

ORACLE®

Making Sense of Location: Tracking, Visualizing & Analyzing Moving Objects in 2D, 3D & 4D

Location Intelligence On-premise and in the Cloud

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HOUG Conference 2019

 @SpatialHannes

Safe Harbor Statement

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

Agenda

- 1 Geospatial Data in the Database
- 2 Using the Database for Tracking and Tracing
- 3 Visualizing Results on a Map
- 4 Advanced Analysis using Road Networks
- 5 Wrap-up

What is Spatial Data

Integral part of almost every database

- Business data that contains or describes location
 - Geographic features (roads, rivers, parks, etc.)
 - Assets (pipe lines, cables, transformers,
 - Sales data (sales territory, customer registration, etc.)
 - Street and postal address (customers, stores, factories, etc.)
- Anything associated with a physical location
- Described by coordinates or implicitly as text (place name), ...
- **Location is a “universal key” relating otherwise unrelated entities**



Required database capabilities for geospatial analysis

- Data type to store points, lines, areas, solids, ...
 - In two or three dimensions
 - Taking into account coordinate system
- Topological Operators
 - Point-in-polygon, intersecting linestrings, overlapping areas, ...
- Geometric Functions
 - Calculating areas, distances, buffer zones, ...
- Spatial Indices
 - Fast access to relevant data

Storing spatial data in SDO_GEOMETRY

Table Counties

| | | |
|--------|----------|--------------|
| ID | NAME | BOUNDARY |
| NUMBER | VARCHAR2 | SDO_GEOMETRY |

| | |
|---------------|---------------------|
| SDO_GTYPE | NUMBER |
| SDO_SRID | NUMBER |
| SDO_POINT | SDO_POINT_TYPE |
| SDO_ELEM_INFO | SDO_ELEM_INFO_ARRAY |
| SDO_ORDINATES | SDO_ORDINATE_ARRAY |

Creating Geometric Objects

- Creating point data ...

```
select sdo_geometry('POINT (10 50)', 4326) from dual;
```

```
SDO_GEOMETRY
```

```
-----  
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(10, 50, NULL), NULL, NULL)
```

- Alternatively ...

```
select sdo_geometry(2001, 4326, sdo_point_type(10,50,null), null, null) from  
dual;
```

```
SDO_GEOMETRY
```

```
-----  
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(10, 50, NULL), NULL, NULL)
```

Accessing Coordinates in SDO_GEOMETRY

- Which points describe the boundary of Germany?

```
SQL> select k.id, k.x, k.y from
2     countries c,
3     table(sdo_util.getvertices(c.geometry)) k
4     where country_name='GERMANY';
```

| ID | X | Y |
|----|------------|-----------|
| 1 | 14,7200450 | 51,582406 |
| 2 | 14,7554651 | 51,603937 |
| 3 | 14,7570239 | 51,644129 |
| : | : | : |

Example: Spatial SQL Queries

- Which German Länder are touching North-Rhine Westphalia?

