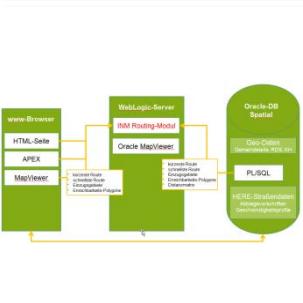
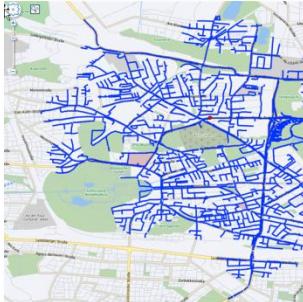




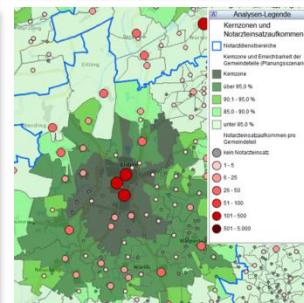
Improving Emergency Services Planning for Bavaria with an Oracle Spatial and Graph Routing Solution

Marc Lazarovici

INM, Munich



IN|M



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

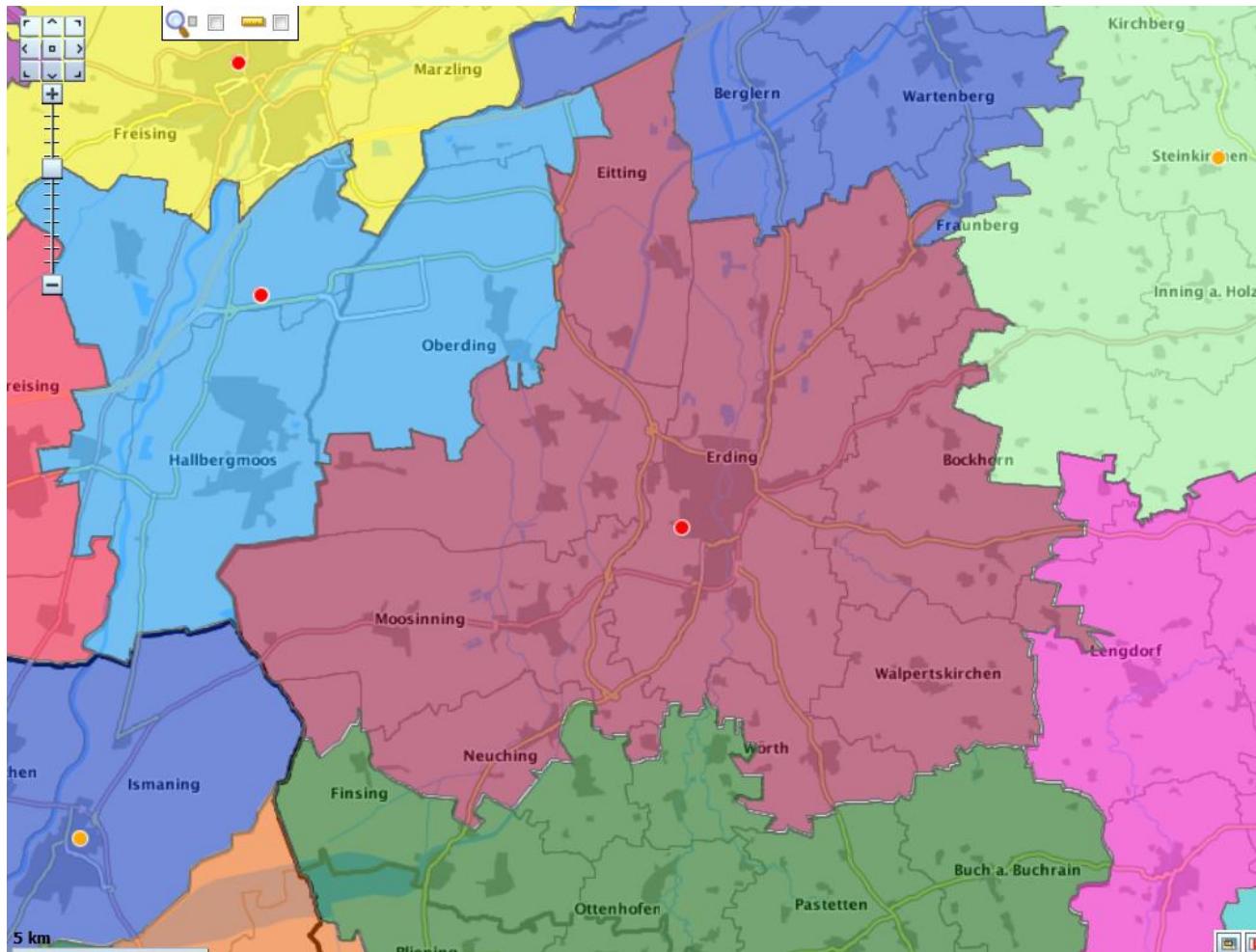
- Geo information system
 - ESRI ArcGIS Desktop
 - Network Analyst
- Routing analyses and spatial calculations
 - Routing between defined points (fastest, shortest)
 - distance matrices
 - coverage areas
 - alarm priority lists
 - accessibility
- street maps
 - Digital Data Streets, Route (based on HERE-Navteq)
 - ESRI Shape-Format

ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE

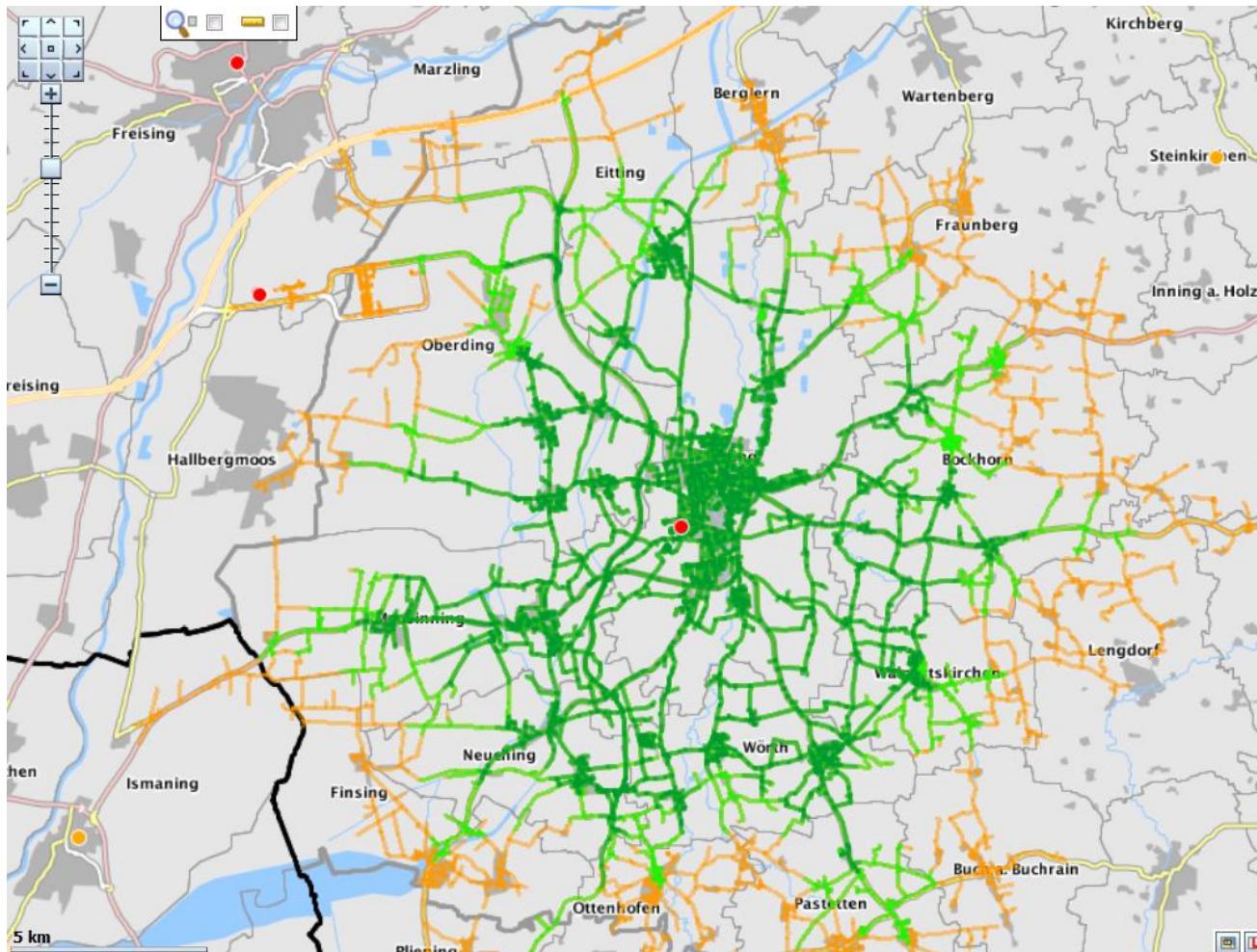
■ Possible questions

- 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?
- ...

