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Modeling impact of Variable Message Sign on routing in DTA with Information Comply Model

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Abstract

Variable Message Signs (VMS) are widely applied in urban transport networks. Their main purpose is to inform the drivers about the actual traffic situation and events. Drivers utilize the VMS information to update their routing decisions and in turn to avoid unexpected delay. If the VMS informs driver that the travel time on his route increased significantly from what he expected, he may react by shifting from current route to a better one. Here we call this phenomena (changing the currently chosen path, after receiving some information about a traffic event) rerouting. The representation of rerouting phenomena is particularly challenging if the information reaches a driver who is already travelling toward the destination. Here we focused on extending recently proposed ICM model (Kucharski, et. al, 2014) to capture the rerouting phenomena when information is provided on the VMS.

1 Context

Recently, we have proposed two approaches to simulate rerouting phenomena in the context of a macroscopic DTA model: the Rolling-Horizon Model (RHM, Gentile et al., 2013) and the Information Comply Model (ICM, Kucharski et al., 2014). Here, we extend the ICM to handle the rerouting due to VMS information.

Proposed model is designed as part of DTA and its machinery is designed for seamless work within the DTA granting both efficiency and sound representation of the phenomena We follow and extend the DTA as defined by (Bellei et al., 2005), where the macroscopic dynamic assignment model was proposed and defined as a fixed-point problem. We apply theoretical considerations of ATIS by (Bifulco et al., 2009) and employ the information spread observations (Procter et al., 2013).

2 Background: Information Comply Model

ICM models the rerouting phenomena by asking: when?, why? and where? do drivers reroute. And the answer is given through a set of three sub-models:

1) the **information spread model** is a function of time, global severity of the event at given time. It gives share of flow that received the information.
2) the **experience model** is a function of the driver's location and time. The main factor playing role here is experienced delay.
3) the **compliance model** is model of consequences of not rerouting (measured with functionals of node potentials (Dial, 1971) and arc conditional probabilities). Compliance model gives share of drivers that will comply.

The outcome of the three models is a share of flow which reroutes at each node at each time. Technically idea of ICM is to operate on two cost patterns: typical and actual (including unexpected event). We specifically call rerouting decision the moment at which driver starts using the actual costs for routing. The ICM works with the default input available during the DTA and can be fit inside the fixed-point DTA schema. ICM gave a good results during test on both small and real-size networks providing meaningful results.

3 ICM applied for VMS

Here we apply the ICM for the case when mains source of information is VMS. The machinery of ICM remains intact and only the information spread model is modified. In ICM the information was assumed to spread over the communication networks (i.e. Radio, Twitter, Traffic Services, etc.) which are independent of the transportation network, the information spread in time reaching more drivers regardless their location. The VMS-es on contrary are placed in the transport network and are passed by drivers in time. Thus they deliver the information only to the drivers who pass the VMS during broadcast. The informed drivers propagate on the network in time according to their destinations. Therefore the share of informed drivers is dependent on their location and their origin and cannot be modelled by simple time evolution process like in ICM. To handle this we modify the information spread model of ICM.

First let's assume that VMS is the only source of information. This way we can substitute the ICM information spread model $\iota_{id}(\tau)$ (share of drivers traveling from node i towards destination d at time τ who has received the information) with $v_{id}(\tau)$ (share of drivers traveling from node i towards destination d at time τ who has passed the VMS while it was active). We obtain $v_{id}(\tau)$ within Network Flow Propagation (NFP) when flows from all the origins are propagated towards single destination using demand pattern. We extend NFP so that we additionally propagate the flow from the VMS points. In modified NFP procedure at each node the share of drivers who has actually seen the VMS is available. This way we overcome the limitation of implicit-path, destination-based NFP where information about origin (and past) is lost. This modification is implemented in non-invasive way, so that computation burden is minor.

However in reality the information is spread both through the VMS and through other communication networks. Thus to obtain more realistic results we need to capture both processes simultaneously. We address it as follows: Let's divide the flow into two parts the drivers which passed the VMS and the drivers which didn't. The drivers who passed are all informed. The remaining path is informed according to the default information spread model of ICM.

In both cases the informed drivers enter the remainder of ICM machinery to finalize the rerouting. First, within the compliance model, they choose whether they comply to information or not and then a new path is chosen based on actual travel costs.

4 Application

Proposed model can be applied for both planning and real-time management purposes. Planner can assess the locations for VMS to optimize their impact as shown in the example below. In real-time the modeller can use the proposed model to forecast the effects of the VMS on the flows in the network for given unexpected event.

5 Results

We show the results of the algorithm on the simple toy network. We analyse the efficiency of the two locations for VMS (VMS1 and VMS2). The VMS is active from 2:30 to 2:45. The model shows that second location has greater impact as it is passed by more drivers.

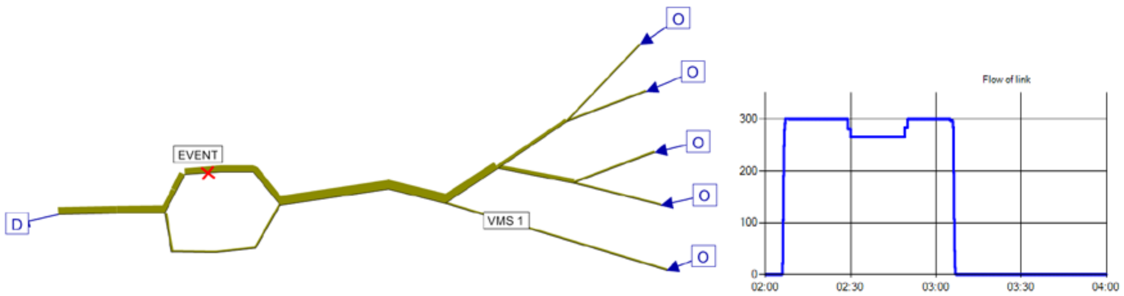

Fig.1 Impact of placing VMS at location VMS1 on flows - small share of flow at link of event is affected (left).

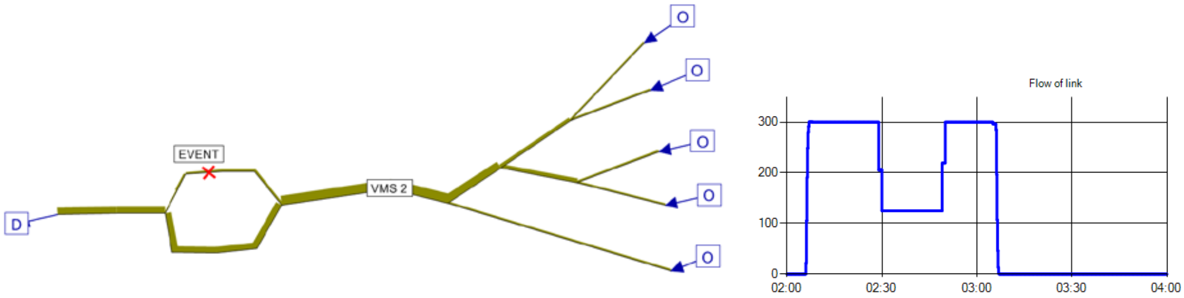

Fig.2 Impact of placing VMS at location VMS2 on flows - much greater share of flow at link of event is affected (left).

Keywords: DTA, rerouting, VMS, ATIS, route-choice, en-route rerouting, information spread.

References

The short list of references presented below is only mainly aimed at delineating the research stream followed by the authors. A proper literature review goes beyond the scope of the extended abstract.

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