



**LOCATION ANALYTICS:
A NEW KEY TO
BUSINESS INTELLIGENCE**

TERADATA

TABLE OF CONTENTS

- 2 Where?
- 2 Geospatial: New Perspectives on the World
- 3 The Map Gives Way to Geospatial Data
- 3 Working Together: GIS Vendors and Teradata
- 3 Geospatial in Action: Typical Applications
- 4 The Necessity of Geocoding
- 5 Making the Connection: Connectivity Solutions
- 5 Visualization is Worth 1,000 Data Points
- 5 Services to Accelerate Implementation
- 6 Case Studies: Teradata Geospatial in Action
- 7 Conclusion

WHERE?

It's one of the most fundamental questions that arises in any human endeavor.

At the individual or consumer level, "where" generally translates into easily addressed queries: *Where is my appointment? Where is the nearest hardware store? Where is my package?*

For the enterprise, the question of "Where?" runs from basic operational necessities (*Where does my customer live so I can make a delivery?*) to issues of tremendous strategic importance (*Where should I locate my next retail outlet?*).

Answering those questions, and countless others with location components requires a *technology* that is thousands of years old: the map. In today's world, the map has been replaced by geospatial data and geographical information systems (GIS)—incredibly robust and increasingly flexible tools for asking and answering questions that begin with the word "Where..."

The next revolution in business intelligence is being called location analytics. It's the analytical insight that results from the combination of geospatial data, mapping and visualization solutions, and business intelligence (BI) platforms (the data warehouse and the tools associated with it). More and more BI efforts are incorporating geospatial data into their data warehouses and putting them to work in surprising, creative, and powerful ways.

The result is something Teradata calls "Location Intelligence." This paper outlines the basics of location analytics and the challenges of putting it to work.

GEOSPATIAL: NEW PERSPECTIVES ON THE WORLD

A map offers a representation of something in the physical world. Highways and roads, for example, for the traveler. Drop-off locations for a shipping company. Cell towers and routers for the telecommunications company. Those are simple examples of location data. But location analytics goes beyond the visual display of information to become a tool for decision making.

Consider the example of a major insurance company with a significant set of property and casualty customers in central Florida. A major storm, with hurricane potential, is heading for the region. While meteorologists can predict the path the storm is likely to take, it's impossible to know in advance which homes and businesses will be affected. But thanks to the insurer's location analytics solution, it was easy to estimate risk exposure by combining data about the path of the storm with exact location of policyholders' properties and prepare for the inevitable flood of claims once the winds and rains had diminished.

This is an obvious example of location analytics, but until recently, this kind of analysis would have been complex and time-consuming—largely because geospatial data has been so difficult to integrate into a data warehouse.

That's where Teradata® Geospatial enters the picture. Teradata Geospatial is an extension to the Teradata Database that makes storing, accessing, and manipulating spatial data much easier. Teradata Geospatial makes it straightforward to augment business data with location data, and gives rise to new BI applications.

THE MAP GIVES WAY TO GEOSPATIAL DATA

The earliest maps date back thousands of years, and the degree of coverage, detail, and accuracy of maps increased steadily over the centuries. Of course, by the end of the 20th century, virtually every foot of the earth's surface had been explored and mapped, with the basic data rendered in the form of latitude and longitude. Thanks to the pioneering global positioning system (GPS), digital geographic data is widely available.

The widespread use of GPS gave rise to essentially a new IT specialty: geographic information systems, which create and maintain geospatial data and make it useful through visualization and analytics. Companies like Esri, one of the leading GIS providers, are serving government entities as well as companies with location-centric business and service models. According to Esri, its GIS "lets us visualize, question, analyze, interpret, and understand data to reveal relationships, patterns, and trends."

Esri and other geospatial or GIS vendors have made mapping and geographic analysis available for a huge range of applications, including mapping infrastructure

and managing public safety for municipalities; military and defense applications for governments; research and exploration for mining and natural resources companies; land surveying for real estate enterprises; and logistics for transportation companies, to name just a few.

