Oracle 9iAS Portal as a platform for Geographic Information Science distance and flexible learning at the University of the South Pacific

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Abstract

Providing Geographic Information Systems (GIS) courses over the Distance and Flexible Learning (DFL) in the University of the South Pacific has been until now an area where little concentration has focussed. The USP is an international University serving 12 countries where the majority of students are studying through the DFL mode. Many large universities and educational centres are already effectively using different DFL eLearning solutions as a type of eBusiness. The GIS Unit and the Computing Science Department at the USP have developed a prototype for GIS education for the DFL mode, based on GeoMedia Web Map Server and Oracle 9iAS Portal, which provides a comprehensive way to store and deliver structured and unstructured information from a single point of access on the web.

The purpose of this article is to analyse the specifics of the n-tier architecture of spatial data management within the Web-Portals as an interface for the GIS eLearning. This paper outlines features of development and the content of a GIS Web Portal for distance education in a constrained net environment, and accompanying issues for integration of GIS tools within geodatabase client-server architectures of corporative Web solutions.

Keywords: GIS, eLearning, eBusiness, GIS portal, Web Map server, integration, security control, Internet file system.
1 Project background

The University of the South Pacific (USP) is a regional university owned collectively by the governments of the Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu (see http://www.usp.ac.fj). The architecture of the USP through the region is designed in a hierarchical way. The main Laucala Campus is in Fiji, second one is in Vanuatu, and there are eleven centres, each in every USP country member. The majority of the students are studying through the DFL mode.

In the early 90’s, when it had been realized that Pacific Islanders had to leave the Region to seek for GIS education, the USP set out to establish a GIS program. As part of the Geography Department at the USP, the GIS Unit is offering a GIS Certificate and Diploma program. The academic position was assumed by the USP and commitment was made to support various developmental projects in the region through the University’s teaching and research programme.

For the past five years, the Geography Department at the USP has included basic and intermediate GIS and introductory Remote Sensing (RS) courses within its undergraduate curriculum. As a result, more undergraduate students and regional GIS users have received basic GIS/RS training. Today the GIS programme is expanding rapidly. Four courses are currently offered. Classroom-based GIS/RS courses are offered in main campus. The number of students taking GIS courses has increased significantly during the last few years. The demands are much higher than the resources (staff, and the workstations in the GIS/RS Lab) currently available at the GIS Unit. In 2000, the introductory GIS courses were offered in all USP member countries by distance education. Different types of DFL delivery are used for conducting the courses for non-in-campus students.

There are a few types of Distance Learning such as classroom-based (summer school), visiting instructor-led training, videotape or satellite video-based training, and computer-aided learning. Last one can be eLearning from a live Internet connection; offline learning delivered by CD-ROM or via pre-download data and mobile professionals or mLearning [1].

Classroom-based, satellite video-based training, and primary eLearning have been used for GIS DFL education in the Department. GIS/RS Summer schools are in demand among the USP students, but it requires additional staffing. Pre-packaged video-based course material was supported by video conferencing through the University’s high-speed satellite network. Satellite video-conference training is expensive and more appropriate for lecture delivery. Learning from videotape and course books have lack of contact between a lecturer and auditorium, and appropriate mostly for lectures. ELearning form is best for practical and laboratories GIS DFL.

Comprehensive GIS eLearning has to deliver on-line lectures, practical labs, tests, and assignment submissions; give the possibility for live interactions between instructor and student, or even among the students, and provide tools for
visualization and analysis of spatial data. This approach is much more flexible in comparison with distance teaching via satellite broadcasting. Looking from the other angle, this approach can offer the same possibilities as satellite broadcasting by using satellite equipment and special video coding methods for real-video transfer within the integrated system.

2 GIS Web Portal for USP DFL

Taking into consideration the multifunctional nature of GIS eLearning and teaching, the GIS Web Portal has to be developed to serve these services. A Web Portal is: a web site or service that offers a broad array of resources and services through web applications; provides a single point of entry for retrieving web service; offers a mix of content and services information from (some of which may be provided by partners or other third parties) with a large, diverse, target audience.

The GIS Web Portal for USP DFL has to be developed to satisfy the following requirements:
- Develop professional GIS/RS levels of proficiency in teaching and research in the Geography, and Mathematics and Computer Science Departments (MCSD) at the USP. Reduce demands on in-campus education in Suva and increase the number of students in GIS and Computer Science courses under the same capacity of the existing GIS Unit and MCSD.
- Separate common lectures information and real-life presentations from individual tasks, labs and assignment in the same Portal environment under different access rights;
- Support practical teaching and testing in GIS, Geography and Computer Science through the Internet use among USP campuses and centres;
- Support live-maps and spatial database/datasets on-line. Support integrated multi-user interface for spatial and non-spatial information;
- Support live-maps and spatial database/datasets on-line. Support integrated multi-user interface for spatial and non-spatial information;
- Manage administration by supervisor or groups of supervisors remotely from the Internet;
- Allow simple customisation;
- Support private accounts with spatial data for individual students, and highest levels of security for test and examination information;
- Keep lectures, demonstrations, labs, and assignments as archival resources and store of all information (audio, video, files, and documents) in the database environment with very flexible search tools;
- Keep and use FAQ’s, discussion groups, e-mail course activities and support information within the same environment and within the same database system.

