Generalized Macroscopic Fundamental Diagram: Network Dynamics, Level of Service and Resilience Applications

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The generalised Macroscopic Fundamental Diagram (g-MFD) relates the network traffic density and the spatial variation of this density. Recent work of the authors show that by using both the average and the standard deviation in the density, a very crisp relation can be found.

This paper presents empirical results for the g-MFD using empirical data collected for the freeway network around Amsterdam. Next to presenting the g-MFD, we will show how the dynamics in the network relate to the path of the network state in relation to the network conditions. We will discuss regular dynamics, as well as the dynamics in case of incidents occurring in the network. An example is given by Fig. 1, showing the network state path for an incident case. We see how the dynamics of the path are influenced by the incident: when the incident occurs at 19:00, the path breaks away from the congestion recuperation path it was moving along. From this point onwards, the path moves in the vertical direction showing that the average density stays about the same, while the spatial variation increases considerable.

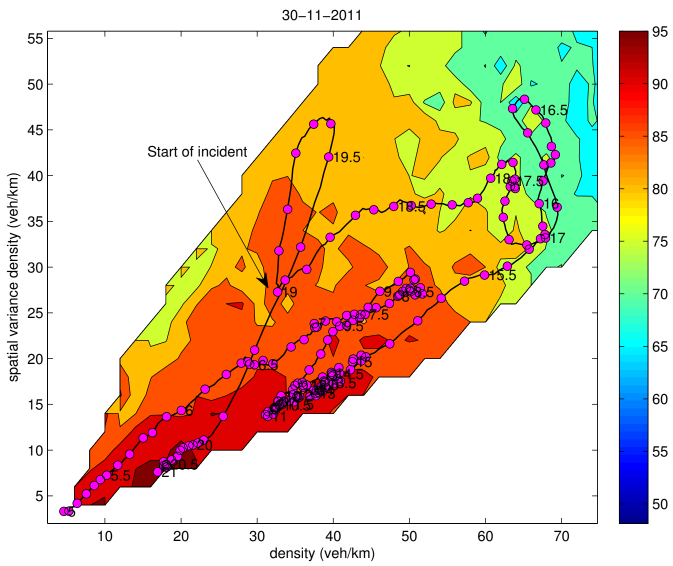

Figure 1: Network state path $(k(t), \sigma(t))$ in relation to the g-MFD. The arrow indicates the starting time of the incident.

The presented results justify using the g-MFD for a number of applications that will be detailed in the rest of the paper. First of all, the g-MFD can be used to determine the network-wide service-level, both for recurrent and non-recurrent situations. The results for incident situations motivate the second application, namely the analysis of the resilience of the network by looking a the changes in the service level for specific network states. We will illustrate these applications using the aforementioned Amsterdam test case.