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On-line Spatial Processing Systems

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Title: On-line Spatial Processing Systems

Subtitle: iMap Case Study

Abstract

On-line Spatial Processing (OLSP) delivers high performance spatial systems for the modelling and monitoring of dynamic environments. It provides an ideal solution for the management of networks, land and assets, and the real-time tracking of changing spatial systems. OLSP is server-centric, as opposed to the primarily desktop-centric world of GIS. It places spatial data at the heart of the organisation's IT systems and integrates it with business and attribute data. The result is more effective use of spatial data and improved decision support and spatial intelligence throughout the organisation.

By Dr. James D. Carswell, Digital Media Centre, Dublin Institute of Technology & Dr. Michela Bertolotto, Department of Computer Science, University College Dublin & Philip O'Doherty, Group CEO, eSpatial Solutions Limited, Ireland

Introduction

In this paper we discuss the iMap Case Study developed with OLSP technology by eSpatial Solutions Limited™. eSpatial™ provides mainstream spatial solutions built on the Oracle™ 9i technology platforms. These solutions use Oracle's open spatial and JAVA/PLSQL programming standards to achieve interoperability between established GIS technologies and mainstream IT computing. This enables organizations to leverage their investment in GIS infrastructure by having their spatial data accessible to a wide variety of applications as needed. This further ensures that spatial data can be tightly integrated with other related business data.

The eSpatial™ iSmart product suite provides the tools and components required to build online spatial processing solutions. For example, iSmart SERVER™ enhances the spatial functionality of an Oracle™ Database by allowing the real-time capture, display, editing and query of spatial data using a standard web browser. Additionally, iSmart Studio™ is a database environment that allows software engineers, data administrators and even non-programmers to design, build and deploy spatial internet applications, based on iSmart SERVER™, without application specific source code. Resulting applications will allow field engineers and other authorized users to enter updates directly to the database via wireless devices. Service engineers can collaborate online with office based support centres accessing the same data. The same data can be used by marketers to plan and implement campaigns, and network engineers to manage operations. Within the realm of eGovernment, Citizens can interact with spatial data directly via the web.

The remainder of this paper illustrates the potentiality of OLSP technology by describing a working system that deploys it. The Land Information Management System (LIMS) application (called iMap), developed for the Irish Department of Agriculture, utilises the iSmart SERVER™ platform to deliver a spatially enabled Internet solution for the tracking and management of land information based on land usage, land classification and land ownership changes over time.

iMap Case Study

In Ireland, the Department of Agriculture, Food and Rural Development (DAFRD) is responsible for maintaining a record of every farm in the country, in terms of both land use and acreage. This data is essential to administering the complex network of grants upon which the agricultural industry relies. Previously, this data was stored in two distinct and isolated ways:

- Ortho-rectified aerial photography and spatial data stored in proprietary GIS packages
- Land area and use data stored in conventional RDBMS database systems

This “two database” approach added additional workload in the administration of the system. The accurate checking of grant applications involved examining GIS data and then attempting to correlate this with the stored business information on each farm - a lengthy and inefficient process.

To overcome these difficulties, DAFRD wished to create a system that truly integrated spatial data with the business rules and financial data used to manage grant claims and awards. In this way, DAFRD officials would be able to work directly on physical representations of farmland to calculate field areas and uses, which in turn could be used to automatically calculate the size of relevant grants. Furthermore, the system would be entirely dynamic - new field boundaries could be inserted at any time and grants recalculated, for example.

The iMap application serves 125,000 farmers for a total of 700,000 field parcels. In response to this demand, OLSP technology by eSpatial™ was deployed to deliver a single, web-enabled information system that integrated the existing GIS datasets with the DAFRD's Area Aid transactional data within one Oracle Spatial™ database system. The finished system is one integrated solution rather than a collection of several packages.

This approach delivered a number of key benefits to the department:

- Improved Public Service - Queries from the public regarding grant status and land records could be answered immediately by non-specialist users, who by simply selecting another tab could locate and query the relevant spatial and mapping data. This greatly improved both efficiency and satisfaction levels among public users of Department data.
- Support for Accurate and Efficient Payment Administration - iSmart SERVER provided a single point of access for all data and functions, integrating all mapping and transactional data, and thus allowed comprehensive reporting and printing of maps, application forms, reports and letters. Grant calculations could now be dynamically managed online.
- Remote Farm Inspection - The representation of spatial data enables the Department to conduct farm inspection using remote sensing imagery,

radically improving the efficiency of this essential operation. Reports on individual farms can be generated instantaneously.

