British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Oracle Spatial in BGS

Information Management Programme
Internal Report OR/08/003

BRITISH GEOLOGICAL SURVEY

INFORMATION MANAGEMENT PROGRAMME

INTERNAL REPORT OR/08/003

Oracle Spatial in BGS

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Keywords

Report; Spatial, GIS, RDBMS; Oracle spatial; shapefiles; database.

Keyworth, Nottingham British Geological Survey
202008

BRITISH GEOLOGICAL SURVEY

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Foreword

This report derives from a successful presentation of BGS's spatial story at a UKOUG SIG in 2008 and also the national UKOOG conference the same year. The report outlines BGS's spatial history and the key initial steps required to incorporate Oracle spatial capability into BGS's data architecture. It outlines the spatial capability at the time and what immediate initial steps were required to embrace and incorporate spatial database technology.

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1 Introduction

The BGS is a data and information rich organisation. The vast majority of these information assets have a spatial component (i.e. they have some form of geographic location that ties the information to a point on the surface of the Earth). This information can be represented on a map, for example as a point, a polygon or an image.

Spatial datasets take a variety of formats, example datasets include:

- Relational tables
- Spatial vector data as points, lines and polygons,
- Spatial raster data with or without attributes,
- Surfaces – TINS and GRIDS,
- Images – borehole, map and photograph scans,
- Time series measurements-depth series,
- Downhole measurements,
- 2.5D,
- 3D data in the form of cross-sections,
- Borehole data,
- Seismic sections,
- Stratum contours

The above list includes some of the spatial datasets held in BGS, the majority of which have been modelled using specialist packages.

The ability to manage, use and integrate spatial and non-spatial information, from numerous sources (both internal and external) is fundamental to reducing costs, optimising efficiency, increasing the quality of service, and enabling both scientific research and the development of new commercial opportunities.

As an organisation, the BGS has used industry standard software packages to capture, store, manage and make its data accessible. The Oracle relational database management system has long been used to store, manage and allow connectivity to BGS's attribute datasets. At the same time, ESRI products such as ArcInfo, ArcView3 and more recently ArcGIS, ArcIMS and ArcGIS Server have been separately used to store, manage, analyse and display Geographic Information System (GIS) data.[1]

2 Parallel Paths

2.1 OVERVIEW

At the BGS the two environments of GIS and RDBMS have developed side-by-side for over 20 years with very little real integration. However, it is also true that data has been shared between the environments, but this has involved translations and copying of data. Translation layers can

[1] ESRI's ArcIMS and ArcGIS Server allows the delivery of our spatial datasets via the web and allows BGS Customers to visualise and query some of our major datasets.

be complicated and must be correct, consistent and properly documented for easy maintenance. Refresh rates for data copies can at times be seriously compromised resulting in incomplete and/or inaccurate, but certainly inconsistent datasets presented to users. Real integration has been hindered due to technology, data and separate cultures in the RDBMS and GIS worlds.

Spatial implementations by software vendors for the integration of GIS and RDBMS have been limited and immature. Thus providing a limited opportunity for GIS and RDBMS developers to come together and create a unified data store to support both relational and spatial data.

Software tools for spatial information management have been known traditionally under the name of Geographical Information Systems (GIS). These systems are specialised applications for storing, processing, analysing, and displaying spatial data. They have been used in a variety of applications. However, until recently, GIS have employed specific spatial data models and proprietary development languages, which held them separate from the main corporate databases. This has represented a barrier for full deployment and exploitation of the added value of spatial data in organisations.

However, recent improvements and the maturity of Oracle spatial and the gradual universality of the spatial models for GIS is seen as a way to start to bring the two parallel developments of GIS and RDBMS closer together to achieve deeper and potentially full integration.

Spatially enabling BGS Oracle data tables using Oracle spatial techniques (rather than having our spatial datasets in a separate proprietary format) could help us overcome a number of issues. For example:

- There are a number of shapefiles across BGS that are not updated centrally, or backed up property. These datasets could (and should) be stored relationally. If necessary datasets could be translated to ESRI shapefile format on a monthly basis and held on a central fileserver. This means that GIS users do not see the current state of the active database

- Small point datasets held in Oracle can be accessed directly from ArcGIS by creating an event theme but this is very slow for larger datasets as no spatial index is used. Storing these point datasets in Oracle Spatial would provide much faster access.

