Assessing the energy impacts of automated on-demand service deployment strategies in sprawling, auto-dependent cities

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Introduction

The rapidly advancing developments in vehicle automation and related technologies have increased near-term prospects of varying levels of Automated Vehicle (AV) deployment in several urban areas. As AV technology matures and gains broader acceptance, its integration with on-demand services is poised to disrupt the mobility sector. Restricted testing of AVs is already ongoing in Singapore and various cities in the US, with companies such as Waymo, Cruise, Uber and nuTonomy at the forefront. Limited Automated Mobility on-Demand (AMOD) service deployment is also expected to increase, with a few already launched (e.g. Cruise operates AMOD for its employees in San Francisco; Etherington, 2017). While progress has been made in simulating various outcomes, very little has been done to estimate the energy and environmental impacts of the large-scale deployment of AMOD services. In this research effort, we simulate various AMOD strategies in a prototype city that is representative of large auto-dependent cities that are largely found in North America. We apply energy models to measure the consumption of various vehicle powertrains across the network using an agent-based simulator. Our results provide insights for efficient deployment strategies and indicate future research directions in energy outcomes for future mobility.

Methods

We simulate a prototype city in a multi-modal framework, SimMobility MidTerm (Adnan et al, 2016), which executes agent behavior and travel patterns at a mesoscopic level. The prototype city is developed from an urban typology (Oke et al, 2018; forthcoming) that represents sprawling, auto-dependent cities with low public transportation mode share. This typology was one of the 13 discovered in a global discovery effort. In developing the prototype city for simulation, a pipeline for population synthesis, network generation, demand and supply model calibration was applied (Oke et al, 2018; forthcoming). A state-of-the-art AMOD controller (Basu et al, 2018) developed for SimMobility underlies the strategies explored: (i) base, (ii) AMOD introduced as a new mode, (iii) AMOD deployed with no mass transit and (iv) AMOD as first/last mile service. These strategies are iteratively simulated for 24-hr periods with network feedback loops. Calibrated energy models (Rakha et al, 2011; Fiori et al, 2016; Wang, 2017), provide multimodal measurements across each of the strategies. Estimates of CO_2 emissions are also provided in each case. Costs of implementation are also compared.

Expected results

We compare energy, emissions and costs across three AMOD deployment strategies (along with the base case), each representing a potential mobility future. The results indicate potential policy pathways for sprawling auto cities exploring future investments and improvements in their transportation systems.