Beyond PostGIS

New developments in Open Source Spatial Databases

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TERRA GIS
TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS
Seattle

- Intro
  - Relational Databases
    - PostGIS
    - JASPA
    - INGRES Geospatial
    - MySQL Spatial Support
    - HatBox – a user space extension
  - File Based
    - SpatiaLite
  - Document Based DB
    - GeoCouch
- Comparison - Summary
- Resources

- PostGIS is an extension for PostgreSQL
- Adds support for geographic objects to PostgreSQL
- Enables PostgreSQL server to be used as a backend spatial database for GIS
- Spatial operations and analysis simply mean running a (spatial) SQL query in the database
- Similar functions as ArcSDE and much more ….

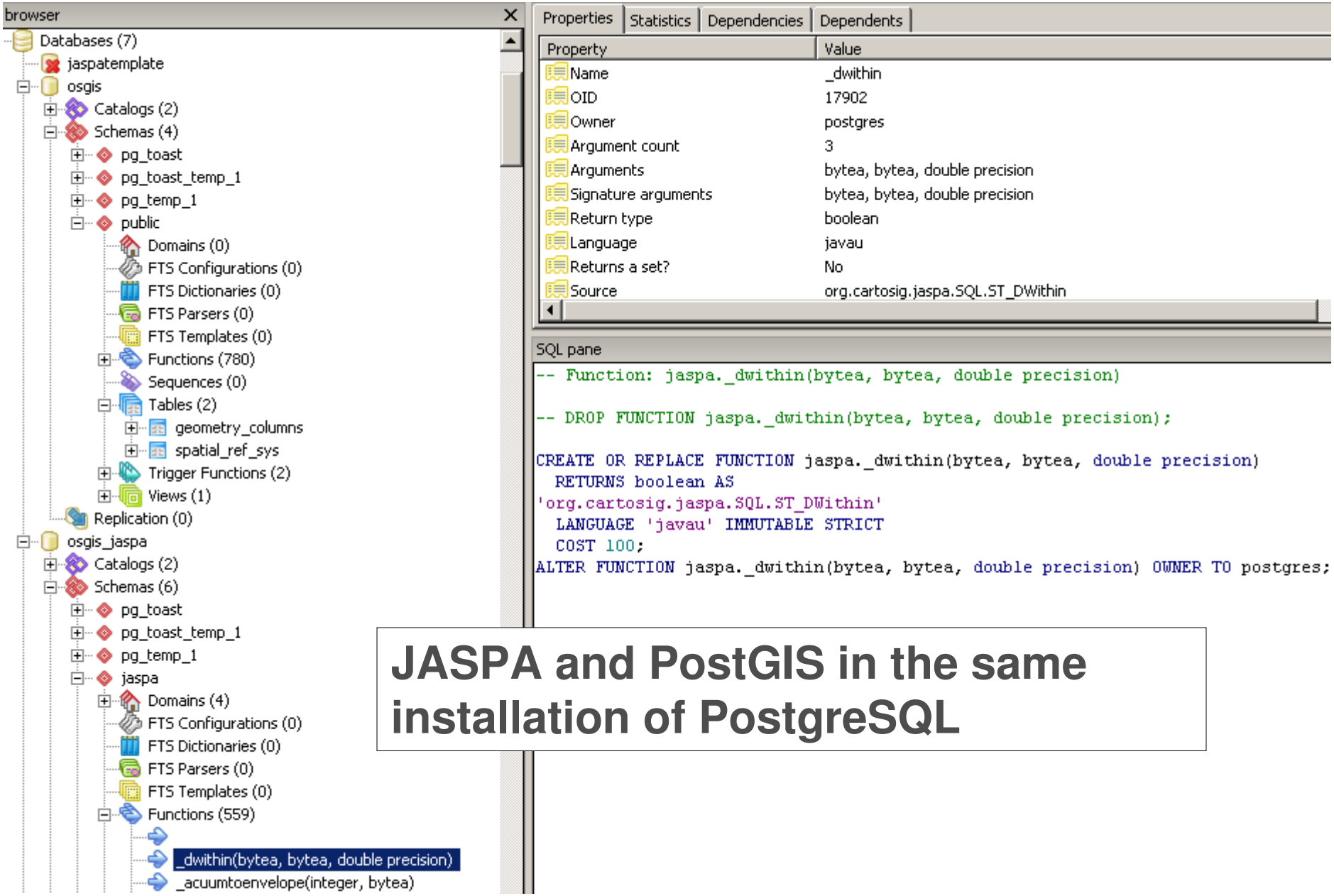
JASPA "JAVA SPATIAL"