Inconsistencies between geographic areas (e.g. county boundaries) in the GIS and the text held in the relational database have resulted in customer dissatisfaction. Storing the spatial elements and the attributes in Oracle spatial would create mean datasets are consistent.

3 The Way Forward

3.1 OVERVIEW

The BGS is now in a position to reap the benefits of a platform that integrates RDBMS and GIS. The infrastructure, software, language standards required to use Oracle spatial are well embedded within the IT systems of the BGS and there now is a willingness and a greater corporate approach to managing our spatial and non spatial data as a fully integrated dataset. This would facilitate deeper mining of our data enhanced scientific use and enhanced GIS development.

Spatial information is everywhere in our organisation: Infrastructure, environment, land use, boreholes, models, surfaces etc. and this spatial data adds value to our organisation in the services and products we produce and deliver. Examples datasets include:

- SOBI – Single Onshore Borehole Index
- Borehole Accessions
- Landslides
- Site Investigations
- Geochemistry Boreholes & Samples
- Geotechnical Boreholes and Samples
- Mine Plans
- Mineral Planning Permission Areas etc.

The adoption and standardisation of Oracle spatial in the BGS as our spatial data repository will facilitate the integration of RDBMS and GIS addressing current issues such as:

- Data Isolation
- Multiple proprietary formats
- Admin and Management costs
- Scalability issues
- Complex support systems
- Speciality servers for different kinds of data
- Lack of consistency

The points below as detailed in an Oracle presentation illustrate benefits of incorporating spatial database technology into a corporate data architecture:

- A database as opposed to files provides,
  - Robustness, manageability, availability, scalability for your spatial applications
  - Data structuring and modelling
  - "Single source of truth" for spatial data
- Managing a single rather than multiple format enables
  - Combining best-of-breed spatial tools
  - Preserving investment in existing tools
- The use of GIS tools and Direct access (SQL) allows,
  - The addition of spatial intelligence to business applications

The illustration below shows our current GIS and relational database architecture, and some possible future architecture.

