An Introduction to Oracle's Location Technologies

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Introduction

The use of spatial data and location services is changing the way people work, live and play. Every day more and more people are using location-based services from their smart phones and tablets to make their lives easier. Examples of these services include turn by turn navigation to any address, finding the nearest ATM or restaurant, tracking a parcel or delivery, or finding the real-time location of a friend.

Similarly, by incorporating the context of *location*, businesses are now working smarter and more efficiently. Retailers now apply location-enhanced profiles to analyze their customers' lifestyles and purchase behaviors. These profiles are used to optimize marketing strategies and increase sales. Business analysts and executives use location analysis tools to analyze property investments and sales performance.

To support people and goods on the move, spatial analysis is transforming the way businesses efficiently schedule, track, and move products to market. Location is an important filter for Big Data sources (traffic, weather, news feeds, social media). It helps align Big Data with other forms of business information to bring about a smarter and richer form of predictive analytics.

For nearly two decades, Oracle has been investing in spatial and graph technologies to make location and mapping capabilities available across enterprise IT environments. Our business values focus on simplicity, performance, ease of development, and integration with other Oracle technologies and applications.

Oracle Spatial and Graph, an option to Oracle Database 12*c* Release 2, is the most widely used spatial database in the world. It is unsurpassed in spatial and graph capabilities. Thousands of customers in many different industries use these technologies, including the world's leading mapping agencies, state and local governments, telecommunications, utilities, insurance, banking, retail, and more.

Common application uses for Oracle Spatial and Graph are location-based services, where business and public sector websites embed location and maps into their web applications and operational systems. Location intelligence such as customer addresses, store locations, and physical assets all provide valuable information to an organization. This information is critical for planning and decision making. In addition, the ability to visualize these assets with maps makes decision making easier.

Some key Oracle Spatial and Graph capabilities include geocoding, routing and driving directions along street or other networks, spatial proximity searches, and map visualization of geographic data. Examples of industries that use Oracle Spatial and Graph include:

» Utilities: Oracle Spatial Network Data Model graph is used by gas, electric, pipeline, and water agencies for live, mission-critical network applications such as mobile asset maintenance, outage management, network maintenance, and crisis management. Agencies need to closely monitor their network environments, quickly identify impacts to a community if outages occur, and rapidly fix the outages. Real-time and historic data is associated with the network topology, resulting in better information for decision making, and improved reliability and efficiency.
» Government: Federal, state, and local governments use Oracle Spatial and Graph to store and manage a rich variety of spatial data types and models including vector and raster data, topology and network models. All of these spatial data types are stored and managed along with other data types in an Oracle Database, thus eliminating the need for disparate systems that are expensive and difficult to manage. In addition, government agencies such as land management, defense/homeland security, public works, and urban planning, make use of Oracle Spatial and Graph's advanced spatial functions to improve operations.
» Transportation: Oracle Spatial and Graph is used by transportation organizations such as highway/roadway agencies, railways, public transport, and delivery services. These organizations need to track and maintain assets, develop delivery and transportation schedules, and optimize routes. Oracle Spatial Network Data Model graph with routing capabilities and advanced spatial analytics give them flexibility to model their applications to achieve maximum operational efficiencies.
» Retail: Businesses use Oracle Spatial and Graph and Oracle Business Intelligence Enterprise Edition (OBIEE) to gain valuable information for decision making. Spatial analytics and map visualization help organizations decide where to locate new stores based on customer demographic analysis and where to deploy sales personnel based on sales by region. The OBIEE dashboard offers much flexibility in presentation views with charts, tables, and maps so businesses can easily understand, digest, and glean insight from the information displayed.

This white paper highlights key location technologies that enable Oracle customers to quickly and easily incorporate mapping and location analysis into their enterprise.

Oracle Location Technologies

Oracle offers key technologies that allow customers and partners to deliver any class of spatial application – ranging from entry-level web locator solutions to highly scalable and secure national map production platforms.

