REALIZING FOCUS MAPS WITH LANDMARKS USING OPENLS SERVICES

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Abstract: Landmarks and focus based maps can play a important role within routing by supporting users in route finding and navigation. This paper shows one possible solution for generating focus based maps with landmarks by only using completely OGC-conform web service and standards. The aim is to increase technical interoperability also at this levelof realizations of LBS or navigation services. The techniques for choosing specific landmarks and generating the focus maps are shortly presented and their functionality is explained. The OpenLS core services implemented by ourself and their supporting functions are illustrated. The integration of the landmarks to the route instructions of the OpneLS Route Service happens during the route calculating algorithm without adding extra attributes or new elements to the standardized service interface. The generation of the focus based maps is realzed by our first implementation of an OpenLS Presentation Service. The article ends with an outlook on ideas for future deployment and research. One of these ideas is to extend the generation of focus based 2D maps to a generation of focus based 3D scenes and to integrate the landmarks as 3D models.

Keywords: OpenLS, Focus Maps, Landmarks, OGC Web Services, Navigation, Interoperability

1. Introduction

Two important topics have been identified among others as being relevant when assisting a user of navigation system with mobile maps from a cognitive point of view:

a.) Focusing on relevant information in the area the user is currently interested in - e.g. through the concept of "Focus Maps" (Richter & Zipf 2003) and
b.) Adding Landmarks as key elements of wayfinding support (e.g. Golledge 1996).

Further aspects of presenting route instructions present e.g. Kray et al. (2003). In addition to that, it is desirable from a technical point of view, to realize such systems based on open standards (e.g. by the OGC) on top of spatial data infratructures (SDI)(Zipf 2004). This helps to increase interoperability of such systems within a heterogenous world of mobile devices and web services. In the context of mobile *Location Based Services* (LBS) the *Open Location Services* (OpenLS) initiative of the OGC is developing open specifications for standardizing these.

The concept of focus maps (Zipf & Richter 2002) shortly states that some regions on the maps are ususally of higher interest to the user and should therefore presented in a more dominant way as the reminder of the map – especially in the case of maps on mobile devices with limited displays. A range of stylistic means are available in cartography to realize that, from different degree of generalization to faded usage of colours and size of labels in different "focus regions" – e.g. buffers around the "areas of interest". E.g. Svienty & Reichenbacher (2006) extend some of these ideas and also apply these to landmarks.

Therefore the following question arises: How can we realize focus-based maps in combination with landmarks using OpenLS Services? The OpenLS Service Framework offers several core services, among them the *OpenLS Route Service* and the *OpenLS Presentation Service*. The realization should re-use existing OGC Web Services (OWS) whenever possible, in order to minimize duplication of work. So the aim is to implement a service-oriented architecture (SOA) of well-known standardized components like WMS, WFS and the suite of OpenLS Core Services such as the OpenLS Route Service, the OpenLS Presentation Service and the OpenLS Location Utility Service (Geocoder/Reverse Geocoder). These OpenLS services have been implemented within our projects (Neis 2006, Neis et al. 2007). In this paper we present an extension to our current implementations of these OpenLS services.

2. OpenLS – The OpenGIS Location Services

OpenLS is the short form for Open Location Services or OpenGIS Location Services. Since 2000 this OGC initiative has been developing implementation specifications (interfaces and protocols) for standardizing services that are relevant for Location Based services (LBS). The OpenLS service framework consists at the moment of five core services (OpenLS 2000):

- The *Directory Service* is a network-accessible service that provides access to an online directory (e.g., Yellow Pages) to find the location of a specific or nearest place, product or service.
- The *Gateway Service* is a network-accessible service that fetches the position of a known mobile terminal from the network; this interface is modelled after the Mobile Location Protocol (MLP), Standard Location Immediate Service.
- The *Location Utility Service* provides a Geocoder/Reverse Geocoder; the Geocoder transforms a description of a location, such as a place name, street address or postal code, into a normalized description of the location with a Point geometry usually placed using Cartesian coordinates, often latitude and longitude.
- The *Presentation Service* portrays a map made up of a base map derived from any geospatial data and a set of Abstract Data Types as overlays.
- The *Route Service* determines travel routes and navigation information according to diverse criteria.

Three of these five core services (Location Utility Service, Presentation Service und Route Service) have been implemented by us. Especially the Route Service is already used by some of our furhter projects.

