Virtual ITS European Congress, 9 – 10 November 2020

Paper number ITS- TP2252

Strategic Routing for cooperative Mobility Information and Management

Abstract

Strategic Routing for cooperative Mobility Information and Management Services combines technologies of multimodal platform services with strategic traffic management. It sets the ground for cooperative routing and management service for use by public traffic management centers and private mobility and navigation providers.

Strategic Routing is a target of the developments delivered in the MobiData BW environment. It was designed and developed for the city and region of Stuttgart, Germany. Based on the open multi-modal mobility data platform of Baden-Württemberg province, it can include city strategic services such as reduction of air pollution in city areas, parking strategies and measures to increase traffic flow.

It aims to give private companies, scientist and interested citizens access to urban mobility data and strategic traffic management services to make city transport in all forms more efficient in flow and sustainable. Strategic Routing is operated by VMZ, the Berlin enterprise focused on multimodal mobility platforms and traffic management.

Keywords:
Interoperability / Standards, Platform

Section Title: Transport network design and operations

Challenge and Objectives

The rapidly evolving mobility transition sets new challenges for urban traffic management. Traffic management formerly focused on optimizing the use of different transport systems must expand to an advanced and coordinated multi-modal management system to optimally use the entire transport network. In addition, to make urban mobility more sustainable, future traffic management needs to include environment-oriented mobility strategies that help to reduce traffic-related air pollution, noise, and demands on city space.

Many European cities have taken initiative to address these new challenges and set fresh goals to further improve sustainable urban mobility. Digital multi-modal data and service platforms bring mobility services together and provide integrated mobility information systems. At the same time, more and more cities are developing and implementing traffic management strategies to manage urban traffic in a more environmentally-friendly and transport-efficient way. Traffic control and information services focused on meeting PM10 and NOx limits are one example, and on-line information on Park+Ride, or traffic control measures to prevent traffic jams are other approaches.

Combining these available technologies is the next step towards achieving future strategic, multi-modal and cooperative traffic management. Sharing the technology results between public and private partners and providing open access to the overall public mobility platform sets the ground for a new cooperative concept for sustainable traffic information.

Strategic Routing for cooperative Mobility Information and Management Services is a successful concept showcase. It is based on the ideas competition which was organized by the Ministry of Transport Baden-Württemberg in 2015. The aim of the competition was to contribute to positively influencing the traffic situation, especially in the Stuttgart region and to prepare an expansion to whole Baden-Württemberg. This proof of concept was realized by Trafficon and Prisma.Solutions GmbH. It offers the basis for potential future realization of cooperative and optimized management of urban traffic networks in cities such as Stuttgart and their surrounding regions.

This proof of concept for solutions of Strategic Routing was realized by Trafficon and Prisma Solutions GmbH. Based on this POC a first Strategic Routing prototype solution has been developed for the Stuttgart region. This sets the ground for a further implementation of cooperative and optimized management of urban traffic networks in cities and the surrounding metropolitan areas.

Project Background

Strategic Routing for cooperative Mobility Information Services has been implemented within the MobiData BW environment. MobiData BW converts the concept developed in the preceding research

project ‘moveBW’ in a stable operating system[1], consisting of a central data platform and a (strategic) routing engine. The project was joined by the public transport authority of the state of Baden-Württemberg (Nahverkehrsgesellschaft Baden-Württemberg mbH, NVBW) in collaboration with the Ministry of Transport Baden-Württemberg. NVBW operates the background components of the whole mobility information and management system under the label ‘MobiData BW’. The key goal of MobiData BW is to provide a non-discriminatory open data platform that integrates and harmonizes mobility data by several real-time data providers for both individual and public transport. This data is then made available to third parties via several open standard APIs. In an upcoming implementation stage it will also be used to provide an intermodal routing service. On the basis of a traffic incident testsuite this routing will be able to consider municipal routing strategies. VMZ Berlin developed both the data platform and the intermodal routing service. For further developments, a software-tool for editing traffic recommendations was installed to test the possibilities of strategic routing.

Overall Concept

The traffic information and management system consists of three different components connected to each other to provide a broad municipal and regional system:

- an open mobility data platform,
- an intermodal routing service,
- a testsuite for editing traffic incidents and strategies.

