Enriching OSM road networks with TMC LCL information

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Abstract

Increasing traffic, especially in urban areas, leads to more and more infrastructural bottlenecks and congestion inside transportation networks. The aim is therefore to use existing transport networks as efficiently as possible. Live traffic and incident reports from the Traffic Message Channel (TMC) are an important source of information to provide further services in the context of a dynamic routing.

The state of North Rhine-Westphalia currently intends to organize the traffic information of the country in order to represent it to the road users in a new manner. The Road Construction Department of NRW has realized this development of an integrated transport information portal (Verkehr.NRW). In the portal address lookup table, a route planner and basic maps are provided. In order to furthermore integrate current traffic information in the portal, a road graph with TMC LCL information based on OpenStreetMap (OSM) is needed. To enable this service BASt (German Federal Highway Research Institute) agreed to implement the Location Code List (LCL) [1] for Germany into the OSM project. The part of the initialized MDM funded project "Enriching of an OSM road graph with TMC LCL information" was therefore now to develop a matching method to associate TMC/ LCL information automatically with crowdsourced OSM data.

Keywords: OSM, TMC LCL, VGI, Data Enrichment, Data Fusion

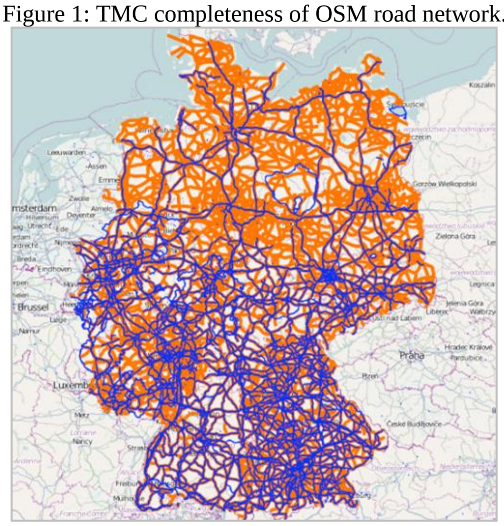
1 Introduction

The community is already integrating LCL information into the OSM project since 2009. Currently there are two different tagging variants of how TMC location codes are included in the OSM project. The first scheme [2] is most commonly used but has, due to the incorporation of different types of OSM objects (nodes, ways & relations), a higher complexity. In comparison the new proposed scheme [3] only uses one object type (ways).

1.1 Current status of TMC information within OSM

According to the OSM TMC Import Project [4], the majority of integrated TMC information was derived from LCL version 9.0. As of April 2011, 28855 of 42537 TMC objects have been populated to OSM. Based on this status, no further automated or manual update of the graph has been carried out with newer LCL information (current version 14.0). When looking at all derived OSM changesets during 01/2012 - 12/2012 and again during the period 01/2014 - 12/2014, less than 1% of the OSM graph containing TMC information has been edited with relevant attributes by the OSM community. Figure 1 visualizes the completeness of TMC information related to the OSM road network highlighted in blue for Germany. The overall LCL 9.0 coverage is shown in orange. Comparing the entire TMC/ LCL data to that available in OSM, it can be assumed that the OSM community will not continue to further update and complete LCL information into OSM.

Figure 1: TMC completeness of OSM road network.



2 Automated matching between OSM and LCL

The objective was therefore to develop an automated matching process to continuously derive LCL information and match it onto the OSM road graph. Our proposed method has the advantage that it works independently of the community and the current LCL version. Thus, a constant update of the OSM road network with current LCL information is conducted. First prototypes and procedures of how to combine TMC data and OSM with routing solutions is described by [5, 6]. The current LCL graph generates the following specific requirements for an automated matching process:

- LCL points contain point geometries:
  only LCL points can be located at OSM nodes geometrically (with a corresponding position accuracy)
- LCL segment/ roads topologies between LCL points are manufactured exclusively semantically:
  purely geometric matching procedure does not allow unambiguous identification of all OSM road segments between two LCL points
- Direction topologies between LCL points are made semantically:
  Identification of directional information and LCL topologies of OSM road segments can only be mapped by using routing algorithms