- Open disaster management with free GIS solutions - http://www.ok-gis.de
- A Web-SDSS (Spatial Decision Support System) for automatising of multi criterial model building for user specific and regional analysis of the residential market in Rhineland-Palatinate / Germany
- Spatial Data Infrastructure for 3D spatial data (SDI 3D) - exemplified for the city of Heidelberg / Germany - http://www.heidelberg-3d.de

In addition several services have been developed as spin-offs of the OpenLS RS:

- *Emergency Route Service* (ERS) – The ERS is a special OpenLS Route Service, that considers actual avoid areas (flooded or blocked roads, landslides, poisoned areas) while calculating the requested route. But requesting a route from the ERS takes place in exactly the same way as requesting it from the OpenLS RS (Weiser et al 2006).
- *Accessibility Analysis Service* (AAS) – A service that calculates a polygon around a certain start point given as parameter (e.g.: city, point of interest, address). This polygon represents the area that contains all the points that are reachable from the startpoint within a certain time or a defined distance. The calculation is based on a street network with each street leg having several different attributes (e.g.: one-way-track or speed limit) (Neis & Zipf 2007).
- *Route Service 3D* (RS3D) – The RS3D is a cascade of the OpenLS RS. It calculates the 2D route geometry in the known way. But after that, it maps this route geometry onto a high definition Digital Elevation Model (DEM) and calculates ground heights for the

existing route points as well as new 3D-points to avoid intersections with the terrain. The response consists of all these new or altered 3D-route-points (Neis et al. 2007).

The OpenLS Directory Service will be implemented in near future. A OpenLS Gateway Service was not needed within our projects so far. Its realisation is also dependent from access to a mobile telephone location server.

3. Landmarks – geographic features

Various research, going at least back as far as 1960 (Lynch) have shown the significance of landmarks for human wayfinding. A route instruction using landmarks is rated much better by the recipient than the current standard using only distance information and road names (Lovelace, Hegarty and Montello 1999, Michon and Denis 2001).

Landmarks are generally divided into two groups regarding their visibility. Those that are visible over great distances are called „global landmarks“. Their position, seen from the user's point of view, changes only insignificantly upon minor movements what makes them suitable reference points for global orientation. On the other hand those landmarks that are only evident within close range are called „local landmarks“. They act as means for supporting navigation decisions along the route and can be incorporated into the route instructions as an affirmative as well as to make the instructions more natural sounding. In the approach specified below, we primarily use local landmarks.

When used as a decision support along the route, local landmarks can be subdivided regarding their position in relation to the route. There are „check points“, landmarks on decision points where change of direction is required, and „potential check point“ at crossroads where only a confirmation to stay the course is given (Lovelace et al 1999).

To adapt landmarks to individual situations and user requirements, metrics and evaluations are needed that rate the importance of the integrated objects. Based on the results of the analysis, important landmarks can be visualized more prominent than less relevant information. This differentiation can be apparent by generalization or different colouring of objects. Zipf (2002) emphasises the inclusion of situational parameters like personal preferences or general context parameters. Especially with the growing usage of mobile maps, route visualisations that adapt to individual and situational attributes will gain in importance.

4. Route Service with Focus Map Landmarks

To generate focus-based maps including landmarks for the usage in routing we created the "Route Service with Focus Map Landmarks". It acts like a proxy to the conventional OpenLS RS. This means that it uses the identical interface for requests and responses – just like the specified OpenLS RS. The difference is the response: the route instructions and route maps are supplemented with landmarks for a more cognitive adequate representation of route instructions and filtered for producing focus-based route maps.

As shown with the base OpenLS RS, routing can by done by the "Route Service with Focus Map Landmarks" with respect to many different criteria, e.g.: "Fastest", "Shortest" or "By Foot". For giving the points of destination and arrival or some user defined via points there are many possibilities as there are address, coordinates, points of interest or geometries. With using addresses there is the ability of using structured or non structured addresses. The geocoding of all forms of addresses is done by an extern OpenLS Location Utility Service (Geocoder/ Reverse Geocoder). To support the numerous spatial reference systems (for giving start-, endor via- points) the Focus RS is connected to a special database containing all spatial reference systems with their specific parameters as specified by European Petroleum Survey Group (EPSG). This makes it possible to transform all needed coordinates to one system needed for calculation (e.g.: Gauß-Krüger or WGS-84).