The testsuite was developed by Prisma Solutions GmbH and is operated by NVBW, and the open mobility data platform as well as the intermodal routing service were developed by VMZ Berlin. The architectural concept differentiates the system into independent, yet connected components, enabling any traffic information and management system operator to run the components independently to permit flexible options regarding the technical hosting and operation of the system.

The concept intends a traffic incidents and strategy client, currently simulated by the testsuite, which allows municipalities to integrate, create, and edit incidents and strategies that on the one hand have an informational character for the public and on the other hand affect the individual traffic in the municipalities’ interests. These incidents and strategies are integrated into the mobility data platform for distribution through open standards APIs and for forwarding to the intermodal routing service, which in turn takes them into consideration in the routing calculation for individual car journeys. All information and data, both from mobility data and service providers as well as routing information, is made accessible to the public and third party providers through open standard APIs.

Innovation

[1] See https://vm.baden-wuerttemberg.de/de/politik-zukunft/zukunftskonzepte/digitale-mobilitaet/movebw

The connection of the traffic incidents and management system with the intermodal routing service provides an innovational approach to develop an intermodal routing service that considers real-time traffic data like floating car data and road blockages. A special feature is the interface towards municipalities to include city strategies in the routing responses and recommendations in order to optimize the current traffic and air pollution situation. Thus in general municipalities can define specific situational records that are linked to certain strategies. A potential use case is for instance, that the city of Stuttgart defines low emission zones within its city area that have specifically high concentrations of particulate matter during certain traffic and weather conditions and therefore have stronger negative impacts on the people and the environment. By using a traffic information and management system, the city would be able to activate a particulate matter alarm in the defined areas by activating a pre-defined strategy. An employee of the municipality creates a message in the traffic incidents and strategy client and defines the start and end date and time of the particulate matter alarm. The end time is not mandatory; in the case of no pre-defined end time the strategy will be considered in the routing service as long as the message is active. The routing service receives the message regarding the activated strategy and considers it when calculating car routes in the network. By defining certain bonus or malus values or even hard-coded tags within the network, the car router will produce routes that avoid the low emission zone areas as long as the strategy is activated. Within MobiData BW there are several routing strategies considered with certain pre-defined impacts on the routing calculation, for instance routing strategies to avoid traffic in specific areas as long as the traffic flow on the alternative routes is not too slow, or strategies that prefer specific Park+Ride areas. We go into more detail on these different routing strategies below.

Technical concept

As described above, all MobiData BW components can be operated independently yet are connected in the environment of an information and traffic management system. The communication follows standard API specifications via secured https-connections. It is possible to implement an authentication mechanism in order to control the access to the data as well as the volume of data to be transferred between the single components and /or to third party providers.

An authentication process is implemented in the MobiData BW routing service and mobility data platform for every third party provider wishing to receive data from the mobility data platform or the routing service by the DORA-API. The communication between a traffic incidents and strategy client and the routing service works via the European standard data model Datex II through an XML interface. To integrate the data into the car routing engine directly an incidents and strategy importer is used, which receives the Datex II data. It converts it to an internal data model that is specifically developed for the purposes of the implemented routing service and the mobility data platform. Within the data platform the harmonized data and routing information is transformed into open standard data models like the Open Journey Planner routing data model and provided to third party providers through open standard

APIs. Figure 1 gives a detailed picture of the different components, their technical connections to each other, and the different data sources.

