INTRODUCTION

- Automated Mobility-on-Demand (AMoD) combines benefits of MoD with AVs – low operational cost; superior energy efficiency; reduction of negative externalities; increased road network utilization; decrease in insurance and parking cost
- Most literature focuses on efficiency of AMoD and AVs in terms of on-road movement and fleet management
- How will AMoD impact an urban transportation system?
- Requires a holistic integrated research approach → demand and adoption coupled with supply and movement
- Two-fold contribution:
  1. Introduction of a flexible framework, developed in SimMobility
  2. Case study: role of mass transit in future urban transportation systems

SIMMOBILITY

- Open source transportation systems simulator: agent based, multi-scale, multi-modal, integrated (demand and supply are simulated)
- Mesoscopic supply and microscopic demand simulator → Mode choice, Route choice, Activity pattern

AMOD FRAMEWORK

- AMoD is made available in the pre-day as a viable mode
- A-priori values of generalized travel cost set according to literature; updated later using day-to-day learning module
- Travelers adjust their travel choices (mode, route, etc.) based on these values
- Flexible enough to allow testing of different hypotheses (adoption rate, price, service)

   Design in supply simulator has three components: passenger, vehicle, and controller
   - Passenger: picks up and drops off passengers;
   - Vehicle: serves passengers and reduces number of trips;
   - Controller: allocates resources based on demand.

   Waiting time of all passengers included in the schedule, as well as of the new passenger, must be below a certain threshold [10 mins for case study]

   Additional delay, which accounts for detours due to ride-sharing must be below a certain threshold [10 mins for case study]

EXPERIMENT DESIGN

- A prototypical city - Virtual City, which resembles land use patterns, travel behavior, and activity patterns observed in Singapore
- Total population: 351,000 (~10% of Singapore)
- Network: 95 nodes, 286 segments, 12 bus lines, 86 bus stops, 4 MRT lines, 20 MRT stations
- Available modes: single occupancy car (Car), pooling with one extra passenger (Carpooling 2), sharing with two extra passengers (Carpooling 3), public bus (Bus), Mass Rail Transit (MRT), traditional taxis (taxi), motorcycle (Motorcycle) and walking (Walk)

BASE CASE | WITH AMoD | WITHOUT MASS TRANSIT
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No smart mobility services | Introduction of AMoD; all other modes kept available | Removal of mass transit modes, i.e. Bus and MRT
Available modes are those mentioned above | Intermode door-to-door service, AMoD also provides first and last mile connectivity for mass transit |  

RESULTS

MODE CHOICE

- Mode Choice: AMoD more preferable to taxi due to lower tariffs; Drop in Bus share is compensated by AMoD;
- Multi-service AMoD drives increase in MRT share (With AMoD scenario)

SYSTEM PERFORMANCE

- System performance metrics | network congestion: Extremely high levels of congestion without mass transit which does not drain away during off-peak unlike other scenarios
- User performance metrics | travel time: In-vehicle travel time increases drastically due to congestion; dynamic fleet sizing strategy enables low waiting time for AMoD and taxi
- AMoD performance metrics | sharing and VKT: Shared trips increase by 30% as demand increases; 40-50% of AMoD VKT while going for a pick-up/parking and empty vehicle cruising

USER PERFORMANCE

- Completely replacing mass transit with AMoD might not be possible without adversely affecting user experience and LOS
- AMoD may help augment mass transit travel by providing first and last mile connectivity
- Next Steps: urban vs sub-urban; effect of subsidies for AMoD; more refined ride-matching and fleet sizing algorithms
- When are we better off without mass transit, and when does mass transit complement AMoD?