Integrating Enterprise Oracle-Based Applications with GIS Capabilities: WEB-SDE Editing

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Abstract

Israel Antiquities Authority (IAA) has developed its enterprise GIS over the passed three years. IAA has decided to facilitate its GIS operation using an Intranet web based application, providing all GIS users with view, edit and query capabilities. Throughout the development process, IAA encountered two main problems: how to integrate geographic data into an existing Oracle based application while not using "Oracle Spatial" and how to enhance ArcIMS application with ArcSDE editor (insert, delete and modify) capability and Oracle capabilities to improve multilayer queries and alphanumeric data entry. This paper presents IAA's solution for those problems and how it facilitates IAA GIS infrastructure using ArcIMS web application serving Oracle existing applications as a kind of "Geographic Web Service" and SDE "Editor" Module developed by IAA (using Java API)

Introduction

GIS technologies are used extensively by the Israel Antiquities Authority (IAA) in order to support archaeological site administration and to assist in the management of the activities within the organization.

IAA began to develop GIS technologies during 1999:

- Infrastructure: local stand-alone ArcView based desktop and ArcExplorer based viewers
- Development and maintenance: centralized development and manual batch based maintenance of applications and data.
- Implementation: off-line work, manual adjusting of data for the IAA working environment.
- Operators: the operators had to have special training and skills for using the system

There were many problems in this approach:

- It required expensive desktop hardware and software.
- No integration between the Alfa numeric (AN) legacy database with information about archaeological sites and the new geographic GIS based data (GEODB).
- Limited access to GIS data,
- Errors in data because of lack of synchronization.
- Available on-line data for end users was incomplete or inaccurate because of the off-line work.
- Inefficient data entry and retrieval.
- Lack of centralized and enterprise level enforcement of quality of data

The IAA received various software offerings from ESRI to overcome these problems. This presentation describes how we overcame the technical problems and consequent limitations in the GIS applications.

ArcIMS steps towards a comprehensive solution

An important step forward from the off-line situation was taken by the end of 2001 when IAA launched an intranet Web site based on a modified ArcIMS Java viewer. The purpose was to build several different Web pages each representing some unique process with in the organization.

The ArcIMS Web server answered a significant problem as it allowed the querying of alpha-numeric data from within a pure GIS platform. The user could get information from the database about an archaeological site by clicking a map or perform queries on database and see the results visually highlighted on the map. However, this approach required that we dealt with each process separately building the applications each time from the scratch. There was no reusability of code. It also did not solve the problem of integration between alpha-numeric legacy data and the accumulating geographic data.

After the opening of ArcIMS Web pages the IAA decided to extent the Internet browser based operations. An application was needed that would provide all GIS users with the ability to view, edit and query attribute data and GIS data. The problem was serious seemed to require changing the entire legacy system relating to geographic data. Since from the point of view of the IAA such a massive investment of time and money was not feasible we established the following guidelines:

- Preservation of legacy application and database structures
- Centralizing the software development and maintenance for alpha-numeric and GIS data
  Easy assimilation of new modules into the system
  Gradual rather than abrupt transition to new technologies
- User friendly GUI that allows independent work and does not require special training
- Data entry and editing simple and flexible
- Performance speed is critical

IAA solution

The IAA learned from development and maintenance experience that the original concept was incorrect. It was understood that in order to implement a broader non-technical user base with minimum development/maintenance time, a more integrated solution was needed.

The development concept changed from:

1. "Different server pages to different users" to "Different modules to different functions".
2. Instead of two different databases (geographic and alpha-numeric) a single integrated central database with different views and GUIs.

The concept was realized by developing four modules:

1. Module 1 - general geographic viewer configurable for the specific needs of different users and work process providing view, query and print only.
2. Module 2 - data collection modules providing insert, update and delete capabilities on the central geographic and alpha-numeric databases. The module allows uploading of well formatted Shape files and manual editing of GIS and alpha-numeric data through Internet.
3. Module 3 – various ArcIMS/Java API "WEB services" to the legacy Oracle Forms and Reports application using embedding and host calls.
4. Module 4 – small Oracle PSP programs build a bridge between ArcIMS world of Java scripting and Oracle database PL/SQL technology and opens for us a gateway to very fast Oracle queries impossible in ArcIMS alone.

