Implemented Systems
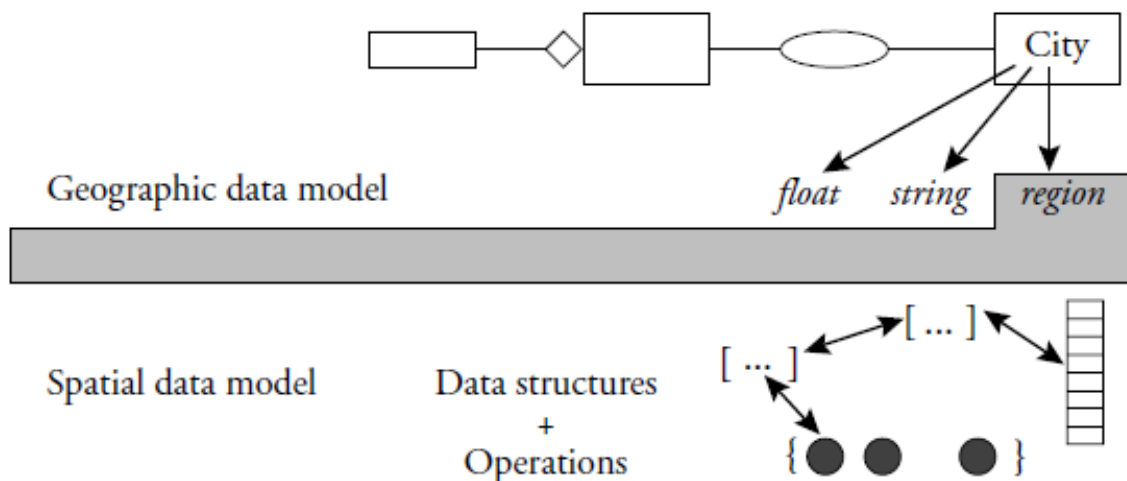
Presenter: Manos Karpathiotakis

Outline

- Relational DBMS with a geospatial extension

- RDF stores with a geospatial component:

    – Research prototypes

    – Commercial systems

How does an RDBMS handle geometries? (1/2)

- Geometries are not explicitly handled by query language (SQL)

- Define datatypes that extend the SQL type system

  - Model geometries using Abstract Data Type (ADT)

  - Hide the structure of the data type to the user

    – The interface to an ADT is a list of operations

      » For spatial ADTs: Operations defined according to OGC Simple Features for SQL

    – Vendor-specific implementation irrelevant - extend SQL with geometric functionality independently of a specific representation/implementation

