authoritative geospatial data source for cross-Navy access, data sharing, and strategic decision support. This impedes the decision process for many strategic functional areas. In addition, under NMCI, the Navy is challenged to:

- Eliminate duplicate existing systems
- Leverage of existing efforts and infrastructure
- Maximize system performance, flexibility, security
- Collect or develop new data at a very low cost

In order to address these issues, the GeoReadiness Repository needed to normalize and store high quality data conforming to the Spatial Data Standards for Facilities, Infrastructure, and

Environment (SDSFIE). Incorporated metadata needed to meet Federal Data Geographic Committee (FGDC) metadata standards. Using these well-defined standards, the Navy could provide quality input to the Defense Installations Spatial Data Infrastructure (DISDI) as well as expand current capabilities to include basic tools to search, mine and access the data utilizing commercial-off-the-shelf (COTS) products that conform to NAVFAC and Navy-Marine Corps Internet (NMCI) standards. Web services would provide automated enforcement of the accepted standards; a secure, controlled access (down to the spatial layer level) with a chain-of-custody audit trail; and an interface to other Navy and cross-Services authoritative data.

With these requirements and limitations in mind, NAVFAC engaged Systems Management Engineering, Inc. (SMEI) and its business partners to design, develop, and implement the GeoReadiness Repository. The GeoReadiness Repository, completed in 2004, provides a single source of authoritative strategic level geospatial data for Class I (land) and Class II (facilities) properties. Using Web services, ArcObjects 9, and open standards, geospatial data is available to support the Navy's role in the Base Realignment and Closure (BRAC) process and provides the foundation for the enduring Navy Shore Installations Management System (NAVSIMS). As an authoritative data source with standards-compliant local data, the Repository's planned functionality includes highly secure browser-based applications for 1) the submission and conversion of existing spatial and metadata from Navy Regions and Mission Knowledge Experts (MKE); 2) an inventory of submitted spatial data and tracking mechanism for missing information; 3) an automated QA/QC checker for standards compliance, 4) visualization tools for conflict resolution and initiative support, 5) distribution tools for data sharing; and 6) a general portal for access to planning applications and mission critical authoritative data.

The GeoReadiness Repository, as an enterprise ArcSDE GIS data store, was developed using an open architecture and COTS tools, including a suite of the new ArcGIS 9 tools that provide a powerful new service (using ArcObjects) for submission, storage, and analysis. Not designed to replace current Navy information systems, the GeoReadiness Repository provides a corporate resource for sharing existing data at the Regional and Enterprise levels, serving a broad constituency to reduce the cost of data acquisition.

2. GeoReadiness Solution

The Navy required a scalable repository design that would support complex enterprise and regional functionality. Factors that influenced the design of the GeoReadiness Repository included the implementation of both Navy and DoD Installation Visualization Tool (IVT) standards, the implementation of standard architecture, and adherence to the Navy Enterprise

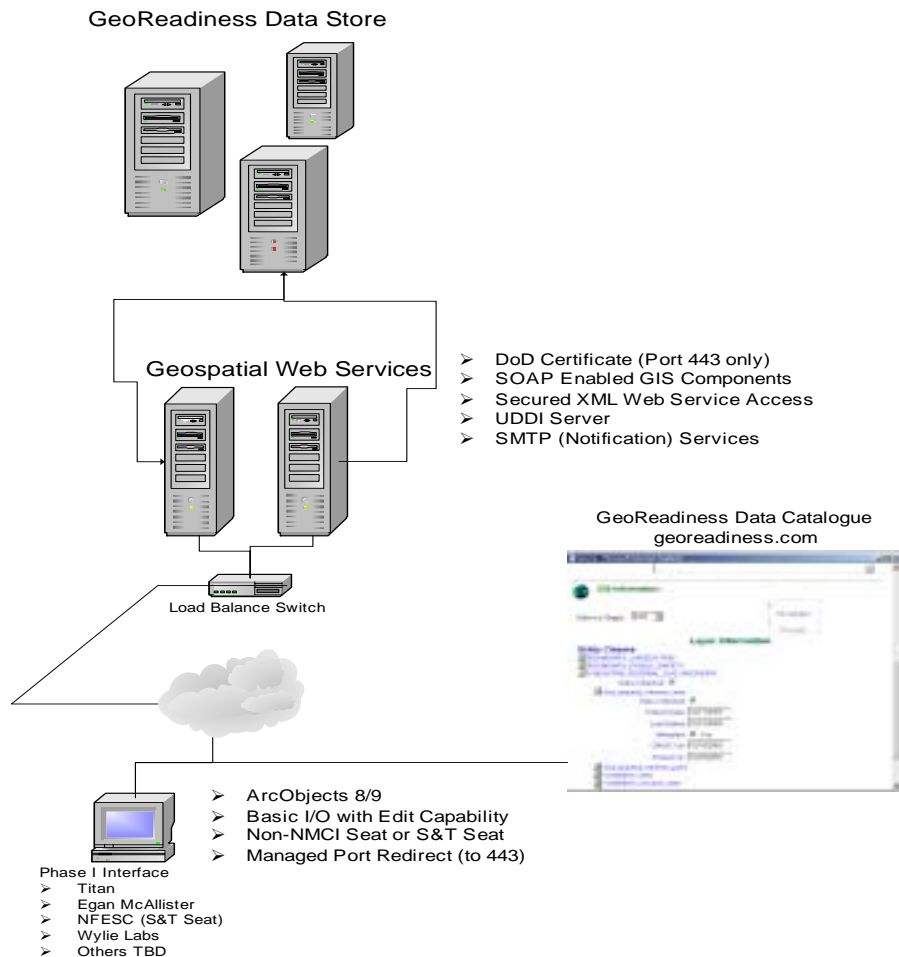
Application Developer's Guide, as well as the ability to interface with current Navy regional planning and real property systems. As a result, a rich, distributed geospatial environment to support high security, high performance, and high fidelity applications was developed. The foundation established support for the early uses of the Repository with the flexibility to expand the utility of the interface over the next five to eight years. Investment in hardware and network components based on a balanced system load model provides the highest possible system performance at the lowest overall cost.