by José Carlos Martínez,
Univ. Politécnica de Valencia.

- released in 2010
- Written in Java, built on top of JTS, Geotools as an alternative to PostGIS
  needs PL/Java language in PostgreSQL
- Not restricted to PostgreSQL
  can easily ported to other Java based databases
- For Windows and Linux; PostgreSQL and H2 databases
- Goal is to be almost 100% compatible with PostGIS
- About 200 functions total: all functions that PostGIS 1.4 has are completed plus some additional functions (clean polygons, create feature nodes..)

- **JASPA "JAVA SPATIAL"**

- Spatial Indexing borrowed from GIST in PostgreSQL
- First performance comparisons to PostGIS 1.4
  JASPA faster: ST_Union
  PostGIS faster: read/write geometries from text and binary
- Currently UMN Mapserver only as a front end using PostGIS connection
  gvSIG, ogr and JASPA JDBC planned

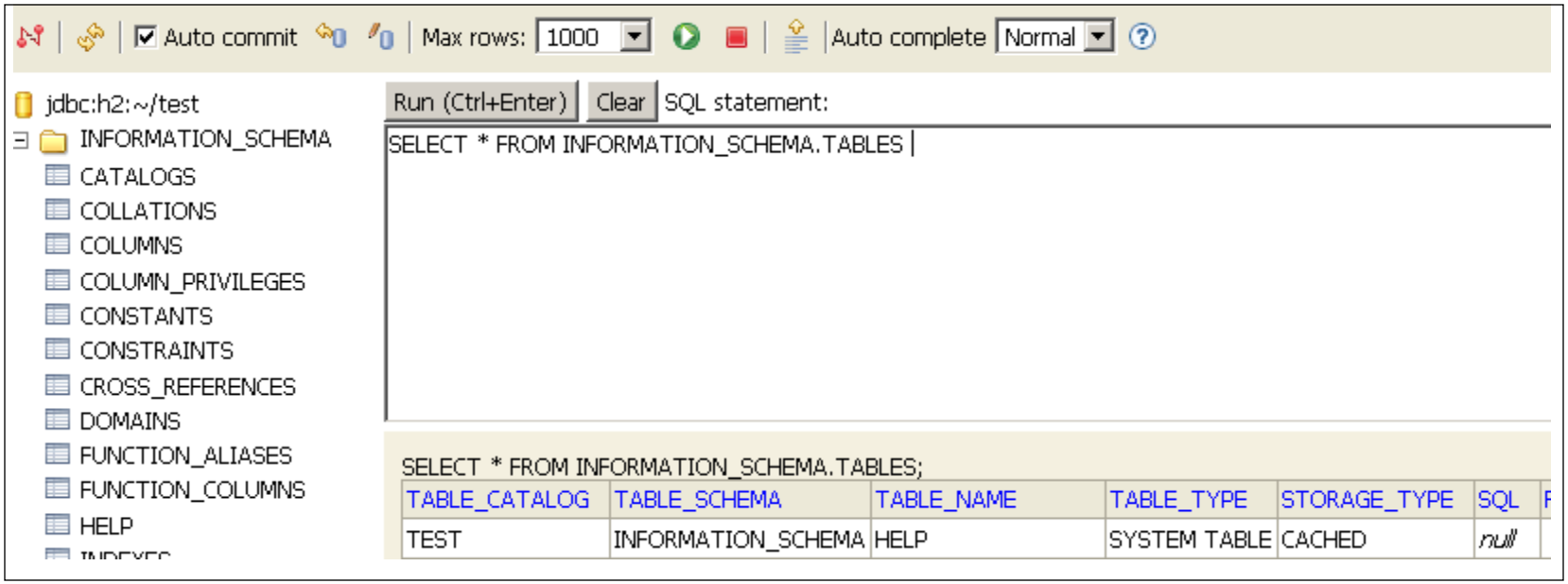


JASPA and PostGIS in the same installation of PostgreSQL

H2 Database

- Java SQL database
- Very fast, open source, JDBC API
- Embedded and server modes; in-memory databases
- Browser based Console application
- Small footprint: around 1 MB jar file size

Web based Admin tool



INGRES GEOSPATIAL

- Great-grandmother of many DBs
  Sybase, MS SQL Server, PostgreSQL
- Since 1974, became open source in 2005
- Geospatial Branch available from SVN
  Community release planned 2010
- Implementation Phase 1 completed
  two-dimensional data types implemented
  point, linestring, polygon, multipoint, multilinestring, multipolygon, geometrycollection
- Focus OGC SFS compliance
  http://www.opengeospatial.org/standards/sfs
- All functions OGC SFS SQL v1.1 working

INGRES GEOSPATIAL

- OGR driver for Ingres – already usable with MapServer
- Rtree indexing.
- WKT / WKB support
- Coordinate system support using Proj.4
- Ingres/VectorWise project cooperation with CWI Amsterdam [1]
  -> Greatly improved performance
  Planned to release as OS – 2010/2011?

