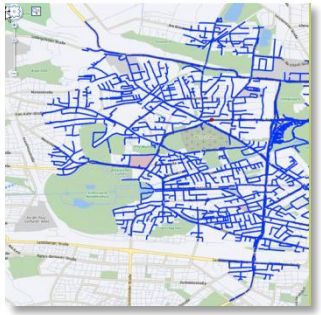
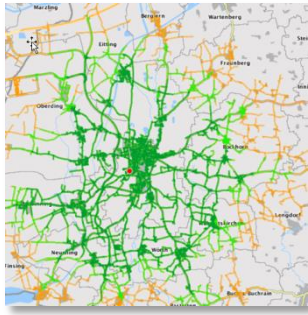
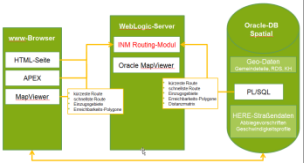
LMU
KLINIKUM
DER UNIVERSITÄT MÜNCHEN
CAMPUS INNENSTADT
INSTITUT FÜR NOTFALLMEDIZIN UND MEDIZINMANAGEMENT

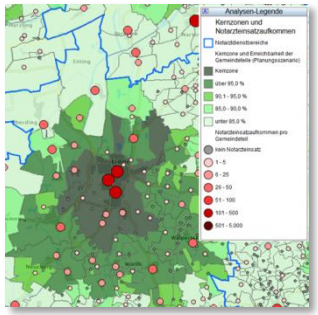
Improving Emergency Services Planning for Bavaria with an Oracle Spatial and Graph Routing

Marc Lazarovici INM, Munich









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

INM

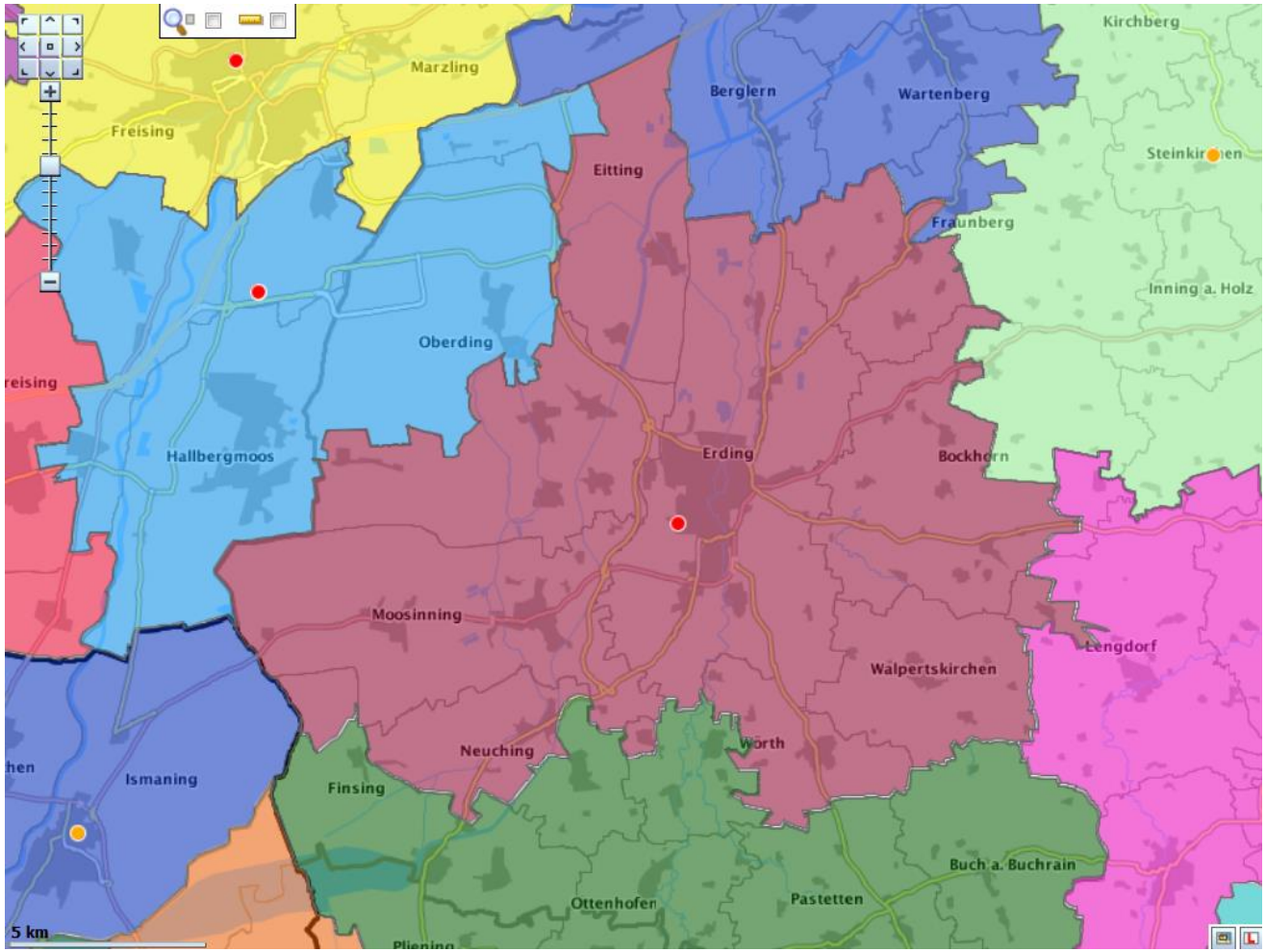
ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE

- 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
  - accesibility
- 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



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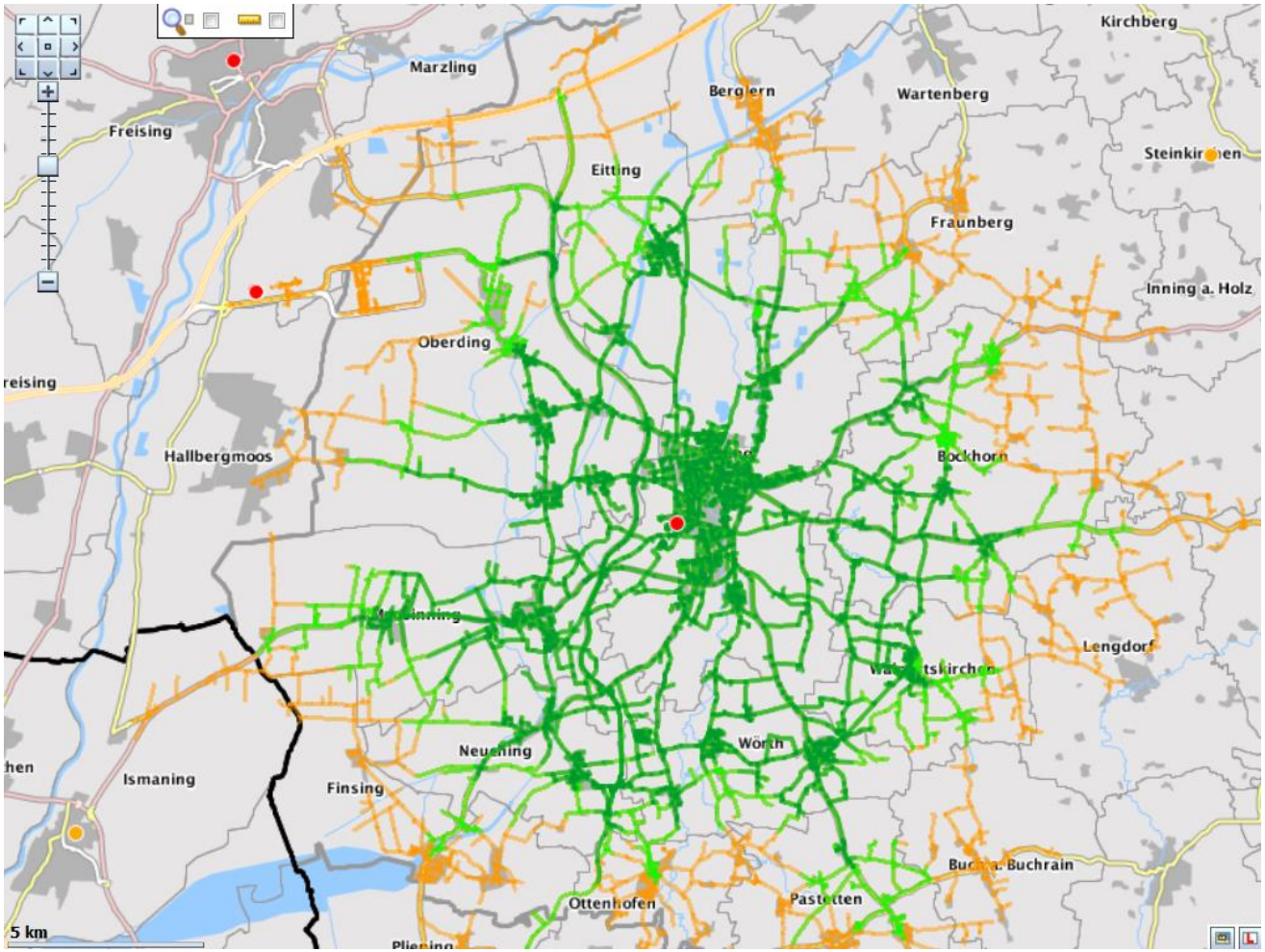

