DMOTION – PUBLIC-PRIVATE STRATEGY MANAGEMENT

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Abstract:

Because of growing penetration rates of individual routing and traffic information systems, private traffic service providers are becoming an important actor in the process of traffic management and alternative route guidance.

By establishing an information and strategy network of private service providers and public road authorities, the knowledge on current traffic conditions will be improved and consistency between collective and individual information offers will be guaranteed. In addition, the private service provider is able to support the implementation of traffic management strategies and to consider public alternative route advices by providing an individual ´strategy conform` routing service.

INTRODUCTION

With increased and enhanced possibilities of traffic monitoring, of traffic control and of providing information to road users, the establishment of a traffic strategy management is often seen as an effective approach to reduce traffic related problems for conurbations.

There are two different philosophies to be followed when designing a strategy management system; either an information philosophy or an integrated information, control and guidance philosophy. Within the first approach, road users are only provided with information on cur-

rent traffic conditions on their intended routes and they adjust their routes according to their own decision. This paper focuses on the second philosophy: to inform and, additionally, to guide road users in case of incidents via alternative and less congested routes through the network.

Especially with regard to growing penetration rates of individual routing systems, road authorities need to include private partners in the process of traffic management and alternative route guidance. Within the Dmotion project, a public-private strategy management will be demonstrated. The private service provider is involved in the processes of data collection and implementation of traffic management strategies.

The Dmotion project is a German research project within the VM 2010 (Traffic Management 2010) research initiative funded by the German Ministry of Economy and Technology (BMWi). The aim of Dmotion is to develop and implement an integrated traffic management system for the conurbation of Düsseldorf. This traffic management system is based on a comprehensive data, information and strategy network for regional and local authorities, as well as for private service providers.

This paper focuses on the role of the private service provider in this network and describes how to consider traffic management strategies in hybrid and off-board routing systems and how to provide a ´strategy conform` routing which will guarantee consistency between collective and individual information services.

OBJECTIVES

By establishing a data, information and strategy network between public authorities and private service providers, the following objectives shall be achieved:

- Enhanced traffic state analysis in the traffic management centres by processing FCD provided by private partners
- Continuous up-to-date information to road users, which cannot be offered via collectively informing media
- Increase of road network efficiency by directing traffic streams through less congested areas
- Matching the objectives of individual routing services and public traffic management strategies by offering a strategy conform routing

PRE-CONDITIONS OF AN EFFECTIVE PUBLIC-PRIVATE STRATEGY MANAGEMENT

A major pre-condition for an effective strategy management is a consistent and comprehensive report on current traffic conditions. For the Düsseldorf region, a real time estimation of traffic conditions has to be provided to achieve an overview on the current traffic conditions on the urban main roads and the surrounding motorways. This network wide traffic state analysis will be used as a basis for decisions on implementing traffic management strategies

and for providing high quality traffic information services as e.g. dynamic on-board and off-board routing services.

Therefore, an information network of local and regional authorities and the private service provider has to be established. The private service provider will contribute FCD to enhance the traffic state analysis. Especially on road sections without any static detection, FCD will help to gather information on current traffic conditions. Furthermore, vehicles providing FCD are used as moving sensors in the network and, by processing this data, incidents can be identified more quickly than by relying on conventional detection only.

In the urban centre, traffic data from static detectors and FCD from different sources is fused. Within the scope of Dmotion, FCD is provided by private service providers as well as by special data suppliers, such as the vehicles of Düsseldorf's taxi service and public transport vehicles. Based on the data fusion, a real time model will provide estimation on current traffic conditions and short-term prediction for the network of the City of Düsseldorf. The urban overview on current and predicted traffic conditions is merged with the regional overview determined by the road authority operating the motorways. This network wide traffic state analysis is provided to the private service provider in order to offer high quality traffic information and routing services.