To get information about the requested route there are four parameters, that could be sent along with the route request and that have effect on the route response in different ways (OpenLS 2000).

1. *RouteSummary* – The route summary gives some meta information about the requested route, e.g.: overall distance, overall needed time expected. In addition one can demand a special distance unit (M for meters, Y for yards, KM for kilometers and FT for feet) by specifying it inside the route request.
2. *RouteGeometry* – Using this parameter one can demand information about the routes geometry (line string containing all waypoints of the route). Here one can define a maximum of waypoints. This causes a generalisation if more waypoints have been calculated. The generalisation is done by the well known Douglas-Peucker-Algorithm.
3. *RouteInstruction* – Route Instructions are "step by step" driving- or walking instructions of the calculated route. This was realized in our application in a simple form for various languages (e.g. German, English, Italian, Swedish…). As important additional feature of the new Focus RS, the relevant landmarks along the route are mentioned within the route instructions when it makes sense.
4. *RouteMaps* – These are maps, onto which the calculated route is displayed. Amongst other possibilities it is possible to request several route maps in the same request. For example also an overview map as well as detailed maps of the start- and destination points can be returned. Here also the known landmarks are included as special feature of the Focus RS and the map is focused to the demanded route.

4.1. Architecture of the RS with Focus Maps

The implemented Focus RS is a Java servlet running on the Tomcat Server (for architecture see fig. 1). It can be accessed exclusively through HTTP-POST and XML. The request and response are modelled as XML schema as specified through OpenLS. The core feature, the routing, is done by an OpenLS RS conform service. To generate 2D maps the Focus RS uses an OpenLS Presentation Service. The Web Feature Service (WFS) shown in Fig. 1 must be able to provide all landmarks and map layers that should be contained in the resulting map.

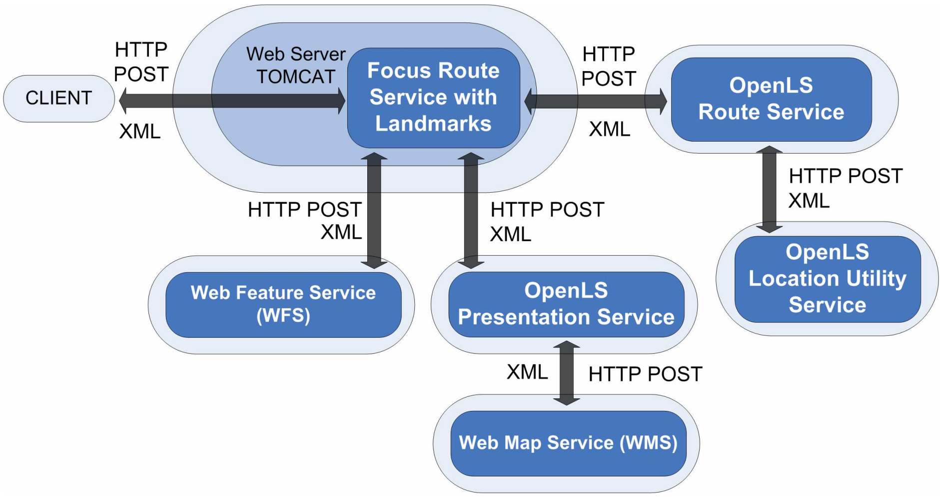

Figure 1: Architecture of the OpenLS Focus RS

4.2. Interaction between Focus RS and other *OpenGIS Web Service* (OWS)

The request to the Focus RS with landmarks is transferred to the OpenLS RS without changes. The OpenLS RS determines the route accordingly and sends it back to the focus RS with landmarks. The route instructions returned by the OpenLS RS are parsed by the focus RS. These contain also the geometry of the route besides the instructions itself. The geometries are used to query landmarks from the WFS through a spatial buffer query (WFS filter function DWITHIN) and further criteria like type or name of the landmarks.