- Special indices needed for geometry data types
- Specialised query processing methods
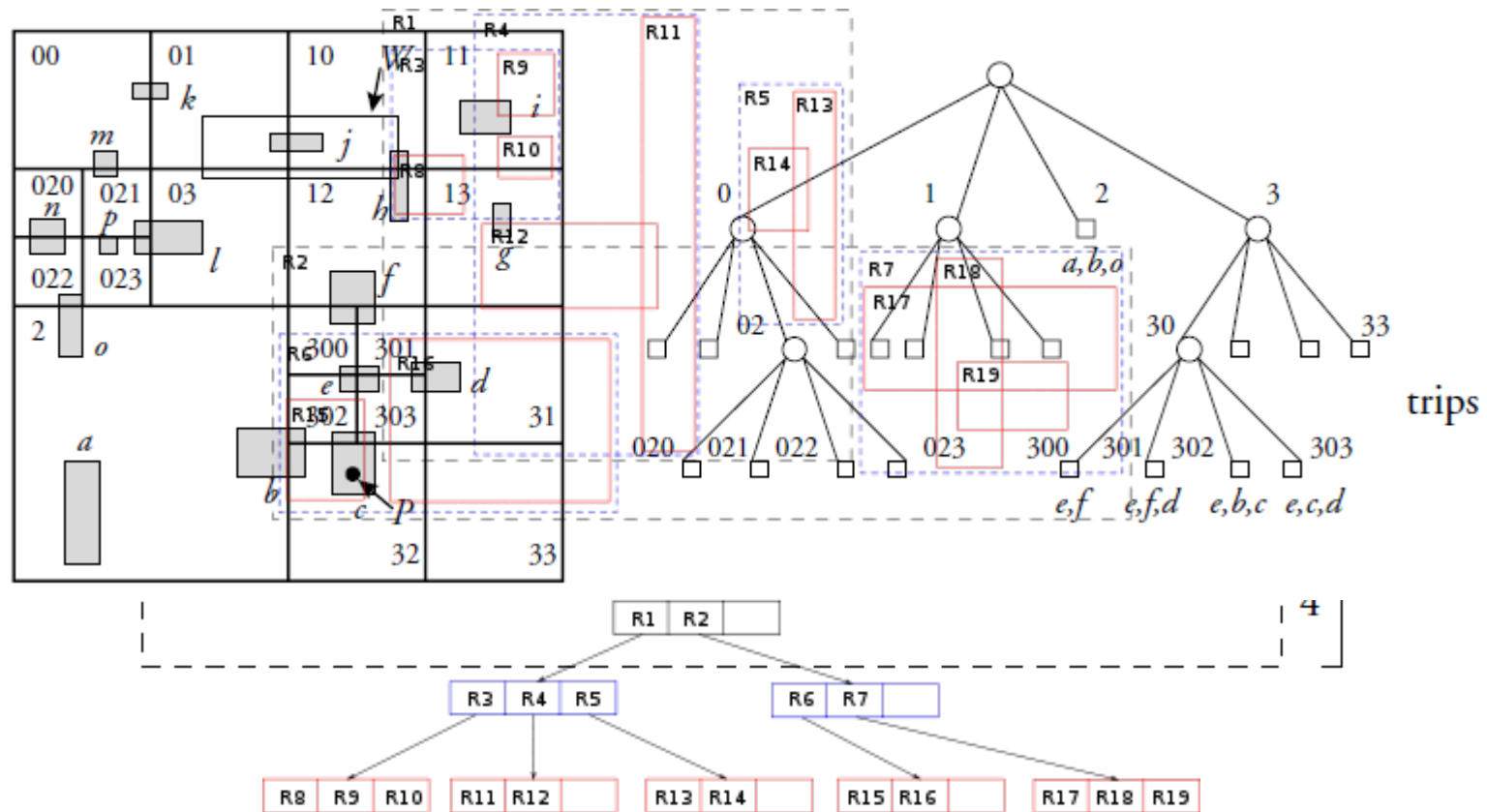
Implemented Systems

- Will examine following aspects:
    - Data model
    - Query language
    - Functionality exposed
    - Coordinate Reference System support
   - Indexing Mechanisms