A major issue in establishing a cooperation between public authorities and private service providers and in enabling data exchange of traffic related information is to find a suitable location referencing system. Private service providers usually use commercial digital maps while public authorities often use customer specific solutions. Within Dmotion all traffic data exchanged between private service providers and traffic management centres is geo-referenced by using TMC (traffic message channel) location codes. By agreeing on this standard, the information network is open to other public and private partners like e.g. other traffic service providers who want to offer additional traffic services, but do use supplier specific digital maps.

While a full coverage with TMC locations already exists for the motorway network, for the urban network of Düsseldorf the definition of 280 additional location codes still had to be done. By this means now all major sections of the urban network are defined by location codes.

PUBLIC-PRIVATE STRATEGY MANAGEMENT

A workflow based strategy management will be established in the traffic management centres of the City of Düsseldorf and the Federal State of North Rhine-Westphalia. The specified strategy management provides an on-line adjustment of coherent strategies taking into account operational and strategic requirements of the involved partners.

Both authorities evaluate the current traffic conditions for the road network of their responsibility and keep the sovereignty of actuating dynamic traffic signals, variable message signs and related roadside equipment within their own network. At the same time, the strategy management selects and agrees on implementing predefined strategies comprising the networks of all involved authorities.

Workflow

Once an incident is detected, a predefined strategy is chosen automatically and the system checks if it can be implemented according to idle capacity on the alternative routes. Furthermore, the system verifies the technical availability of actuating elements needed to implement the strategy (e.g. VMS, traffic lights) and if contradicting strategies are currently implemented. As soon as a strategy is implemented, it is communicated to the private service provider to be considered within the routing services.

Road users, that request routes via road sections affected by the detected incident, shall be routed according to the currently implemented strategies. Even road users, who have requested routes before the strategy has been implemented, shall be rerouted dynamically if they still have not passed the affected road sections.

The strategy negotiation between public authorities will be realised fully automated. This means that the number of interventions by operators will be minimised according to the common control philosophy in Germany.

Further Development towards a Strategy Conform Routing

To realise this concept of 'strategy conform' routing, navigation systems have to be enhanced to consider single user preferences as well as overall traffic management strategies when calculating routes. Within Dmotion the approaches of the finalised German research project INVENT are consistently developed further.

These further developments mainly relate to the automation of the process. While in INVENT on the part of the private partner the strategies were already predefined as strategy layers and only needed to be activated when required, in Dmotion an automation of the whole process chain – from the strategy selection on the part of the public authorities up to the processing of these strategies within the services of the private partner – will be established.

Moreover, regarding the transferability and sustainability of the developed approaches, two aspects need to be focussed:

1. communication on activated strategies between the public authorities and a private service provider will be standardised (interface).

2. an automatic consideration of public strategies in services offered by the private service provider will be established (e.g. strategy conform routing).

The first aspect will be met through a specification and realisation of an integration interface for strategy recommendations between the urban centre and the private service centre. It will be realised according to OTS 1.0 (Open Traffic System) standard. The interface will be specified and realised for bi-directional communication. Thus, not only strategy recommendations of public authorities are transmitted to the private service provider but also FCD are provided by the private partners to enhance traffic state analysis in the public centre. The specification will be documented in detail and revealed so that other actors can join the public strategy management in the future.

System Architecture

In Dmotion, the system architecture between public partners and the private service provider is based on establishing one bi-directional communication interface. It will be implemented between the urban traffic control centre of Düsseldorf and the service centre of the PTV AG. In principle, an interface with the traffic control centre of the federal state is also conceivable but during the planning of the workflow in this research project, a single connection between public authorities and private actors proved to be more feasible to achieve the desired results.

Due to the traditional information deficit on current traffic conditions within the urban networks, cities have a higher interest in the provision of FCD than the operators of motorway traffic centres – here a coverage off all sections via static detection is already available for large parts of North Rhine-Westphalia (NRW) – the implementation of an interface to the urban traffic control centre is prioritised. Basically the interface to the motorway control centre is also feasible to realise. In this case, the interface has to be specified not according to the OTS interface architecture but rather according to the guidelines of the Study Group Traffic Control Centres of the Federation and the Federal States (Bund-Länder-Arbeitskreis).