Running Esri's industry-leading geospatial applications on top of geospatial data residing in a Teradata Database allows users to perform sophisticated location analysis by cross referencing geospatial and non-geospatial data on a platform known for its performance and scalability.

WORKING TOGETHER: GIS VENDORS AND TERADATA

The potential of integrating GIS and BI solutions has been known for some time. GIS leaders like Esri have been eager to expand beyond traditional geospatial applications; enterprise business intelligence users have wanted to be able to incorporate true geospatial data and visualization tools into data warehouses. The challenges have been connectivity and data integration.

Traditionally, geospatial data, if it exists within the enterprise, has been siloed and separate from the traditional BI and data warehouse functionalities, largely because geospatial data has been challenging to integrate, process and render in a format easily processed by a data warehouse system. Teradata has worked with Esri and other GIS vendors to leverage new standards-based extensions to the Teradata Database and to bring this critical class of data into the data warehouse.

GEOSPATIAL IN ACTION: TYPICAL APPLICATIONS

By integrating geospatial data into the Teradata data warehouse, Teradata Geospatial enables users to address multiple location analytics applications, such as:

Facilities Location

Where should an enterprise locate its next retail store? Its next office? Data warehouse? Physical goods warehouse? Distribution facility? Cell tower? Using Teradata Geospatial makes it easy to map customers, prospects, competitors, locations, and assets, and use all kinds of location data to make decisions about ways to improve coverage, operations, and other location-based initiatives.

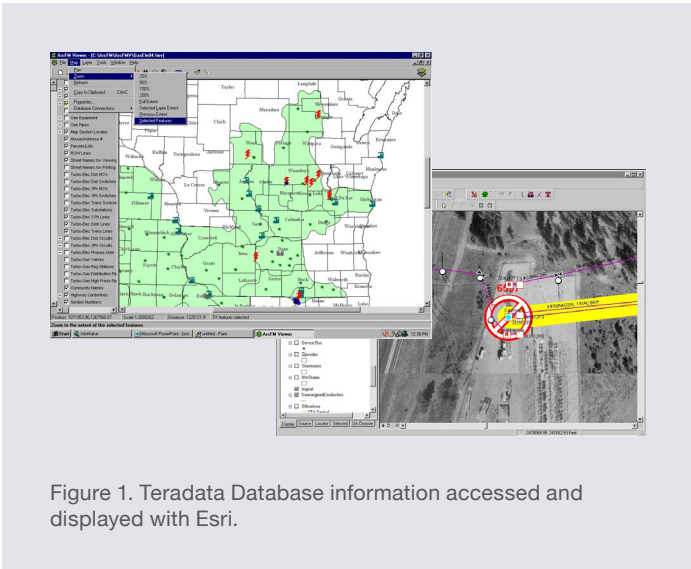


Figure 1. Teradata Database information accessed and displayed with Esri.

Telematics

Trucking and logistics companies, for example, are using telematics to understand not just where their vehicles are but how they are performing. They are equipping trucks, rail cars or locomotives, and even large parcels with GPS devices as well as sensors for speed, engine performance, and other metrics for real-time fleet and delivery management. Some insurers are also equipping policyholders' cars with sensors to offer discounts for drivers willing to have their cars remotely monitored. Teradata Geospatial supports telematics applications.

Risk Assessment

Geography has long played a role in understanding risk, but typically (at the enterprise level), this has been done by zip code—a wide and imprecise *filter*. For example, the zip code of an area in south Florida might include homes right on the beach that are quite vulnerable to hurricanes as well as homes a few miles inland that are considerably less likely to be damaged. Geospatial data allows for much greater precision in the analysis and measurement of risk. Risk assessment is not just relevant to property and casualty insurance either; facilities location decisions should be made with an understanding of potential risks to those locations and the impact of a disaster, such as natural or terrorist, on the enterprise as a whole. Deciding the location for a warehouse or a distribution hub could greatly benefit from geospatial-driven risk assessment.

Situational Awareness

As the hurricane example given in this white paper illustrates, the ability to map and visualize the impact of an event in real time can be critical, and situational awareness is an important application for Teradata Geospatial. This kind of real-time perspective has long been important to defense and military organizations, public safety and police groups, utility or infrastructure organizations and any organization that provides location-based services, such as logistics, retail services, and utilities. Situational awareness is emerging as a valuable tool for insurers and other enterprises that must deal with crisis situations with agility and speed.