Main constrains for development of the Portal in the USP environment are: low network speed bandwidth from/to USP, poor hardware equipping in some university centres, and frequent staff turnover that can effect maintenance of the Portal. Intranet/Internet connection and videoconference are provided from the main USP campus to other centres through a satellite network. The bandwidth of this network is one Mbps, but practically we have very slow network connection amongst various USP centres.
The GIS Web Portal was decided to implement within an integrated environment by using two industrial solutions such as Oracle 9i Application Server (AS) Portal within GeoMedia Web Map Server (GWM) from Intergraph. Factors such as the software availability were considered to reach this decision. Thus, Oracle 9i/8i Server and Oracle 9iAS Portal SW are available in the MCSD and the Department has access to technical support information and Oracle technical library, which are necessary for the project. GeoMedia Pro and GWM are available in the GIS Unit as a part of its Registered Research Laboratory program membership from Intergraph. The Unit has the license for research and education purposes. Secondly, these two solutions offer the possibilities to integrate their components and build GIS Web Portal with required functionalities.

3 Methodology of building GIS Web Portal

There are two strategies to create a web based information system for a particular application. The first choice is to build a system by using client/server or n-tier development within J2EE, JSP/Servlets, Java Applets, ASP, etc technologies; the second choice is employing one or few of the industrial portal products. In case of educational institution like USP, there is no special programmer support group and movement of staff is high, the best strategy is to utilize existing solutions. One solution has to be responsible for spatial data handling, and second one can be fully functional web portal, which enables dynamic integration of spatial data application component. The portal has to have the ability to manage enterprise applications and content resources in conjunction with governing enterprise access to the resources under management [2].

An architectural model for GIS DFL Portal can be based on n-tier design, which can be leveraging all of advance features the Oracle 9iAS Portal environment. Such architecture provides user access to data resources and GIS services through the Web interface and at the same time provides better data and service management and protection via legacy RDBMS. The middle tier is developed using servlets that encapsulate the business logic and provide flow control. Database interface is separated into a back-end tier that allows all database changes to be addressed in one place. It also allows the developer to easily reuse data related programming elements and provides a single access point for implementing connection pooling.

Several deployment components of Oracle 9iAS Portal were considered from the point of view to comply with the requirements for the GIS DFL Portal development. These are application development support, static content publication and customisation, integration of structured and unstructured information, control of user environmental characteristics, security control, administration of the components, and ability for dynamic application integration.

Java2 Enterprise Edition (J2EE) development practices and standards can be deployed for Oracle Portal web based application development
and customisation. Other technologies such as .net also can be used, but has some limitations.

The Portal administrators have the capability to customize the user experience through built-in functionality by managing: templates, navigation pages, styles, categories and perspectives, links, tabs, content. Development and customisation of website and organization of data is made simpler through portlets. A page inside a Portal is divided into regions; and inside these regions portlets are contained. Portlets constitute a structure that contains the information from different sources. This feature aids a lot during development of website but is particularly useful during maintenance of website when little to large changes are required and this feature allows changes to be made easily. Since the unit of information access is the portlet, GIS users can be given access to information such as map viewing while course coordinator can have access to student user owned folders to assess their work submissions.

Oracle Portal has ability to store and provide structured and unstructured information. The structured data can be broken down into logical entities and stored in database tables. The unstructured data cannot be logically subdivided and can be stored in columns as BLOBs data-types. The Portal can host and manage static content as web pages through portlets, including documents, spreadsheets, web pages, and presentations. Portal users and administrators have the ability to upload and manage single and multiple files, including their directory structures through the Oracle Internet File System (see section 5.3).

Once a web site is made available on a network or Internet, security becomes a major concern. The Oracle Portal deploys a comprehensive security structure in place that controls access to content from unprivileged users. This issue is discussed in detail in section 5.2.

The Oracle Portal offers range of tools for administration of the different components that make up the Portal. Administration can be made through web interface.

The Oracle Portal has a structure in place for integration external (for the Portal) applications such as GeoMedia Web Map into one access point. GWM can provide tools necessary to generate a map from the Web Map Server that can be provided to a client for viewing using a Web browser [3]. Users on the client sites will be able to work with the map interactively and dynamically (see section 5.1 for more detail).

