GIM INTERNATIONAL INTERVIEWS DR JAYANT SHARMA, TECHNICAL DIRECTOR SPATIAL PRODUCTS, ORACLE

Linking Geospatial Database with GIS

The database vendor Oracle Corporation has for a long time shown a strong interest in geospatial data storage. For a fuller picture of the spatial aspects of their latest product, Oracle 10g, GIM International interviewed Dr Jayant Sharma, technical director of Oracle Spatial Products, in New Delhi, India.

Biography of Dr Sharma
Dr Jayant Sharma is technical director, spatial products at Oracle's New England Development Center and has over a decade experience in databases and spatial information systems. He was responsible for building the spatial product team when he joined Oracle Corporation in 1996. He also represents Oracle at Open Geospatial Consortium Technical and Planning Committee meetings and its working groups.

Can you give a brief history of how Oracle moved into the geospatial domain?

Since their creation GIS systems have been developed using the available IT technologies. When the first commercial databases began to be used in GIS systems Oracle became the preferred DBMS in this domain. Over time, GIS applications and application vendors began to require more and more core database management facilities. We began by adding native spatial datatypes, the â€˜simple featuresâ€™, as well as high-performance indexes and SQL language extensions to permit GIS applications to integrate business data with spatial data, thereby enabling enterprise user communities and datasets. Very early on, the GIS community and leading GIS tool and application vendors began to take advantage of these features because they enabled them to address more complex problems, larger datasets and numbers of users. Over time, with the help of our customers and partners, weâ€™ve continued to apply our expertise in database science to the specific needs of the geospatial community. Oracle is an information company focused on secure, scalable information management and processing needs of customers and these needs include spatial information management.

Where do you consider the borderline to lie between the GIS industry and Oracle Spatial 10g?

We see Oracle Spatial 10g as a platform that is absolutely a key part of the GIS industry. We believe that Oracle Spatial 10g will act as a catalyst for growth and expansion of the geospatial and GIS industry. Our longstanding partners, companies like Autodesk, Bentley, e-Spatial, ESRI, Intergraph, Ionic, Laserscan, MapInfo, and Star Informatics, understand that simplifying their data management issues allows them to address the requirements of a broader geospatial information system market. With new 10g features weâ€™re extending the platform in ways that are being exploited by new kinds of partners â€“ companies like Abaco, Acquis and Fitchner, and in imaging Leica, Lizardtech and PCI.
There is a distinction between application level and the infrastructure for the information management level. The application level deals with your model of the world and interactions with that model to solve a problem and manage your organisation. Partnersâ€™ tools and solutions provide this application-level capability. The data management infrastructure advanced by Oracle provides a secure, scalable, robust foundation for the application. Thus the synergy lies in the geospatial domain knowledge provided by partners and Oracleâ€™s information management platform. With 10g we provide enabling capabilities to manage remote sensing data and satellite imagery in an integrated system with vector data, to perform graph-based queries and analysis and to manage topology. The business rules, the application data models and the application logic are where core geographic knowledge comes into the picture.

What is Oracleâ€™s philosophy in respect of standards such as ISO and OGC?

We strongly believe in standards and in supporting them through participation in their creation and implementation. Standards are essential to the growth and adoption of geospatial technologies. Oracle is a founding member of the Open Geospatial Consortium and continues to be an active participant at very senior levels. We implement the standards accepted by OGC members. We also have representation on ISO, ANSI, W3C and other standards committees. Oracle Spatial has been compliant with the OGC Simple Features for SQL (Normalised geometry) specification since version 8i. In Oracle 10g we implemented the Types and Functions section of the SFS specification and GML 2.1.2. The Oracle Application Server 10g MapViewer supports the OGC Web Map Server 1.1.1 interface specification. Similarly, the Oracle Application Server Wireless product implements OGC OpenLS 1.0 interface specification for location-

based services (see listed websites for further information). In Oracle 10gR2 we are also using the coordinate systems standard from the European Petroleum Survey Group EPSG (see websites).

How are geospatial elements currently stored in Oracle 10g

Oracle Spatial provides data types for representing spatial elements, spatial indexing methods and functions for analysis and manipulation of these types, all of which are an integral part of the database server. Thus the language interface is SQL and the SQL query optimiser is fully aware of the spatial index methods, operators, and functions and considers these when constructing query execution plans. There are now four types in Spatial: SDO_GEOMETRY, used mainly for vector data such as points, lines, polygons and homogeneous or heterogeneous collections, and SDO_GEORASTER for imagery and gridded data, and types that are part of the new Topology and Network data models.
The Network data model is used to represent, store and analyse graph structures. It provides functions to perform shortest path, minimum spanning tree and network flow-type operations on graphs. The Topology data model provides a means to structure geospatial data according to topological principles, so that the topological relationships such as adjacency, containment and connectivity are stored persistently in the database. Using SDO_GEORASTER users can store raster or gridded data and associated metadata in the database. Oracle GeoRaster consists of this type, an associated schema and indexes and function on this type. A variety of processing operations may be performed on GeoRaster data, including changing the format, subsetting (cropping), scaling and generating pyramids.