- Fast Identification of Land Use Inconsistencies - The eSpatial™ solution enables the fast location and resolution of inconsistencies in data, particularly overlapping land claims that would previously have been difficult to identify.
- Web Access To Dataset - The iSmart™ application can be accessed on any web client. In the long term, as such applications are opened up to external use and farmers input data directly, this will automate the entire grant application process at a level of accuracy that was previously unobtainable.

In the following we describe how the system is used after authorised logon, where different security restrictions are applied to different groups of users (e.g., only viewing/querying, viewing and editing, etc.). At first the user is prompted with a homepage from which several different options can be chosen. For example, the *Farmer/Locate* screen can be entered to view farmer details and locate parcels. A remote user can view the claimant's details to retrieve associated information. To access details the user is required to enter a herd number and select a year from a drop-down list (Figure 1).



Figure 1. Screenshot of the Farmer panel.

Alternatively, by clicking on the locate tab it is possible to locate a parcel/area using several different criteria: cadastral locate (specifying a county), Ordnance Survey locate (entering map numbers), coordinate locate (enter x and y map coordinates), LPIS number (land parcel ID). The user then enters a herd number and a year to display all parcels where the specified herd is located. One specific parcel can then be selected and viewed (Figure 2).



Figure 2. Alternative locate method: the user enters a herd number and year; then clicks on the Digitising tab (Parcel Data will have been populated with plot and parcel data for the chosen herd number); the specific parcel is then selected and viewed by right clicking on it and choosing the *View Current Row* option.

The on-line digitising functionality is accessible directly from the result screen of the locate search described above by clicking the digitising tab (see Figure 3).

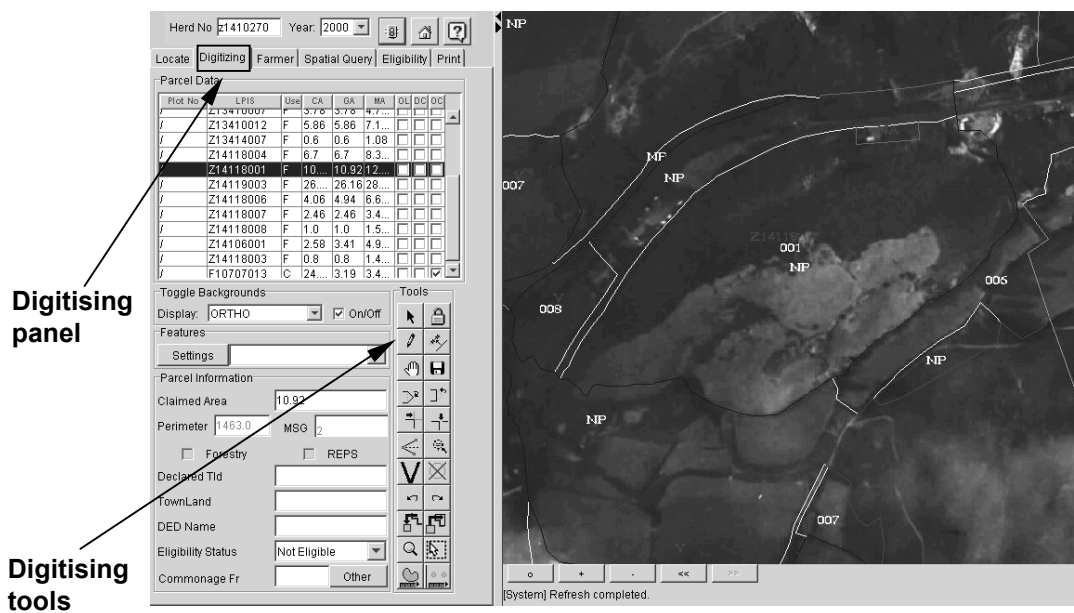


Figure 3. Digitising panel: besides viewing parcel data and changing visualisation settings, the user can utilise standard digitising and validation tools.

Once the user has digitised a new parcel boundary, topology updating algorithms are automatically invoked within the Oracle™ 9i Spatial database. Immediate printing capabilities of graphical/attribute editing updates represent additional benefits of the system.

Spatial query functionalities of the system include: retrieving parcels of a given shape, area, centroid coordinates; buffer queries; window queries; topological queries (e.g., based on overlapping, containment, etc.). Thematic queries are also allowed where re-symbolisation of an area on a map is based on its attributes. In Figure 4 the Spatial Query panel is illustrated.

To enable printing capabilities the Print tab is selected. Two different modes are available: on-line printing and batch printing. Using the on-line mode, users can print (see Figure 5):

- Screenshots: prints what is currently visible in the viewer;
- On-screen parcels: prints a parcel based on its LPIS number, which is entered into the relevant field.
- On-screen herd numbers: prints a farmer's entire herd at a zoom level and paper size chosen by the user;
- On-screen townlands: prints a townland map with any required background depending on user preference.