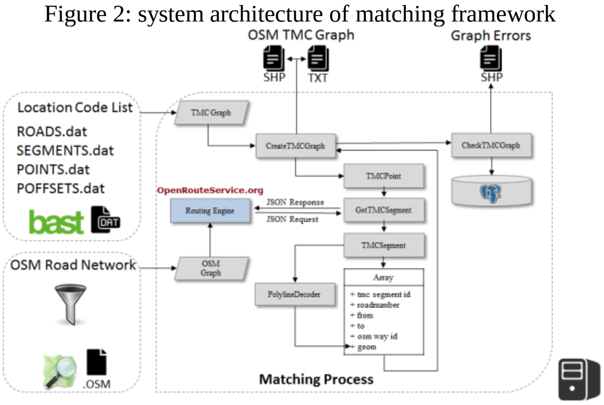
3 Matching between OSM and LCL

For matching the LCL information with the OSM road network, a multi-stage process comprising the following steps has been developed and implemented:

- Creating a graph LCL (topologies and attributes) from the Location Code List
- Transfer of the selected LCL Points and Coordinates using OpenRouteService routing algorithm
- Calculation of the route between two points LCL (depending on the segment and the direction)
- Semantic validation between LCL segment and the calculated route (OSM Ways)
- Matching of segment-based LCL attribute information to the extracted OSM Ways

Figure 2 shows the implemented system architecture of the proposed matching method. All processing steps including a continuously updated object-relational OSM database (Postgres/ PostGIS) are performed on a server hosted by the GIScience Research Group at Heidelberg University. The corresponding Location Code Lists are provided by the Federal Highway Research Institute (BASt).

Figure 2: system architecture of matching framework



3.1 Matching results LCL 13.0

The majority of roads (motorways, trunks, primary roads) are matched correctly with LCL information. For the required 4620 LCL Segments and LCL Roads, a total of 55627 sub-segments are calculated and assigned to the OSM road network. For 50 TMC/LCL segments internal data issues, such as non-existent location codes, occurred.

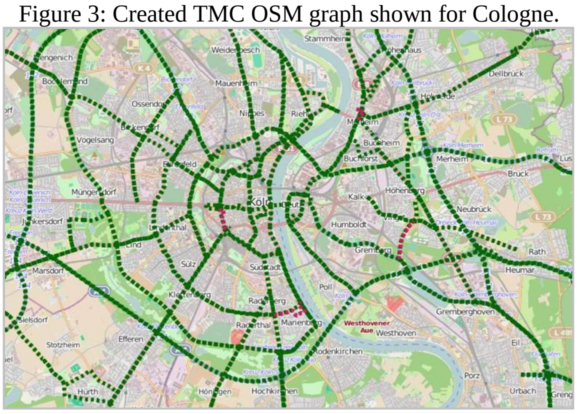
For 30 routing queries using the modified OpenRouteService routing engine, no OSM road segments between 2 LCL points have been identified. Table 1 shows the resulting attributes of the matched OSM graph with LCL information. Each segment consists of an ID, LCL segment ID, LCL node (from/ to), LCL segment name and a road name attribute.

Table 1: Extracted attribute table of matched OSM graph

FID	id	segment	from	to	tmc	roadnumber
1808	1	34	25253	47896	DE:25253+47896	B8
1809	2	34	47896	25253	DE:47896-25253	B8
1810	3	34	47896	25254	DE:47896+25254	B8
1811	4	34	25254	47896	DE:25254-47896	B8
1812	5	34	25254	47891	DE:25254+47891	B8
1813	6	34	47891	25254	DE:47891-25254	B8

As part of the implementation of the matching process, a prototype web-client test has been developed which is used to visualize all the results. The following Figure 3 shows the implemented test client with an overlay of the matched TMC-OSM-graph in green. Red dashed lines show segments where problems during the matching process occurred. Matching results are made available under the following link: http://129.206.228.92/osm-tmc/

Figure 3: Created TMC OSM graph shown for Cologne.



