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Shared Automated Vehicle Services in Multimodal Network Simulation

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Thesis submitted for the degree of Master of Engineering: Logistics and Traffic

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Preface

This work is the final result of my Master of Engineering in Logistics and Traffic at KU Leuven.

I want to thank Prof. dr. ir. Tampère for his inspiring and persuasive introduction to traffic engineering and sparking my deep interest in the field. Thanks to Prof. dr. ir. Cattrysse for offering insights into the equally exciting domain of operations research. Further, I would like to thank my mentors, ir. Paul Ortmann, ir. Mohammad Ali Arman and ir. Gaurav Malik, for their advice and guidance throughout the research process. Moreover, my gratitude goes to PTV for putting its traffic planning software at our disposal.

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Since I first got in contact with traffic engineering, my interest in this field has been ever-growing. This thesis was an enjoyable first encounter with proper research, an area I am eager to continue in.

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Contents

Abstract

Vehicle automation and shared mobility are recognised as a technology and concept that can bring significant opportunities for our mobility system. However, when deployed improperly, they could entail risks as well. To develop successful policies aimed at realising the advantages of shared automated vehicles (SAVs), a better understanding of how SAVs may be adopted is necessary. Therefore, we should be able to include this new type of service in our modelling tools in order to evaluate different scenarios. Essential questions are: What will be the impact on regular traffic when these services are introduced, and how much demand will they attract? This thesis aims to develop a model that enables to simulate scenarios including an independent SAV service and perform scenario analysis from the different stakeholders' perspectives. The developed model is a multimodal equilibrium assignment model based on the macroscopic modelling approach of the mode choice and assignment steps in the traditional 4-steps traffic model. However, a microscopic modelling approach based on operations research is used to model the SAV service supply properly. Specific consideration is given to integrating a multimodal static traffic assignment problem and a solver for the pickup and drop-off problem with time windows. The model is applied to a case study of Leuven, Flanders, Belgium. This thesis considers vehicles of automation level 4 and incorporates a subnetwork in which these vehicles are allowed to drive. Experiments on the model behaviour in terms of convergence are performed. Results suggest that the model is able to reach convergence in link travel times as well as establish the modal split in an equilibrium context for the scenarios considered. Additionally, a proof of concept on the added value of the tool is given. This is done by evaluating different scenarios from a societal (authority) perspective, a traveller's point of view and an SAV service provider's position, using different key performance indicators (KPIs). KPIs are determined on and among others: the modal split, the total vehicle kilometres and hours travelled, the average waiting time, the number of self-driving vehicles used, and the average number of passengers served per SAV.