The internal architecture of the linking of the private service platform to the urban centre is shown in the following figure. The data exchange form the urban traffic control centre to the private platform as well as the provision of traffic data (FCD) in the opposite direction is illustrated.

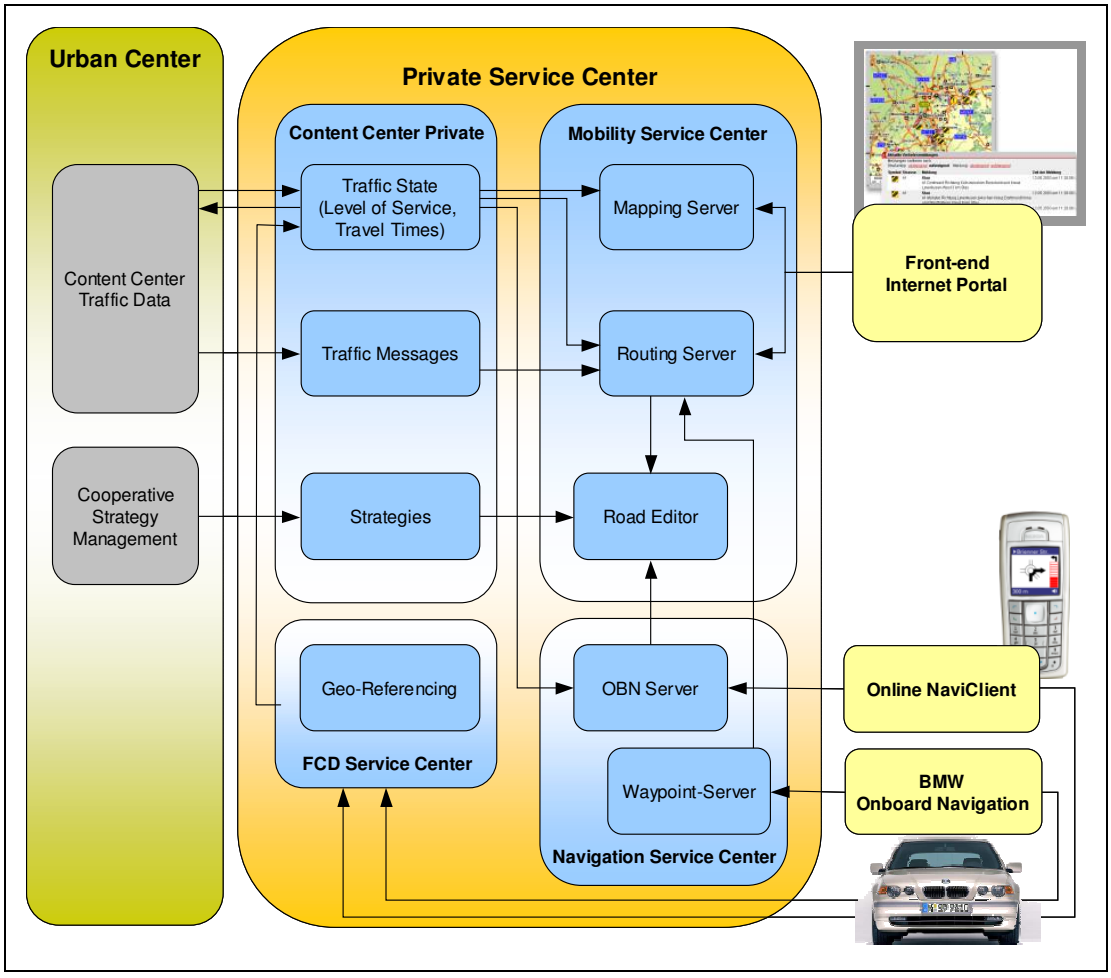

Figure 1: System Architecture

On the part of the private partner all data coming from the urban centre are pre-processed in the content centre and distributed to the connected service modules.