Besides the created OSM TMC graph, additional layers are provided within the web test client to validate the results for a quality analysis:

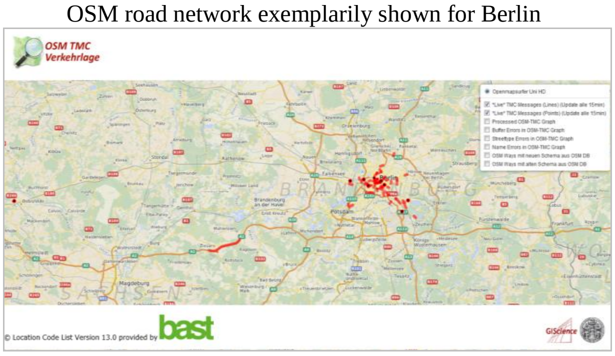
- Buffer error in OSM-TMC graph:
  Comparison and visualization of matched LCL codes with the OSM graph (buffer) whose route does not correspond to 75% of the total route length from the routing algorithm
- Road type errors in OSM-TMC graph:
  Comparison and visualization of OSM segments which have been partially (more than 20%) matched to lower road categories (e.g. residential roads, service ways etc.) where usually no LCL information should be available
- Names errors in OSM-TMC graph:
  Name comparison of the calculated OSM ways with the provided LCL roads names

The error indicator "road type error" as a comparison of the road categories of LCL segment information with the information of matched OSM graph illustrates that in 80% of all 1766 detected "road type error" cases, LCL information has been incorrect mapped onto side streets in OSM on which usually no LCL information is available. LCL segments have been linked to side streets especially within dense urban areas with a complex road network. Therefore the data processing was adjusted to improve the overall OSM TMC matching result. One of the adaption processes is to prioritize main arterial roads while considering the given road hierarchy. Minor service and residential roads are completely removed from the routing graph. In addition, after matching the LCL information with the OSM graph, a validation is done for all matched segments. In case of certain LCL points which are matched on different OSM road categories (e.g. first highway, than primary road and then again highway), a new route calculation is performed by higher weighting the road category where most of the segments have been assigned to (in the given example, highway). The adjustments in the matching process helped to further reduce the number of potentially incorrectly matched LCL segments.

4 Services

Although LCL information is partially already available in the OSM dataset, there are no further services/ applications that illustrate the benefits of localization of traffic information and could imply and activation of the community. The Web client therefor also includes two further layers which uses the currently generated TMC OSM graph to visualize real-time TMC messages. This first initial service visualized in Figure 4 provides real-time traffic information for Germany, which will be also realized in the future in a similar application in the Verkehr.NRW portal.

Figure 4: Real-time TMC traffic information on matched OSM road network exemplarily shown for Berlin



Within conducted performance tests, on average about 90% to 95% of all incoming traffic messages are displayed on a map. For only about 5% of all nationwide TMC messages, no corresponding object in the derived OSM TMC graph could be found. In addition, further services are publicly available. The processed OSM TMC LCL graph is migrated to our object-relational database, converted into a vector format and, like the TMC real-time traffic information, made available as an OGC [7] compliant WMS/ WFS interface.

5 Conclusion

The current version of the LCL OSM tools fulfills the targeted aim of successful enriching the OSM road network with LCL information on a very high percentage rate (85-90%). Furthermore, we have a tool for creating an ad hoc initial but also continuously updated OSM graph containing LCL information. In addition, error detection tools have been developed which allow an analysis of the matching results as well as giving the OSM community and users the possibility to validate these potential errors. The results and experiences of the initial matching process have been used to improve the method in a second phase by making various data preprocessing and routing engine adjustments. As a result we also evaluated to what extent he LCL graph itself has been qualitatively improved by updates and whether the matching method itself is becoming more efficient.

During the matching process of LCL information with the OSM road network, we occasionally encountered LCL graph related problems. Due to geometric inaccuracies for some of the stored LCL points, erroneous matching results have been generated. Especially for the secondary and tertiary road network, routes are calculated between inaccurately located LCL points, decreasing the overall matching performance rate accordingly. Thus, the geometric accuracy of the LCL needs to be improved. A global estimation of the total number of errors in the LCL is only partially possible. The provided error indicators are therefore a potentially promising measure for the localization of potential matching problems between OSM and LCL graph.

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