Research Prototypes

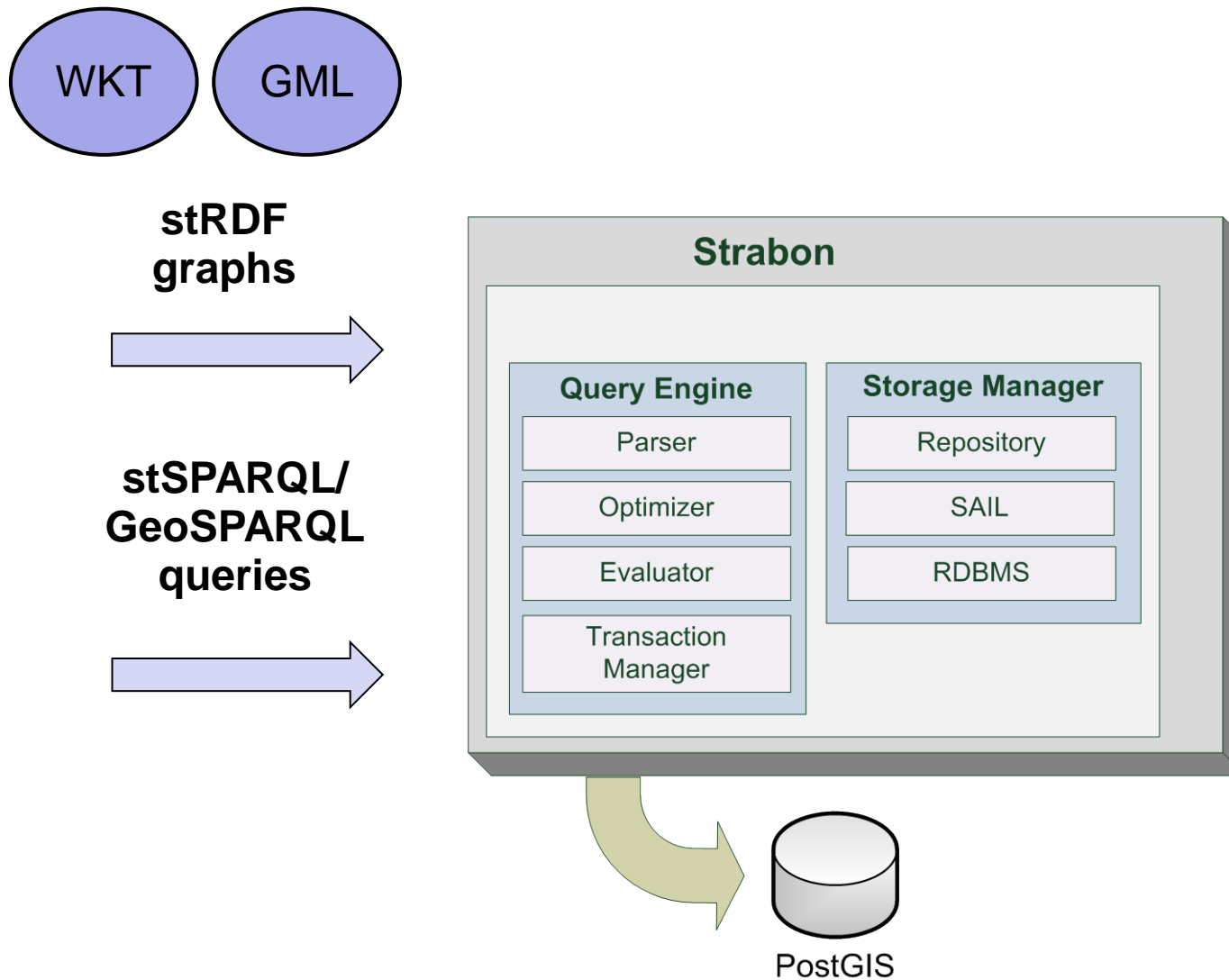- Strabon

- Parliament

- Brodt et al.

- Perry

Strabon

- Storage and query evaluation module for stSPARQL
- Geometries represented using typed literals
  - WKT & GML serializations supported
- Spatial predicates represented as SPARQL functions
  - OGC-SFA, Egenhofer, RCC8 families exposed
  - Spatial aggregate functions
- Support for multiple coordinate reference systems

- GeoSPARQL support
  - Core
  - Geometry Extension
  - Geometry Topology Extension
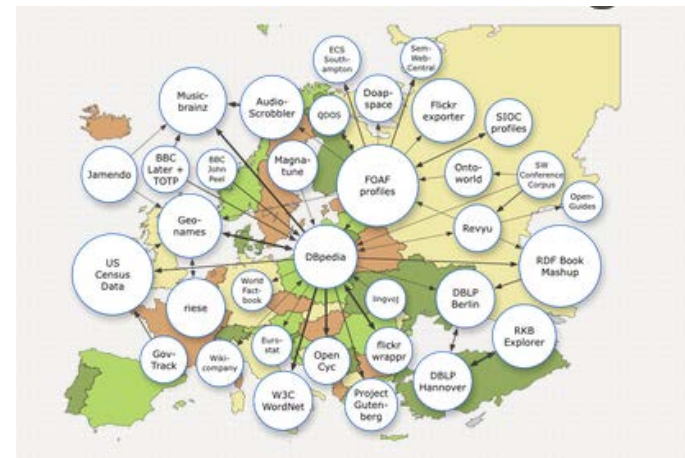
Strabon - Implementation