The urban traffic control centre transmits traffic conditions (level of service and travel times per link) and traffic messages (incident information) in fixed time intervals. In case a strategy, coordinated between public partners, is activated, strategies are communicated to the private service provider as a list of links, including the links of the main routes and of the prioritised alternative routes. In return, the private centre transfers processed FCD which was surveyed via online navigation and onboard navigation clients and processed in the FCD service centre.

Within the Mobility Service Centre information on activated strategies will be transmitted to the RoadEditor module. The RoadEditor takes on the second task mentioned above, to start the process of a strategy conform routing by automatically converting the transmitted link lists into strategy layers.

Due to internal processing, there are two modules performing dynamic routing: the Routing Server and the OBN (off board navigation) Server. Requests of Online Navigation Clients are sent to the OBN server. Routing requests which are generated through an attached service portal in the Internet and requests which are generated by enhanced onboard navigation clients are transmitted to the Routing Server. Within the context of the Dmotion project the onboard navigation will be extended to a hybrid navigation system to enable strategy conform routing.

The dynamic routing algorithm considers current traffic conditions and traffic messages. This data is processed and interpreted as dynamic impedance values for each road section while the algorithm is calculating the optimal route. In order to guarantee strategy conform routing, strategy layers are generated by the RoadEditor. Strategy layers consist of impedance factors being considered when calculating routes. Within the dynamic routing algorithm these factors are used to increase the impedance of the congested main routes and to lower the impedance of the alternative routes. This results in routing via the main route being avoided and routing via the alternative route being prioritised.

Pre-Defining of Parameters

Beyond the actual strategy information, measures and triggers need to be defined for each strategy. The measures represent the already mentioned impedance factors. Corresponding factors must be specified respectively for both main and alternative route of the strategies. It is essential that to each link, a factor is allocated which has to be considered when calculating routes. The consideration of these factors is ensured by establishing the automatic generation of strategy layers by the RoadEditor after processing the link list of the public traffic control centre.

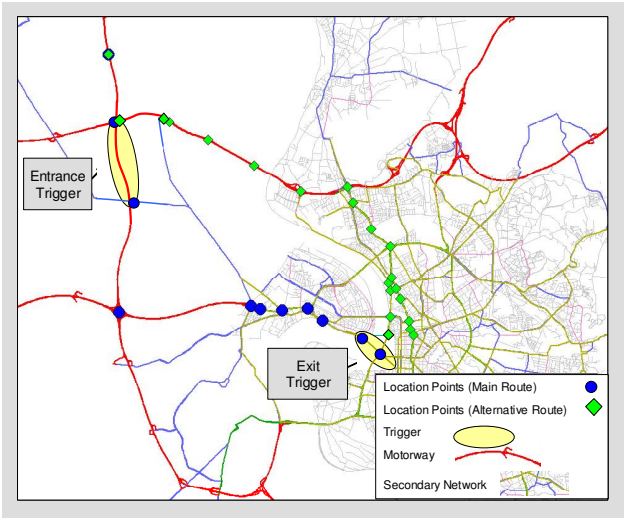

Figure 2: Trigger Definition

Furthermore, for each strategy an entrance and exit trigger must be defined. Triggers are allocated to road sections and are used to decide, if a certain strategy layer is rele-

vant for a specific route calculation initiated by a navigation request.

In case a route request is received and a route is calculated, the routing result is checked up on crossing the provided trigger sections. If the criterion – both trigger sections are included in the determined route – is met, the routing calculation is carried out again using related strategy layers. By this means it is secured that only road users, who wanted to pass the original route completely, will be rerouted.

So far, provision of the data has to be executed manually by an experienced traffic engineer. Because this procedure is impedimental during continuous operation, further functionalities to provide an automated editing of triggers and impedance factors are planned.

