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Integrating smart mobility services in operational dynamic traffic management

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Abstract

Private companies are developing more and more smart mobility services, which have impact on operational dynamic traffic management of public parties. A public-private collaboration seems to be logical to exchange plans, targets and strategies, as dynamic traffic management (DTM) services taken by public parties strengthen smart mobility services of private companies and vice versa. Nowadays, no concrete method which achieves this seems to exist. Though, in The Netherlands a DTM 'control strategy' exists. At this moment only traditional DTM-services are included, but it is possible to incorporate smart mobility services in this framework. This 'control strategy' contains three building blocks, of which the first two describe policy and available road network. The third building block contains four DTM-strategies for which DTM-services must be identified. Road authorities should cooperate with service providers to identify the available DTM-services and how/under what circumstances these services can be activated. This paper combines the results from three EU-funded projects: C-MobILE, SOCRATES and MyCorridor.

Keywords:

OPERATIONAL DYNAMIC TRAFFIC MANAGEMENT, SMART MOBILITY SERVICES, PUBLIC-PRIVATE APPROACH

Introduction

Similar to 'ITS' (Intelligent Transport Systems), smart mobility is a broad domain aimed at providing a variety of solutions to facilitate travel demand and solve traffic problems. Smart mobility solutions are generally the result of so-called disruptive technologies which have a large impact on society. In the context of mobility and transportation the most relevant among those technologies are: connectivity (like mobile internet), internet of things (and big data), artificial intelligence, robotics (and autonomous vehicles) and social media (including digital platforms and cloud).

These technologies not only have led to the introduction of a range of new solutions, they changed the actors involved in the field of dynamic traffic management. Since a few decades private sector business-to-consumer vendors like service providers, data aggregators and distributors and networks operators are offering mobility services to assist travellers in making their trips as comfortable and efficient as possible. As their success is growing and more travellers are using such mobility services, the influence of these services on traffic patterns in the road network (i.e. trip, mode, route, lane and speed choices) and thereby the network performance increases. The main challenge resulting from this notion is how to incorporate or connect private sector mobility services in/to day-to-day dynamic traffic management.

This challenge is addressed by multiple projects, with each project looking at it from a different perspective. For example the CEF-project SOCRATES 2.0 [1] builds upon the TM2.0 legacy and aims to demonstrate the feasibility of 'interactive traffic management', which is based on a close cooperation of road authorities, service providers and car industries. Secondly, the H2020-project C-MobILE [2] aims to accelerate the large-scale deployment of C-ITS services and simultaneously elaborate how services can be utilized and operated by different actors. Finally, the H2020-project MyCorridor [3] intends to add traffic management to the Mobility-as-a-Service (MaaS) concept. What all three projects have in common is the provision of a set of services which is based on public-private collaboration, and the ambition to achieve more efficient traveling and traffic management through this collaboration. At the heart of such a collaboration lies the exchange of (traffic management) plans, targets and strategies, to inform each respective counterpart about desired responses and intended stimuli. To date, no concrete method which achieves this seems to exist.

Control strategy design

A few years ago in the Netherlands an approach has been developed for designing dynamic traffic management (DTM) 'control strategies' [4]. Such a strategy is focussed on preventing congestion on road segments and to secure policy goals by optimizing traffic flow. The 'control strategy' contains a framework including a step-by-step approach for selecting and activating so-called strategies when trying to solve a throughput problem with the pre-defined policy objectives. For each of the four strategies contributing DTM-services have been identified. At present mostly traditional DTM-services like providing more green time for a specific direction at an intersection and displaying

alternative routes on VMSs mostly have been included in this framework, but it seems possible to incorporate smart mobility services in this framework. The approach presented in this contribution aims to incorporate smart mobility services in this existing framework.

As written above, the framework consists of a step-wise approach for activating so-called strategies when trying to solving a throughput problem with the pre-defined policy objectives. The framework offers four strategies: (1) inform traffic about the traffic situation, (2) enlarge the outflow, (3) reduce the inflow, and (4) reroute traffic or influence traffic demand. Typically but not necessarily, these strategies are applied as escalation phases, the first being the least severe one and the last being the most radical one.

Before it is possible to apply these strategies, an important prerequisite of this traffic management control strategy is necessary. Based on (existing) policy defined by a road authority a description is required of the importance and function of roads as well as quantitative thresholds for control nodes, networks links and route parts.