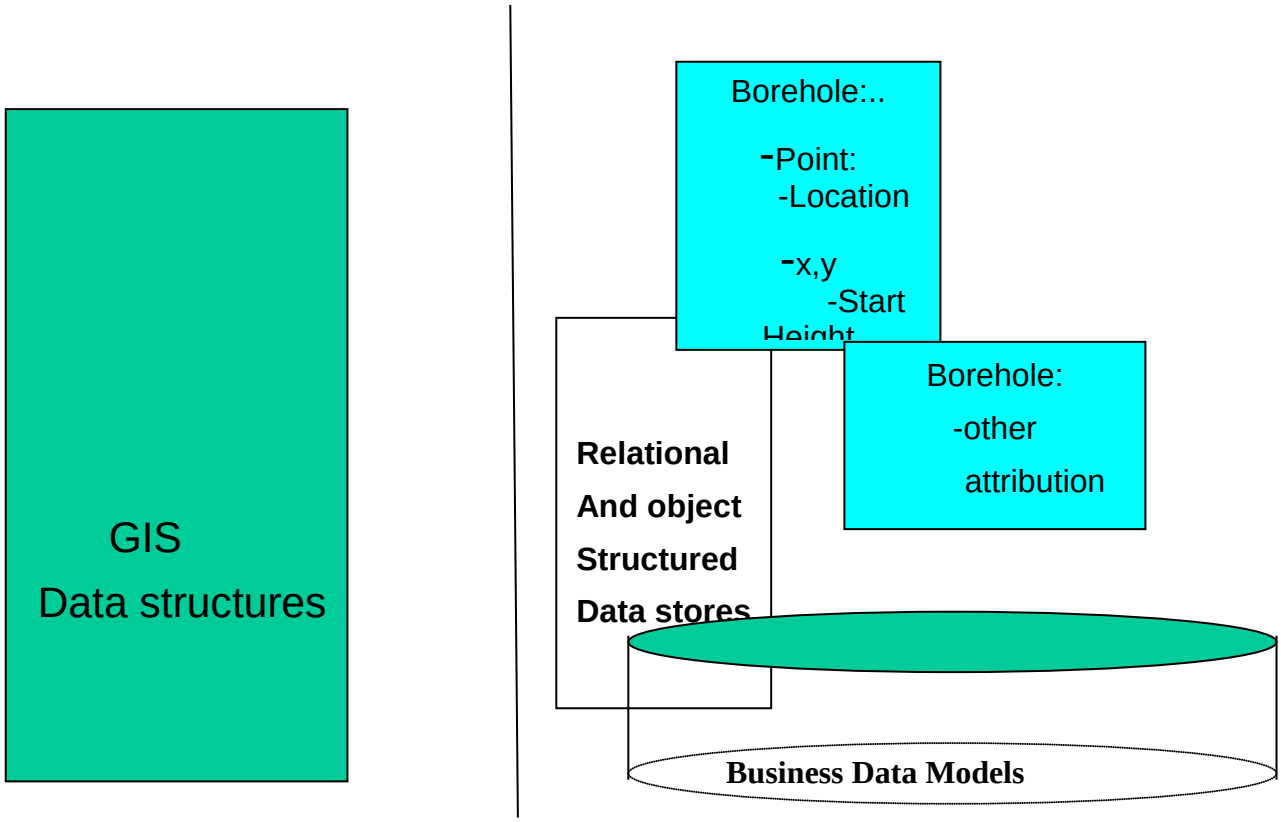

Figure 1: A schematic view of the current separate environments of GIS and RDBMS with an example point dataset.

The schematic architecture illustrated in Figure 1.0 shows the current and traditional separation of GIS and RDBMS. This architecture does not promote integration (except for the read-only data copies), corporate data management, deeper mining or the extraction of enhanced intelligence from the datasets.

Today's spatial database technology enables us to adopt a central data repository (logical and/or physical) that lends itself to both GIS and relational environments with a set of tightly defined and controlled physical implementations that still support the approach of a central repository. Oracle spatial can be used to store spatial data in an Oracle database. Once the data is stored, it can be processed, retrieved, and related to all other data stored in the database: spatial information or location is just another attribute of a business object.

Use of this technology would eliminate the need for coordinating multiple data sources due to an application's dependence on spatial data structures and the use of different languages to query data.