3. Process

The GeoReadiness Repository began as proof-of-concept effort with five Navy installations from one region. 1-meter imagery was provided for the pilot, providing the development team with a model for development of the "Areas of Interest" – the Navy footprint defining the imagery extents for the remaining CONUS installations. Once the AOI's were determined, imagery collection and processing proceeded, taking about 6 months to accomplish. Regional training introduced the Regional POC's to the GeoReadiness architecture and required formats/process for submission. A phased approach to development and implementation supported the IVT process – initially providing a Web Services interface for data submission, archival, conversion, QA/QC compliance checking, re-projection, geodatabase storage, and external output. A Web Viewer was subsequently added to support the dual data submission (Regional and MKE) and reconciliation process, providing a mechanism to review site-by-site imagery, vector layers, and metadata. The selection of Regional versus MKE submissions was automated through the Web Viewer, triggering SDE to flag the selected application for IVT output. As the project moves into its next phases (DISDI and non-BRAC data acquisition), the GeoReadiness Repository continues to support IVT QA/QC review, revision and rework.

4. Architecture

The base architecture for the GeoReadiness Repository consists of an Enterprise geospatial database hosted at NITC (NAVFAC Information Technology Center) in Port Hueneme, CA. Two Windows and three UNIX (Sun V880's configured with Solaris 9) computers provide the Web Services for data submission, QA/QC, spatial processing, staging, warehousing and distribution for the GeoReadiness data. Redundant and mirrored systems utilize a load balancing model for high performance processing at a low cost. The geospatial applications/web services are built with ArcObjects 9 and the new ArcGIS Server 9, ESRI's GIS enterprise application server. ArcSDE (Spatial Data Engine) 8.3/9 and Oracle 9i with Oracle Spatial option provide the powerful centralized spatial database foundation for the ArcGIS Server and the Repository.



5. Data Model

The GeoReadiness schema is structured to accommodate enterprise and executive analysis, while supporting Regional access and distribution. While the system supports multiple local formats (personal geodatabase, shapefiles, CADD) for installation-level data submission, the enterprise geodatabase feature classes are structured at the regional level. Tablespace and tables maintain the Regional level model, while the installation-level data becomes available again through views.

5. Web Services & Security

Many of the integration, support, deployment, and even security issues facing enterprises today can be solved with a well designed Web services architecture. Web services offer a standardized way of integrating data and cross-platform systems using open standards, XML, simplified object access protocols (SOAP), and other Web technologies. With the release of ArcObjects 9,

a rich GIS environment built on Web services and modular components can be rapidly deployed to provide a robust architecture in support of enterprise GIS.

SMEI designed and built the foundation of the Navy's GeoReadiness Repository on ArcSDE and ArcObjects 9. The architecture supports a wide variety of users and clients ranging from browser based thin clients to smart clients running on Windows desktop platforms. The GeoReadiness platform implements a .NET middle tier Web services layer integrated with Active Directory Web Services Enhancements (WSE) 2.0 for .NET. WSE 2.0 provides a security policy framework, enhanced security model, and a message-oriented programming model to enable the implementation of a wide variety of security models using X.509 certificates, Kerberos tickets, and many others. The GeoReadiness Web services tier implements WSE 2.0 to secure feature level access through an ArcObjects/ArcEngine interface.