Step-by-step approach

The aforementioned framework consists of a step-by-step approach, called ‘building blocks’ in the Dutch ‘control strategy’:

1. Policy;
2. The available road network;
3. Strategies.

1. **Policy**: an important prerequisite of a traffic management control strategy is a policy defined by a road authority. This includes a description of the importance and function of roads as well as quantitative thresholds for links and route parts.
2. **Identify available DTM services in the available network**: the next step for a road authority is to define an available road network including its different nodes, segments, links and route parts.
    - A link is the road between two control nodes or between a control node and a choice node and is used to detect traffic problems;
    - A policy link is the road from outside the available network towards a control nodes or choice node and is only used to protect policy goals;
    - A route part is the road between two choice nodes and is used to detect traffic problems;
    - A control segment is a road section in the traffic network where the capacity can be affected and can be used to affect traffic flow;
    - A (regular) node is an intersection where traffic cannot be affected and the road users do not have a choice between travel alternatives;

- A choice node is a node where the road user can choose between travel alternatives and can be used to affect traffic flow;
- A control node is a node in the traffic network where the capacity of one or more directions can be affected and can be used to affect traffic flow.

For each choice node, control node and control segment it has to be predefined which are the available DTM-services. After this building block the result is a defined available road network (see Figure 1).

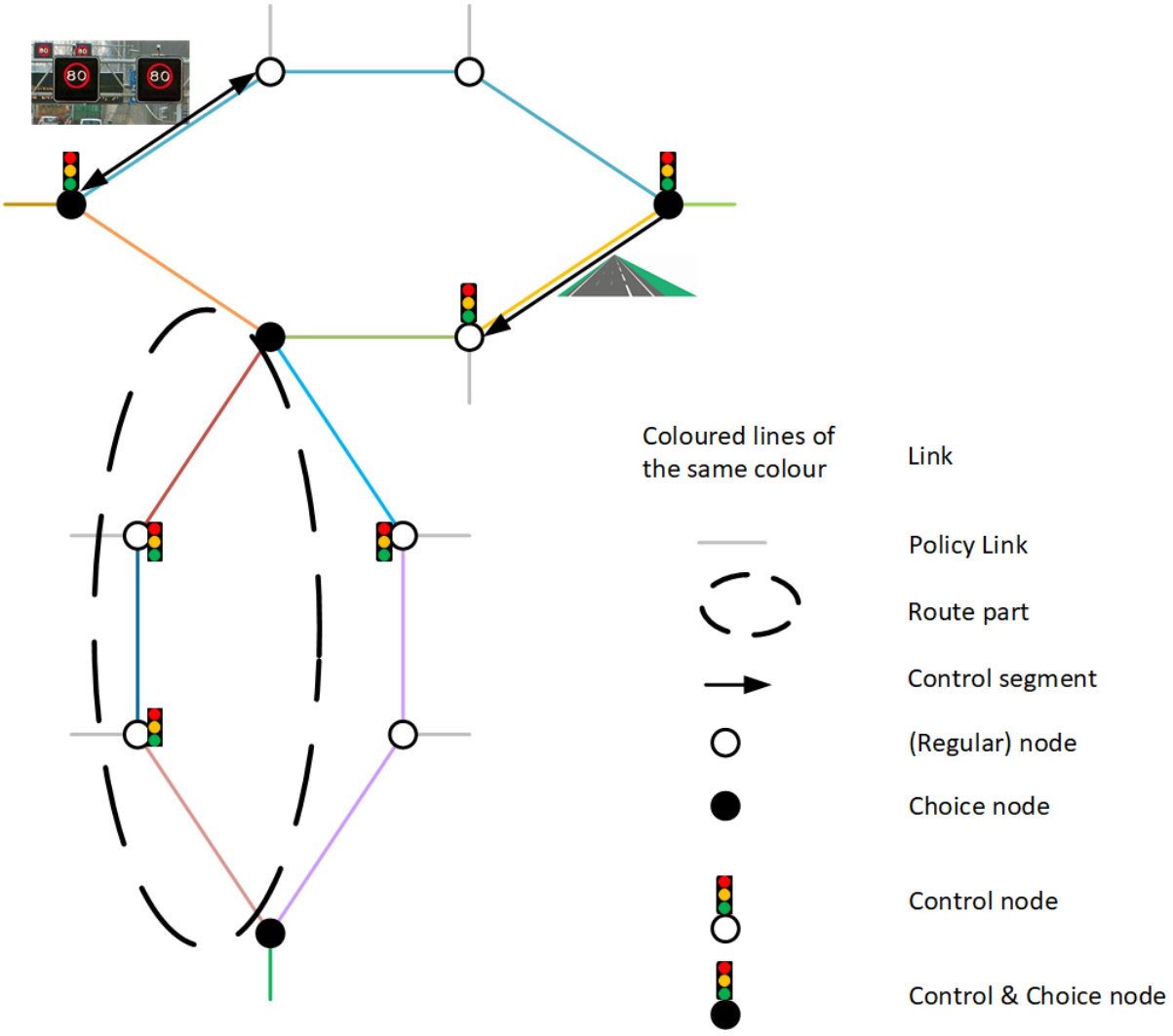

Figure 1 – Road network including all types of links, nodes and segments.