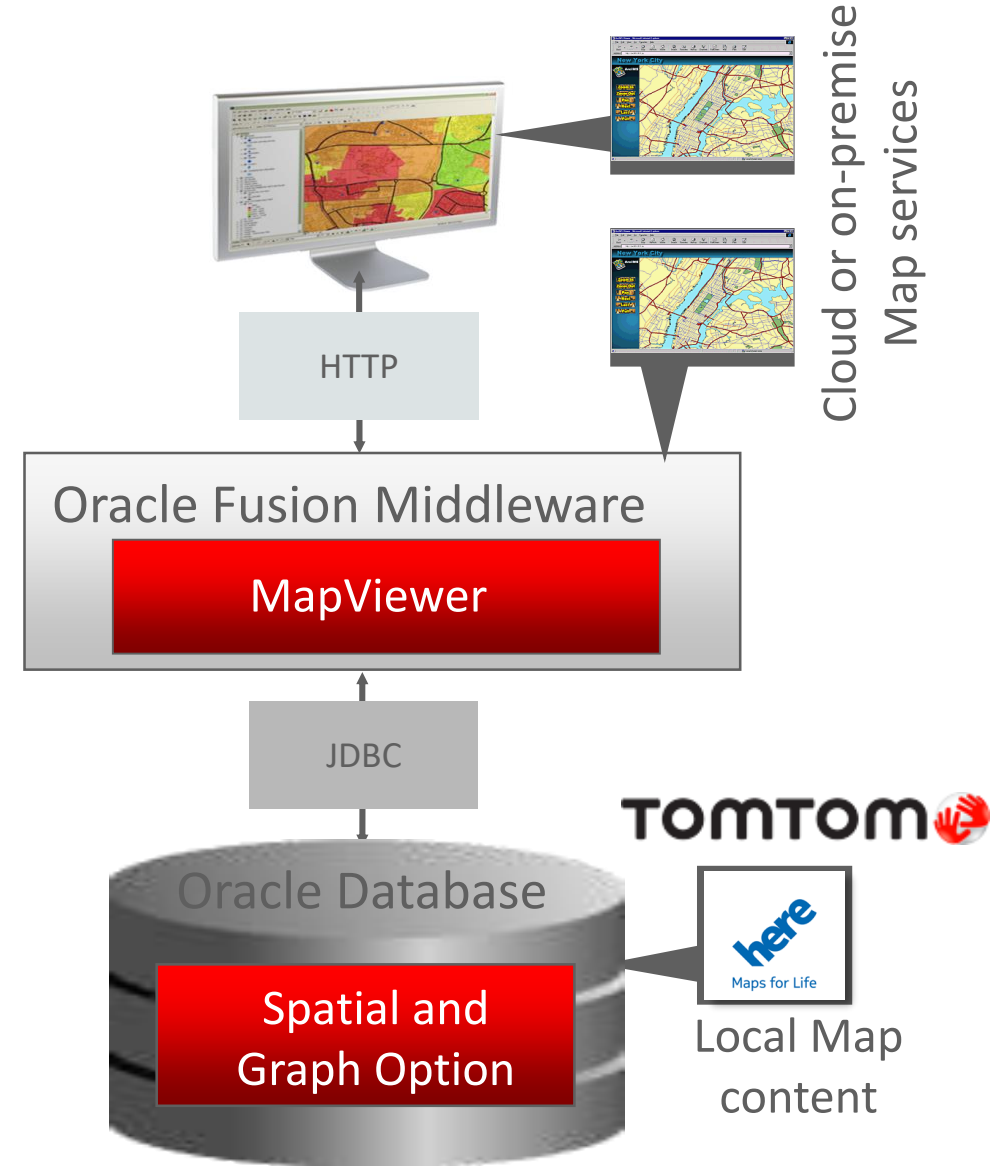
```
select l1.name
from laender l1, laender l2
where l2.name='NRW' and
sdo_relate(
  l1.boundary, l2.boundary,
  'mask=touch'
)='TRUE'
```



- Using spatial (R-Tree) index for query optimization
 - Two-step filter process
 - Checking interaction between minimum bounding rectangle first, then detailed test

Geospatial Product Portfolio

- **Oracle Database**
 - Basic capabilities for spatial data management
- **Oracle Spatial and Graph**
 - Priced option for Geocoding, Routing, High-Performance Query and Analytics, and more
 - Includes RDF Graph capabilities (triple store, SPARQL queries, inferencing and ontology support, ...)
 - Includes property graph analytics engine
- **Oracle Fusion Middleware MapViewer**
 - Java-based map rendering engine built on HTML5
- **Big Data and NoSQL support**
- Built on open standards (OGC, ISO 191xx, ...)
- Partnerships with data providers, SIs, ISVs, ...