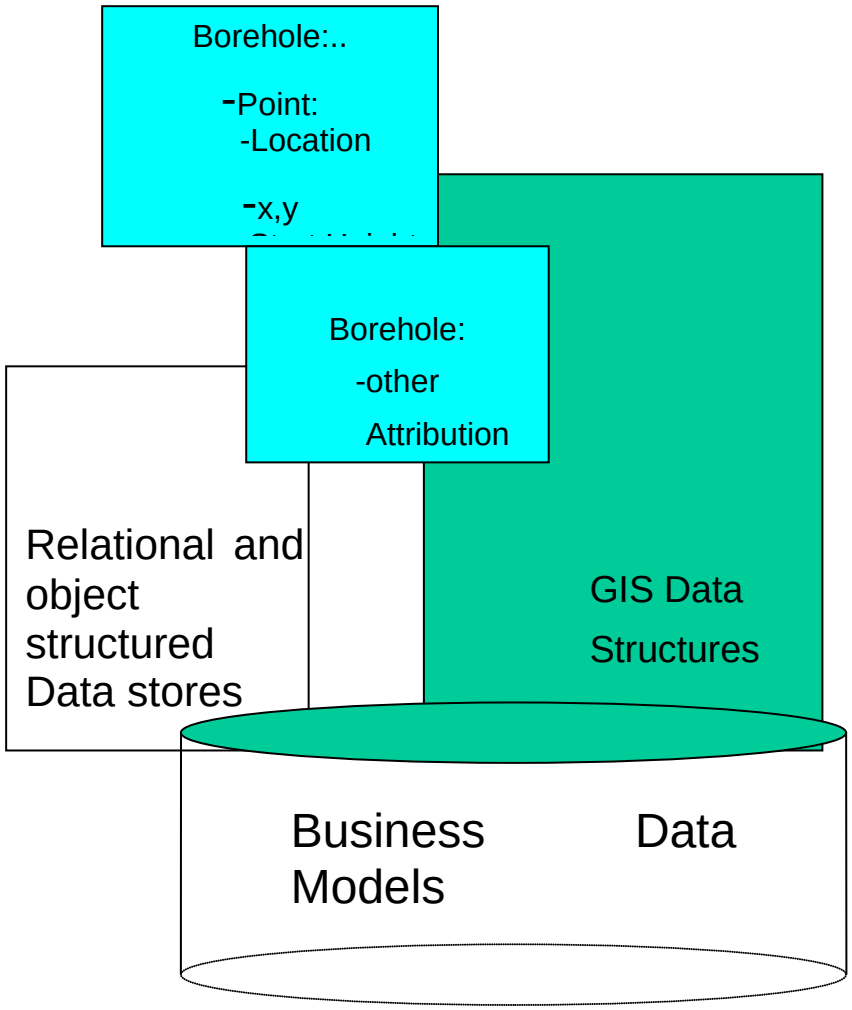

Figure 2: A schematic view of a unified database platform with spatial data for access by different applications.

Figure 1.1 shows a view of a unified database platform and spatial structure. Oracle spatial provides:

- The ability to access spatial data through SQL statements, just like any other database content.
- Support for industry standards for spatial information (SQL and OpenGIS).
- Above all, it facilitates leveraging the full added value of spatial information, which becomes an integrated part of the information assets of organisations.

BGS has a very long and credible history in the use of the Oracle relational database system in managing its huge data and information resource. Most if not all of the key digital data indexes are held within the Oracle database, so for continuity, consistency, and familiarity it's a sound platform. Yes, we may be new to Oracle spatial but not new to Oracle and the languages used for interaction, SQL is a standard that we are already familiar with. Using the Oracle database and its spatial capabilities allows us as an organisation to continue to reap the benefits of a database approach to structuring, storing, managing and providing access to our data. Benefits include;

- Spatial component is inside the database and not middleware
- Oracle Spatial is considered mature, reliable and a functionality-rich product
- Integrity is managed by the database
- Scalable – supports terabytes of data and also many users
- Few data modelling restrictions
- Seamless integration with other Oracle products
- To standardise formats to make sharing possible
- Centralise for easy access by all parties
- Provide in generic form also for non-specialist GIS staff

The BGS by spatially enabling its databases should improve:

- Uniqueness and security
- Speed
- Spatial queries on structured data
- Structured queries on spatial data
- Effective data management and data consistency
- Enable alternate access views

The BGS's current implementation of Oracle is the Enterprise version of Oracle 10g R2 and this offers the full implementation of Oracle Locator and Spatial options. The 10g implementation of Oracle spatial supports up to 2D the following geometric primitive types:

- Points
- Line Strings
- Polygons
- Polygons with holes
- Circles
- Arcs, Arc Strings
- Compound Elements

These can be stored in a native data type called MDSYS.SDO_GEOMETRY. It's the data type currently documented, recommended in Oracle text and also used by GIS vendors such as ESRI.