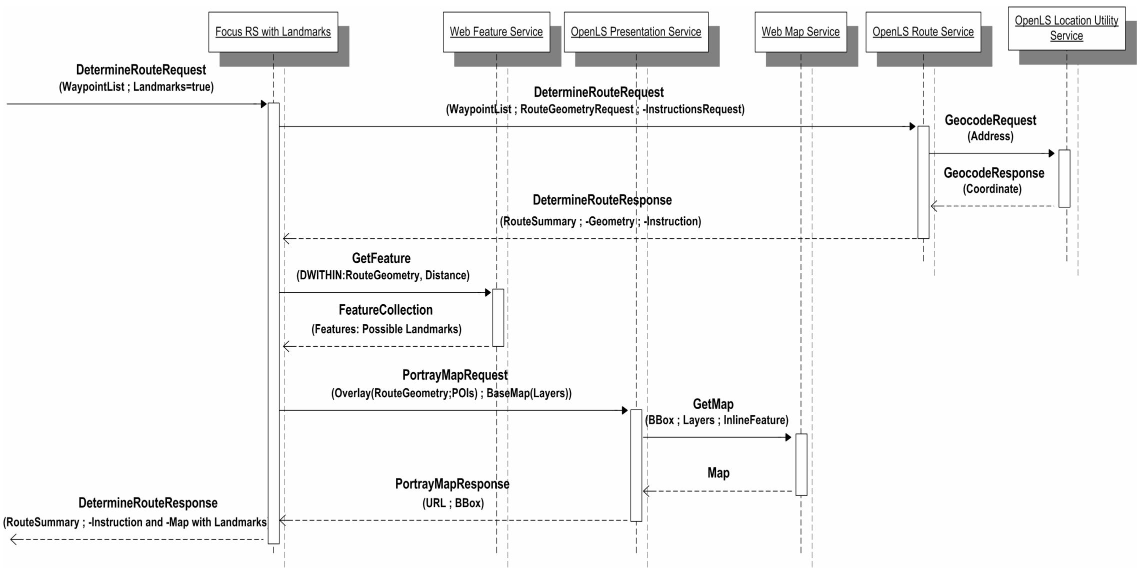

Figure 2: Sequence-Diagram of the Focus RS with Landmarks

The DWITHIN filter function is also used for generating the focus of the maps. The route is embedded in several buffers to determine the objects (e.g.: buildings or streets) in the near distance to the route. The feature ID of those detected objects is stored and every geometry collection belonging to the same buffered area is styled in the same way. This is done via a *PortryMapRequest* and SLD (Styled Layer Description) to an OpenLS Presentation Service.

The following figure shows the DWithin buffer functionality. For detecting the necessary landmarks this is a first but not optimal solution. We focus in this paper on usage of standard-based OWS, therefore we mention only this part of the detection process in detail. Of course better solutions for choosing landmarks would include a range of further parameters and also include the analysis of visibility of all landmarks. From such an approach even a context- and user adapted selection of landmarks would be possible as proposed in the literature earlier a couple of times (e.g. Meng et al. 2004). As this selection for the automated decision to put the landmark on the map or that the landmark is not important enough to be mentioned in the route description needs a range of further parameters, we assume here that this data is then available within a Web Feature Service (WFS) and can be retrieved through the standard WFS Filter Encoding functionalities. On the other hand more dynamic information can be gathered through a OGC Sensor Web service (e.g. SOS) or being calculated by the recently introduced Web Processing Service (WPS). In particular the calculation of visibility based on dynamic attributes (e.g. weather condidions) can be realized also in a standardized way by using a WPS. We have already implemented a range of WPS processes within the project www.OK-GIS.de (Stollberg and Zipf 2007), but a visibility analysis process is not yet available as a WPS process at the moment, but there is work in progress within the project www.mona3d.de. Therefore within this paper we only present the realized version using existing OWS.

Figure 3: DWithin Filter

The image above shows two geometric buffers of different size. The inner buffer (dark-blue) is responsible for detection of the landmarks and focusing the map, while the second buffer is supporting the focus algorithm. Of course a larger number of buffers could be used for a more fine-grained differentiation of the focus regions. This figure is only for explaining the principle.

4.3. Focus Route Maps

To receive the needed maps the Focus RS creates a *PortrayMapRequest* and sends it to the OpenLS Presentation Service. This request contains the position and character of the detected landmarks additionally to the route geometry. The ID's of the objects necessary for focusing the maps come along with that request as well.

The OpenLS Presentation Service generates a SLD (Styled Layer Descriptor Version 1.0.0) document in which the route geometry and the useful landmarks for the calculated route are included in the SLD element *InlineFeature*. The SLD is sent to a WMS that generates the resulting map including the SLD *InlineFeature* and *UserStyle* (Müller 2007).

Examples of resulting focus maps of our first implementation prototypes are shown below.