4 Contents of GIS Portal for USP DFL

Traditional classroom-based geo-information science teaching at the USP includes PowerPoint lecture presentations and computer-based practical exercises with using local spatial data and GIS/RS software. The course’ content that can to be shared with students should be same for classroom-based and online learning.

The prototype of GIS Portal for teaching GE308 “Advanced GIS” course was implemented at first. Oracle Portal technology and GWM were used to implement GIS Portal with the individual pages for each student and pages for
each instructor as an administrator. User has to login to own the main page. On the main page, there are tabs, which would hold links to the common content for all students and instructors, e.g. course information, lecture materials, labs and spatial data download; and to individual information e.g. submissions of assignments, marks for assignments and instructor comments. The main GIS Course Page was divided into three regions: First region contains the course content, the second holds submission folders and the third region presents links to external web map applications.

Main page (Figure 1) contains the following tabs, folders and links:
- Course Information tab shows course related information: outline, overview, objectives, resources, schedule, evaluation and policies of the course, and explanation how to navigate and work within the Portal etc. The HTML page with this information is integrated into the tab as a portlet with the link into the same window. Course information also can be downloaded as a PDF file from this tab.

- Lecture Materials tab holds the links to the lecture notes, which are prepared as HTML and/or downloadable PowerPoint or PDF files. The lecture HTML files were linked from the Lecture category as portlet provider and integrated into the tab portlet, while the links pointed to their actual location in the Lectures folder. Since there were a number of lecture files that can be viewed, the type of links was chosen to open lecture content within new window and since the files were HTML files, they would display without any pre-processing. This was made mainly for users who do not have installed software to display files in special formats e.g. PDF. The enhanced version of the Portal may contain links to multimedia files with recorded lecture presentations.

![Image of Student main page.](Figure_1.png)
- Lab Materials tab holds the links to the course session files. The laboratory hand-notes are prepared as HTML and downloadable PDF files. Course administrator may prepare and put the current lab files in the Lab folder and create links weekly. The students would view links and open the files during their lab sessions. The lab files were configured to open up in new window in HTML. This material can be supplemented with pre-recorded lab explanations in the next version of the Portal.

- GIS Data Files tab holds the links to the downloadable files and/or folders with spatial and attributive data; e.g. map layers for the lab session course work and assignments. The data files could be opened in external GIS applications like GeoMedia, MapInfo, or ArcGIS.

- Student Submissions folders are for student work submissions to course coordinator. Each student has owned content area for storing files (assignments results) that are to be submitted to course coordinator. A region within the main page was developed that could hold the link to student folder. A student owned folder exists in a content area, which belongs to the student. A student would only view his/her owned folder. For the course coordinator, access control settings are configured in such a way that he/she would have access to all students’ folders and would find it easier to download their submission files from one place and access them.

- Results of Assignments links – where student may see individual results of his/her assignments and tests.

- View Maps links allow students to view and work with map files over the web using GWM (Figure 2). Upon applying on any link, an interactive web map
would open up in a new browser window. Functionalities of GWM allow cartographic visualization and simple spatial analysis only (These capabilities are available in all existing commercial GIS Web mapping software). Some lab assignments can be carried out by using GWM only; but more comprehensive assignments still require the installations of full functional GIS/RS software on LAN and/or individual computers.

Since students can belong to either of the courses, each student has a separate account inside of the portal, which would login the students to their course page by default. Student may make simple customization of own folders. Instructors have similar main page, but with more information and higher rights for customisations and changes of student content within Portal Content Area Builder page. The content of the Portal is easily extendable and updateable. An instructor may create new folders, tabs or links, and change their contents during the semester, on an as-needed basis, with little customisation efforts.

5 Implementation issues

5.1 Integration of Oracle Portal and GeoMedia Web Map

The Oracle Portal has a structure in place for integrating external applications into one access point for the Portal. There are three ways for the integration: native J2EE applications using Oracle's Portal Development Kit; certified portlet integration for Oracle 9iAS Portal; and using URL integration [2].

GeoMedia Web Map utilizes the ActiveCGM (Active Computer Graphics Metafile) format to generate client display and employs the technology of Active Server Pages (ASP) or java servlets for medium or thin clients. Integration of GeoMedia Web Map within the Oracle Portal can be made by using Oracle’s PDK for the J2EE application or URL integration. For the prototype version of the GIS Portal, GeoMedia Web Map solution based on ASP technology was utilized. To host external applications that have not been developed using J2EE, URL based portlets are integrated into the Oracle 9iAS Portal application framework through registration and configuration through the Oracle PDK.