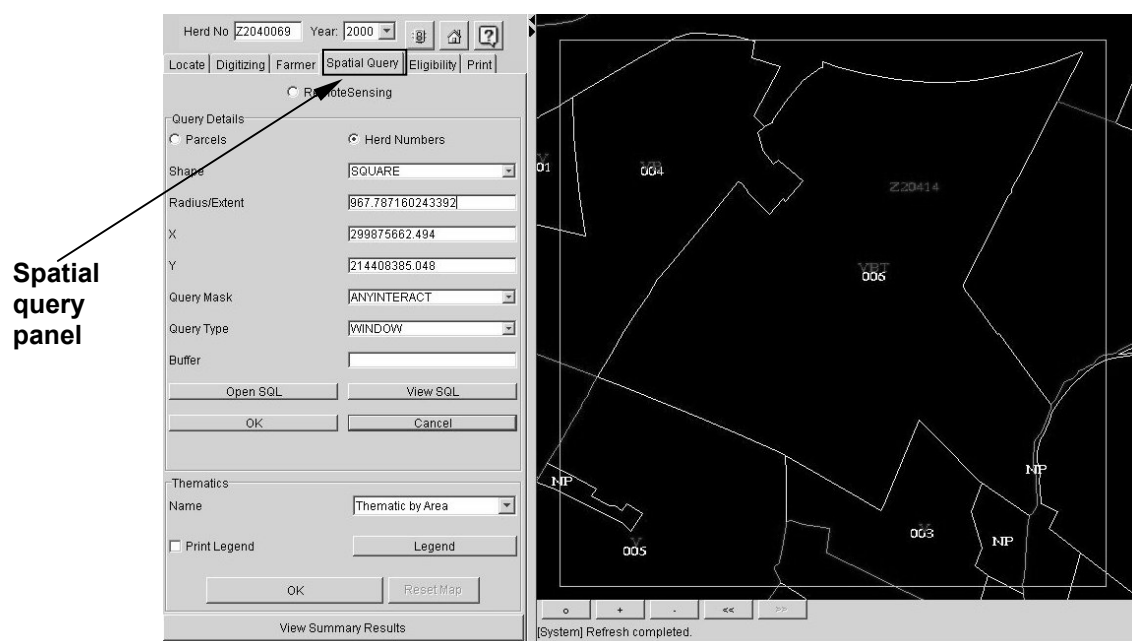


Figure 4. Spatial query panel: the user can enter query details such as the shape of the geometry, the distance from specified map coordinates, the query type (window, buffer, etc.), the topological relations (overlap, touch, equal, anyinteract, etc.). The corresponding automatically generated SQL statement can be viewed and manually edited if required.



Figure 5. Printing panel with on-line option: a wide range of parameters can be selected by the user (zoom levels, paper size, background settings, etc.).

Conclusions

This paper presents a LIMS application of OLSP technology developed by eSpatial™ Solutions™. It extends Oracle Spatial™ databases by adding spatial information management functionality that can be used within web-enabled applications accessed via any device that supports the Java Virtual Machine (e.g., standard web browsers, PDAs and 3G mobile phones). A major advantage of this technology is that it does not require the use of complex proprietary application specific software to differentiate itself from traditional GIS vendors. This includes the ability to both access and edit raster and vector spatial data allowing:

- True enterprise integration of spatial information within mainstream applications using Oracle's technology platform and open application development tools.
- Rich traditional desktop GIS functionality within any spatial application on any web-enabled device.
- Centralized server-based spatial computing and manageability.
- Rapid, zero code spatial application development.
- Integration of legacy CAD and GIS data and tools with the enterprise.

We have shown the potentialities of eSpatial's OLSP technology as deployed in the land information management system developed for the Irish Department of Agriculture. This system serves 125,000 farmers in the territory of the Republic of

Ireland and after two weeks of on-line operation, it generated 200,000 maps. This application provides a seamless Oracle™ 9i Spatial database environment for the combination of multiple land information datasets. The normal edit (e.g. create, modify, and delete) and spatial analysis functions associated with traditional GIS based land management applications are deployed as Java stored procedures in the Oracle Spatial™ database. Integrated database topology ensures spatial data integrity within the database. The automatic preservation of topological properties makes this system a reliable decision-making tool. Statistical data analysis (e.g., land use, land classification and land ownership changes over time, etc.) can be easily compiled using standard Oracle™ reporting functionality.

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Further Reading

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Biography of the Author

Dr. James D. Carswell is the Research Coordinator for the Digital Media Centre of the Dublin Institute of Technology and the Chief Technical Consultant for eSpatial Solutions.

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Figure Captions

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Figure 5. Printing panel with on-line option: a wide range of parameters can be selected by the user (zoom levels, paper size, background settings, etc.).

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