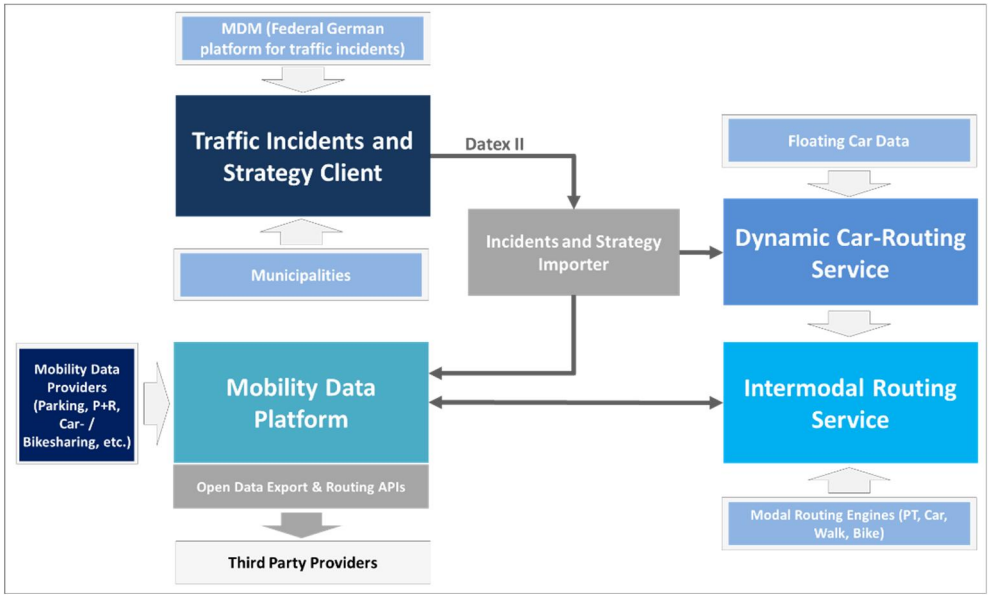

Figure 1 – Technical components and how they are connected

Mobility Data Platform

The mobility data platform integrates data from several mobility data providers like car-sharing or bike-sharing providers or parking operators. Thus, it supports several API standards as well as proprietary data models and API specifications. The mobility data platform integrates both expected and real-time data from different data providers and harmonizes them in such a way that they can be provided in a standardized data format through open standard APIs. The mobility data platform is scalable and extendable, which means that additional data providers can be added to the platform any time. For instance, the (similar) mobility data platform provided by VMZ in Berlin integrates a wide range of data providers including several car-, bike-, and (e)-scooter-sharing providers, taxi operators, parking data providers etc. The mobility data platform provides the harmonized data to third party providers, but also to the modal and intermodal routing engines via internal APIs. The platform system can be hosted both in the cloud or in a self-hosted server environment, operated either by the customer or by VMZ.

Routing platform and intermodal routing service

The routing platform is the heart of all intermodal routing services. It takes all the information regarding mobility data providers like parking lots or bike-sharing systems, combines them with the routing information calculated by modal routing engines and generates intermodal routing options based on the different information. The routing platform is based on a multi-stage process. In a first step, all routing access options surrounding the start or end of a routing request are considered, for example public transport stations or network access for car or walking routes. Based on generic non-real-time data, the

routing engine generates possible connections between start and end, calculates actual routing options and sorts them in an optimization process. A configurable selection of optimal routes is validated using either real-time public transport routing data or, as an example, data on the availability of bicycles at pre-calculated bike-sharing stations. In a final stage, the sorted routes are provided via the routing API based on the requested optimization criteria like time, distance, or air pollution emissions.

The key of strategic car routing, which is the core object of this paper, is the ability of the car routing engine to consider strategies provided by external sources like the traffic incidents and strategy client. Managing the car routing responses naturally affects the intermodal routing, for instance in terms of Park+Ride routes. The car routing is based on a routing network consisting of links and nodes. Every routing strategy has an impact on the weighting of the links by setting defined bonus or malus values for the links affected in the router. A specific routing strategy, like a strategy that aims to avoid traffic in a certain city area, is connected with a pre-defined bonus or malus value setting. This sets the links that have to be preferred in the routing calculation in order to divert the route around the area to be avoided. Depending on whether a strategy is active or not the router dynamically adds a bonus or malus value to the considered link. In this way, municipalities gain the ability to implement urban routing strategies in overall routing systems.

Integration of Traffic Management Strategies

Municipalities can define several traffic management and routing strategies. In the MobiData BW routing environment, there are currently six strategies, taken into account by the routing-engine:

- alternate routing strategies: avoid traffic in specific areas
- city traffic compatible strategies: define preferred routes between specific origin and destination areas in a city
- diversion strategies: define preferred alternate routes connected to a specific incident, like a blockage due to roadworks
- parking strategies: define preferred routes if the destination is in a specific area
- Park+Ride strategies: define preferred Park+Ride facilities
- particulate matter (PM) alarm: avoid traffic in specific low emission zones

The routing strategies were implemented for the proof-of-concept in the editor-tool and routing-engine in the Stuttgart area. They are depicted in Figure 2.