3. **Identify contribution smart mobility services**: four different strategies are distinguished, each strategy representing a target. Typically, but not necessarily, they are applied as escalation phases, the first being the least severe one and the last being the most radical one.
   I. Inform traffic
   II. Enlarge the outflow
   III. Reduce the inflow
   IV. Reroute traffic (demand)

For each choice node, control node and control segment it is necessary to predefine the available DTM services that can contribute to achieving each strategy. For traditional traffic management services, like providing more green time for a specific direction at an intersection and displaying alternative routes on VMSs, it is relatively easy to conceive how these can be activated or adapted within this framework. For example, simple changes to the configuration of a traffic light controller can enlarge the outflow or reduce the inflow of traffic at a certain control node. Then how to include non-traditional services offered by service providers?

Smart mobility services integrated in the 'Control Strategy'

The approach for integrating smart mobility services is very similar to the approach (building blocks) applied for more traditional DTM-services. First, based on a policy defined by a road authority a definition of the importance and function of roads as well as quantitative thresholds for links and route parts should be described. Secondly, the available smart mobility services have to be allocated to choice nodes, control nodes and control segments in the network. And finally, for each choice node, control node and control segment it is necessary to predefine the available smart mobility services that can contribute to achieving each strategy.

1. **Policy**

   This step is exactly the same as it is for traditional DTM services: a description of the importance and function of roads as well as quantitative thresholds for links and route parts

2. **Identify available smart mobility services in the available network**

   The second step is to identify for each choice node, control node and control segment the available smart mobility services. This step is a slightly different than it is for traditional traffic management services. For traditional traffic management services road authorities can identify the available services by themselves, for identifying smart mobility services road authorities are partially dependent on the smart mobility services provided by service providers. Therefore, part of this step is a dialogue between road authorities and service providers in which they identify the available services and how/under what circumstances these services can be activated.

3. **Identify contribution smart mobility services**

   The last step is to identify the contribution of smart mobility services to each of the four strategies (inform traffic, enlarge outflow, reduce inflow, reroute traffic). This step should provide insight in the impact of smart mobility services. See table below for an example for five smart mobility services.

Table 1 – Example of outcome of step 3

Smart mobility service	**Primary objective**	**Inform traffic**	**Enlarge the outflow**	**Reduce the inflow**	**Reroute traffic (demand)**
Green priority for designated vehicles	Reduce delay time at traffic light for designated vehicles	-	Enlarge the outflow of priority directions	-	-
Flexible infrastructure (HOV, peak-hour lanes)	Control available road capacity	-	More road capacity increases the outflow	Less road capacity reduces the inflow	-
In-vehicle signage road section	Present dynamic road sign information for road sections in the vehicle (personalised and extrapolated)	Inform about conditions, restrictions	e.g. speed harmonisation increases outflow	e.g. speed harmonisation reduces inflow	-
In-vehicle signage route	Present route and travel time information in the vehicle (personalised and extrapolated)	Inform about options	-	-	e.g. travel time information and route advice
Mode & trip time advice (e.g. by incentives)	Multi-modal travel and departure time advice (MaaS-like concept, by incentives)	Inform about conditions, restrictions and options	-	-	Delayed trips or trips by collective modes reduce demand

When reviewing the complete list of smart mobility services, only a subset are suitable for inclusion in aforementioned framework. Most notably it has to be acknowledged that some services, e.g. in-vehicle signage, represent an extensive set of use cases and thereby are an array of potential services.

Operational process

The process for activating smart mobility services is very similar to the process for activating traditional traffic management services. First of all, based on network assessment the traffic problem as seen from the traffic manager (or road authority) perspective is identified and the traffic situation including bottlenecks and the primary causes of these bottlenecks are described. Thereafter, the preferred situation is defined, which provides an objective for the control strategy. The core step is to identify which (available) services could provide (a part of) the solution for the traffic problem. Here, note that some services are under direct control of a traffic manager (e.g. services that require adaptation of traffic lights), whereas others require the involvement of service providers and are

therefore subject to business and collaboration models. The resulting set of (traditional and non-traditional) services together constitutes the control strategy to be activated to tackle the traffic problem.