Oracle's Spatial and Graph Strategy

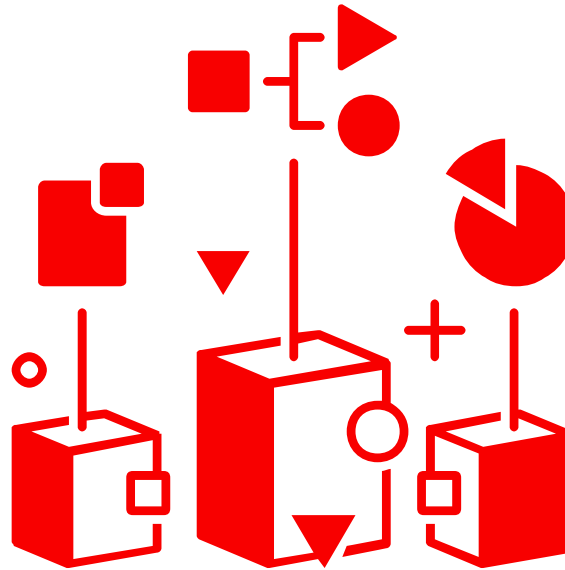
Enabling spatial analysis use cases on every platform

Oracle Database
Spatial and Graph Option



Exadata
Non-Engineered Systems

Oracle Big Data
Spatial and Graph



Big Data Appliance
Commodity Hadoop
Spark

Cloud
Services

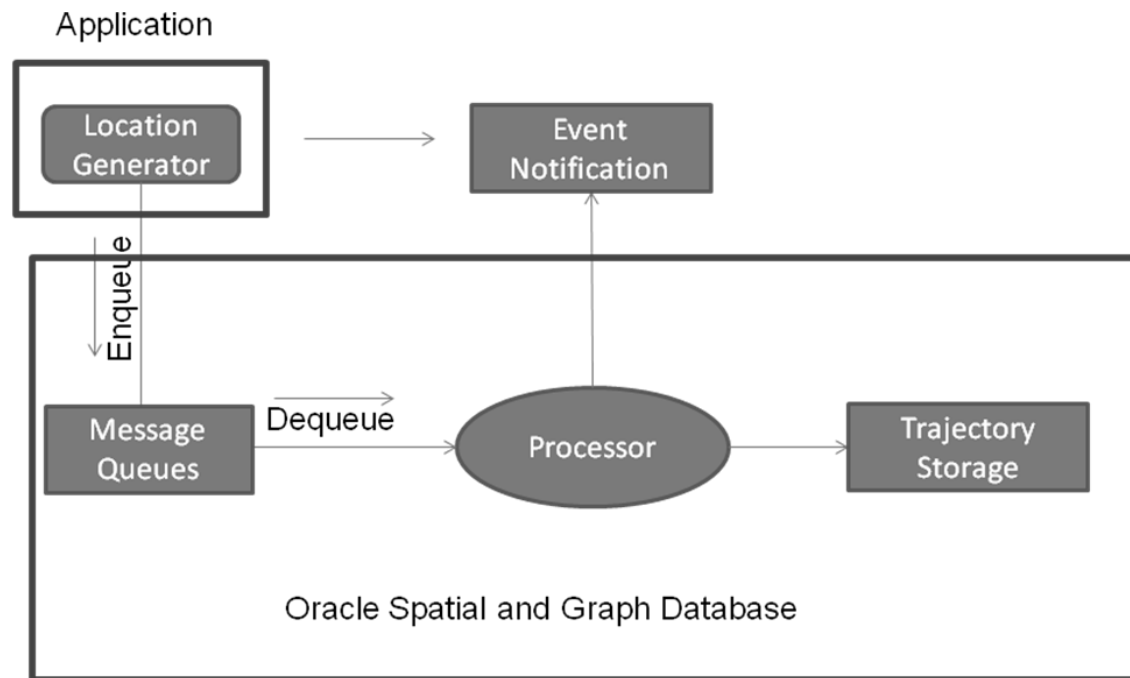


Database Cloud Service
Exadata Cloud Service
ADW/ATP-S (coming up)

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Location tracking in Oracle 12.2



- New APIs in Oracle 12.2
- Tracking many moving objects against many regions
- Enhanced „point-in-polygon“ analysis
 - Tracking multiple objects simultaneously through parallelism
 - Designed to scale to millions of objects
- Java API and PL/SQL API for event capture and processing
 - Using Advanced Queuing in database for performance and async. processing