What are the benefits to users of maintaining and storing topology in the Oracle database?

Topology has long been used in GIS to support data integrity, enhance spatial analysis and help minimise storage through minimum coordinate redundancy. Persistent topology refers to the model of structuring data according to topological principles so that the topological relationships are stored and available persistently in the database. This has several benefits, including efficient storage, eliminating redundancy of spatial data, easier implementation of certain business rules in the database, and improved management of hierarchical geographic relationships. The proven mathematical foundation for the Oracle Topology data model means considerable flexibility and performance for the user or application. One such benefit is that the topology is transparently maintained, not rebuilt, on modifications to a geographical feature.
Edits to features can be classified in two categories; one in which the topology itself is not modified and the other in which underlying primitives (nodes, edges, or faces) are modified and hence the topology is updated. In both cases the topology itself is not rebuilt but simply maintained. Consider a first case where topology is not modified; once persistent nodes, edges and faces are loaded the user may create new spatial features by associating a list of primitives with the feature through a simple INSERT statement. No topology is modified. Similarly, users associate and de-associate primitives to or from a spatial feature (for example, extend a road) with a simple UPDATE statement. Again, no topology is modified. The Oracle model is extremely flexible and allows a primitive, such as an edge, to be associated with multiple feature classes, for instance with a road and also with a parcel boundary.
Support for feature hierarchies provides additional flexibility. For example, assume a feature class called â€˜parcelsâ€™, with each parcel associated with a list of face primitives. Users may also create a feature class called â€˜neighbourhoodsâ€™, where each neighbourhood points to a list of parcel features instead of a list of face primitives. Another level up in this hierarchy could be a feature class called â€˜school districtsâ€™, where each district points to a
list of neighbourhood features. Changes to features in the hierarchy are transparently reflected in derived feature classes. For example, if a neighbourhood boundary expands, the school district associated with that neighbourhood is transparently adjusted; no topology is modified.
Now consider the second case, in which an underlying primitive, a node, edge or face is modified. In this instance, topological integrity is maintained and all features that reference the modified primitives are also updated. For example, if a road (feature) refers to primitive edge E1 and a node N1 is inserted on E1 (i.e. it splits E1) to create E1 and E2, the road feature becomes â€˜transparentlyâ€™ associated with E1 and E2. Thus the topology is modified but not rebuilt from scratch on every addition, deletion or update of a primitive in the original topology.
The US Census Bureauâ€™s recent publication Spatial Data Storage and Topology in the Redesigned MAF/TIGER System provides further details on these benefits from a user and organisational perspective (see websites).

What are the new geospatial features envisaged by the Oracle development team for future implementation?

There are a number of market drivers that will influence the new features under consideration. Of course, we will work to address the requirements of our existing customers and partners who are always looking for faster, easier to use, easier to manage systems at lower cost. We have significant support for Service Oriented Architectures and Web Services today, but there are many new capabilities to be added in this area. We believe there are many new features that can facilitate the management of raster data and TINs (Triangulated Irregular Networks) in the database and we are working with our partners to address their needs.
Equally important are the needs of business applications in logistics, finance, insurance, sales & marketing, planning, service, business intelligence and the like. We see this as a huge area for the use of spatial technology and are investing in simplifying the use of spatial analysis in every application.

How is the â€˜fourth dimensionâ€™, time, dealt with in Oracle 10g?

Customers and partners successfully do this today by treating time as an attribute (just as they do for location) of an entity using date-time or interval data types. Consequently, all the attributes are treated the same way, spatial or non-spatial. This provides all the flexibility and power of Oracleâ€™s SQL (e.g. the SQL analytic and statistical functions) in handling temporal information.

How do you see the competition between Oracle geospatial and other database designers like IBM and Microsoft, given that the latter has recently opened a geospatial facility in Bangalore, India?

Oracle has invested in geospatial database technology for nearly a decade now. IBM has also had a number of initiatives in this area for about the same time. Microsoft has spent more time in the geospatial desktop tools and application server area, rather than databases; while they really haven't developed products in the spatial database arena, they also appear to be taking a hard look at this. I think it is fair to say that all of the major IT vendors view spatial technology as an important feature of the IT infrastructure. We believe, and customers and analysts have confirmed through product evaluation and our market share, which IDC puts at between 80 and 90%, that our investment has been extremely effective. Oracle is tremendously committed to spatial database and IT technology, and to customers and

partners who depend on it.