An example of the operational process for activating smart mobility services is shown in Figure 2. In this example, a road operator detects a traffic jam in its network and wants to solve this traffic jam. Therefore, the road operator chooses a strategy to enlarge the outflow by activating speed harmonisation (IVS) for drivers. The road operator provides this information to service providers. Notice that it is not required to have dynamic traffic signs on this road section. Service providers now have an extra service available for drivers and will provide this to their customers. The customers of the service provider receive this information on their HMI.

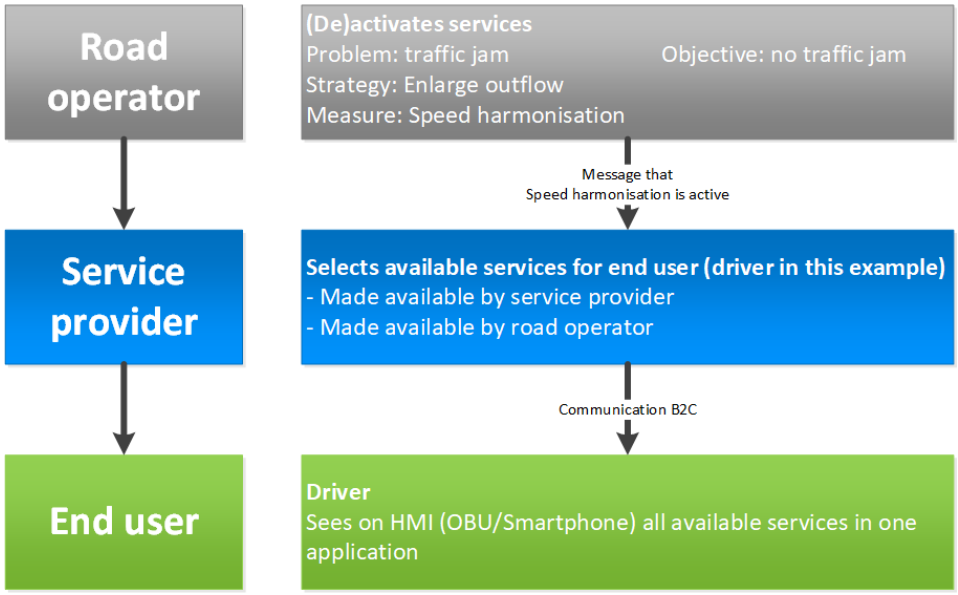

Figure 2 – Example of the operational process for activating smart mobility services

Requirements for deployment

In order to deploy the control strategy including smart mobility services, the following requirements apply:

- It must be possible to create an 'operator view' (monitor) of all the traffic network, available services (e.g. through the Services Directory), active services (services that are turned 'on') and how services are affecting the traffic performance (for example with how much the capacity is increased by opening a rush hour lane).
- Architecture and interfaces must support that an operator can interact with (has access to) services in the field, be it services under direct control of the operator (e.g. traffic lights) or services operated by service providers. In case of the latter, service providers and operators should agree on how and in what situations operators are allowed to access services operated by service providers.

Conclusions and next steps

In the C-MobILE project [2], smart mobility services will be integrated in operational dynamic traffic management by implementing the control strategy as described in this paper. From 2019 this control strategy will be operated in the eight C-MobILE deployment sites (Barcelona, Bilbao, Bordeaux, Copenhagen, Newcastle, North Brabant, Thessaloniki and Vigo) and evaluated for two years.

Next to impact on traffic performance the inclusion of smart mobility services in operational dynamic traffic management has other benefits to road authorities. Firstly, road operators will have more dynamic traffic management services available to manage traffic, resulting in a more effective operational traffic management and a better network performance. Secondly, road operators are more in control with regards to operational traffic management as one common dynamic traffic management strategy is operated by service providers and road operators.

Ongoing work includes to further quantify the magnitude of the impact of services in different projects to allow ex-ante assessment of the effects of services as input to the decision-making process. Also the effects of simultaneous operation of multiple bundled services should be better understood. Secondly, it is imperative that the collaboration principles for service providers and road authorities needs to be further defined. Finally, test cases and impact assessment plans are developed to evaluate the effects of integration of smart mobility services in operational traffic management, both organizationally and on the performance of the traffic network.

Acknowledgement

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References

1. SOCRATES 2.0, URL: https://socrates2.org/
2. C-MobILE, URL: http://C-MobILE-project.eu/
3. MyCorridor, URL: http://mycorridor.eu/
4. Krikke, R., Spreeuwenberg, S. (2015). *Handboek verkeersmanagement – Module Regelaanpak, Werkwijze en richtlijnen voor de inrichting van een regelaanpak voor verkeersmanagement*, Ede, The Netherlands: CROW.