Location Tracking API workflow

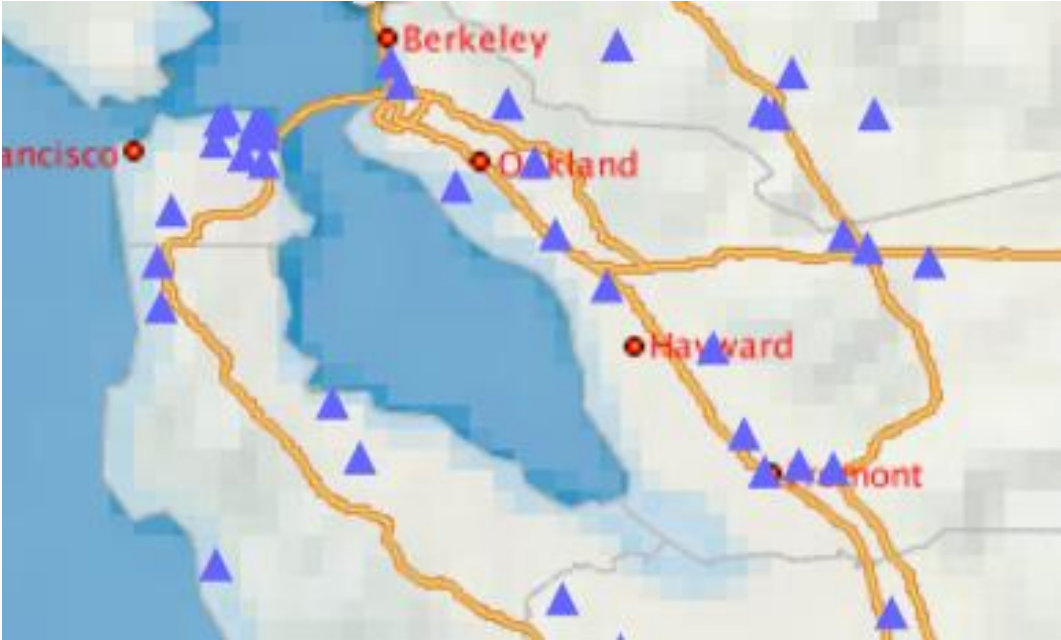
- Create regions of interest in database as polygon geometries
- Initialize the location tracking server
 - Initialization of 3 queues: one for receiving location objects, one for receiving location messages, and one for storing the notifications after the locations are processed
 - Each location object (moving item) has many location messages, can be persisted
- PL/SQL APIs to create location objects and insert location messages
- Java Applications can use AQ Java API to insert data into the input queues
 - JMX queues used for maximum performance
- Alerts are sent to output queue
 - Subscription to output queue for further processing

Location Tracking – Use cases

- Raise alert when object enters area-of-interest



- Raise alert when object leaves area-of-interest (Geofencing)

