

Creating a GIS-Based Web Service for Naval Educational Facilities

**By Charles Bailey, P.E., Naval Education and Training Command
And Brian E. Murphy, GIS Analyst and Programmer, 3001**

Abstract

Management of classroom space has become gradually more difficult with enrollment increasing and classroom space remaining constant. In order to maximize the effective utility of military real estate, the need for a centralized GIS has arisen. By accessing and managing legacy spatial and non-spatial data from a single access point, planning personnel will be able to control Naval classroom space more efficiently.

The Naval Education and Training Command (NETC) and 3001, Inc. has developed a hierarchal inventory of installations and their buildings to the seat-level for each classroom. By combining a GIS webservice with the management of classroom data, we have made it possible to integrate maps, floor plans, property records and building photos in one centralized location. NETC maintains its spatial and non-spatial data by using a combination of ASP.NET, Oracle, ArcSDE and ArcIMS software.

Disclaimer

The views and opinions expressed in this paper reflect those of the authors and do not necessarily represent the views of the Department of Defense (DoD), Department of the Navy (DoN), or the Naval Education and Training Command (NETC). Reference to certain companies and/or the services or products provided to or used by the Navy does not, expressly or impliedly, indicate DoD, DoN, or NETC endorsement of the products, services, or companies described.

Introduction

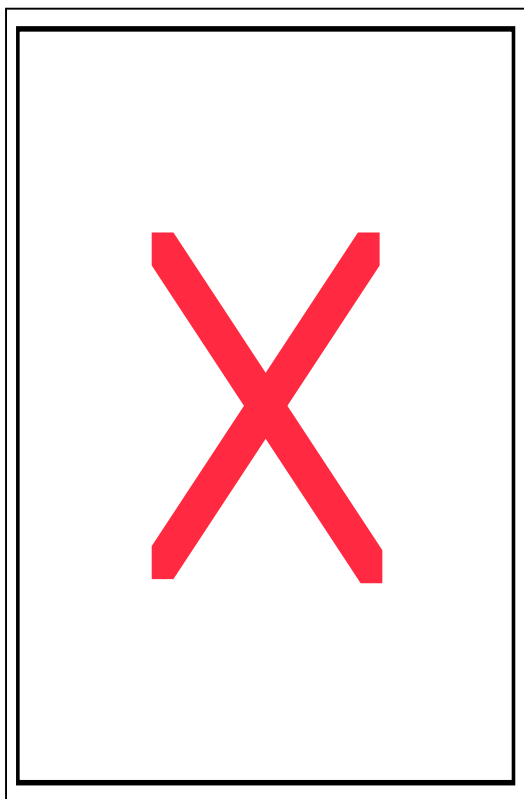
The Naval Education and Training Command (NETC) has almost 40,000 sailors in their schools daily. NETC operates within 676 facilities accounting for over 25 million square feet. NETC is in the midst of a Revolution-in-Training (RiT) with a vision "to be the world's premier learning organization" while also striving to achieve "cost wise readiness" through the efficient and effective implementation of blended training solutions. In order to make quicker and better informed decision-making the Navy issued an initiative called the Navy Training Infrastructure Plan (NTIP), which emphasizes the efficient utilization of facilities while decreasing excess resources. The plan calls to reduce the overall square footage by 1 million sq. ft. per year, for six years. This will effectively reduce the total square footage by 6 million sq. ft., an amount exceeding the floor space of the Empire State Building and the Pentagon combined. Through RiT

initiatives and improving the utilization of NETC facilities, the Navy will reduce its footprint, without compromising Fleet requirements.

NTIP also called for a state-of-the-art technology that will allow planners to maintain and view data in an efficient manner. Planners set out to create a web-service to access both geographic and property information. Much like many tax collector websites, this site accesses data from a central database, and displays building data in the form of a property record. What sets this site aside from municipal sites is the ability to access the data both in read-only format, and in administrative mode. As an administrator, changes can be made for just about everything within the database; including, but not limited to the ability to upload building photos, change facility ID's, and upload building floor plans.

Web Service Architecture

The web-service prototype was built offsite on two machines, and was accessible by



Navy officials throughout the development stage. Both machines are 2.8 GHz Windows 2000 servers which house the database, website and web service, using a combination of Oracle 9i and ArcSDE 8.3 on one machine and ArcIMS 9 on the other. A number of factors made this project the cutting-edge technology desired by the Navy, such as the use of active server pages .NET (ASP.NET), Active X connectors, and on-the-fly axI file creators.