1 Research Institute in Mathematics and Computer Science

Hat Box

Apache Derby

H2

- User Space Spatial Extension for Apache Derby and H2
- Avoiding license incompatibilities JTS – Derby – H2
- Independent of Derby and H2 version
- User regular user visible tables and functions etc. to implement spatial functionality (same way as ArcSde)
- RTree indexing but need to join to spatial index table in SQL
- Supports the full range of OGC spatial filters, including Distance Within (DWithin) and Beyond
- Relies on JTS and GeoTools libraries
- Geometries Well Known Binary (WKB)
- Allows one geometry column per table

- Popular and fast OS database
- Spatial Functionality limited
- Spatial data types and functionality not OpenGIS compliant
- Useful Spatial indexes only on "MyISAM" table type (R-tree)
- Spatial operations only on minimum bounding boxes (mbr) for most functions with some exceptions
  BUFFER, DIFFERENCE, DISTANCE, INTERSECTION, SYMDIFFERENCE, UNION, WITHIN
- Despite the limitations can be a good option for storage of large spatial databases

SpatiaLite

By Alessandro Furieri a.furieri@lqt.it

- File based portable light weight spatial DBMS
- Built on top of SQLite
- Related tools include the RasterLite library to handle Raster data and spatialitegis - a simple GIS tool
- Depends on the PROJ and GEOS libraries
- QGIS can read the format, ogr driver in gdal ≥1.7
- SpatiaLite http://www.gaia-gis.it/spatialite
- Potential to replace shape files as a simple data exchange format

SpatiaLite

- Supports standard WKT and WKB formats
- Implements SQL spatial functions
  AsText(), GeomFromText(), Area() etc…

  select name from counties where intersects(counties.Geometry,setsrid((MakePoint(1622794, 150532)),2285));
- OpenGIS functions via GEOS
  Overlaps(), Touches(), Union(), Buffer() etc
- Coordinate reprojection via PROJ.4
- Spatial metadata along the OpenGIS specifications
  Spatial Index based on the SQLite's RTree extension