Employees of the municipalities should be enabled to create, edit, and activate the strategies in the traffic information and management client. The strategy messages consist of the name of the strategy, the localization of the preferred routes defined by geometries, link ids, and / or Open LR referencing, start and, to some extent, end date and time, as well as defined city areas like parking areas or low emission zones defined by polygon geometries. The strategies follow the European standard data model Datex II.

As every module of the infrastructure is tool-independent. An exchange to other software-products or an extension of already used traffic management systems by the municipalities is possible, as long as the exchange interface is supported

As soon as a strategy is active, the incidents and strategy importer integrates it via an XML interface and converts it to an internal data format that the routing engine is able to process. Pre-defined bonus or malus values set on the links in the routing network affect the preferred routing response.

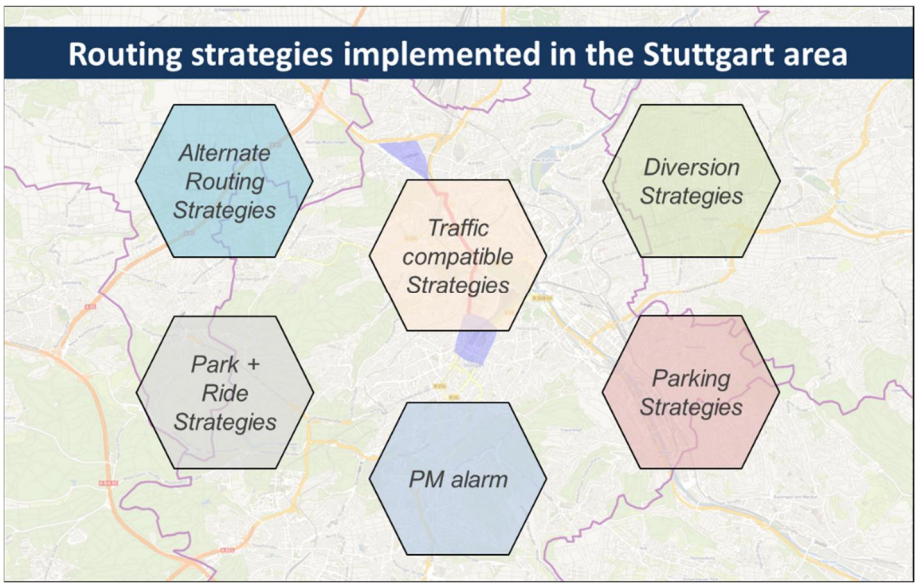

Figure 2 – Routing strategies implemented in the routing-engine for the Stuttgart area

Implementation Goals

The implementation of the traffic management system can be best explained with a detailed example from the MobiData BW approach. One of the priorities of traffic management in the state of Baden-Württemberg, specifically in the city of Stuttgart, is to reduce air pollution, especially the volume of particulate matter pollution. Therefore, low emission zones have been established in the city of Stuttgart in areas where PM limit values are frequently and significantly exceeded. The aim of the traffic management in the city is to divert traffic around these low emission zones and to reduce or even avoid motorized individual traffic in these areas.

In case of air pollution measurement values above a specific threshold value, with the implemented Strategic Routing a particulate matter alarm could be activated in a traffic information and management client and submitted to the incidents and strategies importer of VMZ via an XML interface. The importer delivers the message regarding the activated particulate matter alarm to the car routing engine. As long as the message is active, the car routing engine considers all links that were defined as part of the low emission zone and tagged accordingly. The car router sets these links as not passable. As a result, the routing engine calculates a route that does not traverse these specific links. The routing service provides

a route that is diverted around the low emission zone as illustrated exemplary in Figure 3.