Figure 4: Map without focus (left) and Focus Map (right) as returned by our prototype of "Focus RS with Landmarks"

The left example shows a conventional route map while the right example is a first version of a Focus Map that has been generated by our new implementation as described above. These maps shall attract the user's attention to the spatial information relevant for the current task. Therefore the map has been divided into different zones. Those areas that are further apart of the area of interest (AOI) – in our case the route – are shown more generalized, with less labels and in lighter colours within our current first implementation. This has been realized by generating focus-buffer along the route calculated.

4.4. Route instructions with landmarks – First Examples

Besides focusing the map to the route geometry the realized service also mentiones the selected landmarks also in the route instructions and presents them in the resulting map. The used landmarks are divided into two groups of being needed for route description or not. The following map contains two landmarks (a stop-sign and a church). The example of the respective route instructions only contains the part with the stop-sign in order to shorten the example.

Figure 5: Route Map with Landmarks

The route instructions seem to be similar to those of a basic OpenLS RS. A difference occurs if the route leads past a detected landmark, then these particular landmarks are mentioned inside the instruction (see fig. 6 - row 13-18). Hansen et al (2006) complete those route instructions of the OpenLS Navigation Service by giving also more information about the descriptive landmark (e.g.: coordinates, description), but by this they change the standardized format of the OpenLS specification what we wanted to avoid for this version.

```xml
.....
 <xls:RouteInstructionsList xls:lang="en">
   <xls:RouteInstruction duration="PT0S" description="Action No. 1">
     <xls:Instruction>You start on Rheiner Landstrasse</xls:Instruction>
     <xls:distance value="0" uom="KM"/>
   </xls:RouteInstruction>
   <xls:RouteInstruction duration="PT25S" description="Action No. 2">
     <xls:Instruction>
       Drive straightforward on: Rheiner Landstrasse for 0.4 KM - approx ~1 minute(s)
     </xls:Instruction>
     <xls:distance value="0.4" uom="KM"/>
   </xls:RouteInstruction>
   <xls:RouteInstruction duration="PT49S" description="Action No. 3">
     <xls:Instruction>
        Drive right at the stop sign on: Augustenburger Strasse for 0.7 KM - approx ~1 minute(s)
     </xls:Instruction>
     <xls:distance value="0.7" uom="KM"/>
   </xls:RouteInstruction>
   <xls:RouteInstruction duration="PT0S" description="Action No. 4">
     <xls:Instruction>You arrived at destination</xls:Instruction>
     <xls:distance value="0" uom="KM"/>
   </xls:RouteInstruction>
 </xls:RouteInstructionsList>
.....
```
Figure 6: Example RouteInstruction with Landmark

5. Summary and Future Work

We have presented here a realization of an extension of an existing route planning service by focus maps and landmarks both on the map and within the route instructions. This has been realized through the use of OGC services solely. We did not change the interfaces of the services in order to achieve this. Instead we connected several OWS and OpenLS services in a defined manner. This interaction between the services can be regarded as a service chain of web services which is an important aspect of service oriented architectures (SOA). Currently research is conducted regarding how such service chains can be defined and orchestrated (as it is called) the most flexible way (e.g. Weiser & Zipf 2007, Stollberg & Zipf 2007, Einspänner et al 2003).

Future work on landmarks and OpenLS will be done within our new project “MoNa3D” – Mobile Navigation 3D, where another focus is on using 3d city models for this purpose on mobile devices (http://www.mona3d.de). As navigation support within future ubiquitous environments (http://www.ubigis.org) needs to combine support for indoor and outdoor envirionments some first empirical studies regarding landmark based 3D indoor navigation are presented by Mohan & Zipf (2007).

One task is to extend the algorithm further to implement an advanced filter for the inclusion of landmarks or buffers originating from landmark facades intersect with the route geometry, while the buffer size is dynamically defined by the landmarks relevance. Further investigations regard the question what parameters can be used for adapting and selecting landmarks based on the data available in the MoNa3D project, such as 3D city models and data from the project partner Teleatlas, extending work e.g. by Elias (2006) who focused on ALK (2d building) data. While there exist some proposals on how formulas for context-aware landmark selection can look like (eg. Winter and Raubal 2002, Zipf 2002) etc., practical implementations are always limited through the number of actually available attributes.

Also the algorithm for creating the focus maps has to be enhanced in the way that features or buildings which are in a higher distance to the route are generalized to a higher degree in order to support focusing the map content. A further challenge is to minimize the possible loss of performance through adequate techniques such as the usage of multi-resolution databases etc. (Jones & Ware 2005).