By initially designing the architecture in a web service format, we could gear the programming towards server-side map production. Also, the data has the potential to be accessible through a variety of mediums;

one medium of choice is a website written

Figure 1 Diagram of data structure and relations of tables using identifiers

in ASP.NET, having the advantage of running on the server-side as opposed to on client-side (like JavaScript)¹ In the end, this results in a faster download to the client due to less data being sent, and allows the code running on the server to access the server's file system and databases (Bricker, 2005).

Early Attempts

Initial steps towards creating the web-service consisted of keeping separate feature-classes for each data type (installation boundaries, buildings, roads, etc) and location. By doing this, we were able to maintain individual areas and have them projected in their appropriate state plane region. This structure was found to be highly inefficient and time consuming from a programming and data management standpoint. In addition, multiple map services would have to be created and maintained for each installation, which would have amounted to nearly 90 different services, severely slowing down the IMS server. Reducing the number of map services by grouping each data type together as one feature class and projecting it into the WGS 1984 coordinate system was much more efficient from both a user and developer standpoint.

Using the FEATURECOORDSYS element from ArcIMS allowed us to preserve the map service and project features virtually on the fly based on the extent of the view. The FEATURECOORDSYS element uses ids for specific areas, such as stateplane regions and stores them as strings. The element ids reference all of the parameters of a specific coordinate system, including datum, units and meridians. Thus, as a user zooms into a specific region, the data will automatically display with the optimal projection for that region (ArcUser, 2005). More information regarding Projection Elements can be found in the *ArcXML Programmer's Reference Guide*.

Speed and Efficiency

Administering speed and efficiency was an important factor towards designing the website and ultimately sustaining the users' attention. By the use of image rendering,

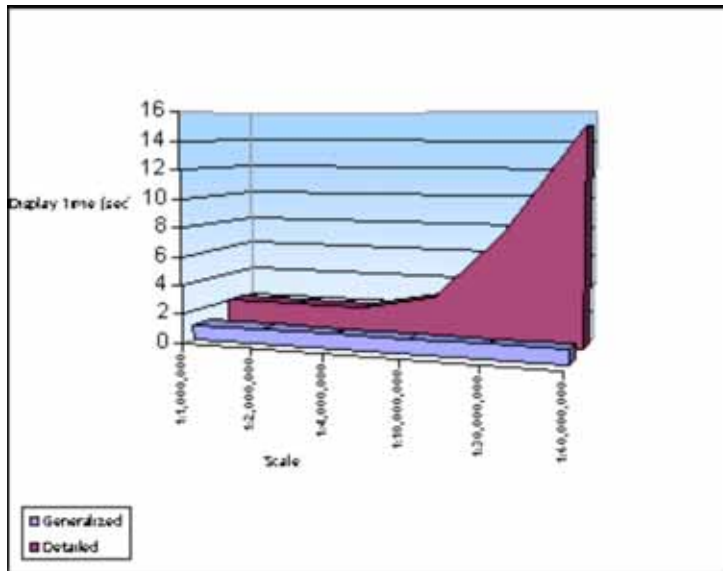


Figure 2: The difference in draw times between generalized and detailed sets of state boundaries for the United States

creation of a snapshot of the current view occurs and is sent to the client browser through ArcIMS. By limiting the number of services to only two, one for the general map and one for the floor plan viewer, we could effectively reduce the amount of requests to the server. Another factor contributing towards increasing browser response included using scale-dependant rendering of the features in the map service. This is similar to the turning on or off of a specific layer as one zooms in or out. By turning off unneeded layers, such as state boundaries, county boundaries, and road layers as one zoomed into an installation. More importantly, certain highly detailed data should be prevented from being drawn when zooming to a large extent, such as buildings, installation boundaries, local roads, and detailed boundaries. Also, by inherently having certain layers turned off, like TIGER road lines, multiple point layers (areas of interest), and detailed polygon boundaries, developers effectively reduced time spent waiting for maps to display in the browser.

By transferring rasters into the SDE database, access from multiple users can take less time than normal in a file-based system.