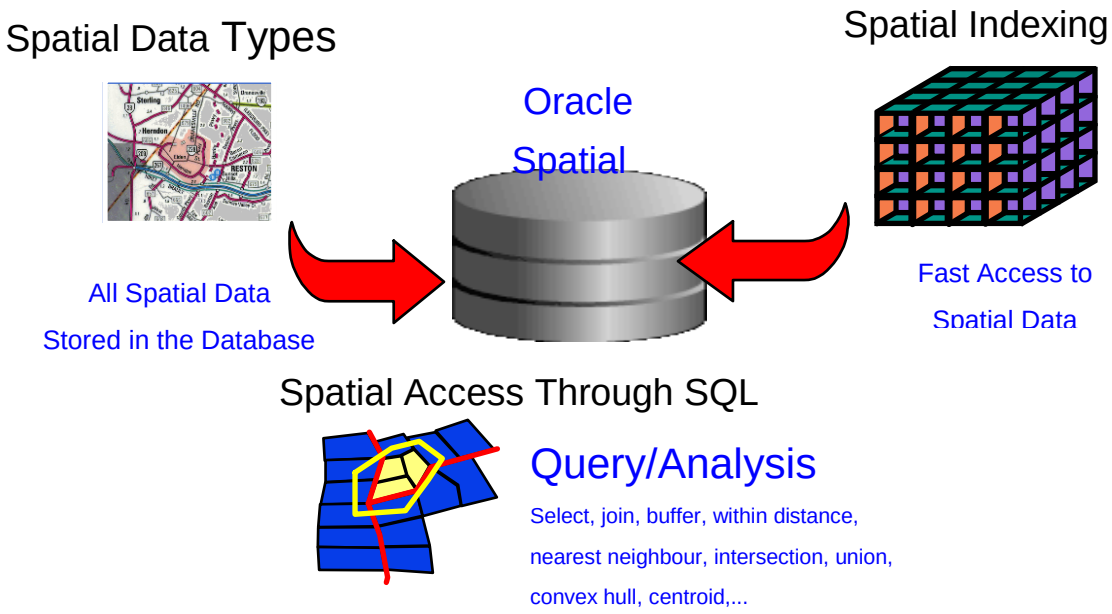

Figure 3: Oracle Spatial Capabilities

4 Immediate steps

4.1 Spatially Enable Corporate Database Objects

- Spatially enable BGS attribute data tables with location data making them accessible for use by all applications. (The objects used by the GDI are currently been worked on)
- Spatially enable any new database designs for the corporate area, so that this capability is readable and available

4.2 Produce Best Practice Guidelines for Spatially Enabling Databases

- Produce a technical best practice for spatially enabling corporate database tables and also for importing existing GIS layers into the Oracle database

4.3 Identify Other Spatial Objects for Integration into Oracle

- Identify GIS layers or datasets residing outside the Oracle database that can be immediately imported to use the native data type and render these layers to all applications and users.

- Identify spatial datasets outside of the Oracle database that long term can be mapped to be stored in the Oracle database.

4.4 Best Practice Guidelines for GIS Development – Layer Creation and Management

- Produce a best practice for GIS development regarding project layers and the management of the data during and after this process.

The emphasis has so far been on storing data directly in Oracle, creating spatial layers, querying and displaying these layers via a third party tool or directly querying the spatial datasets for other web reports such as the data portal. The long term goal however is to achieve full integration for both reading and writing of spatial data such that edits to the spatial data can be done directly from clients by users and these updates reflected in the Oracle database.

This is a huge step but also an important next step that will bring to the fore even more of the benefits of a fully integrated spatial database incorporating GIS and the RDBMS.

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Appendix

Things of Note:

1.1 SQL Multimedia Types:

In Oracle 11g, support for the SQL Multimedia types (ST_xxx) has been enhanced. These types are specified in ISO 13249-3, *"Information Technology – Database Languages – SQL Multimedia and Application Packages – Part 3: Spatial"*. The ST_GEOMETRY data type with its associated subtypes, although this data type is currently implemented in Oracle 10g R2, there's little documentation and we would continue to use SDO_GEOMETRY but with research into ST_GEOMETRY and how best we can adapt this if necessary when it becomes operational with major vendors. Oracle 11g Technical Notes also offers a full chapter on these types and also "ST_GEOMETRY and SDO_GEOMETRY interoperability ".

1.2 3-D Geometry Support in Oracle 11g:

Oracle 11g will also have an implementation for storing, managing and analysing 3D geometries. Check the link below for full listing of "What's New in 11g Oracle Spatial".

Also see: http://download.oracle.com/docs/cd/B28359_01/appdev.111/b28400.pdf