Open Source, available from http://www.strabon.di.uoa.gr/

Parliament

- Storage Engine

- Developed by Raytheon BBN Technologies (Dave Kolas)

- First implementation of GeoSPARQL

  - Geometries represented using typed literals

    - WKT & GML serializations supported

  - Three families of topological functions exposed

    - OGC-SFA

    - Egenhofer

    - RCC8

  - Multiple CRS support

Parliament - Implementation

- Rule engine included

- Paired with query processor

- R-tree used

Open Source, available from
http://www.parliament.semwebcentral.org
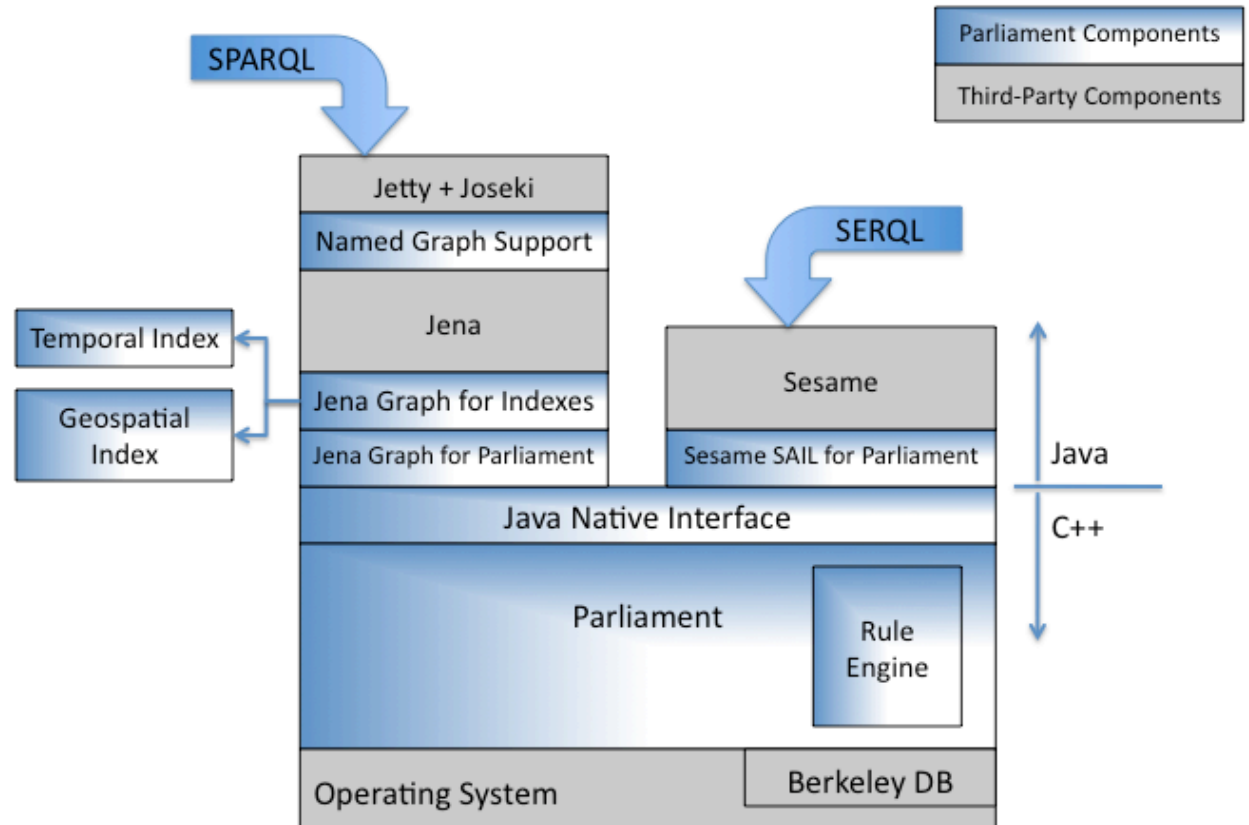
Brodt et al.
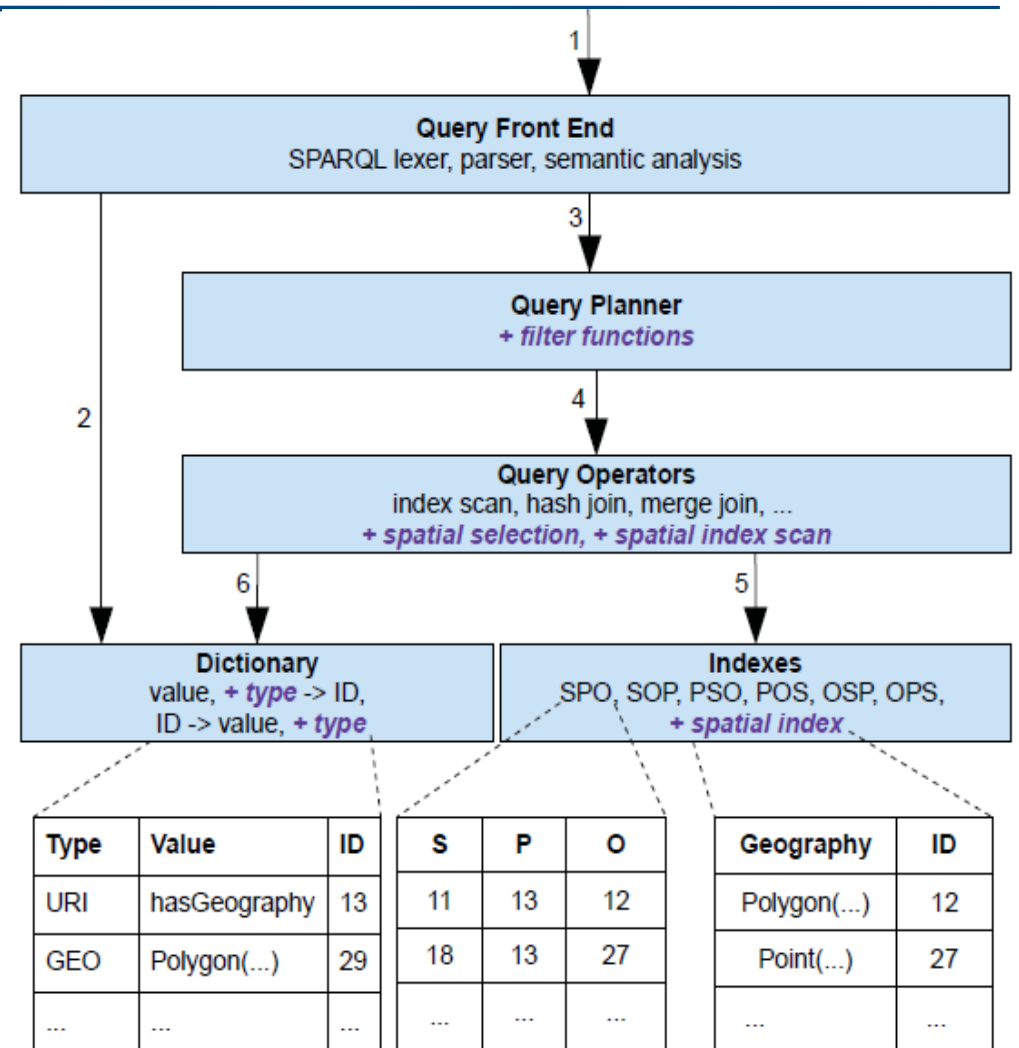
- Built on top of RDF-3X