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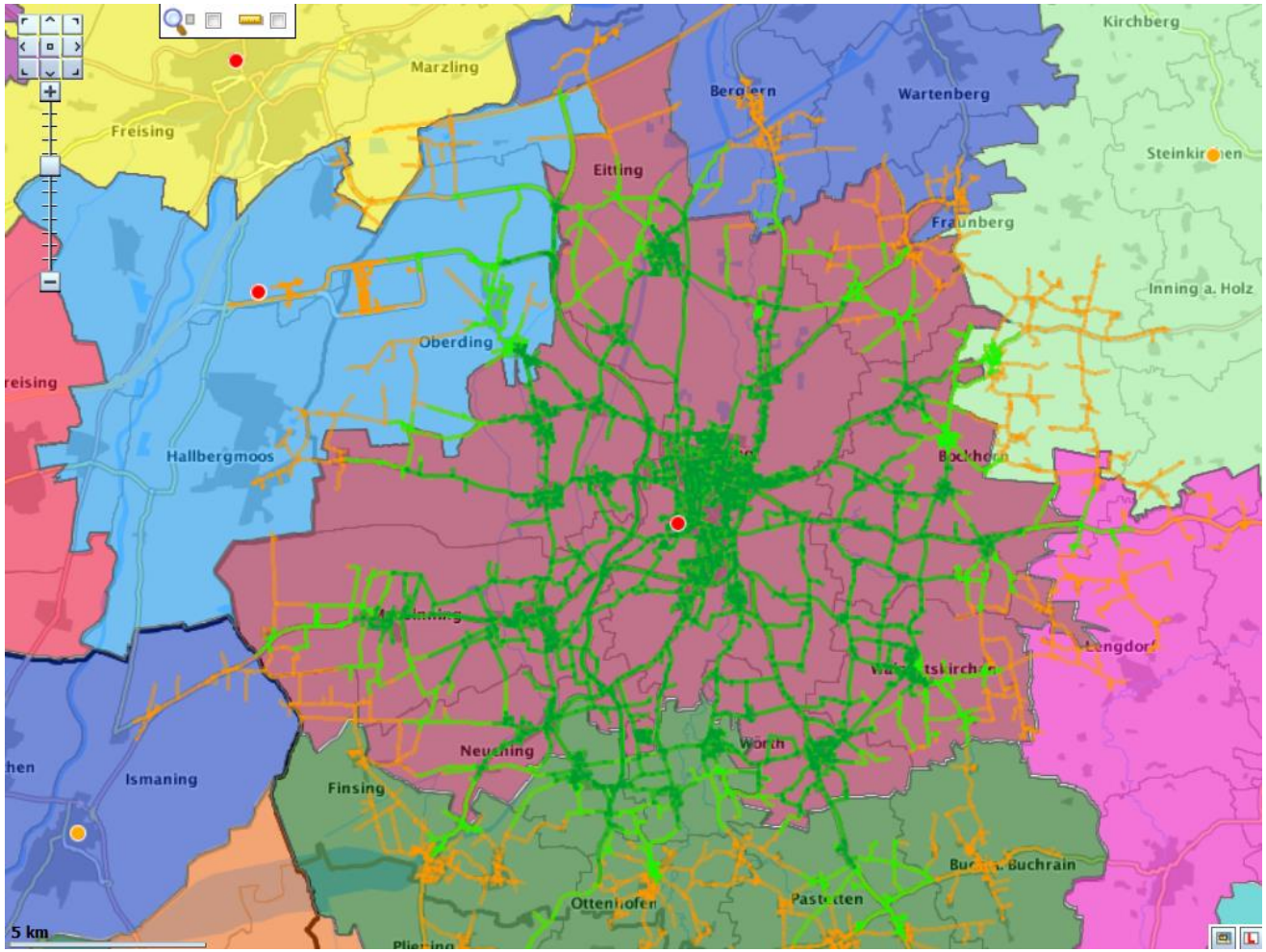
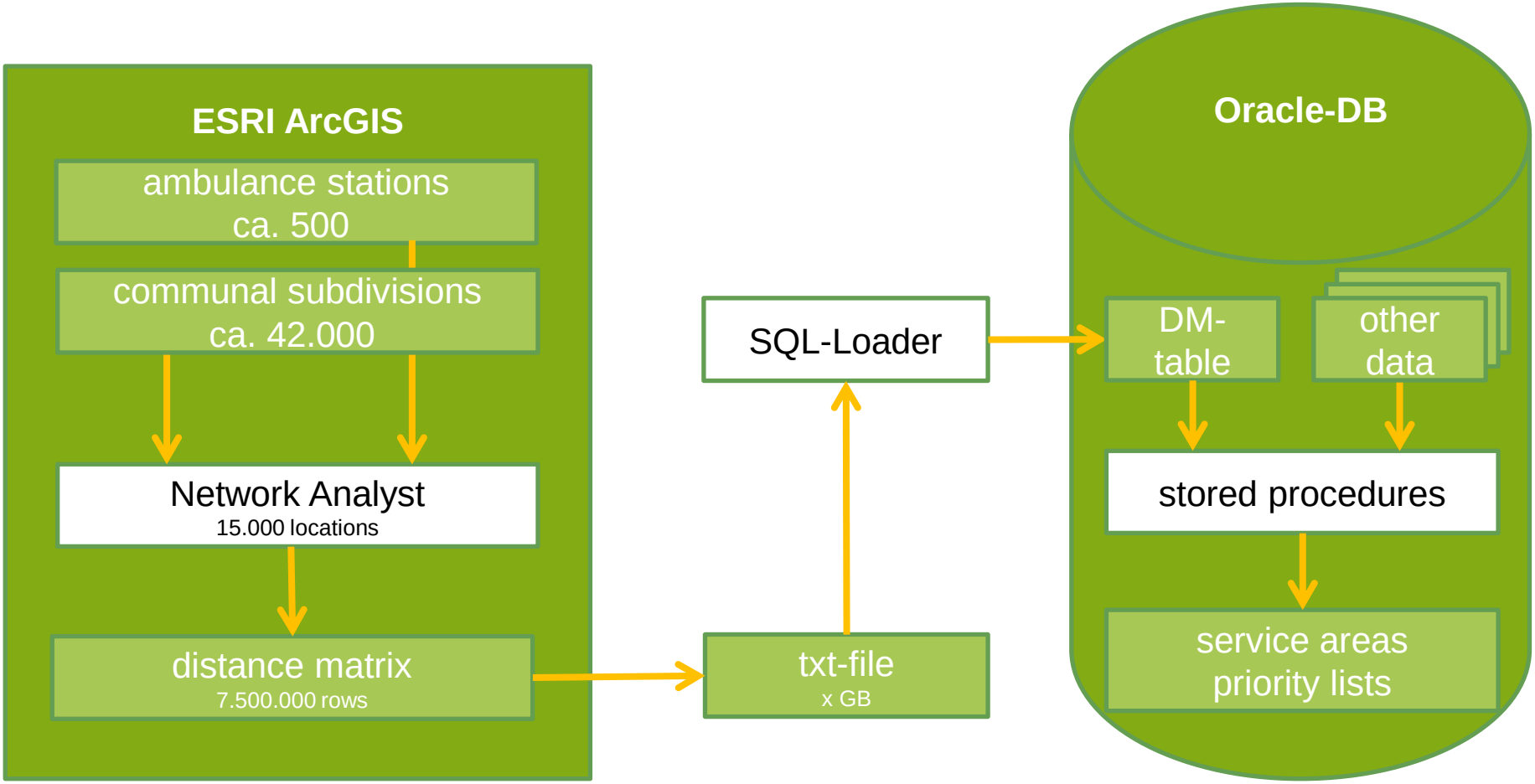