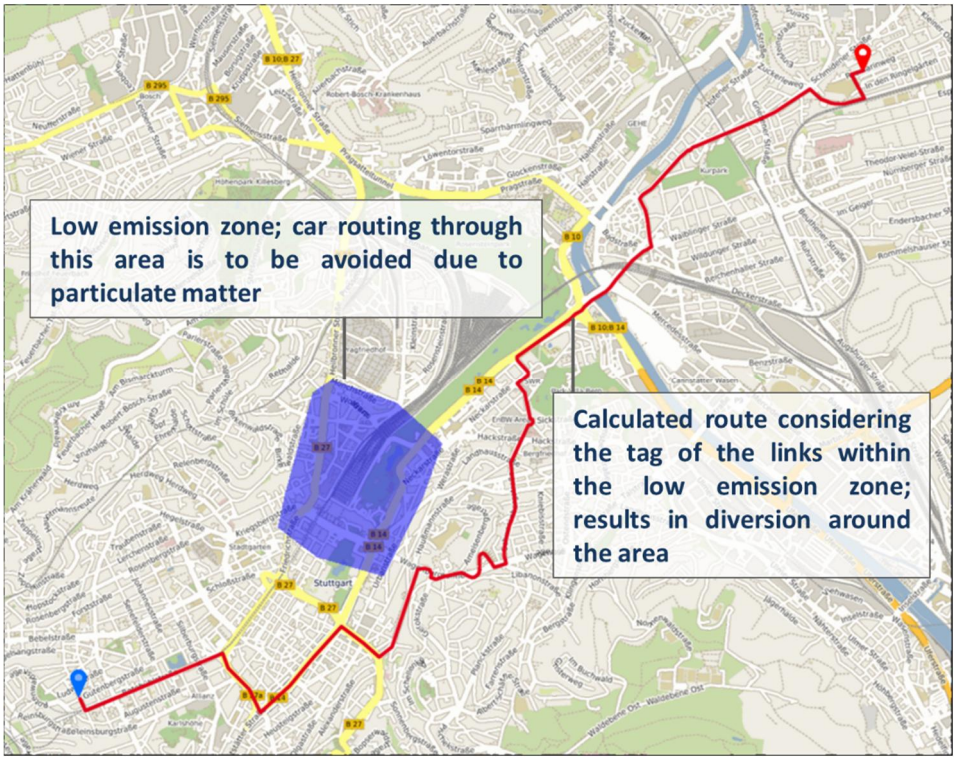

Figure 3 – Calculated route diverting around the low emission area due to particulate matter alarm

Storing and Sharing Routing Strategies

Routing strategies are managed in a software tool. A Web Geo Information System (web-GIS) allows a map based editing and is supported by geometry stitching and potential route calculation for bypasses. All strategy-geometries are combined with attributes like start and finish date and several other optional information (e.g. contact address, specific traffic guidance). These data are saved in a PostgreSQL-database. Entered datasets are reusable. The previous example might be active for a period of bad weather conditions. By adjusting the period of time the example could be activated labour-saving.

Furthermore, the strategy could be exchanged with other information systems by the used standardized interface. Strategies from partners, using their own tools, could be integrated by operating with the accepted technologies.

Next Steps

Implementing a traffic information and management system based on an incident and strategy client and an intermodal routing service that integrates urban strategies offers many opportunities for a commercially and socially beneficial cooperation between public and private mobility partners.

On the one hand, the open multimodal mobility platform that is operated by the public partner gives third party mobility providers easy access to services that help to improve and optimize the usage of

their transport offerings. On the other hand integrating the strategic routing service into private services supports the overall urban mobility strategy and aligns private mobility (information) services with public traffic management to further support sustainable urban mobility.

Currently the cooperative approach of implementing a traffic information and management system consisting of a strategy-information-ready intermodal routing service that is able to integrate and consider the strategies through a car routing engine is on an information level. Third party providers can implement the provided routing API and provide routing services that include defined urban routing strategies.

The next step is to activate municipalities as a data provider for incidents and strategies. Usually the information are available in internal processes. By connecting and expanding existing systems a benefit for citizens, economies and municipalities is available.

Furthermore, it is intended to give navigation providers access to the system and to integrate the traffic information and management system services both in a modal car routing as well as in an intermodal context. Alternatively, municipalities could provide solely their routing strategies through an open standard API directly to navigation providers. However, technical details need to be discussed on how to define and integrate these routing strategies.

Another future aim is the integration of such routing strategies in the products of OEMs. Navigation services are often integrated in the on-board infotainment systems of modern cars and could therefore be delivered with real-time routing strategies. An effective solution for the management and control of traffic flows needs to provide these strategies where they are consumed: in the car on the street. Open standard data models and interfaces are of high importance to realize such a solution.