Geographic Market Segmentation

Market segmentation is a common application of business intelligence, and the ability to understand segments according to geography is a powerful application of Teradata Geospatial.

THE NECESSITY OF GEOCODING

Most businesses already have some kind of location data, like the mailing or shipping addresses of their customers. But this data must be *geocoded*, a process which transforms address data into a unique identifier composed of latitude and longitude.

Geocoding is a nontrivial challenge because there's a surprising amount of variability in location data. For example, which prime meridian will be used? Wikipedia lists more than 30 prime meridians that are or have been used in the past. Which map projection system—for representing the three-dimensional surface of the globe onto a two-dimensional plane—is used?

Teradata Geospatial is based on the *ST_Geometry* data type, where a location can be a point, a line, or a polygon. A point is a unique place, say a customer or store location, defined by latitude and longitude, and rendered as $(x\ y)$. A line is defined by several points (xy, xy, xy) : a transportation route, a power line or a river, for example. A polygon is a set of connected points that defines an area or region (xy, xy, xy, xy) . Teradata Geospatial implements the SQL/MM standard for geospatial queries. By integrating geospatial data within a data warehouse, geospatial data simply becomes another business attribute.

Teradata Geospatial also includes *spatial metadata*: the schema for how and where geographic data resides in the database as well as how third-party tools can access that data. Geospatial data is loaded using the Teradata GeoImport/Export tool for loading spatial data, but also works with third-party tools from vendors like Esri and Safe Software.

Teradata Geospatial adds a large library (more than 60) of *spatial functions, methods, and stored procedures* that allows the system to process and analyze spatial relationships, measurements and attributes. Spatial queries use a syntax similar to traditional SQL. In line with Teradata's overarching philosophy for business intelligence, Teradata Geospatial uses parallelized in-database analytics to greatly improve query performance by eliminating unnecessary data movement and to accelerate the analytic performance.

SQL can be used to ask and answer virtually any question that has a geometrical component: What's the distance between these two stores? What is the area this sales rep covers? How much overlap is there between our store areas and those of a competitor?

Here's a simplified example of a Teradata Geospatial location query: Find the top 100 customers by value within five miles from the store X:

```
SELECT top 100 C.name, C.address, C.value,  
       C.location.ST_Distance(S.location) AS Distance  
FROM   cities C, stores S, store_area SA  
WHERE  S.id=1 and S.id=SA.id and  
       C.location.ST_WITHIN(SA.area)  
ORDER BY 3 Desc;
```

MAKING THE CONNECTION: CONNECTIVITY SOLUTIONS

On a more granular level, there are multiple ways to connect tools from GIS and geospatial vendors with a Teradata Database. For example, Teradata can link with Esri using Esri Query Layers, Esri GeoServices REST interface, and Safe Software's FME technology. To connect other geographic information systems to Teradata Geospatial, some companies may use the open source GeoServer connector.

VISUALIZATION IS WORTH 1,000 DATA POINTS

Typically, relational database queries generate tabular results. But with the addition of geospatial information in the database, it becomes possible to generate maps and other graphically rich answers to questions such as sales by region rendered on a map, or, as in the example early on in this white paper, calculating the path of a storm moving through central Florida.

Teradata Geospatial can work with several providers of sophisticated mapping and visualization solutions, including GeoServer (WMS/WFS), Esri (WFS, Query Layer), Oracle Business Intelligence EE (MapViewer), Google Maps, and others.

SERVICES TO ACCELERATE IMPLEMENTATION

Teradata Geospatial can integrate robust, proven GIS-geographic visualization tools—with Teradata Database's proven BI capabilities. To help customers in implementing this capability, Teradata offers a full range of professional services, including a proven, repeatable methodology that includes these components:

Geospatial Requirements Assessment

This could include elements such as gap analysis or opportunity evaluation.

Geospatial Data Modeling

Teradata services can help users integrate geospatial data in the data model and optimize the data model for geospatial queries.