ROUTING AND GEOGRAPHICAL CALCULATIONS – STATUS QUO ANTE

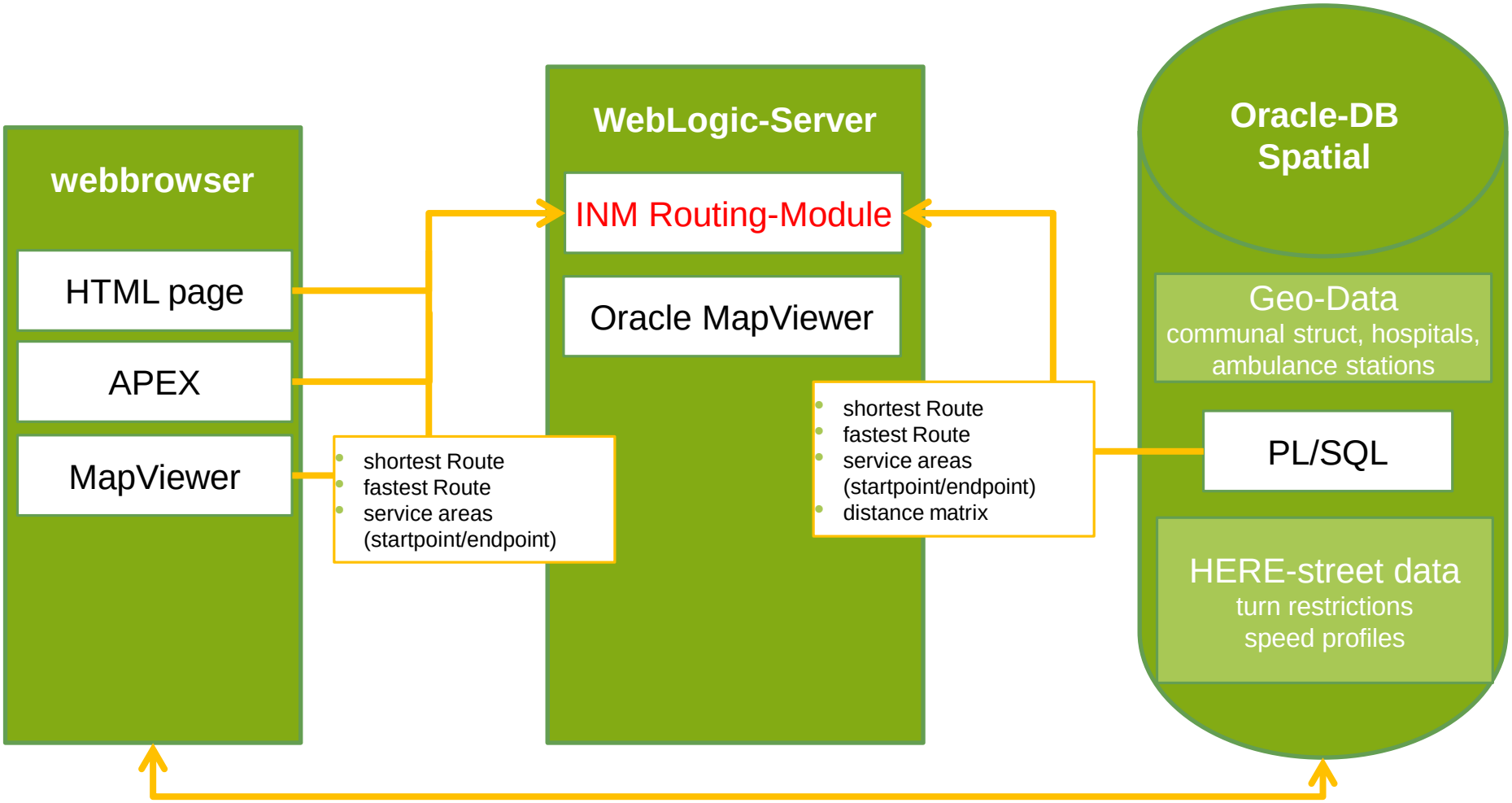
„The old way"