» Oracle Database Locator feature
» Oracle Spatial and Graph Option
» Oracle Big Data Spatial and Graph

Oracle Database Locator Feature

Over a decade ago, Oracle redefined modern database systems by ensuring that every Oracle Database included basic geospatial capabilities. The Locator feature in Oracle Database provides a core spatial data type and set of operators appropriate for entry level business analysis and web applications.

The Oracle Database Locator feature provides a native spatial vector data type (SDO_GEOMETRY), to describe geometries such as points, lines, and polygons. Locator also provides fast spatial R-tree indexing, and spatial queries such as within distance, nearest neighbor, buffering, and more.

Oracle Spatial and Graph in Oracle Database

Oracle Spatial and Graph, an option to Oracle Database Enterprise Edition and on Oracle Cloud, includes advanced features for spatial data and analysis as well as for physical, network and social graph applications. It extends the Oracle Locator spatial query and analysis features with more advanced spatial and graph analysis and processing capabilities.

Oracle Spatial and Graph includes map visualization of geographic data, new with Oracle Database 12*c* Release 2 (12.2) on Oracle Cloud. The spatial visualization feature in Oracle Database is an HTML5-based mash up component that allows developers who are familiar with SQL and JavaScript to incorporate a wide variety of map styles and spatial analysis into business applications. Its mapping engine visualizes data in Oracle Spatial and Graph, and allows developers to combine this data with external web services such as WMS, WFS, GeoRss streams, and WMTS. The map visualization feature must be deployed in a JEE container or in Oracle Java Cloud Service.

Oracle Spatial and Graph features are designed to support the most complex requirements found in Geographic Information Systems (GIS) and business applications. These geospatial data features include native support for types and models such as GeoRaster (for rasters and georeferenced imagery), topology, 3D and point clouds (supporting LiDAR data), and linear referencing system. A geocoding and routing engine, and spatial web services support, are also provided. These advanced features provide a complete platform for geospatial applications in domains from defense and land management to retail, insurance, and finance.

The graph feature includes three graph databases: a property graph for social and network analysis (new in 12.2 on Oracle Cloud), a network data model for network modeling and analysis used in industries such as transportation and utilities, and an RDF (Resource Description Framework) graph for linked data and semantic web models. Oracle provides the most advanced spatial and graph database management technologies available in the industry today.

Oracle Big Data Spatial and Graph

For over a decade, Oracle has offered leading spatial and graph analytic technology for Oracle Database. Oracle is now applying this spatial and graph expertise to Big Data workloads on Hadoop and NoSQL, with a recently introduced product, Oracle Big Data Spatial and Graph. Hadoop and NoSQL big data platforms have been gaining adoption with the growth of social media and the unstructured data it has generated, and with their suitability for other use cases such as data preparation and cleansing, which have large scale processing volumes, and do not have traditional transaction processing requirements.

Oracle's objective is to provide the spatial and graph capabilities that are suited for the use cases and workloads found in big data environments. Graph analytics requires large scale performance and scalability, suited to an in memory engine on Hadoop.   Data feeds from social media, sensors, and other unstructured sources often contain a location component, such as a text address, city name, or lat/long coordinates. Location can be used to enrich and serve as a key to harmonize these disparate, voluminous datasets. Cleansing and preparation of vast amounts of sensor-generated imagery can be performed efficiently in parallel on MapReduce nodes.

Oracle Big Data Spatial and Graph includes a range of spatial capabilities: a geo-enrichment service to enable data harmonization based on location, location analysis functions for categorizing and filtering data, and the ability to perform raster data cleansing and image processing. Graph features include a distributed property graph with over 35 high-performance, parallel, in-memory analytic functions, for social network analysis, recommendation engines, fraud detection, and other applications that need to discover relationships and connections among customers, organizations, and assets. This package of commercial-grade components allows developers and data scientists to obtain deeper insights into Big Data workloads – while reducing complexity and simplifying development.