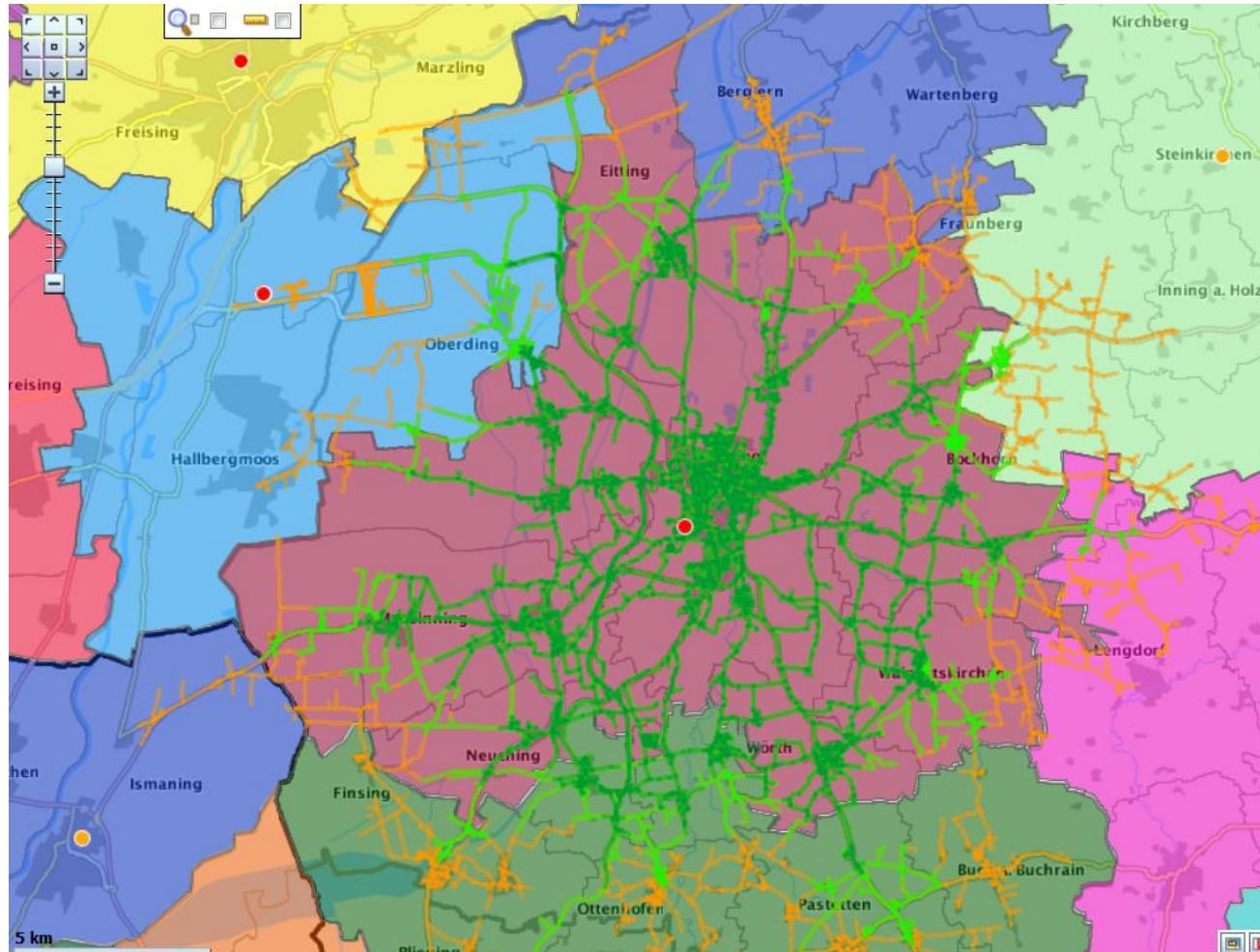
ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE



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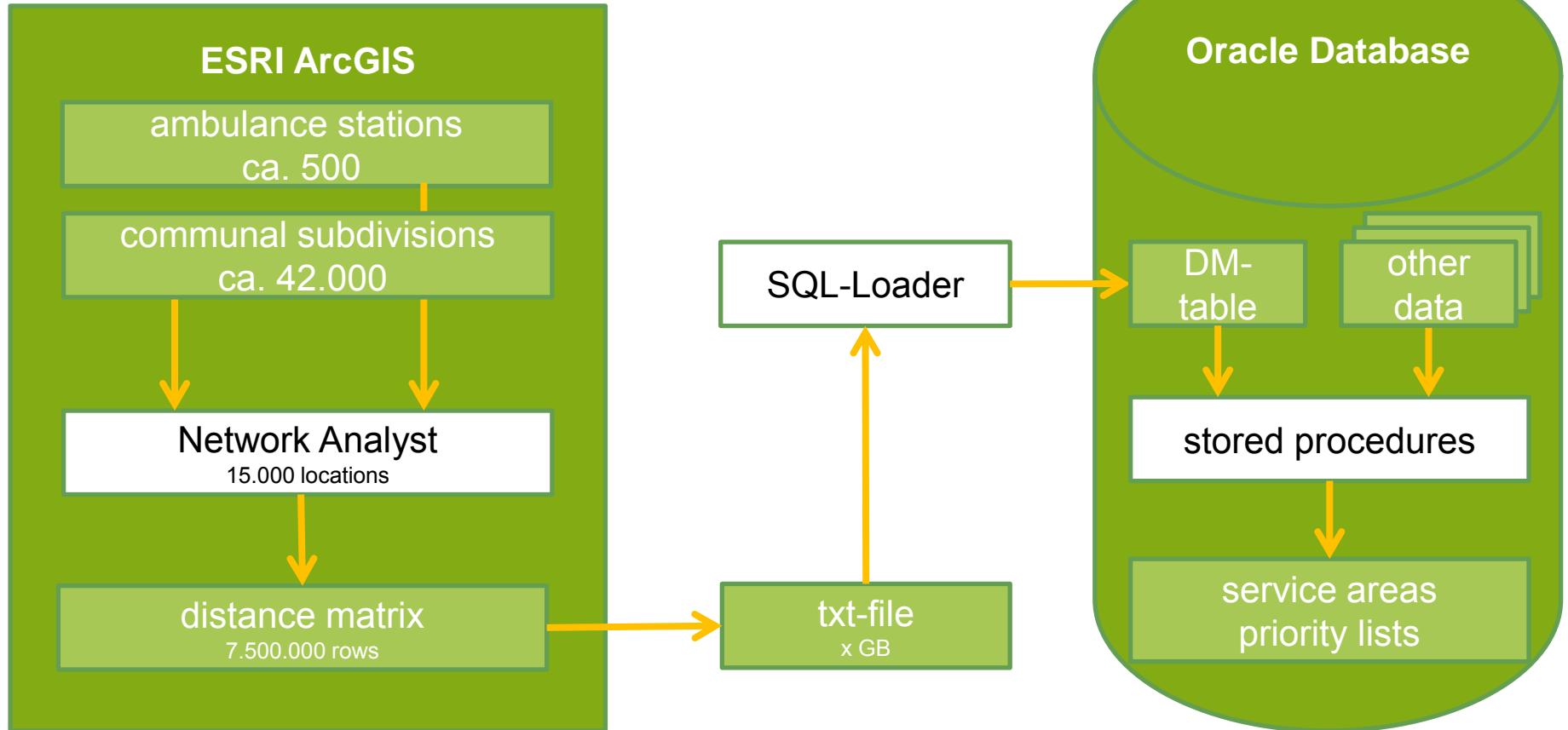


ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE



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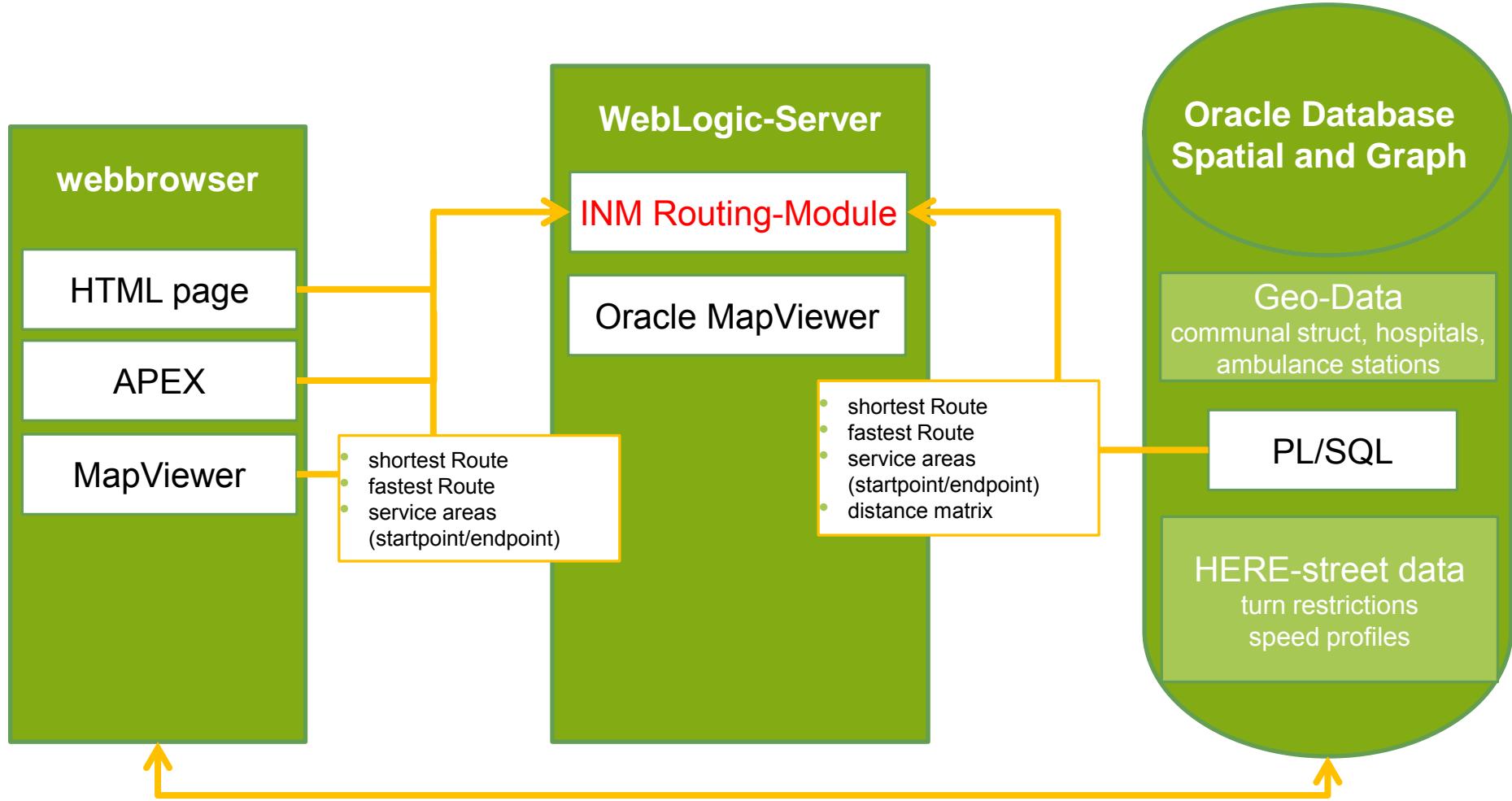
„The old way“