GeoCouch

- Spatial extension for Apache CouchDB
- Document oriented DB – schema free
- Collection of JSON documents
- RESTful HTTP API (PUT, POST, GET, DELETE)
- Highly concurrent- designed for local replication
- Pure Erlang, depends only on CouchDB
  (first version used SpatiaLite backend)
- Geo-spatial queries: bounding box, radius & polygon searches
- Features: (Multi-)Points, (Multi-)LineStrings, and (Multi-)Polygons
- Vertically scalable

Schema Free

```
{
    "_id": "950da89b4748cc6d08bc2f86fa2860c9",
    "_rev": "3-77f17a55f6ab11f7f6668e63a75f2281",

    "name": "Station-294",
    "date": "2009-10-20",
    "location": [140.39583, -37.48272],
    "state": "SA",
    "temperature": 18,
    "rainfall": 3,
    "atmospheric_pressure": 1021
}
```

Figure taken from Volker Mische FOSS4G 2009 Sydney

Web GIS – Typical 3 Tier Architecture

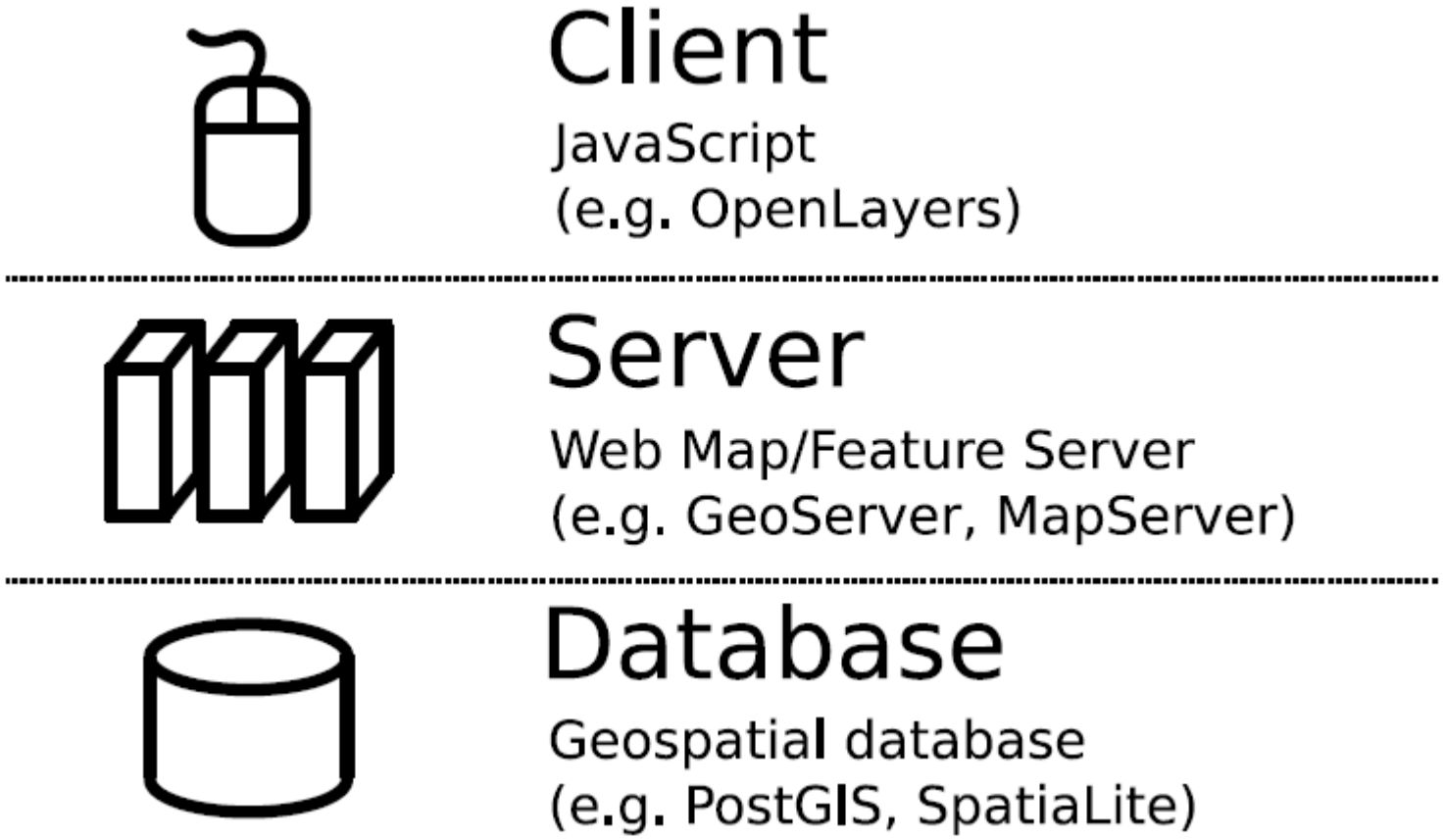


Figure taken from Volker Mische FOSS4G 2009 Sydney

Web GIS – 2 Tier Architecture with Geocouch

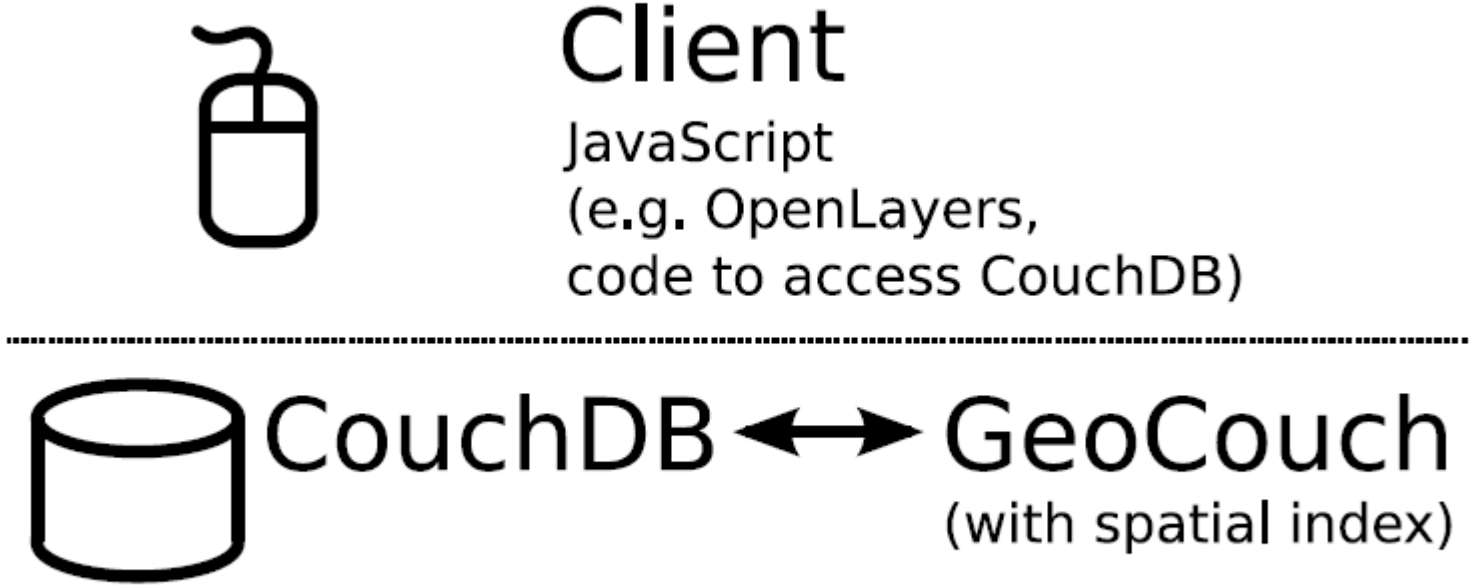


Figure taken from Volker Mische FOSS4G 2009 Sydney

Comparison - Part 1

DB system	depends on	db type	usage	Lang.
PostGIS	PostgreSQL	relational	enterprise	C
JASPA	PostgreSQL H2	relational	academic, pot.enterprise	JAVA
INGRESS GEOSPATIAL	INGRESS	relational	enterprise	C, C++
MySQL	MySQL	relational	enterprise	C, C++
Hat Box	H2 Apache Derby	relational, user-space extension	large DBs smaller to mid size systems	JAVA JAVA