Oracle Big Data Spatial and Graph was developed to support specific classes of applications well suited to big data platforms. Oracle Spatial and Graph in Oracle Database is a more complete platform for Spatial, Graph and large-scale GIS analytical and operational applications. Users should consider their workloads, environments, and processing requirements when deciding on which technology will best meet their needs..

Oracle's Location-Enabled Tools and Applications

Because Oracle Spatial and Graph is part of the database kernel, it is a differentiating feature for the Oracle technology stack – applications, tools, and engineered systems.

Oracle Business Intelligence Enterprise Edition Map Views

Oracle Business Intelligence Enterprise Edition is a comprehensive business intelligence platform that delivers a full range of capabilities, including interactive dashboards, ad hoc queries, notifications and alerts, enterprise and financial reporting, search and collaboration, and mobile, with transparent access to multiple data sources.

With the OBIEE Map views feature, BI users can visualize their analytics data using maps, thus bringing spatial visualizations and analytics to business intelligence. Map views are completely integrated, out of the box, in OBIEE dashboards. The maps are fully interactive, and data on the maps can be visualized using numerous formatting options including color fill, variable-sized markers, percentile binning, value binning, and continuous color-fill. This provides a rich, interactive visualization capability, since most business intelligence data contains a geographic dimension such as store addresses, sales districts, sales regions, etc. Map views are also interlinked with tables, charts, filters, with bi-directional query and presentation. Map views provide an intuitive and interactive way to convey spatial relationships such as proximity or containment that is harder to do with other types of visualizations.

Powerful location-aware predictive analytics capabilities are included in OBIEE – helping organizations gain better insights into customer value and behavior. Predictive analytics, data mining, network analytics and spatial analysis are now brought together; this is useful for real-world scenarios such as evaluating airline on-time performance and retail establishment performance. BI provides transparent, easy access to the rich analytic capabilities of the Oracle Database platform.

Performance metrics illustrated by OBIEE Map View
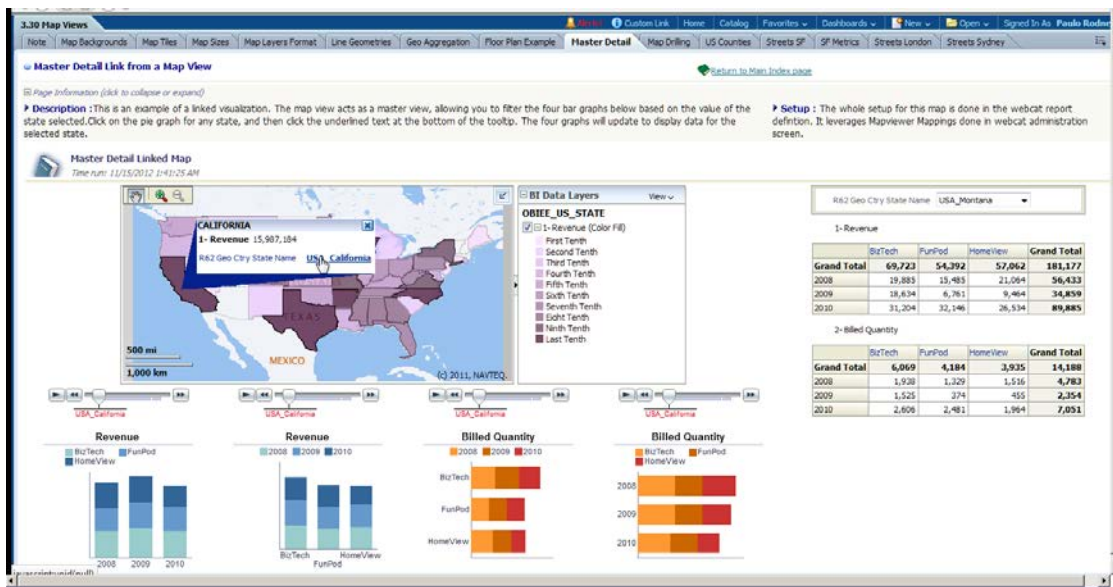
Oracle Industry Applications

Maps add value to enterprise applications by providing intuitive and cost effective data visualization. Oracle industry applications and business applications are increasingly including location analysis and mapping capabilities to optimize work processes, manage assets, improve planning, and evaluate business results.

