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SPATIAL

May 2012
Oracle Spatial User Conference
May 23, 2012
Oracle Spatial User Conference
Ronald Reagan Building and International Trade Center
Washington, DC USA
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How Nokia Uses Oracle Spatial to Create the NAVTEQ Map
Program Agenda

• About Nokia Location & Commerce
• The NAVTEQ Map
• Map Specifications
• Oracle Spatial
Nokia Location & Commerce

Created to deliver differentiated location experiences

Enabling a new range of opportunities to create products across multiple screens
Largest Commercial Map Provider
High quality is our hallmark

Continued Investment in the Map

Resource
Investing over €250M/year

People
+7000 employees globally

Coverage
Global with > 38 million KM roadway
Nokia Location & Commerce

- 196 Countries with maps
- 91 Countries with NAVTEQ maps
- 26 Cities with Natural Guidance
- 1.8K destination maps
- 2.4M map changes/day
- 12K 3D landmarks
- 75M Places
- 120M point addresses
- 500+ Public transport cities
- 38M kilometers of roadway
- 28 countries with Traffic
- 26 countries with Traffic
- 120M map tiles served daily
- 11B probe points processed monthly
- +1B search queries annually
- +19M geocoder requests daily
- 55M positioning requests daily
- >100M uses of the NAVTEQ Map every day
- 45 NAVTEQ True cars deployed
- 24M route requests per month
Nokia L&C and Oracle

Nokia and Oracle have been collaborating since 2001
  • NAVTEQ map shipping in Oracle format for over a decade

Nokia is the only turnkey provider of production global content for mapping, geocoding, and routing services for the Oracle stack
  • With unique add-ons such as point addressing, truck specific attributes for truck routing, and much more

Nokia is not only the foremost provider of content for the Oracle platform…
  …we are Oracle Spatial users too!
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The NAVTEQ Map

- 22 million miles of roads in 91 countries
- 44 million points of interest
- 80,000 data sources
- Used in 85% + of all in-vehicle navigation systems
- Portable Navigation Systems
- Web based applications including Yahoo maps, Bing maps and Mapquest
- Smartphones
  - Lumia apps: Nokia Maps, Nokia Drive, Nokia transport
The NAVTEQ Map

1750+ analysts making 2.4 million changes daily.

Collecting up to 260 attributes of the real world around us.

Road Network Attributes:
- Street names
- Speed limits
- Number of lanes
- Functional class (5 Levels)
- Paved roads
- Access and exit roads
- Roundabouts
- Road sign text
- Intersection coding

Postal Data:
- Postal codes
- House number ranges

Administrative Data:
- Country
- State
- County
- City

Restricted Driving Maneuvers:
- Access characteristics: autos, buses, taxis, emergency vehicles, deliveries, residents, pedestrians, car pools
- One ways
- No left/right turns
- Legal and physical dividers
- Gates
- Toll booths
The NAVTEQ Map

44 million points of interest

50+ categories:

Hotel chains
Gas stations
Restaurants
Cuisine
Banks
Airports
Tourist attractions
Cemeteries

Shopping Centers
Auto Repair Shops
Bus Stations
Golf Courses
Hospitals
Universities
Parks
Woodlands
The NAVTEQ Map

Applications:

Telematics
Location-Based Services
Geomarketing
Geographic Information
Systems (GIS)
Field Force Optimization
Call Center
Resource Scheduling and Optimization
Business Intelligence

Industries:

Automotive
Utilities
Telecommunications
Insurance
Transport and Logistics
Retail and Banking
Emergency Services
Map Delivery Formats

- SIF+ (ASCII)
- GDF 3.0 (ASCII)
- RDF (Relational)
- NAVTEQ-ODF (Oracle Delivery Format)
- NAVSTREETs (GIS systems)
  a) ESRI shapefile format
  b) MapInfo table format
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Map Specifications

• Single worldwide specification with cartographic continuity across borders.

• Permanent and unique identifiers for map objects.

• WGS84

• Quarterly updates soon to be monthly.
Map Geometry

Linear Vector Model

Links

Nodes

Shape points

Polygons

Cartographic Objects

Administrative Boundaries
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Business Problem

Early 2000s recognized that existing map build technology was not scaling

- Major database expansion plans
- Lack of scalable solution impact business operations
- Evaluated existing technologies
  - GIS
  - DBMS
Business Problem

Early 2000s recognized that existing map build technology was not scaling

- Evaluation showed us:
  - Best of breed solution uses a mixture of technologies
  - Oracle Spatial provides the best, most scalable solution for storage and integration of NAVTEQ map content
  - Lots of GIS technology use too
Countries Added

• Mexico
• Martinique
• Guadeloupe
• Colombia
• Brazil
• Argentina
• Chile
• Venezuela
• Peru

• Taiwan
• Bulgaria
• Jordan
• La Reunion
• New Zealand
• Mozambique
• Egypt
• India
• Indonesia
• Malaysia

• Iceland
• Lebanon
• Taiwan
• Ukraine
• Philippines
• Malta
• Kenya
• Nigeria
• Croatia
• Tanzania
Map Implementation

- Stored in Oracle Database Server
- Hundreds of tables to hold Map Objects, Attributes and Geometry
- Hundreds of millions of rows
- Oracle Spatial allows us store geometry together with other attributes and exploit advantages of an RDBMS.
- Oracle Spatial provides spatial indexing and efficient operators to work with millions of rows
Oracle Spatial

- All geometries in SDO_GEOMETRY
- Spatial R-tree indexes allows very fast queries and enables efficient search
- Data can be quickly inserted or updated in bulk (allows us to bring new countries online in a very short period of time)
- Allows for efficient data validations
Development Goals

Build a set of Processes and Tools used to migrate new and updated data elements into the NAVTEQ Core Asset (Database)

- Data Sources (80,000!) can be:
  - GIS Based (Layered)
  - Tabular Based
- Use of Spatial ETL technology to map sources to NAVTEQ Standards
- Use of Commercially off the shelf Databases like
  - Oracle Spatial
  - ESRI Personal/File Geodatabase
- Capitalize on the database rules NAVTEQ has established

Create a Worldwide Database at a consistent NAVTEQ standard
Tool Design principles

• Use whatever language/platform is faster

• A tool must leave the schema in same state as when it started
  – All constraints/indexes enabled and validated
  – All tables and indexes are analyzed

• Keep the code close to the database

• Organize implementation in two parts
  – Detect change
  – Apply change

• Parallel paradigms
  – Oracle parallel DML
  – PL/SQL pipelined functions
  – Java multiprocessing
    • Ant <parallel> tag
  – Java multithreading
    • Producer/Consumer
Operations involving Spatial

- External Data
  - Source validation
  - Coordinate system conversion
  - Geometry alignment and repair
  - Attribute derivation
  - Integration of existing extraction components

- Coverage expansion in existing or new countries
  - Layer replacement and augmentation
  - Map cut, import, and stitch
Operations involving Spatial

- Administrative/zone hierarchy replacement
  - Remove nodes on old boundaries
  - Align geometry to new boundaries
  - Split links on new boundaries
  - Assign new admin/zone coding

- Map Matching
  - Identify new geometry
  - Derive new road names, address ranges for matching geometry
Q&A