"ArcSDE provides a fast, scalable platform for multi-user access to raster data; support for loading all raster data formats supported by the ArcGIS Desktop applications; options for storing raster data with no compression, lossless LZ77 compression, or lossy JPEG compression; image "pyramids" (a series of reduced resolution representation of each raster data set) for fast display performance; and caching for fast redisplay. (ESRI, 2002)"

By the use of image rendering, creation of a snapshot of the current view occurs and is sent to the client browser through ArcIMS. By limiting the number of services to only two, one for the general map and one for the floor plan viewer, we could effectively reduce the amount of requests to the server. Another factor contributing towards increasing browser response included using scale-dependant rendering of the features in the map service. This is similar to

Operability

Data features for much of the operational map, such as installation boundaries, road lines and building polygons, came from internal Naval operations. Building features are the most functional of all data presented in the web-map, due to informational linkage to the database. As the user clicks on a building feature using the informational tool, a window will display the facility information as seen in Figure 3.

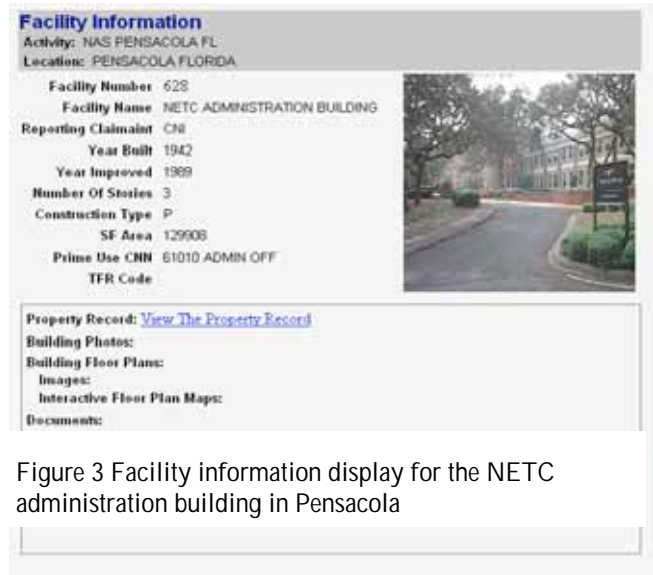


Figure 3 Facility information display for the NETC administration building in Pensacola

Queries are performed through a number of tables stored in the database, with key identifiers linking buildings to data tables containing key features each building. This gives users implementing NTIP the ability to quickly retrieve data pertinent to making decisions regarding a building's usage; such as square footage, number of seats, NETC organizational users and even floor plans. Administrators will also be able to make changes to room and building usage as the footprint is reduced and assets are relocated.

Ultimately, the goal of the system is to monitor the capabilities of rooms by linking the current web service to the Training Asset Management System (TAMS), which is currently in the developmental stage. By linking to the TAMS database, room inventory tables will be linked in order to provide information regarding the capabilities and intended users of a room. For example, if a Cryptology instructor is looking to book a room in Jacksonville, he will be directed towards rooms that contain computers, hardware, and software that meets his specifications. The instructor will also be supplied with the number of seats available for that classroom in order to provide limits towards student scheduling.

Summary

When designing the NTIP GIS, having the system operate functionally and efficiently was an important component to the usability of the interface from the beginning. Having the website operate from a web service infrastructure allows for data to be centrally

located, eliminating the need for replication and preventing contradictory information. In addition, it allows for easy manipulation of user interfaces, such as the website currently used. As data becomes available, it will become easy to manipulate in order to supply users with greater power of planning. As the Navy implements its plan to reduce the overall footprint, this site will become an invaluable tool towards the coordination of user groups, classroom space and resources. This web service is exportable to Navy regions in order to offer them requirements for training services. In addition, the web site can operate with other web services, such as ones offered from Navy Regions, and TAMS.

Acknowledgements

Thank you to Justin Carasick and Ron Ison, who contributed countless amounts of time and effort towards the creation of the NTIP GIS.

References

Bricker, T. "Using the ArcIMS .NET Link" ArcUser Jan- Mar. 2005, 42-43.
"Understanding ArcIMS Projection Elements", ArcUser Jan- Mar. 2005, 36
"ArcSDE Focus on Raster Data Management", ESRI Brochure, 2002

Author Information

Charles E. Bailey, P.E.

Naval Education and Training Command

Training Readiness Branch, N433

(850) 452-4094 DSN 922-4094

Fax (850) 452-4066/DSN 922-4066

charles.e.bailey@navy.mil

Brian E. Murphy

GIS Analyst and Programmer

3601 SW 2nd Avenue, Suite Y

Gainesville, FL 32607

Office 352.379.3001

Fax 352.377.4234

bmurphy@3001inc.com