The following are some Oracle enterprise applications that use Oracle Spatial and Graph capabilities:

Oracle Transportation

Oracle Transportation Management uses advanced features of Oracle Spatial and Graph. By geocoding delivery addresses, optimum truck routes can be computed, enabling logistics planners to optimize their fleet. The routing engine can determine the fastest delivery routes and location of shipments throughout the delivery process to keep costs down. As a result, businesses can reduce transportation costs, improve operational efficiencies, and improve customer service.

Shipment Routes
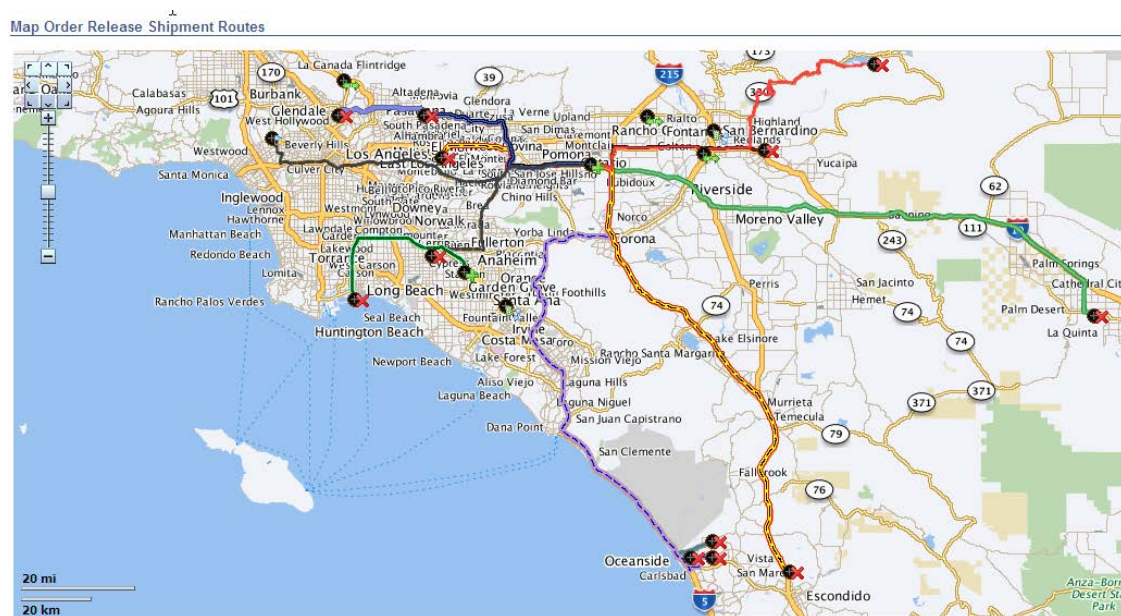
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Oracle Utilities

Oracle Mobile Workforce Management uses advanced features of Oracle Spatial and Graph and maps.oracle.com, a web mapping service application, for display. Utility operators need to know the location of field personnel so customer service requests and emergency work is handled properly, cost effectively and within specified service level agreements and/or customer appointments. Customer service addresses are geocoded, while crew location information is determined by GPS location reports or based upon the address of the last completed service order. MWM combines location information, along with skills, job requirements and duration information to assign work and dispatch crews to the appropriate customer service locations.

Oracle Utilities Network Management System viewer provides a dynamic perspective of the geographic maps and schematic diagrams that represent the distribution infrastructure of a utility's service territory. The Oracle Utilities Network Management System Web Workspace (which the viewer is a component of) provides system operators and dispatchers a highly functional decision support environment. This decision support environment includes a single context where real-time network status and connectivity can be visualized. Network assets (including crews, tags, and device information) as well as near real-time status of network devices and sensors are displayed on the map or schematic. Assets can be searched by location and tasks can be initiated from the map.

