The effects of optimizing public transport on the bi-modal network capacity: A microscopic simulation approach

Master's Thesis of Antonia Pawlowski

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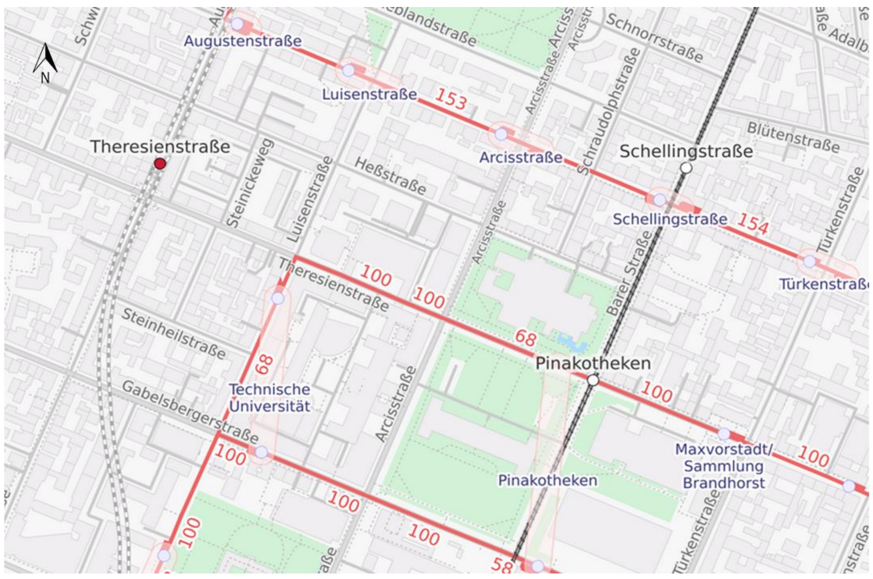

Fig. 1: Map used for the case study retrieved from https://osm.org/go/0JAfzFaS?layers=T on 07.12.2020

A case study examines the bi-modal network capacity of an area of approximately 1 km² in the district of Maxvorstadt in Munich, Germany. Four scenarios are conducted in the case study. The base scenario without any preferential treatment of buses constitutes the first scenario. The second scenario examines the effect of allocating bus lanes in a network. Five different bus lane segments are chosen based on the bus lines operating on these lanes, the length of the lanes, and the road characteristics. All combinations of the five segments are tested resulting in 31 sub-scenarios which are executed to find the optimum distribution of bus lanes in the network. In a third scenario, transit signal priority (TSP) is implemented at all signal-controlled intersection where buses operate. The fourth scenario comprises a combination of both priority measures: On the one hand, the earlier determined optimum distribution of bus lanes is applied, and on the other hand, TSP is employed at all signal-controlled intersection where buses operate. The 3D-pMFD is estimated for all four scenarios. The aim is to find bus lanes and TSP specifications that maximize the bi-modal network capacity and the system's robustness in a microscopic simulation environment compared to the base scenario.

Scenario	Bus priority measure	Maximum passenger production [pers-m/s]
Scenario 1	-	1207
Scenario 2	Bus lanes	1853
Scenario 3	TSP	1130
Scenario 4	TSP and bus lanes	1244

Tab. 1: Bus priority measure and maximum passenger production of the four scenarios

The three-dimensional passenger Macroscopic Fundamental Diagram (3D-pMFD) shows the vehicle accumulations of two transportation modes (mostly private cars and buses) in relation to the passenger production in the network. This allows to analyze the capacity of bi-modal urban networks.

This thesis presents an approach to increase the passenger throughput and thus improve the capacity of a bi-modal urban network by prioritizing buses in mixed traffic. To prioritize buses, bus lanes and transit signal priority are considered.

An approach is introduced for estimating the 3D-pMFD based on the output data from microscopic simulations using the multi-modal simulator SUMO.

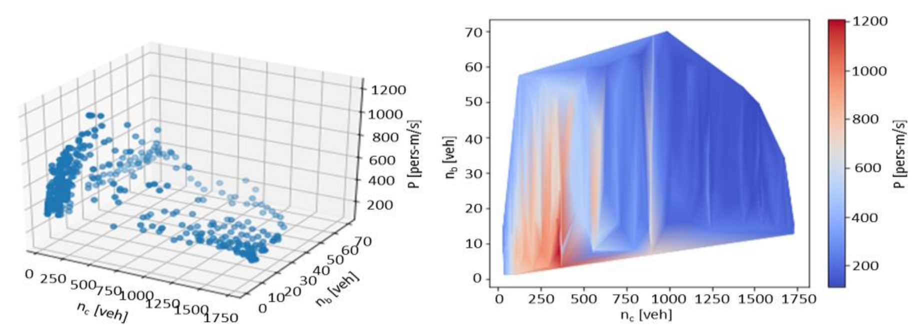

Fig. 2: 3D-pMFD of the base scenario

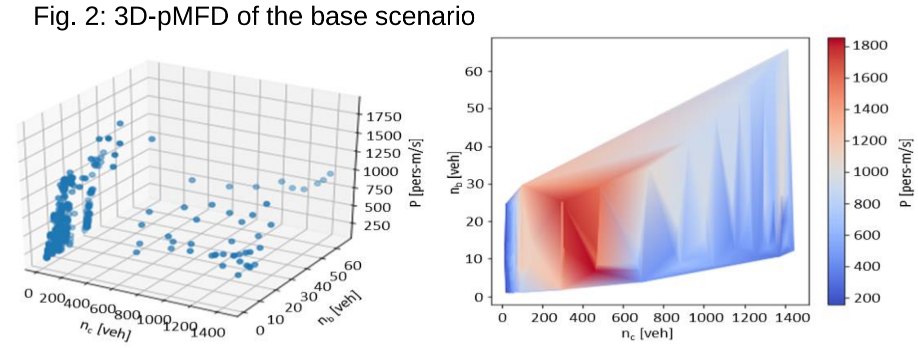

Fig. 3: 3D-pMFD of the optimum scenario

The case study demonstrates that a significant increase in the passenger throughput and thus in the bi-modal network capacity is achieved by declaring well-selected bus lanes with a total length of 2.43 lane-kilometers. The bus lanes are assigned to one complete stretch from one end to the other in both directions and to a lane of an additional road. However, a successful allocation of bus lanes is dependent on the distribution, length, road characteristics and number of bus lines operating on these lanes. In contrast, employing TSP at signalized intersections does not result in the expected improvement of the bi-modal network capacity. The reason for this might be the simplified approach of implementing TSP in SUMO and the fact that routes and modes are calculated without considering TSP. Furthermore, even employing TSP and allocating bus lanes can barely increase the capacity.