Spatialite	SQLite	file	personal, great data exchange format	C
GeoCouch	Couch DB	document oriented	simplifying web development, easy recovery	Erlang

Comparison - Part 2

DB system	connectors			OpenGIS SFS	functionality	spatial index	storage format
	GIS	*other*	*MapServer*				
PostGIS	ogr	ODBC	postgis	yes	comprehensive spatial functions	yes GIST	extended WKB
JASPA	gvSIG in the works	JDBC	postgis	yes	comprehensive spatial functions	yes (GIST) no	WKB
INGRESS GEOSPATIAL	ogr	ODBC	ogr	yes	nearing OpenGIS compliance	yes	WKB
MySQL	ogr	ODBC	ogr	no	limited; not OpenGIS compliant	MyISAM tables R-tree indexes	MySQL specific
Hat Box		JDBC JDBC		yes	OpenGIS compliant.	RTree join to spatial index table in SQL	WKB
Spatialite	ogr, QGIS	ODBC	ogr	yes	almost complete OpenGIS compliant	Rtree via SQLite	WKB
GeoCouch				partial implementation		yes	JSON

Comparison - All

DB system	depends on	db type	usage	Lang.	connectors			OpenGIS SFS	functionality	spatial index	storage format
					GIS	*other*	*MapServer*				
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JASPA	PostgreSQL H2	relational	Academic, pot.Enterpise	JAVA	gvSIG in the works	JDBC	postgis	yes	comprehensive spatial functions	yes (GIST) no	WKB
INGRESS GEOSPATIAL	INGRESS	relational	Enterprise	C, C++	ogr	ODBC	ogr	yes	nearing OpenGIS compliance	yes	WKB