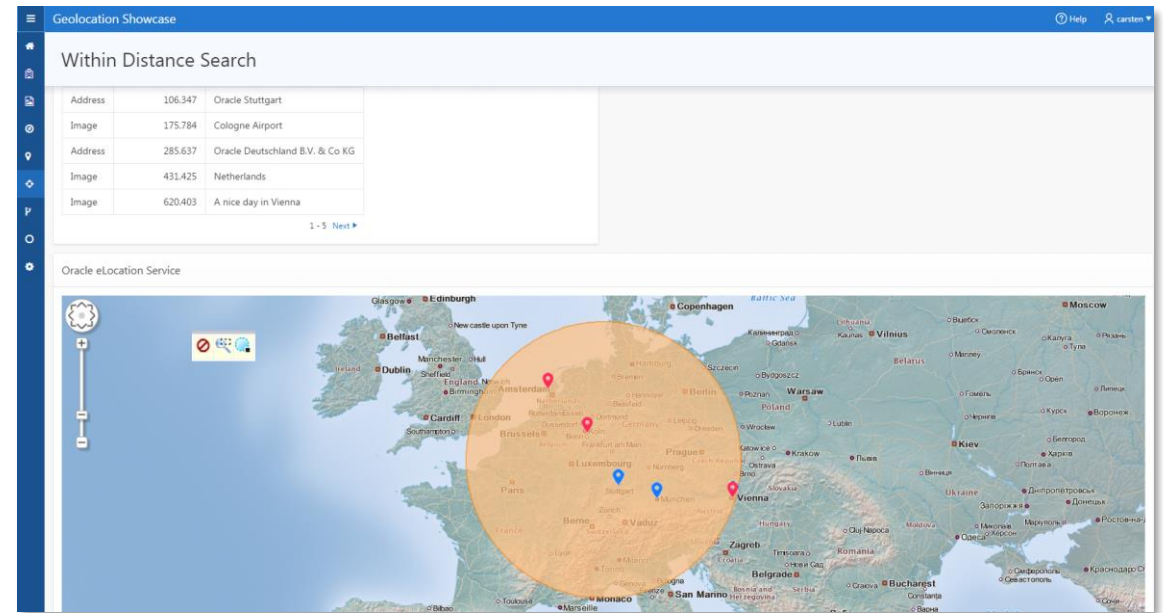


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Visualizing Relevant Events in Context

- HTML5-based visualization component
 - Included in Spatial and Graph license
- Rendering dynamic maps
 - Data from database
 - Data from external sources (WMS, WFS, GeoRSS, WMTS)
 - Integration of Google Maps, etc.
- Available as plug-in for Apex
 - Geolocation Showcase
- Many 3rd Party Tools available as well
 - eg. Luciad RIA, working with OracleJET



Agenda

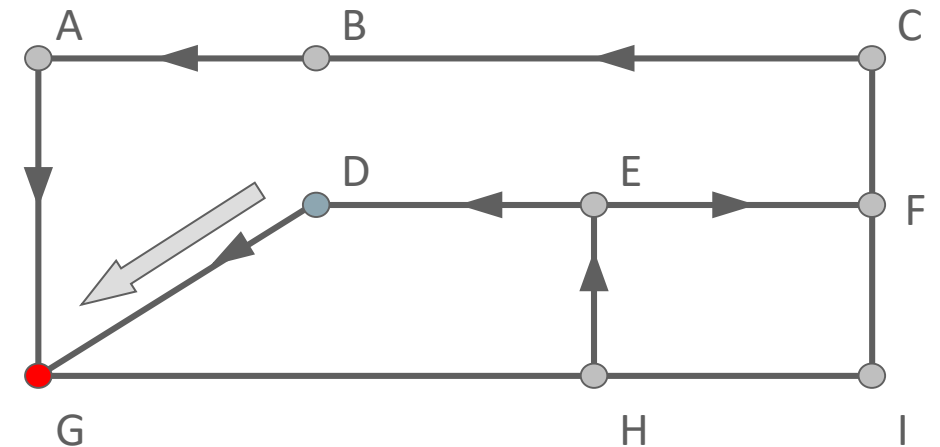
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Tracking und Tracing based on Road Network

- Object position not sufficient in all cases, but position on road network required
 - eg. exact route needed, despite GPS inaccuracies/errors
 - eg. route planning, calculating (remaining) drivetime
- Road network as reference dataset needed
 - Commercially available from HERE, Tomtom
 - OpenStreetMap converter available from CISS TDI
- Required database functionality
 - Support for linear coordinate systems
 - Network data model (graph), routing engine