Geocoding

The geocoding process calculates locations (longitude and latitude) based on existing address data, such as customer or supplier addresses, sales areas, product availability areas, and other locations rendered with geospatial coordinates.

Geospatial Data Enrichment

One of the services Teradata can provide, as needed, is the creation and maintenance of separate tables containing geospatial-specific entities such as city and zip code boundaries, roads, waterways, railroads, points of interest, as well as demographics census information which is geospatial in nature.

Geospatial Data Management

Existing data management activities such as ETL, loading scripts, and pre-processing, will be assessed and modified so they can manage geospatial data.

Geospatial Analysis

Once geospatial data is introduced and maintained within the database, a front-end application or tool will be needed for analysis. This is not necessarily a *map-oriented GUI*, but can be a simple reporting tool able to query geospatial data. Teradata can provide guidance on how to design geospatial queries that will be used during the analysis phase.

CASE STUDIES: TERADATA GEOSPATIAL IN ACTION

Although Teradata Geospatial is a relatively new feature, it is already being successfully used for location analytics in a number of settings:

Analytics Acceleration in Telecommunications

A large telecommunications company with significant experience in GIS has recently transitioned from doing geospatial analytics by using custom mathematical formulas to an in-database approach using Teradata Geospatial. One of its standard queries is “find the three closest stores within 50 miles of a customer”—an enormous challenge given the fact it has more than 30 million customers and more than 2,200 retail locations. Using traditional geospatial analytics required more than 65 billion calculations to find the distance between each of its stores and each of its customers; the system then needed to filter the results to return distances of less than fifty miles. Using Teradata Geospatial and its built-in analytics returned the results 25 times faster. Instead of the exhaustive, time-consuming brute force approach,

Teradata Geospatial set a 50-mile buffer around each store then identified the customers within each buffer. It was then straightforward to calculate each customer’s three closest stores.

Multiple Applications in Financial Services

A leading financial services provider is using Teradata Geospatial for a variety of purposes, including business continuity and crisis management, as well as risk management, customer service, marketing, and fraud prevention. One of its main lines of business is credit cards, and the enterprise built an interface between Esri ArcGIS Server and Teradata Geospatial using the REST connector. The company was able to map and identify the impact zone, including cardholders, post offices, and merchants, to help its customers in the aftermath of a major tornado. The system automatically reduced late fees in the impact zone and even identified cross-marketing opportunities with a local hardware merchant for cardholders who were repairing their damaged homes.

Spurring Innovation in the Energy Industry

A utility that includes both traditional power plants and wind farms made a strategic goal to not build new fossil-fueled power plants before 2020—which meant it had to expand and integrate renewable power sources and get a much deeper understanding of energy consumption patterns of its existing customers. The company integrated smart meter data with a huge volume of other information such as rates, asset data, call center and services address, into a Teradata Geospatial system for integrated data analytics. The smart meters alone generated large volumes of data (feeding data from individual customers several times an hour instead of once a month), and the system helped the company to understand short-term demand location patterns (usage spikes) in a way that helped them adjust pricing and use day-ahead energy markets more effectively.

Improved Location-Based Sales Analytics for a Consumer Products Company

A beverage company used Teradata Geospatial to create an iPhone® application designed to give sales professionals more accurate and highly targeted analytical information. The system uses geospatial data to create a visual representation of stores within a certain area with

color coding to indicate locations where sales are up and those where sales are down, helping sales managers focus on the locations needing the most attention. Using custom geospatial analytics required complex trigonometric calculations; with Teradata Geospatial, the results are obtained using a simple call to a number of built-in geospatial functions.

CONCLUSION

Geographical Information Systems have already proven their worth in a diverse set of applications that addresses multiple sectors, industries, and applications. The ubiquity and importance of location data makes geospatial a natural extension of Teradata data warehousing and business intelligence capabilities. The Teradata Geospatial feature can be integrated with a number of GIS tools from industry-leading vendors. Teradata Geospatial is an integral part of Teradata's world-class EDW and BI platform and promises to deliver substantial new analytical opportunities and insights for all kinds of businesses.



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