Module 1- Generic geographic viewer

The goal in developing the generic viewer was to have a configurable GUI suitable for beginners and advanced users alike. The viewer must perform the following tasks:

- Allow the viewing off all GIS layers existing in IAA by user/password
- Perform both spatial and alpha-numeric queries of the layers
- Print visible map using standard A4 size report templates

The generic viewer is a customized ArcIMS Java viewer instead of the lighter HTML viewer. We decided to use the ESRI Java viewer rich client despite of its weight and the complexities in editing its components (TOC, Scale Bar, and Overview).

Java viewer is useful for us mainly because it lets the user to load local files into the work area. This functionality is very important to the IAA since we have altogether eleven bases in different parts of the country where such ad-hock geographic information is needed on daily basis. For example, a surveyor may wish to plot the line of a new planned major sewage pipe on the Java viewer and see what archaeological sites are in danger.

The generic viewer has an additional frame designed to let the user to ask predefined questions in his or her own familiar vocabulary. The application functions are integrated with these questions and automatically turn options on or off and selects the relevant layer according to the specific question. These are short-cuts created to help the common user. An expert on ArcIMS can perform the same task using standard ArcIMS tools such as “zoom-in”, “zoom-out”, or “query”. The short-cuts we have created reduce the complexity and make the learning-curve much smoother for IAA workers.

Module 2- Data collectors

The data collectors unify and standardize data from various sources and projects within the IAA for the central database.

There are currently two modules,

1. Up loader, an intelligent uploading of well formatted Shape files
2. SDE Editor, an in-house Java API product for manual inserting updating and deleting of geographic data using Internet browser

Both modules are linked to the same ArcIMS based interface and perform automatic data processing. The collectors use a number of computer languages and tools to achieve the required level of standardization and quality control.

1. *Upload module*

Field data

The field data includes numerous items from archaeological findings to exact geographic location information The IAA is standardizing on Trimble GPS devices.

Before leaving to the field the surveyor may upload a subset from an IAA developed flexible data dictionary that is ultimately connected to the central Thesaurus of the organization. The dictionary is accessible through a user friendly Web page and the user may decide what archaeological elements and what element types to upload (points, lines, and areas).

The use of standardized terminology – and the hidden coding behind it – is obviously one of the most fundamental requirements of a unified central database.

GPS data post processing

Back in the office, the surveyor performs free form differential correction on the GPS data and exports it to standard ESRI shape files. These SHP files can then be uploaded into the central database.

Shape file upload

The Web application has additional pages before the opening of the main ArcIMS page requiring the user to select the project he or she is permitted to work according to the provided username and password. (The extensive user authentication/privileges system is developed in Oracle and communicates with ArcIMS through PSP.)

The intelligent upload process uses PHP scripting for FTP in order to transfer the shape files from local disc into the main UNIX server file system. After the module has verified successful file transfer it triggers UNIX scripts that use ArcSDE tools to load field data from the uploaded shape files into specified ArcSDE layers. The UNIX script invokes "*shp2sde"* command with parameters.

The intelligent upload module identifies the newly loaded survey data in the Oracle database and consequently processes the data by modifying key identification fields according to certain passed parameters.

2. SDE Editor

The SDE editor developed by the Israel Antiquities Authority uses the powerful ArcSDE 8.3 Java API for data inserts, updates and deletes. The Java API is called from a modified ArcIMS HTML viewer platform which has the additional functions for insert, update and delete. The platform provides the generic geographic references required by the operations.

The editor uses Java Server Pages (JSP) to communicate with the server.

Insert function utilizes Vector Markup Language (VML) to provide users with visual editing environment on the ArcIMS HTML page.

Modify function has no GUI, it just passes alpha-numeric parameters that the Java class uses to update ArcSDE handled data.