Both outage management applications and distribution management applications utilize the same workspace for the enhanced decision support environment used by the various types of utility users. This enables an organization to restore service as quickly as possible and improve customer satisfaction. With Oracle Utilities Network Management System Outage Analytics multi-dimensional analysis can be performed to maximize the value of the data capture for future operational improvements.

Oracle Utilities Network Management System supports the IEEE P1366 data capture needed to report and present Electric Distribution Reliability Indices.

Outage locations color-coded by number of customers affected
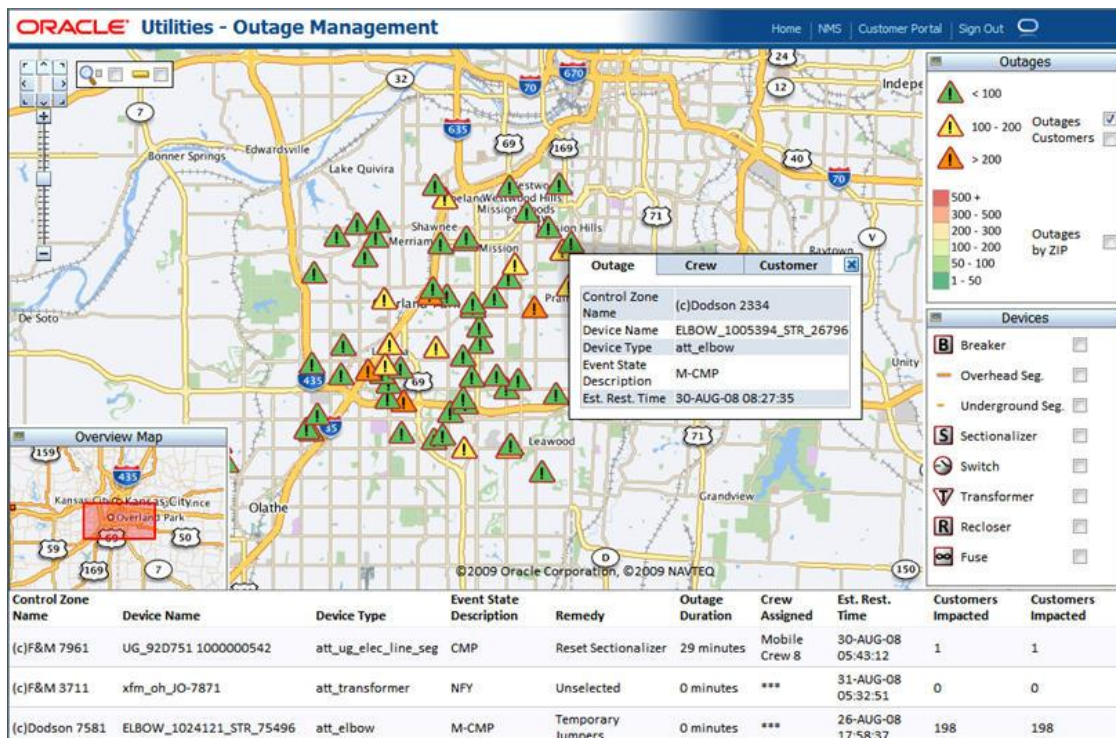
Oracle Communications

Unified Inventory Management for service and network equipment providers uses Oracle Spatial and Graph and maps.oracle.com for display of communications assets. Assets can include any type of physical and logical inventory, including network addresses and telephone numbers. Once communications assets are geocoded, they can be displayed and managed on a map. This allows a customer representative, for example, to perform a spatial search and see on a map where field service calls are coming from, or whether there have been problems in a particular area. These capabilities help improve operations and customer service.