Within our project *GeoSpatial Data Infrastructures for 3D Geodata* (www.GDI-3D.de) we can use the complete service chain of the Route Service with Focus Map Landmarks and present the result not only as a 2D map but also as 3D scene. Therefore a *Web 3D Service* (W3DS) and a Java3D based client have been implemented. The client merges the requested route geometry to the matching 3D scene delivered by the W3DS and provides additionally to visualization of the routes geometry in 3D and navigation instructions also an animated route flight (see figure 7).
We agree here with Zlatanova and Verbree (2005) that LBS needs extensions into 3D and are actively working on these.

Within the project GDI-3D the service for presenting the 3D scences is the Web 3D Service. It has been extended to support also the Style Layer Descriptor (SLD) specification well known from Web Map Service (WMS) in order to define the style of a map. This specificaton has been extended in to the third dimension as a profile of the new OGC Symbol Encoding (SE) specifcation. It has been named “SLD-3D” and is used to define in a declarative way the visual appearance of the geometries of a 3D scene. A realization is presented in Neubauer & Zipf (2007). As it uses and supports the same concepts a s the well known SE/SLD it seems possible to generate focus based 3D scenes in a similar way as focus based maps. Similar approaches though without the use of standards have earlier been presented by Schilling & Zipf (2003). One main problem is that the complexitiý of creating 3D models of landmarks is higher than taking a snapshot of an object and copy it to a 2D map, but we are working on this problem within the MoNa3D project. Some examples of already available functionalities of the services in GDI-3D can be seen from the pictures and video captures on http://www.heidelberg-3d.de.

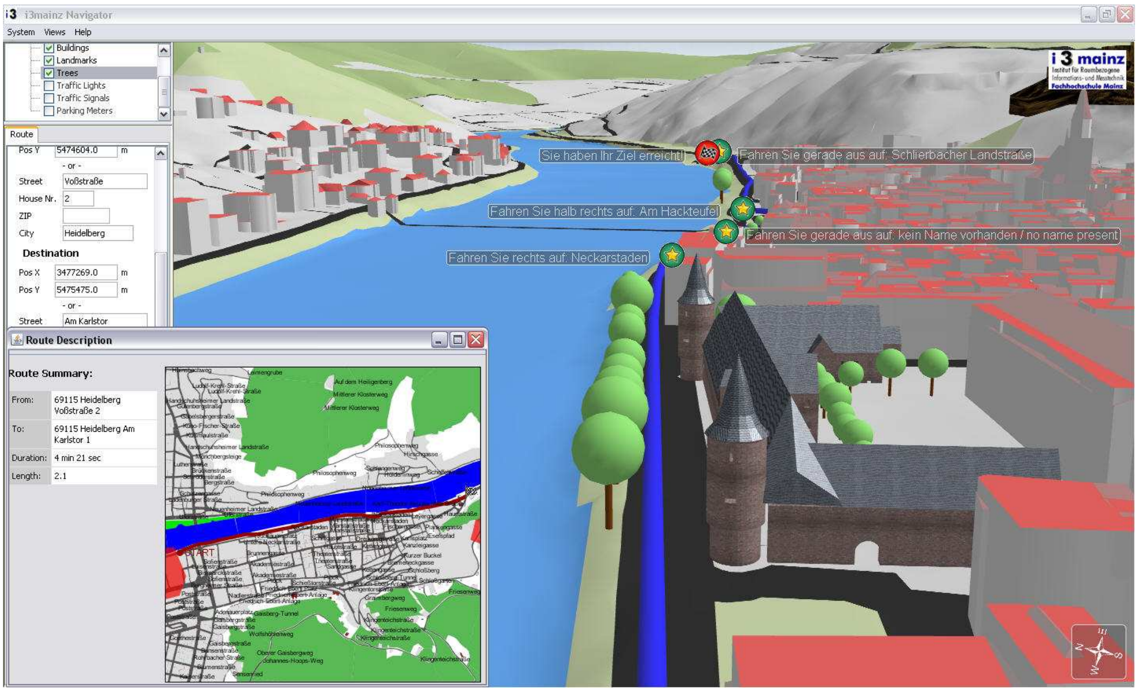

Figure 7: Representation of a requested route and within the resepctive 3d city-model along with route instructions

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