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

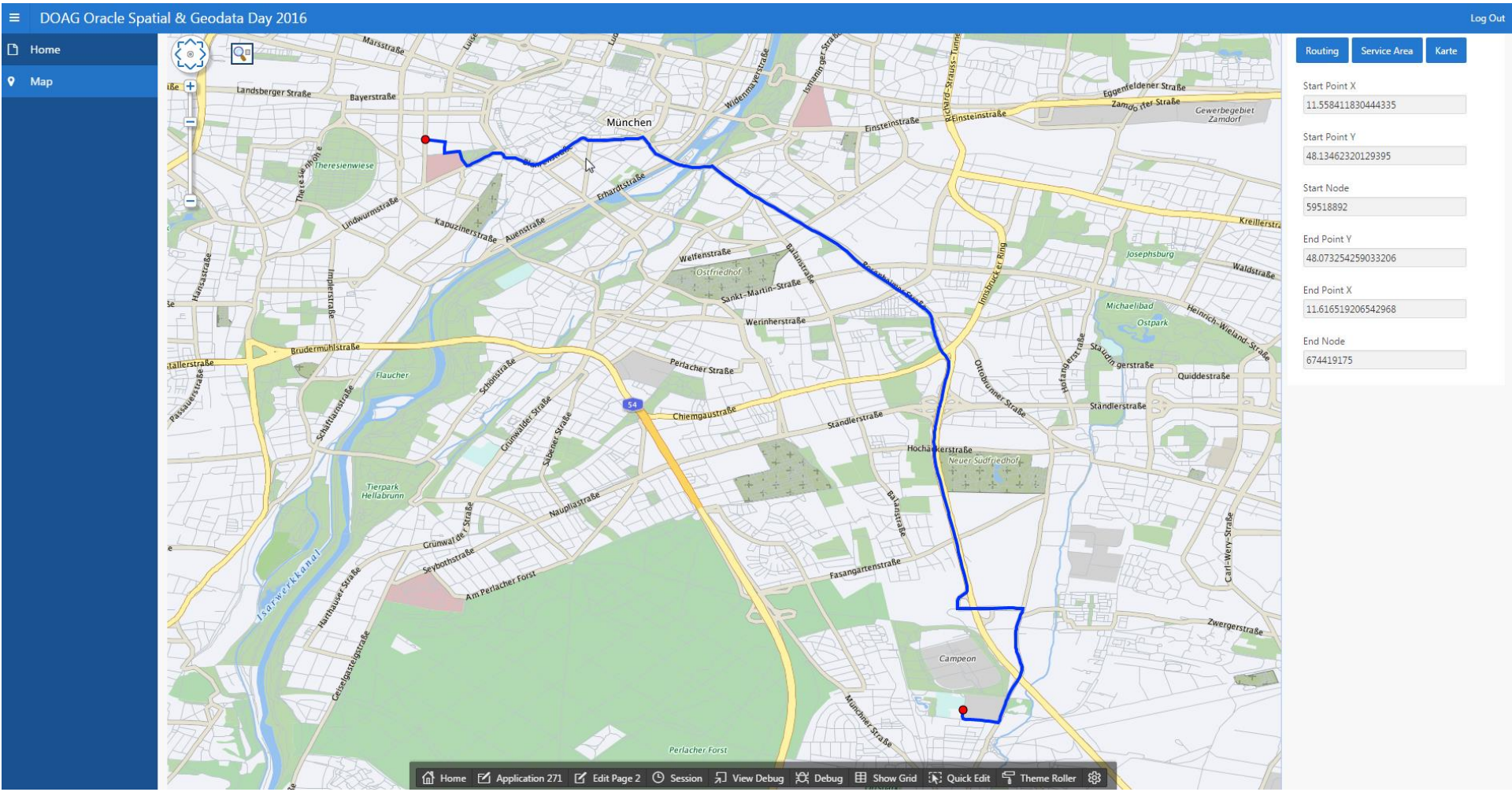
  TXT=RoutingTest

  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	-792893803

PRACTICAL EXAMPLE – SERVICE AREAS

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