Oracle Health Sciences

Oracle Health Sciences Clinical Development Analytics (OHSCDA) uses Oracle Database Locator and OBIEE Map views to visualize clinical development metrics geographically. OHSCDA uses latitude, longitude and address data to display clinical sites on OBIEE Map views and aggregate key metrics across countries. Clinical research associates and study managers can prioritize which sites to monitor by using OBIEE Map views to map site metrics such as total enrollment and number of subjects enrolled since last site visit. OHSCDA Map views also allow executives and regional managers to easily identify enrollment, site performance, and monitoring trends by region. Customers can customize OHSCDA to include their own unique region definitions. As a result, clinical organizations can increase operational efficiency with more focused resource optimization and improve visibility into site and partner performance.

Leveraging Other Oracle Technologies

From a technology perspective, Oracle Spatial and Graph capabilities are native to Oracle Database. The core spatial features are part of the Oracle Database kernel, and spatial data is stored along with all other data in the database. This means the spatial technologies are designed for and can benefit from all other technologies available from Oracle Database such as:

» Compression – multiple compression techniques reduce storage requirements
» Exadata Database Machine – engineered systems provide the highest performance and most available platform for spatial and graph and other applications
» High Availability - comprehensive set of HA capabilities for spatial and graph applications and data
» Manageability – spatial and graph data is managed just like other data in a centralized repository or data warehouse
» Scalability - parallel processing for loading and analyzing massive amounts of data
» Security – advanced technology safeguards all data in the database

Oracle Spatial and Graph support is provided in a number of Oracle and non-Oracle products. Oracle's developer tools have added maps and geospatial analysis in products like Oracle JDeveloper, Oracle TopLink, WebCenter, Oracle SOA Suite, and Oracle Application Express.

Partnerships with Leading Spatial Vendors

Oracle builds and maintains active partnerships with the leading spatial vendors. These include software tool vendors, data providers, and solution providers. Oracle's longstanding commitment to partnerships means that our customers have the widest possible choice; you can deploy the best solution to meet your organization-specific requirements.

For a complete list of partner data providers, and links to sample data and other resources, visit http://www.oracle.com/technetwork/database/options/spatialandgraph/.

Commitment to Open Standards

Oracle is a founding, Principal Member of the Open Geospatial Consortium (OGC). Multiple versions of Oracle Spatial and Graph, and Oracle Spatial, comply with the OGC Simple Features Specification for SQL, Revision 1.1, Types and Functions Alternative. Oracle Spatial and Graph also supports the SQL/MM types and operators, as specified in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial.* Oracle Spatial and Graph operators corresponding to those defined in this standard, as well as the SDO_NN and SDO_WITHIN_DISTANCE operators, can be used on data stored in the SQL Multimedia root type.

Standards compliance testing for Oracle Spatial and Graph is ongoing, and compliance with more recent versions of standards or with new standards might be announced at any time. For current information about compliance with standards, see http://www.oracle.com/technetwork/database/options/spatialandgraph/.

Summary

The largest enterprises worldwide – mapping agencies, transportation, utilities, telecommunications, insurance, and more – rely on Oracle to meet the most demanding requirements for their mission-critical spatial and graph assets.

Organizations can increase productivity and streamline business processes by integrating spatial and graph technologies into enterprise applications. By managing spatial information in an Oracle Database, data can be consolidated and administration can be centralized to support data sharing.

As part of the world's leading spatial information technology platform, customers benefit from Oracle's leading performance, scalability and security capabilities, including advances in Oracle Database and can exploit the extreme processing power and bandwidth of Oracle Exadata Database Machine. Spatial and graph features are part of Oracle tools and enterprise applications, and are supported by leading geospatial vendors.

For over ten years, Oracle has delivered the most advanced spatial and graph capabilities available in the market in an enterprise database management system. With the unmatched spatial and graph functionality in Oracle Database, Oracle continues to be the world's leading platform for enterprise spatial and location-based systems, in the cloud, on premises, and for big data.

Oracle Spatial and Graph Resources

To learn more about Oracle's spatial and graph technologies, visit:

Oracle Spatial and Graph on the Oracle Technology Network (OTN) for comprehensive technical information and use cases: http://www.oracle.com/technetwork/database/options/spatialandgraph/]

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