Routing based on Network Data Model

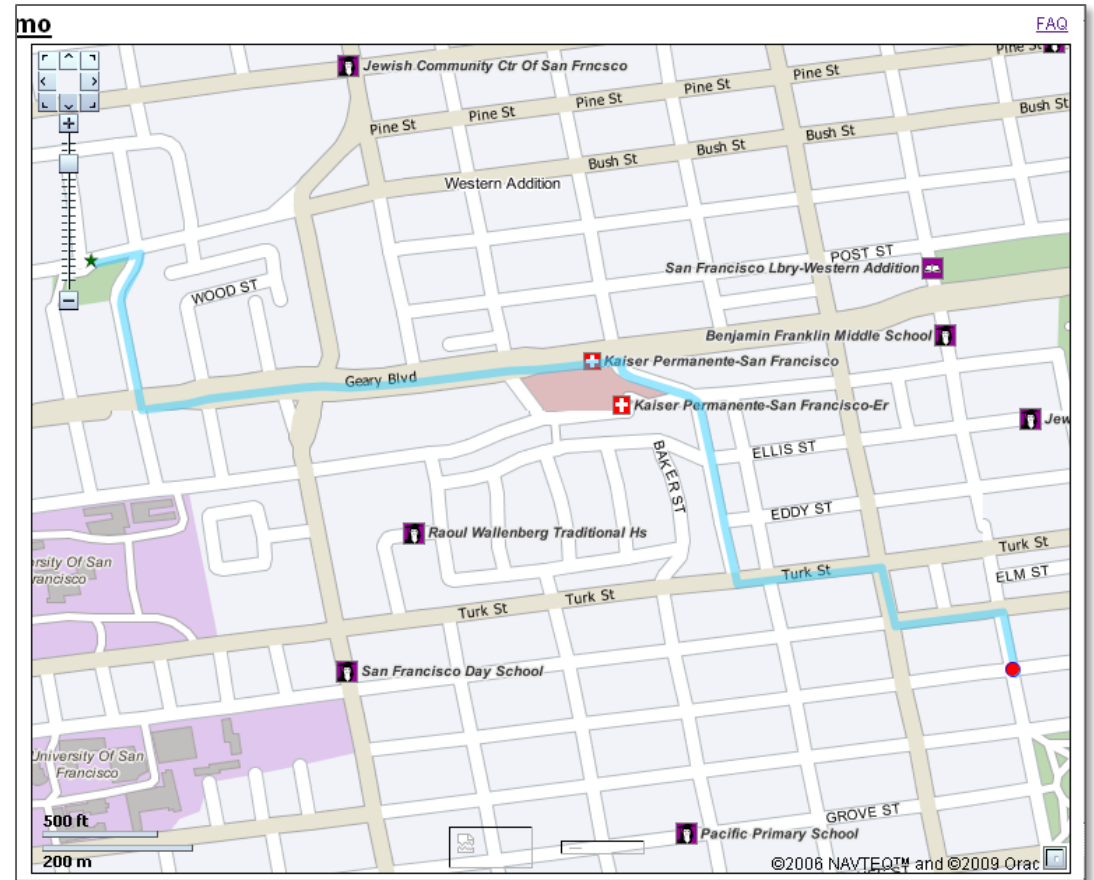
- Entire road network stored as nodes and edges of a graph
 - With or without road segment geometry
- Connectivity and cost (eg. drivetime) per road segment
- Enabling network analysis
 - Using graph algorithms
 - Based on directed or undirected graph
 - Optionally taking cost into account
- Data Management API
 - Caching, Partitioning, load-on-demand, ...



Nearest neighbor in a directed graph

Network Data Model: Analysis

- Shortest path analysis
- Nearest neighbor analysis
- Within cost analysis
- Network Buffer (forward and reverse)
- Reachable/Reaching nodes
- K-shortest paths analysis
- Traveling salesman problem
- Multiple TSPs/Single Depot (new)