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Hat Box	H2 Apache Derby	relational, user-space extension	Large DBs smaller to mid size systems	JAVA JAVA		JDBC JDBC		yes	OpenGIS compliant.	RTree join to spatial index table in SQL	WKB
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OpenGIS Implementation Specification for Geographic information - Simple feature access - SQL option:
http://www.opengeospatial.org/standards/sfs

WKB = "Well Known Binary"

JSON = "JavaScript Object Notation", text-based, human-readable data interchange format

GiST = "Generalized Search Tree", a generic form of indexing

- OGC Definitons http://www.opengeospatial.org/ogc/glossary/w
  - Well-Known Text: Representation of Spatial Reference Systems. Format that provides a standard textual representation for spatial reference system information.
  - Well-Known Binary:Representation for Geometry (WKBGeometry). Data format that provides a portable representation of a Geometry value as a contiguous stream of bytes.
  - OpenGIS® Simple Features Specifications for SQL http://www.opengeospatial.org/standards/sfs
- PostGIS http://postgis.refractions.net/
- JASPA http://forge.osor.eu/projects/jaspa/
  JASPA documentation http://jaspa.forge.osor.eu
- Ingres http://community.ingres.com/wiki/GeoProjectPlan
- MySQL http://dev.mysql.com/doc/refman/5.5/en/spatial-extensions.html
- Hatbox http://hatbox.sourceforge.net
- Spatialite http://www.gaia-gis.it/spatialite
- GeoCouch http://github.com/vmx/couchdb