Delete function lets the user to select an object in ArcIMS or provide alpha-numeric parameters for the Java class.

The technology used in these three modules seems very promising and will eventually allow us to develop numerous other functions pinpointed to the specific needs of the IAA.

Module 3- WEB services

The IAA has a major legacy database that works since 1992 in the evolving Oracle Forms and Reports environment. The organization was facing a challenge with the emerging GIS technologies. Should we keep in line with other Oracle products and implement geographic data in Oracle Spatial? The Oracle 8 implementation of vector data did not look so inviting. Or should we use ArcSDE proprietary tools and protocols to handle geographic information for the legacy system. Using both Oracle Spatial and ArcSDE is theoretically possible but we decided against it for a number of reasons.

The technological rush forward in the world of GIS eventually provided the way out of the dilemma. ESRI improved its ArcSDE engine and Oracle scrapped the version 8i approach for a binary model in Oracle 9i, so a merge of technologies is possible. However, instead of this approach we found out that the ArcSDE Java API and Oracle PL/SQL and Java abilities provide a significantly more open and powerful working environment for us

Module 4 - Oracle modules

Large amounts of attribute data in the legacy database can be used via linked views in ArcIMS queries but the performance is very poor. It does not make it any more acceptable even if the data is copied to the geodatabase – a procedure which in itself is not correct.

Oracle PSP technology provided us with a compact and fast method to use ArcIMS map interface as query tool.

We can now create very complex queries using standard Oracle tools and indexes and expose them to ArcIMS through PSP. We construct the URL query string in ArcIMS using Java scripts, perform the query in Oracle and redirect the call to ArcIMS for graphical display of results. In this way we can query multiple fields in multiple tables (not possible in ArcIMS) and make simultaneously multiple queries and present query results in the ArcIMS viewer.

We also use PSP for simple Web based reports using the Oracle Apache based HTTP server.

Development team

The work is done under the direction of David Gabai, CIO of the Israel Antiquities Authority. The technical team includes Iris Hadar and Mikko Louhivuori.

Hardware and software

The Oracle 9i database supporting the GIS application is currently on a SunFire 280R server with 4GB memory and Solaris 8.

The storage of GIS data is handled by ArcSDE 8.3. (We are not currently using Oracle Spatial 9i because we were able to bridge the ArcSDE and Oracle data using other methods.)

Legacy alpha-numeric data is stored in a Sun SunFire V240 server with 4GB memory and a large and fast NetApp FAS250 storage system. The machine provides Web based data services to the GIS system using Oracle's Apache based HTTP server and PL/SQL and PSP functions.

The ArcIMS server is currently a Pentium IV 2.66 GB Windows 2003 server with 1 GB memory. The ArcIMS 4.0.1 Internet map server is installed with Apache 2.4 HTTP server and Tomcat 4.11 servlet engine using Java SDK 1.4.0.

Clients should have minimum Pentium IV (1.8 GHz or better) with Windows 98 or 2000 OS. Java runtime engine JRE 1.3.0_2 or 1.4.0 and minimum 64 MB memory.

Conclusions

Israel Antiquities Authority needs a great variety of geographic tools. The off-the-shelf ArcIMS Java viewer gives us much needed functionality when it works with the ArcSDE geographic engine and the central Oracle database. However, many specific tasks required by the organization cannot be executed with the Java viewer alone and the IAA looked for many different options to solve the problem.

Eventually we selected the Java API to ArcSDE called via JSP from clients and through PL/SQL on UNIX in the server. These techniques have opened for us a rich and powerful environment for creating critical software modules. These new modules are launched from modified ArcIMS Java viewer platform or from the server depending on the requirements.

One of the main strategic benefits of the Java API/ArcSDE approach for the Israel Antiquities Authority have been the ability to edit geographic data from ArcIMS clients. Even more importantly, the techniques provide a fast and light-weight method to GIS-enable the massive legacy of IAA Oracle Forms and Reports run mostly in MS Windows clients.

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