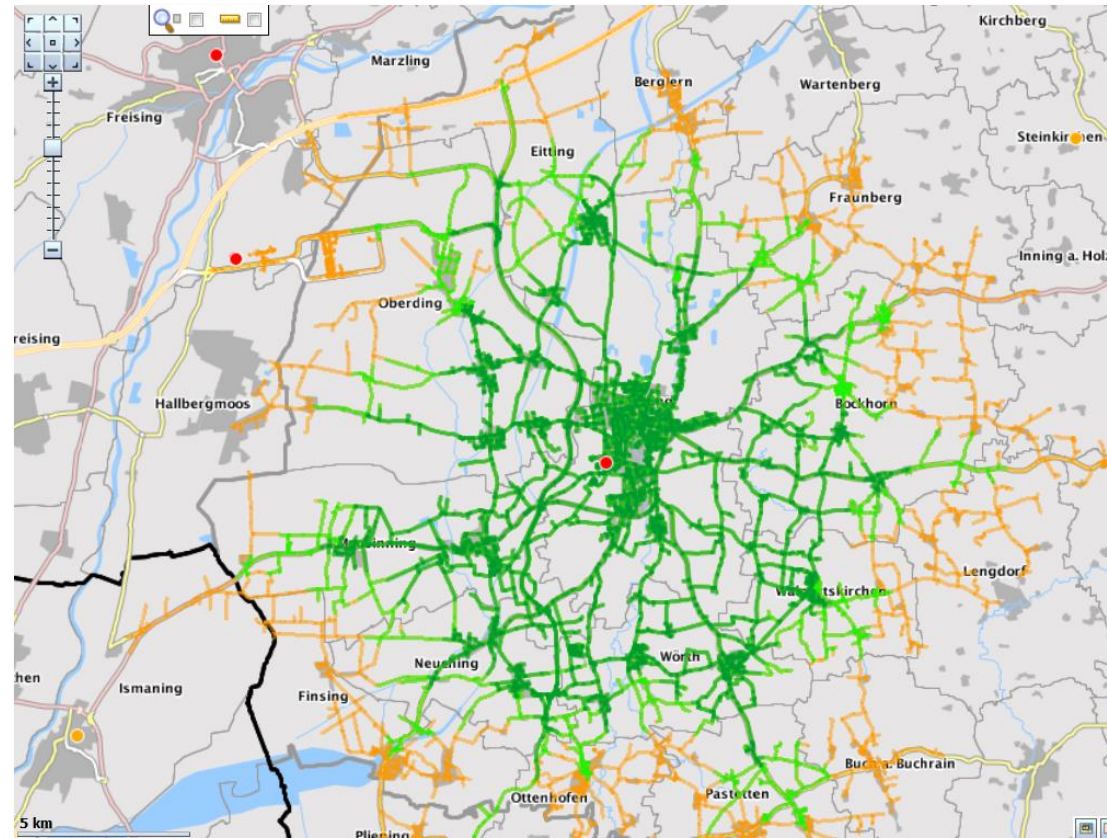
INM Spatial Data Warehouse

Institute for Emergency Medicine and Management in Medicine

- Emergency Services Planning in Bavaria
 - State-wide planning and optimization
 - Site planning for ambulance bases, What-if analysis, ...
- Based on 2TB data warehouse of emergency mission data
 - Location and status information plus medical data
- Combined with road network data, hospital locations, helicopter bases, ...
 - Including individual speed profiles per road segment
- Calculating drive-time areas, hospital service areas, ...
 - Simulation model, ensuring compliance with legal mandate

INM Spatial Data Warehouse

Determining drivetime area based on road network



A woman with long brown hair and glasses is sitting at a wooden table in a bright, modern office or cafe. She is wearing a brown leather jacket over a blue patterned scarf. She is holding a black mobile phone to her ear with her left hand and looking down at a newspaper or magazine on the table with her right hand. The background is slightly blurred, showing other people and large windows.