5.2 Security control for staff and student access

A great feature of Oracle 9iAS Portal is its integrated security. The Oracle 9iAS, as host of the Portal, provides full securing control within Portal by leveraging the capabilities of the Oracle 9i Application Server, Single-Sign-On (SSO) and the Oracle Internet Directory (OID) in addition to management of privileges users and group management. SSO and OID of the Portal guarantees appropriate user authentication and authorization. Security principles to authenticate and authorize users for accessing Oracle Portal content through Oracle 9iAS are as follows [4]:
- Users with URL access have access to public portal content;
- Portal determines if the user is authenticated at login time;
- Oracle portal security determines if the resource being access is protected;
- If the resource is protected, portal security determines if the user is authorized to access the resource;
- User access is granted or denied.

Oracle Portal allows security at the item or component level. All created components in Oracle Portal have an access tab, enabling to specify privileges for a user or a group of users. This feature helps students and staff to control access rights to information. Student user group is not allowed to have access permissions to any folders that contain information on the course, e.g., to Lecture Materials tab etc. Student users are provided with user-owned folder and there is security access control to prevent other student user in accessing these folders, but at the same time allowing course coordinator to access information for student work assessment. Security settings can vary for each item [5].

External applications not registered as Oracle 9iAS SSO partner applications such as GeoMedia Web Map can be hosted through Oracle 9iAS Portal while utilizing an external authentication repository through custom integration.

5.3 IFS for file storage and management

File System within Database (FSDB) is relatively new idea for data file management. FSDB raises the possibility for any file to be created, reviewed, corrected, approved, and finally published with appropriate access restrictions for user groups or simple users into DBMS [6]. At the same time, FSDB can be replicated by standard replication procedures of any sophisticated modern DBMS. The protocol servers that are included, for example, with the Oracle Internet File System (IFS) allow the FSDB to provide support for all common industry standard protocols through the Internet or application server and within the enterprise network [7]. By using the File System within DBMS, the organization can be confident, that spatial content is secure and accessible from a central location, especially if we use additional encryption for the stored data.

Oracle Internet File System was used to store and manage the spatial data files, files with student assignment and respective submissions. A FSDB provides a powerful and secure tool for the storing and managing files. When, for example, a spatial file is moved to the FSDB for storage, FSDB stores the file into a special repository database object. When the students open the file on the FSDB drive, FSDB retrieves the data into logical format that the GIS software or GIS Application Server can read, update and process as a simple spatial file. FSDB is a tool that enables students to share files on a standard Intranet network and over the Internet, or through an Application Server.

Once files have been stored in the repository, access to them is tightly controlled by the security mechanism built into the repository [7]. A FSDB secures GIS and stores files in a DBMS. The FSDB uses authentication mechanism to get access into a DBMS or repository of FSDB, regardless of the protocol or tool being used to access a file. Newest versions of FSDB have more sophisticated authentication mechanisms, such as SSO servers, Internet Directory or LDAP server's utilization.
6 Conclusion

Oracle 9iAS Portal provides a comprehensive administration feature that caters the needs of today’s e-business organizations. This paper describes how these features were utilized for offering GIS web based course through DFL mode at the University of the South Pacific. GIS Portal based on Oracle 9iAS offers huge advantages to staff members as administrators, and students for learning GIS/RS related course.

Course coordinator would find it easier to develop and maintain static and dynamic content of GIS/RS website through adding and removing components within page, tabs, regions, portlets and external application integration with GIS/RS solutions. As a Portal administrator, course coordinator may create and edit users or groups, grant and revoke privileges and controls access at folders, pages and application level. Monitoring is another feature, which course coordinator can use to see who is logging in course Portal, when they are logging in, how frequently they are logging in etc. As a marker, course coordinator can access individual student submission folder and make assessment of assignments. Course coordinator also can have live-interaction with students via aggregation of FAQ, discussion groups, live or pre-recorded video presentations as portlets (these features are not implemented in this project).

The use of Portal technology to provide GIS/RS course on the web is convenient for students residing outside the campus, as well as for on-campus students. This solution gives possibility to integrate all teaching and learning recourses in the same environment; keep and manage these recourses in the same database system. Oracle9iAS allows single point to access, aggregate and search information [5]. A total course for distance students over the web can include all major aspects of the course provided on-campus. Students have possibilities not only to use the GIS Portal content and recourses, but also make a customisation within their working environment (working with files in conventional way, but managed and protected by Oracle DBMS). Part of the GIS/RS courses can be learned by remote users through the web browser since web browser may be the only software available to them. Work with the spatial data can be done through the integration external Web Map Server (e.g. GWM) that was implemented in this project, or via use of dynamic portlets. Second option may provide more functionality for spatial analysis, but required programming development (last feature is not implemented in the current version).

This paper describe only prototype version of the GIS Portal based on Oracle 9iAS Portal and GeoMedia Web Map Server.

The current work was initially motivated in search of the best solution for GIS/RS on-line distance mode education at the University of the South Pacific USPNet. The authors are grateful to USP Research Committee for the financial support of this research.

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