- Implemented at University of Stuttgart

- No formal definitions of data model and query language given

- Geometries expressed according to OGC-SFA

  - Typed Literals

  - WKT serialization supported

  - Expressed in WGS84

- Spatial predicates represented as SPARQL filter functions

  - OGC-SFA functionality exposed

Brodt et al. - Implementation

- Focus on spatial query processing and spatial indexing techniques for spatial selections

  - e.g. "Retrieve features located inside a given polygon"

- Naive spatial selection operator

  - Placed in front of the execution plan which the planner returns

- Spatial index (R-Tree) implemented

  - Only utilized in spatial selections

Available upon request

Perry
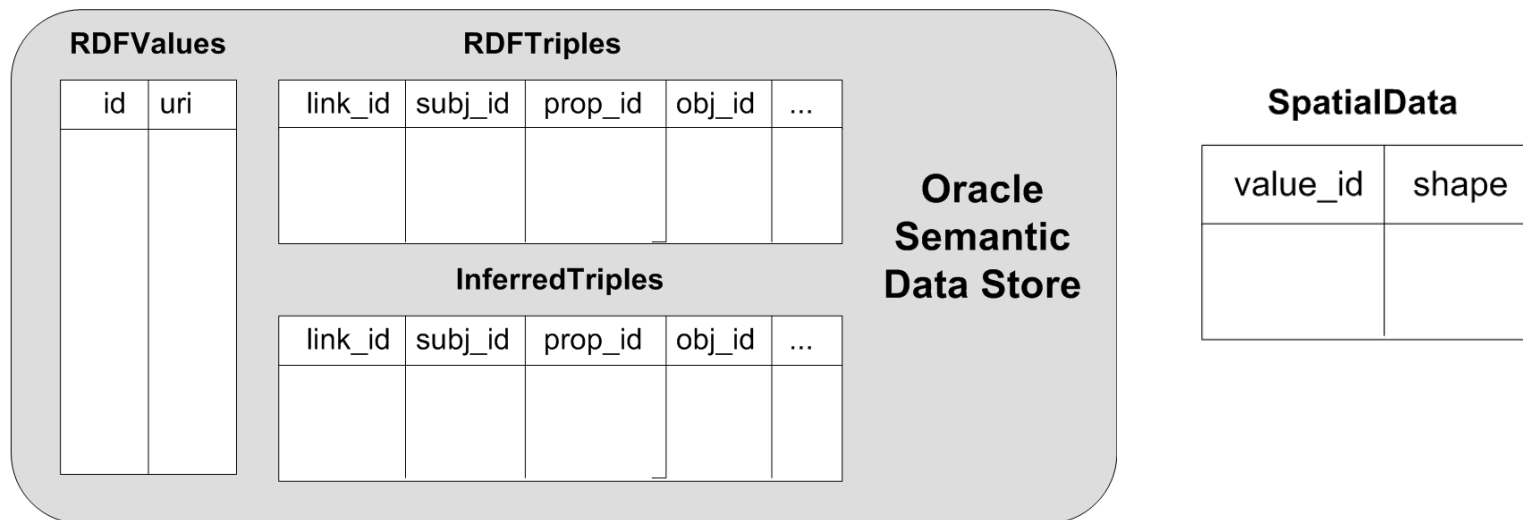
- Built on top of Oracle 10g

- Implemented at Wright State University

- Implementation of SPARQL-ST

  - Upper-level ontology imposed

- Geometries expressed according to GeoRSS GML

- Spatial and temporal variables introduced

- Spatial and temporal filters used to filter results with spatiotemporal constraints

  - RCC8 calculus

  - Allen's interval calculus

Perry

- Spatiotemporal operators implemented using Oracle's extensibility framework

  - Three spatial operators defined

- Strictly RDF concepts implemented using Oracle's RDF storage and inferencing capabilities

- R-Tree used for indexing spatial objects

RDFValues

id	uri

RDFTriples

link_id	subj_id	prop_id	obj_id	...