  NETWORK=NET_INM

  SPEED=rtw

  START_NODE=877666372

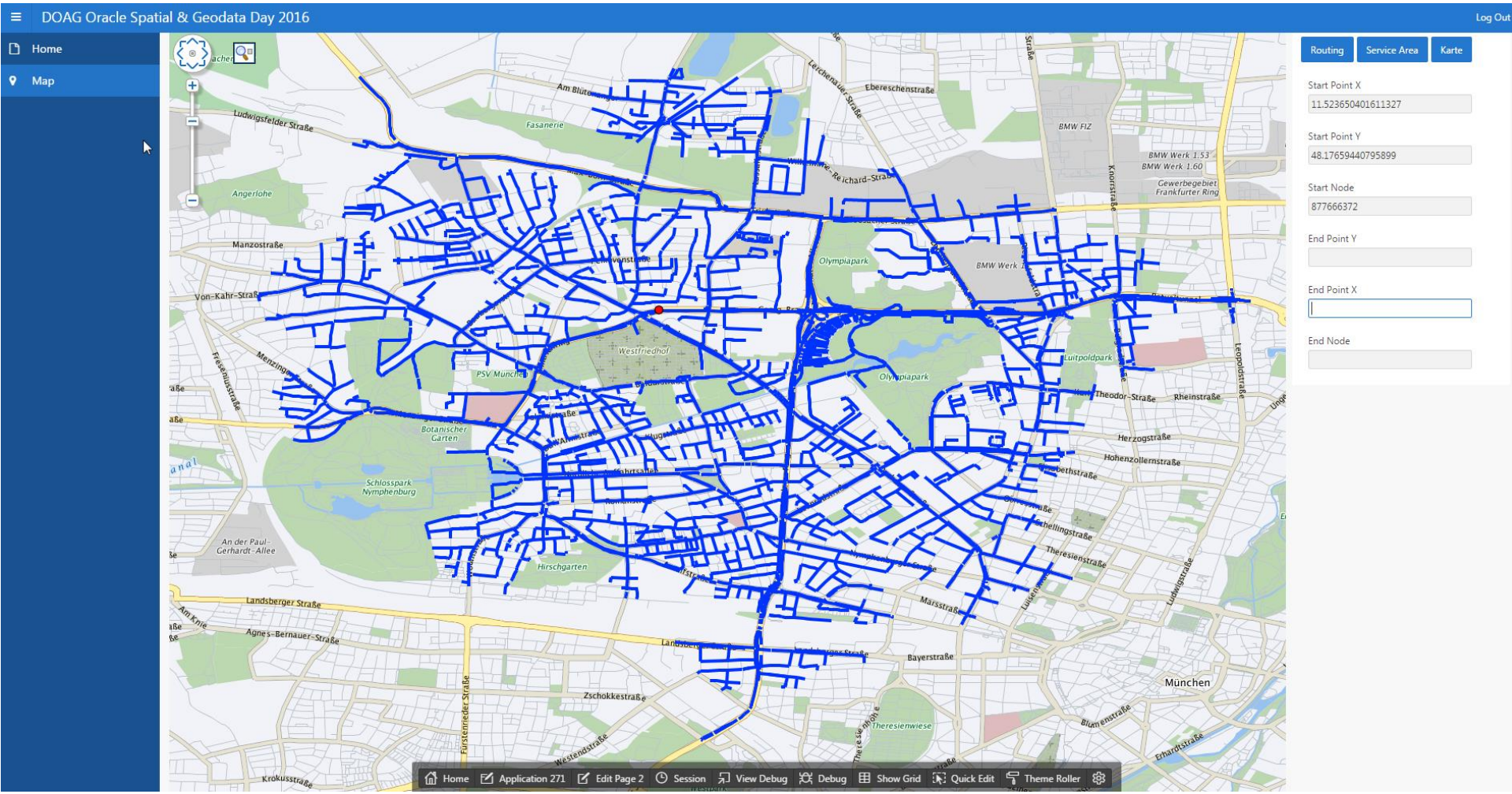
  LIMIT=5

  OUTPUT=SQL

  OUTPUT_SQL=default

  JOBID=2

PRACTICAL EXAMPLE – SERVICE AREAS



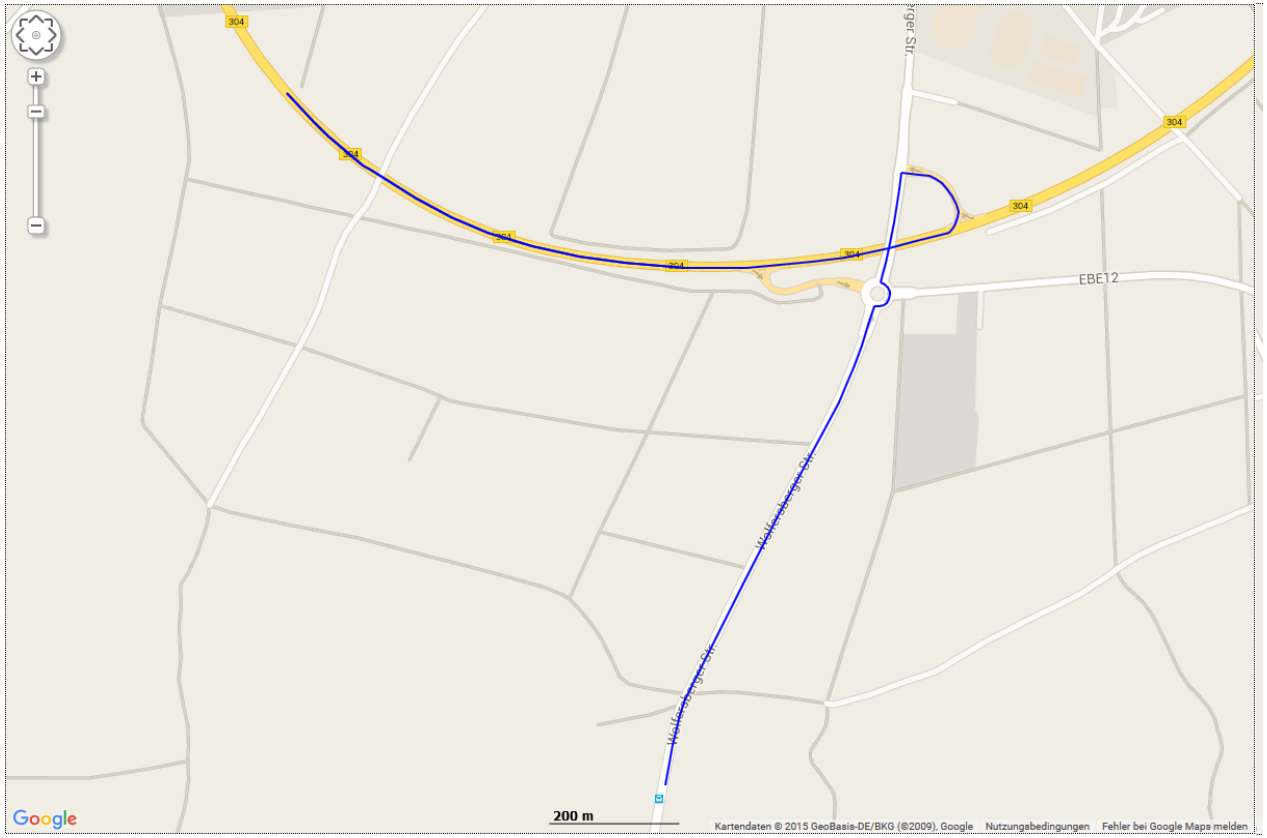
ROUTING MODULE – PARAMETERS AND OPTIONS

- 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

SPECIAL THANKS TO:

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THANK YOU!

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