Additional Web services developed for the GeoReadiness system enable secure data (feature level) transfer from originating sources (ArcGIS, Shape Files, ArcSDE, etc.), remote data access, user authentication, and a wide variety of "geoprocesses" including metadata evaluation, spatial data quality control, and layer evaluation. These procedures were developed in C# and make extensive use of the ArcObjects 9 technology. Geoprocesses currently in development include the generation of explosion safety arcs and facility assessment calculations based on geographic and facility related information.

6. Standards

GeoReadiness enforces the CADD/GIS Center SDSFIE v2.2, the FGDC Content Standards for Digital Geospatial Metadata (CSDGM) and the IVT Quality Assurance Plan 1.1 standards electronically through the QA/QC Web service interface. QA/QC occurs as the first step in the submission of data from the Regions or MKE's. Developed for IVT by the Navy and other services, the QAP defines specifications and minimum standards for both spatial and metadata content list in the table above. The QA/QC interface checks for compliance to both standards – first the SDSFIE spatial and attribute organizational compliance; second, the CSDGM/QAP metadata compliance. An email notification system informs submitter and data manager of completion status and quality of submission. No entry is processed though to the Repository until it passes both SDSFIE and QAP compliance.

The scalable architecture of the QA/QC Web service allows for expansion/modification of the rules-based tables that checked the initial IVT layers to accommodate the subsequent 120 spatial

layers planned for BRAC 2005, Navy Real Property Management, and DISDI initiatives. Through an iterative process of review, comparative analysis, and rework, the high quality spatial and metadata content supports a common set of rules and definitions, ensuring consistency across the Repository.

7. GeoReadiness Today and Tomorrow

In conjunction with the BRAC process, the GeoReadiness Repository recently played a key role in the IVT initiative, where Joint Services spatial, attribute, and metadata data were submitted to DoD for installation and associated range complex boundaries, as well as exclusion zone areas and environmental constraints. The resulting prioritized layers are the initial foundation of the GeoReadiness Repository today.

Initial Phase: BRAC & DoD/IVT Portfolio Development	Subsequent Phases: non-BRAC & DISDI
1-meter/pixel resolution geo-referenced Commercial Satellite Imagery (B/W and Color); 5-meter imagery for Range Complex Boundaries	Sub-meter Imagery
Installation/Range Boundaries	Base Boundary, Leases, Easements
AICUZ Noise Contours (>65 dB)	Building and Structure Footprints
Clear Zones and Accident Potential Zones	Vehicle and Airfield Pavements
Explosive Safety Quantity-Distance (ESQD) Arcs	Utilities Distribution
100-year Floodplains	Environmental Hazards and Compliance
Wetlands	Hydrological Features

Today, the GeoReadiness Repository supports an audience of Navy Regional GIS Analysts and Functional Area Managers for data sharing, access, and distribution of geospatial resources. In that capacity, version 1.0 supports ongoing QA/QC efforts by providing key data suppliers and reviewers with the required essential functionality to finalize DoD’s foundation layers and their associated metadata. Support functions include the following:

- Distributed secure remote data upload & download
- Data capture and automatic update
- Upload status notification
- Quality Assurance / Quality Control
- Data Consistency Viewer
- Selection to SDE load
- Export to IVT format

The integrated GeoReadiness Repository Information Tracking System (GRITS) (www.georeadiness.com) performs as an inventory manager Web service for the Repository. It tracks spatial data submissions from Navy Regions and MKE's, records Point-of-Contact (POC) information, and provides data fulfillment and statistical gap analysis.

As the Repository grows both data-wise and functionally, the user audience will expand to include executives, decision support analysts & managers. In progress for this version is the Web services interface providing visualization of the data for Navy installation planning, facilities management, and executive support. This is accomplished via a highly secure, flexible, and easily managed interface. The Repository architecture will effectively act as an integrated spatial/non-spatial decision support "portal," capable of both horizontal and vertical communications, providing interoperability with leading GIS and CADD vendors. Links to the Navy's iNFADS for building details on Class I and Class II Real Property, as well as links to other Navy mission-critical shore installation management systems (RSIMS, RSIP-Link) will provide a powerful distributed environment for geospatial analysis and query. The open, scalable architecture allows subsequent versions to provide general availability to the Navy and a secure, chain-of-custody environment to authorized external users for non-BRAC efforts in Homeland Security, AT/FP, and Critical Infrastructure Protection.

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