InferredTriples

link_id	subj_id	prop_id	obj_id	...

Oracle Semantic Data Store

SpatialData

value_id	shape

Available upon request

Commercial RDF Stores

- AllegroGraph

- OWLIM

- Virtuoso

- uSeekM

AllegroGraph

- Well-known RDF store, developed by Franz Inc.

- Two-dimensional point geometries

  – Cartesian / spherical coordinate systems supported

- GEO operator introduced for querying

  – Syntax similar to SPARQL's GRAPH operator

  – Available operations:

    - Radius / Haversine (Buffer)
    - Bounding Box
    - Distance

- Linear Representation of data

  – X and Y ordinates of a point are combined into a single datum

- Distribution sweeping technique used for indexing

    - Strip-based index

- Closed source, available from http://www.franz.com/agraph/allegrograph/

OWLIM

- Semantic Repository, developed by Ontotext

- Two-dimensional point geometries supported

  – Expressed using W3C Geo Vocabulary

    - Point Geometries
    - WGS84

- Spatial predicates represented as property functions

  – Available operations:

    - Point-in-polygon
    - Buffer
    - Distance

- Implemented as a Storage and Inference Layer for Sesame

- Custom spatial index used

- Closed Source

  – Free version available for evaluation purposes
    (http://www.ontotext.com/owlim)

Virtuoso

- Multi-model data server, developed by OpenLink

- Two-dimensional point geometries

  - Typed literals

  - WKT serialization supported

  - Multiple CRS support

- Spatial predicates represented as functions

  - Subset of SQL/MM supported

- R-Tree used for indexing

- Spatial capabilities firstly included in Virtuoso 6.1

- Closed Source

  - Open Source Edition available from http://virtuoso.openlinksw.com/

    - Does not include the spatial capabilities extension

uSeekM

- Add-on library for Sesame-enabled semantic repositories, developed by OpenSahara

- Geometries expressed according to OGC-SFA
  - WKT serialization
  - Only WGS84 supported

- Spatial predicates represented as functions
  - OGC-SFA functionality exposed
  - Additional functions
    - e.g. `shortestline(geometry,geometry)`

- Implemented as a Storage and Inference Layer (SAIL) for Sesame
  - May be used with RDF stores that have a Sesame Repository/SAIL layer
- R-tree-over-GiST index used (provided by PostGIS)
- Open Source, Apache v2 License
- Available from https://dev.opensahara.com/projects/useekm

System	Language	Index	Geometries	CRS support	Comments on Functionality
Strabon	stSPARQL/ GeoSPARQL*	R-tree-over-GiST	WKT / GML support	Yes	• OGC-SFA • Egenhofer • RCC-8
Parliament	GeoSPARQL	R-Tree	WKT / GML support	Yes	•OGC-SFA •Egenhofer •RCC-8
Brodt et al. (RDF-3X)	SPARQL	R-Tree	WKT support	No	OGC-SFA
Perry	SPARQL-ST	R-Tree	GeoRSS GML	Yes	RCC8
AllegroGraph	Extended SPARQL	Distribution sweeping technique	2D point geometries	Partial	•Buffer •Bounding Box •Distance
OWLIM	Extended SPARQL	Custom	2D point geometries (W3C Basic Geo Vocabulary)	No	•Point-in-polygon •Buffer •Distance
Virtuoso	SPARQL	R-Tree	2D point geometries (in WKT)	Yes	SQL/MM (subset)
uSeekM	SPARQL	R-tree-over GiST	WKT support	No	OGC-SFA

Conclusions

- **Semantic Geospatial Systems**:

    - Research Prototypes

    - Commercial Systems

- **Next topic:** Applications of Linked Geospatial Data