Improving Emergency Services Planning for Bavaria with an Oracle Spatial and Graph Routing

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THE INSTITUTE FOR EMERGENCY MEDICINE AND MANAGEMENT IN MEDICINE

- founded 2002
- first emergency medicine institute at a german-speaking university
- currently 37 people
MISSION: OPTIMIZING DELIVERY OF EMERGENCY CARE BY

- Research and expert reports
- Training & teaching
- Quality and risk management
ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE

- Geo information system
  - ESRI ArcGIS Desktop
  - Network Analyst

- Routing analyses and spatial calculations
  - Routing between defined points (fastest, shortest)
  - distance matrices
  - coverage areas
  - alarm priority lists
  - accessibility

- street maps
  - Digital Data Streets, Route (based on NavTeq)
  - ESRI Shape-Format
ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE

Possible questions

- Where should ambulance bases be located?
- Which area is reached in the shortest time from which point?
- Are there areas that can not be reached in a predefined interval?
- Are there areas that can be reached from multiple ambulance bases in a predefined interval?
- What are the service areas of hospitals?
- ...

ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE
ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE
"The old way"

- **ESRI ArcGIS**
  - ambulance stations: ca. 500
  - communal subdivisions: ca. 42,000
- **Network Analyst**
  - 15,000 locations
- **distance matrix**
  - 7,500,000 rows
- **Oracle-DB**
  - DM-table
  - other data
  - stored procedures
  - service areas priority lists
- **SQL-Loader**
  - txt-file
  - x GB
INM ROUTING-MODUL – WHAT WE NEEDED

- Web-application with a service interface, using:
  - Java runtime container like Oracle WLS 10.3.6, WLS 12c or a simple tomcat with Oracle JDK
  - Oracle Routing Library
- Shell / Batch – Standalone application – can be called from browser, mapviewer, APEX, PL/SQL, Shell
- Oracle Spatial and Graph Java API
- Analyses taking into account
  - turn restrictions (starting with 12.1.0.2)
  - own speed profiles based on street categories
  - shortest or fastest route
  - service areas – statical and dynamical calculation
  - distance matrix (75.000 communal subdivision)
ROUTING AND GEOGRAPHICAL CALCULATIONS – THE NEW WAY

- **WebLogic-Server**
  - INM Routing-Module
  - Oracle MapViewer
    - shortest Route
    - fastest Route
    - service areas (startpoint/endpoint)
    - distance matrix

- **Oracle-DB Spatial**
  - Geo-Data
    - communal struct, hospitals, ambulance stations
  - PL/SQL
  - HERE-street data
    - turn restrictions
    - speed profiles

- **webbrowser**
  - HTML page
  - APEX
  - MapViewer

- **APEX**

- **MapViewer**
  - shortest Route
  - fastest Route
  - service areas (startpoint/endpoint)
  - distance matrix
SPPED PROFILES

- Integration of own speed profiles
  - Table SPEEDPROFILE
    - SPEEDPROFILE_ID NUMBER
    - RTW_KMH NUMBER
    - KTW_KMH NUMBER
    - NEF_KMH NUMBER
  - 24 street categories
    e.g. Highway (fast, average, slow)
    Speedway (fast, average, slow)
    Motorway (fast, average, slow)
    ...
  - Definition according to street category name (using Stored Procedure)
  - SPEEDPROFIL_ID <--> FUNC_CLASS in EDGE
SPPED PROFILES

- Integration of own speed profiles
  - Table EDGE
    - EDGE_ID
    - START_NODE_ID
    - END_NODE_ID
    - PARTITION_ID
    - FUNC_CLASS
    ...
  - Table PARTITION
    - PARTITION_ID
    - NUM_NODES
    - SUBNETWORK
    ...
  - FUNC_CLASS-Infos are being written to the compiled BLOB’s -> not necessary to update routing network on change
SPPED PROFILES

- Correction of own speed profiles
  - Comparison of routing results (500,000 requests) with real travel times from stored mission data -> correction of calculated times by usage of a regression analysis
  - Pilot project to collect real GPS data
PRACTICAL EXAMPLE – POINT TO POINT ROUTING

- Request -> Routing from NODE 59518892 to NODE 674419175
  OUTPUT=SQL
  OUTPUT_SQL=default
  NETWORK=NET_INM
  START_NODE=59518892
  START_LABEL=starting point
  END_NODE=674419175
  END_LABEL=endpoint
  OUTPUT_GEOM_LENGTH=true
  TXT=RoutingTest
  JOBID=1
  PRJ=100
  SPEED=rtw
PRACTICAL EXAMPLE – POINT TO POINT ROUTING
**PRACTICAL EXAMPLE – POINT TO POINT ROUTING, RESULTS**

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PRACTICAL EXAMPLE – SERVICE AREAS

- Request -> Service-Area from Node 877666372, travel time 5 minutes
  
  NETWORK=NET_INM
  SPEED=rtw
  START_NODE=877666372
  LIMIT=5
  OUTPUT=SQL
  OUTPUT_SQL=default
  JOBID=2
PRACTICAL EXAMPLE – SERVICE AREAS

[Map showing service areas with blue routes]
ROUTING MODULE – PARAMETERS AND OPTIONS

- Node definitions (start / end)
- Speed (RTW, HTW and NEF) or no speed profile
- Label, text and project name
- LIMIT in minutes for WithIn / WithOut

- Results saved into DB
- Encoding for HTML – e.g. preparing UTF-8 character set
- XML- or JSON-output
  - geometry as GML, GML3_2_1, GML3_1_1, TEXT (MDSYS.GEOMETRY), JSON
TURN RESTRICTIONS - BUG

- U-Turns on certain street types
ROUTING MODULE - PERFORMANCE

- JDBC Pool
- Deployment of the webservice in WebLogic-Server 12.1
  - Cluster with several Managed Servers
- Java-Heap-Size
  - 2-4 GB for -Xmx
  - 256 MB for -XX:MaxPermSize (up until Java 8)
- no problem with many parallel requests – round robin cluster
- Optimising caching policy in the LOD definition
  - Level 1 Node – number is dynamically calculated
  - Level 2 Node – number is limited to Integer.MAX_VALUE (2147483647)
- achieved aims
  - less reads from the DB, less network traffic
  - Wiederverwendung von bereits geladenen Routing - Daten
APEX APPLICATION - ADVANTAGES

- Possibility to work outside GIS – not only for specialists
- Preparing projects for customers
- Export to ESRI Shape-Format, further calculations in GIS if necessary
SPECIAL THANKS TO:

Mathias Weber (GIS, Oracle Spatial, APEX)
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Markus Geis (Oracle administration)
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Carsten Czarski (Oracle Germany)
Karin Patenge (Oracle Germany)
Hans Viehmann (Oracle Germany)
Erik Jost (grit GmbH)
THANK YOU!

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