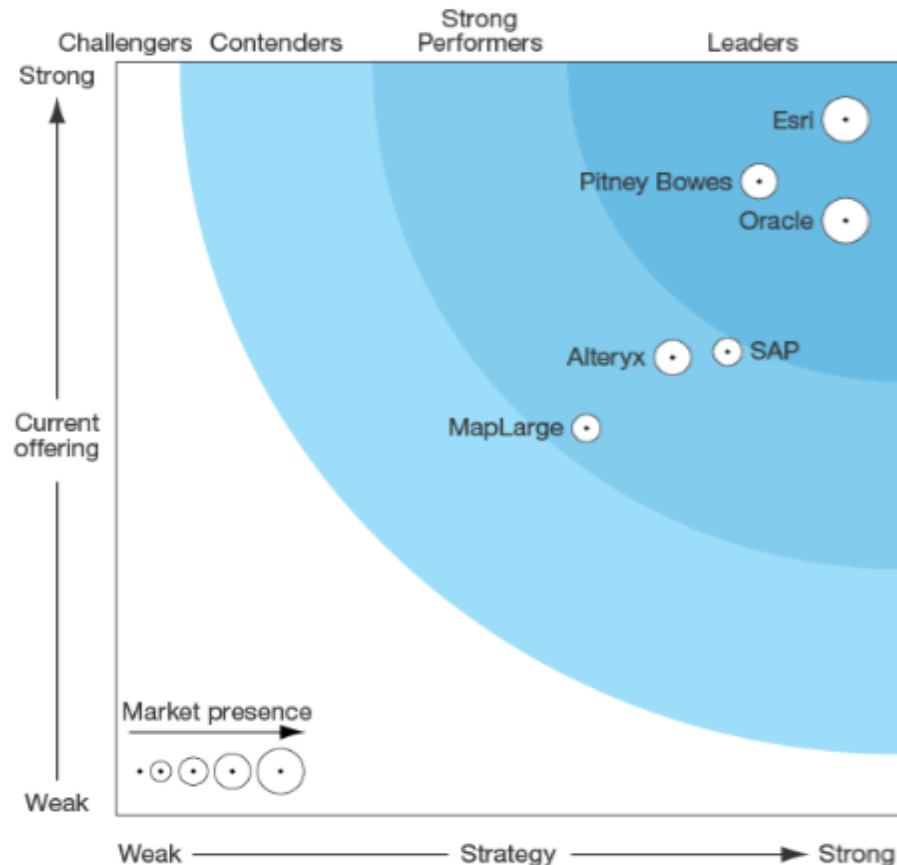
Wrap-up

The Forrester Wave™: Geospatial Analytics Tools And Platforms, Q3 2016

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WAVE LEADER
2016

Geospatial Analytics
Tools And Platforms



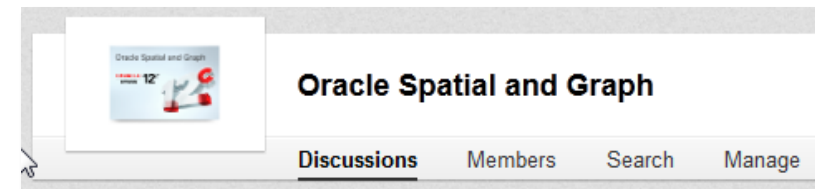
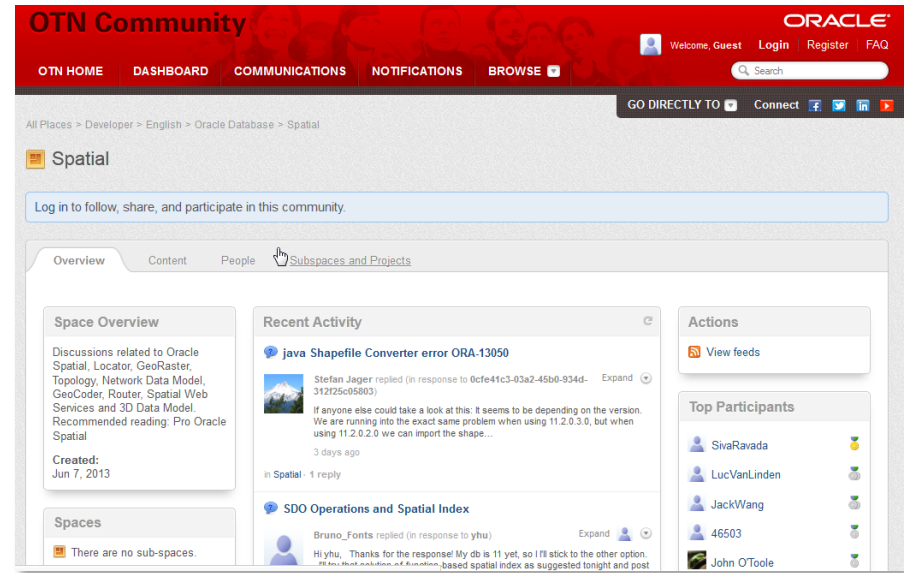
“While hardcore GIS professionals may start their work in other applications, when they want to solve spatial problems in production and with web- and IoT- scale data, Oracle gives them the platform to do so.”

Analysts: Rowan Curran with Holger Kisker, Ph.D.
and Emily Miller
September 1, 2016

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More resources

- Further information on oracle.com
 - www.oracle.com/goto/spatial
- Blogs
 - <https://blogs.oracle.com/oraclespatial>
- Developer forums on OTN
 - <https://community.oracle.com/community/database/oracle-database-options/spatial>
- Social Media
 - LinkedIn: „Oracle Spatial and Graph“ group
 - Google+: „Oracle Spatial and Graph SIG“
 - Twitter: @SpatialHannes, @agodfrin, @Jeanlhm



Q&A

Integrated Cloud

Applications & Platform Services

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