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)
- data basis: HERE ODF Release 3.2014 – 03.2016

ROUTING AND GEOGRAPHICAL CALCULATIONS – THE NEW WAY



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 | NUMBER |
| START_NODE_ID | NUMBER |
| END_NODE_ID | NUMBER |
| PARTITION_ID | NUMBER |
| FUNC_CLASS | NUMBER |

...

- Table PARTITION

| | |
|--------------|--------|
| PARTITION_ID | NUMBER |
| NUM_NODES | NUMBER |
| SUBNETWORK | BLOB |

...

- 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

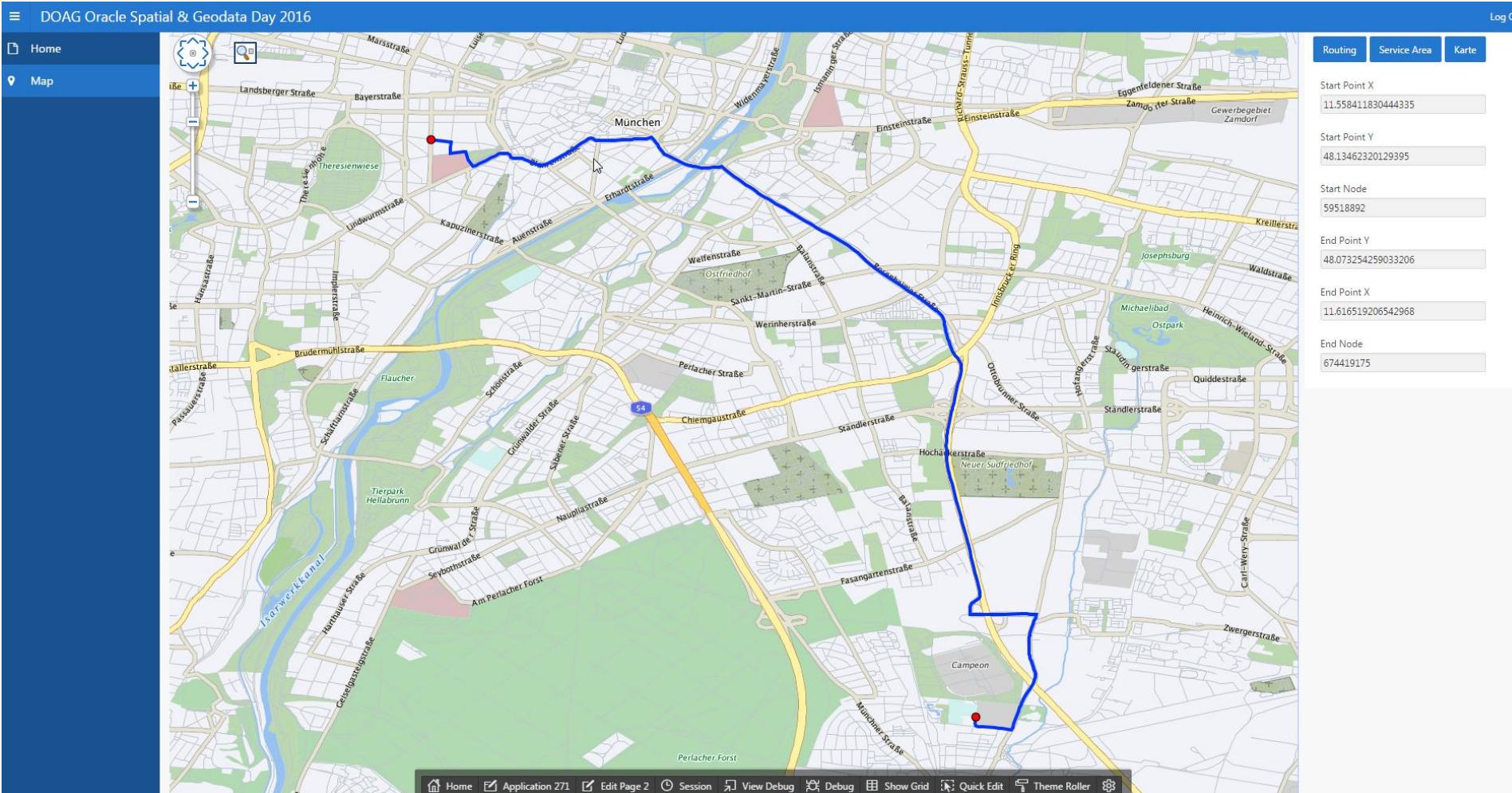
TXT=RoutingTest

JOBID=1

PRJ=100

SPEED=rtw

PRACTICAL EXAMPLE – POINT TO POINT ROUTING



PRACTICAL EXAMPLE – POINT TO POINT ROUTING, RESULTS

| JOB_ID | ROUTE_IDX | ROUTE_CNT | SUBROUTE_IDX | SUBROUTE_CNT | NODEID_START | NODEID_END | LINK_CNT | COSTS | GEOM | LENGTH | NODENAME_START | NODENAME_END | DETAILS | DATE_CREATE |
|--------|-----------|-----------|--------------|--------------|--------------|------------|----------|----------|--------------|---------------|----------------|--------------|---------|---------------------|
| 1 | 1 | 1 | 1 | 1 | 59518892 | 674419175 | 157 | 12,07... | MDSYS.SDO... | 11396,2711... | Startpunkt | Endpunkt | 100 | 09/05/2016 11:56:33 |

| JOB_ID | ROUTE_IDX | SUBROUTE_IDX | LINK_IDX | LINK_ID |
|--------|-----------|--------------|----------|------------|
| 1 | 1 | 1 | 1 | -52820763 |
| 1 | 1 | 2 | 1 | -733073539 |
| 1 | 1 | 3 | 1 | -733073538 |
| 1 | 1 | 4 | 1 | -586896330 |
| 1 | 1 | 5 | 1 | 733149107 |
| 1 | 1 | 6 | 1 | 733149108 |
| 1 | 1 | 7 | 1 | -733154907 |
| 1 | 1 | 8 | 1 | -733154906 |
| 1 | 1 | 9 | 1 | -52822367 |
| 1 | 1 | 10 | 1 | 52823324 |
| 1 | 1 | 11 | 1 | 52823323 |
| 1 | 1 | 12 | 1 | 754719623 |
| 1 | 1 | 13 | 1 | 845972373 |
| 1 | 1 | 14 | 1 | 845972374 |
| 1 | 1 | 15 | 1 | -576276883 |
| 1 | 1 | 16 | 1 | -801200997 |
| 1 | 1 | 17 | 1 | -801200996 |
| 1 | 1 | 18 | 1 | -52821225 |
| 1 | 1 | 19 | 1 | -67627644 |
| 1 | 1 | 20 | 1 | 67627643 |
| 1 | 1 | 21 | 1 | -924065785 |
| 1 | 1 | 22 | 1 | -924065784 |
| 1 | 1 | 23 | 1 | -932312133 |
| 1 | 1 | 24 | 1 | -932312132 |
| 1 | 1 | 25 | 1 | -932312131 |

