COMPARITIVE ANALYSIS OF OPEN SOURCE SPATIAL DATABASE SYSTEMS

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ABSTRACT

The Geographical Information System (GIS) is one of the most prominently used systems in applications that range from astronomy to agriculture. The ever so evolving databases need a more specific and detailed version of elements, where geometric shapes, 3D view, and many other spatial features need to be addressed; that is where spatial database comes into view. The proposed work aims to find out the best option for open source spatial database systems that could be used to develop, deploy, and maintain very large spatial databases. The study proposed to perform focuses on analyzing the reliability, maintainability, and features of open source spatial database systems, PostGIS, SpatiaLite, and MySQL that could be used as the best possible RDBMS in Spatial database requirements.

I INTRODUCTION

The use of spatial database systems extends from the need of featuring data as form of images and geometrical shapes from a long time. A spatial database system represents geographic, geometric, or spatial data in the form of 2-D, 3-D, raster and vector format images. The images pertaining to the objects in a database which are specially represented in a geometrical shape are known as spatial data. The database that is optimized to perform operations on such kind of spatial data is known as spatial database.

A visually depicted datum is more favored instead of a textual one. The spatial database works in such a fashion where not only the numeral, characters, and different file formats exits but they have lines, polygons, areas, homogenous and heterogeneous data to think of. For example, considering a wide landscape, it could be described using text but is their significance to users of such data decreases if not depicted clearly. Thus the spatial data plays an important role in visualizing and performing operations on such elements. The Geographical Information System (GIS), which handles all the data, storage, their processing and retrieval, is crucial for spatial databases.

The need of free and open source software with the maximum possible qualities are a requisite today. Not only spatial data or geometrical related applications but a lot of applications need processing of visual data in Tera and Peta bytes. The leading areas that need a purposeful management of spatial and geo database involve astronomy, agriculture, weather prediction, disaster management, biology, and geosciences.

The open source GIS is important in developing cost-effective applications that are utilized for spatial database systems. In this paper, three distinct open source spatial database systems are used to carry out the comparative analyzing of DBMS for spatial data on different parameters like cost, limitations, performance, maintainability, reliability, support and speed. The open source GIS used in this paper for analytical purposes are PostGIS, MySQL, and SpataiLite.

The open source GIS PostGIS is a software program that supports geographical data to the PostgreSQL object relational database. In addition to the simple SQL features, it incorporates geometrical shapes, geographical datatypes, raster datatypes and other commonly used datatypes for the usage of spatial databases. The functions, operators, index

enhancements, analysis and processing of vector datatypes are also supported by the PostGIS.

The next open source GIS database system used in the proposed work is MySQL. It is one of the most popularly used relational database systems that effectively provide geospatial working platform and support for geographical

II. LITERATURE REVIEW

Many works prior have underlined the importance of spatial databases which is the need of today. There are different databases that offers spatial datatypes and their implementations which are needed for geo-spatial data and related operations. According to, Guting, R.H., "*An Introduction to Spatial Database System*" [1994], The spatial databases are simple database systems that allow data modelling for spatial data, contain operations that support joins on special databases etc. Mostly to work upon captured raster and satellite images, spatial database is required. The paper describes the need of open source systems that can cater the need or requirements of spatial database systems.

There are different requirements including map servers, spatial database systems, web map development kits, and selected varieties of free and open source products. They are crucial in GIS applications, small and medium sized enterprises etc. Steinigger, S. Et. al. "*Free and Open Source GIS Software for building a Spatial Data Infrastructure*", [2011].

The scholars advocate usage of open source software so that it becomes easier to use spatial database systems that are huge in quantity and complex in the nature of execution. Dr. Tsou, M. et al. in *"Free and Open Source Software for GIS education",* [2011], says that to perform spatial data related queries and operations, PostGIS build as powerful database engine upon PostgreSQL is considered as a strong challenger in free and open source spatial databases against licensed spatial databases such as Oracle Spatial and Microsoft SQL Server Spatial.