The result of this parameterisation is a strategy conform routing coordinated between public authorities and private service providers.

Online Navigation and Linking of further private Actors

In online navigation there is no permanent storage of digital road maps in end devices, so route calculation is performed by an off-board server in a service centre. With a navigation end device a routing request is sent to the OBN server including the current GPS position (or manual input of a starting point) and the destination defined by the user. Analogue to the route calculation on the routing server, a route is calculated and the routing result is checked up on crossing the trigger sections stored in the RoadEditor. In case of a positive result, the route calculation is carried out again using the related strategy layer of the RoadEditor data base. The result is a strategy conform routing for online navigation. In Dmotion 50 online devices will continuously be in use. They serve both as data supplier and as control medium of a strategy conform routing.

Within Dmotion, navigation equipment of the third generation of BMW will also be connected to strategy conform routing. As specified in the internal architecture, the clients receive strategy advices via the Waypoint Server from the Routing Server. The reference route is calculated and delivered as a list of waypoints to BMW. These waypoints are referenced in Agora-C. For this purpose a service is realised to be set up which guarantees the generation of reference routes in way points and which executes the on-the-fly encoding in Agora-C.

Cooperation Model

Besides these technical considerations, Dmotion also addresses operational aspects. In principle, it is to constitute that the implementation of a strategy conform routing means a restriction in routing for the private service provider. In return, the supplier is provided with high quality traffic data to offer enhanced services. Aligned with this voluntary restriction is a demand for an adequate traffic quality on the alternative route which has to be assured on the part of the public partners.

So far, no coordinated strategy for data collection exists between public actors and the various private actors. Each actor works on its own, so on one side there are gaps in data collection while on the other side there are redundancies. Until today, no models exist on the subject how – in a data network – different methods of collecting data in the hand of various actors are managed synchronously. On the base of the currently performed field tests, a partnership model for traffic data collection data will be defined within Dmotion.

Thus a strategic framework is set that determines to what extent private actors are involved in the generation of traffic related data. The strategic framework will be led into a partnership model, which coordinates the different methods of data collection with regard to the desired objective – an adequate data base of high quality. Within this partnership model, a basis for a mutual accounting for the provided data will be defined. Therefore, a framework for data provision, data cooperation respectively purchasing and quality control will be developed.

CONCLUSION

In an information and strategy network of private service providers and public authorities as established in Dmotion, all partners benefit from the cooperation. The private service provider supports the traffic state analysis by providing FCD and receives a network wide high quality traffic information. By offering a 'strategy conform' routing, the objectives of individual routing services and public traffic management strategies are matched. Individual information of road users and the strategic diversion of traffic streams are used to optimise the trip of individual road users and to enhance the capacity of the whole road network.

By including private service providers in the process of traffic management, the major challenge of constantly supporting the road user with on-trip information can be achieved. So far, traffic management strategies including deviation advices are communicated to road users only at certain points of the network (by using VMS) or broadcasted via radio. By using in-car devices or e.g. PDAs to distribute traffic information, road users are addressed individually and constantly. Traffic management strategies can be communicated from the traffic management centre to road users via private service providers. This approach guarantees consistency between collective and individual information offers and also enhances public awareness and acceptance of traffic information services among end-users.

With standardised interfaces for the exchange of strategy information and the supply of FCD, an essential technical obstacle for a public-private strategy management is reached. At the same time, fundamental methodical enhancements within the approaches of strategy conform routing, such as automatic generation of strategy layers, are realised on the part of the private provider. With On-the-Fly geo referencing using Agora-C, the possibility to transmit reference routes to other service providers is established. By this means, the interoperability of a technical solution and the integration of several service providers are secured.

The technical approaches mentioned above clearly show the fact that under technical aspects a development towards regular operations has been started with the approaches of Dmotion. Currently, models, which represent organisational approaches for a cooperation are developed based of field test demonstrators.

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