PRACTICAL EXAMPLE – SERVICE AREAS

- Request -> Service-Area from Node 877666372, travel time 5 minutes

NETWORK=NET_INM

SPEED=rtw

START_NODE=877666372

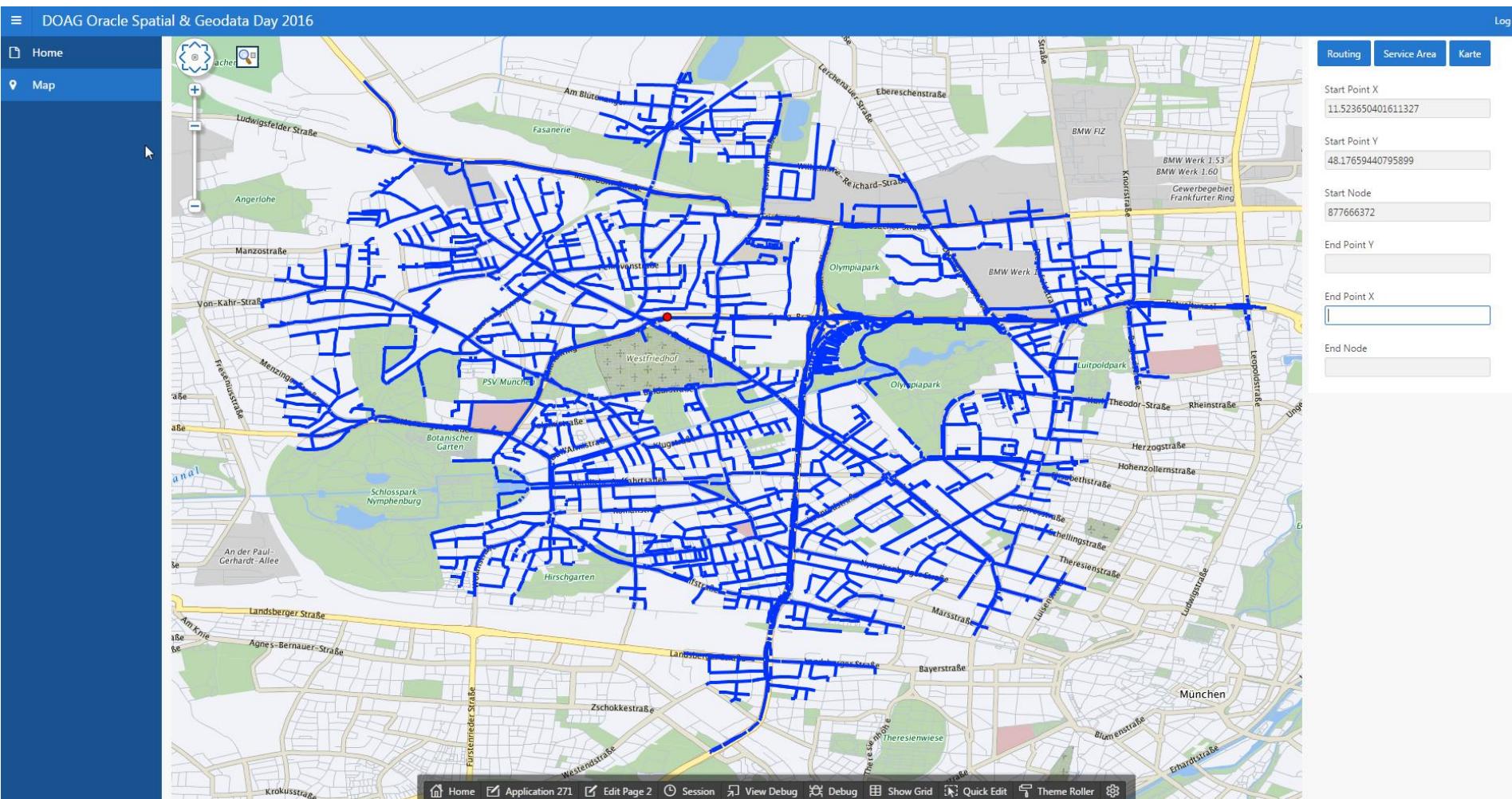
LIMIT=5

OUTPUT=SQL

OUTPUT_SQL=default

JOBID=2

PRACTICAL EXAMPLE – SERVICE AREAS



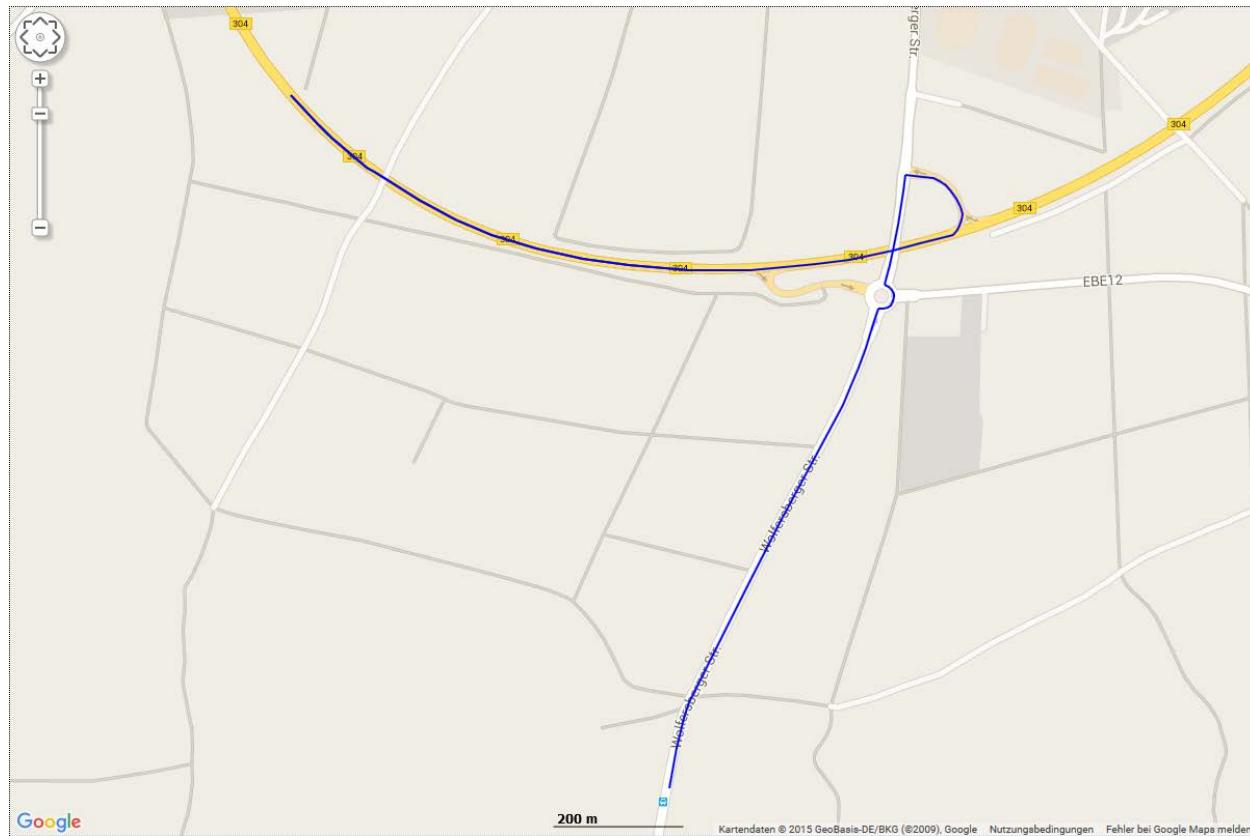
ROUTING MODULE – PARAMETERS AND OPTIONS

- 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

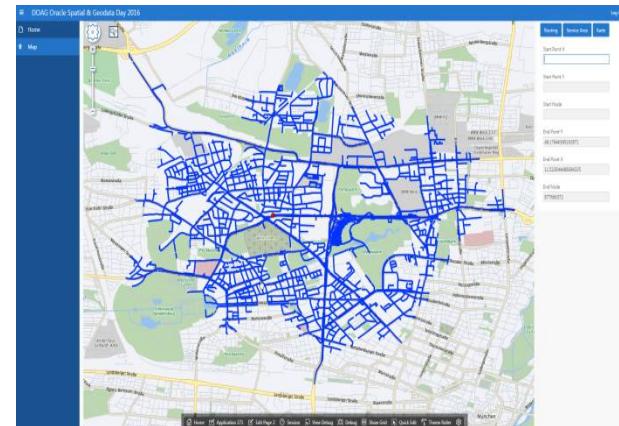
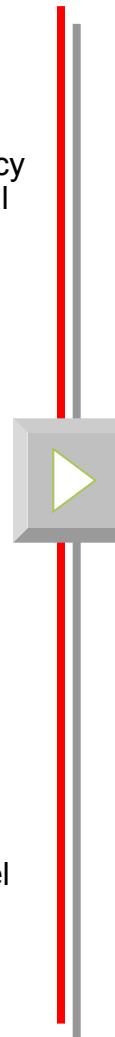
- Possibility to work outside GIS – not only for specialists
- Preparing projects for customers
- Export to ESRI Shape-Format, further calculations in GIS if necessary

INSTITUTE FOR EMERGENCY MEDICINE - INM DATENDIENSTE III



OVERVIEW

- First university institute in Germany with a focus on emergency medicine and management in medicine
- Offering consulting and analysis services for emergency medical services and emergency departments , as well as recommendations for preclinical and clinical emergency infrastructure



CHALLENGES / OPPORTUNITIES



- Need for optimization of routing for emergency rescue systems in Bavaria
- Need to move away from precalculated data sets
- High precision and complexity of routing (turning restrictions, speed profiles)

SOLUTIONS

Oracle Database 12c Enterprise Edition

- Spatial Option with GeoRaster, Network Data Model
- Partitioning
- MapViewer
- Java module
- APEX

RESULTS

- Appr. 1000 users via internet
- Central database including 900GB HERE ODF Release 3.2014 vector spatial data, structural and mission data, overall size appr. 2TB
- System is being used statewide to plan and adjust medical emergency services

SPECIAL THANKS TO:

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THANK YOU!



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