Piorkowski, A. in his paper, "*MySQL Spatial and PostGIS-Implementations of Spatial Data Standards*" [2011], discusses that OpenGIS standards are more prone to 2-D systems in spatial systems like PostGIS but the MySQL developments are rather useful as they follow SQL/MM spatial. It makes a subtle difference in handling systems where data types include different sets of 3-D data, the operations as well differ and needs of such systems as discussed earlier could not be dismissed. Both of the spatial database systems lack one or two functions like only partial 2-D reference sets exist in MySQL whereas PostGIS involves difficulties in integration and installations.

III. METHDOLOGY

The comparison of different open source spatial database systems involves a complex system of classification according to the features that are required in such systems. A product might be helpful in one scenario, efficient in another, and may pose some limitations in certain conditions. The goal of the paper written is to identify such causes and find out the best utility for GIS.

The open source specifications that are needed to construct a functioning spatial database are needed for the integrated systems that operate on data such as geometric shapes, figures, images, visuals, and sensitive data. A thorough comparison is done in the following sections to evaluate the best features.

MySQL as mentioned earlier is an open source RDBMS type of spatial database. It is popular, client-server based database system but it has datatypes for representing spatial values, methods for manipulation, spatial kind of indexing for improving the accessing of spatial columns. The difficulty with MySQL is that it doesn't provide additional metadata view. There are certain issues with the naming methods in the versions prior to 5.6. The issues like lack of context when it comes to spatial or textual data is with respect to pre-defined function "distance" is confusing, other than that; calculations in MySQL are done by the planar coordinate system which can conclude faulty results between two points in a map projection.

SpatiaLite extends the basic SQLite which was needed to address the needs of a spatial database system. Although being an extension, it fully implements SQL engine making it portable and platform independent. The whole SQL engine is embedded within the application itself. Another distinct feature of this spatial database is the non-complex type of client-server architecture and no installation and configuration hassles. There is no bound on the file size in this spatial system where the whole database is related to a single monolithic file. The distinct feature of SpatiaLite is that it presents advanced spatial queries, vector geodatabases functionality, and also supports various map projections. SQLite+ SpatiaLite is approximately equivalent to PostgreSQL+ PostGIS.

PostGIS supports geographical data to the PostgreSQL object relational database. In addition to the simple SQL features, it incorporates geometrical shapes, geographical datatypes, raster datatypes and other commonly used datatypes for the usage of spatial databases. The functions, operators, index enhancements, analysis and processing of vector datatypes are also supported by the PostGIS.

A comparison is done among the three to find out the best open-source solution for a spatial database system.

Table 1 Comparative table of Open source databases

Parameters	Spatial database types		
	PostGIS	**MySQL**	**SpatiaLite**
OS support	Windows 2000+	Windows, Linux, Mac, Unix.	Device independent
Spatial Functions	300+ operators and functions, 2D, 3D functions, multimedia support for circular strings.	Bounding box functions, Spatial relations function, 2D support.	Standard conformance to spatial data.
Spatial Indexes	R-Tree variant	R-Tree quadratic splitting	R-Trees
Stability	Highly stable, no corruption in long terms.	Issues in maintaining consistency.	Non-complex stability.
Raster support	Rapid development in raster	Doesn't support raster analysis.	Supports
Conversions	Fully compliant	No support for one spatial reference conversion to another.	Can do conversions.
Load balancing	Highly stable	Implements performance issue	Not yet too popular
Best For	High loads	Web development	Easy and simple loads

IV. CONCLUSION

As seen above, the different spatial database systems have their own strengths and limitations, yet when it comes to running a stable, reliable, and consistent spatial database in GIS, we need powerful functions, supports, methods, and many different geo-spatial features to start with. In this case, the PostGIS has to offer the at most features making it desirable and popular too. The MySQL database is best for applications which have short term life. It imposes performance penalties in certain conditions but works easily with popularity of its among others. The SpatiaLite is a considerably newer database system yet it's good for light weighted and simple processes. However each of the spatial database types have their own pros and cons which might affect the functionality including installation, integration, functions etc.

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