Motivation

• “How can we design profitable and sustainable mobility systems that leverage AVs?
• What will these new forms of mobility and transportation mean for society?
• How can we ensure that such technologies benefit all members of society, improving equity rather than undermining it?”
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• What will these new forms of mobility and transportation mean for society?
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• A laboratory for analyzing future urban scenarios
• Multiple spatial-temporal scales
• Integrated/modular agent-based platform
• Mobility-sensitive behavioral dynamic plan/action models
• Local and city-wide multimodal networks
• Open-source development
SimMobility Mid-term

• Activity-based demand with dynamic multi-modal assignment
  • Three components:
    o Pre-day
    o Within-day
    o Supply (inc. controllers)
  • Models scenarios/events and their effects on network performance

https://github.com/smart-fm/simmobility-prod
SimMobility and SAVs: a love story…

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<th>Fleet sizing</th>
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Simulation of cities vs. prototypical cities

- Data
- Calibration
- Detailed scenarios
- Detailed outputs
- Transferability

**Objective:** Assess typology-relevant impacts of AMoD scenarios via large-scale agent-based simulation

http://energy.mit.edu/research/mobility-future-study/
Finding Urban Typologies (Oke et al, 2019)

• Data
Urban data from 331 cities (40% of global urban population)
Behavior data from 225 cities, over 18000 individual samples

• Exploratory step
Factor analysis: 9 factors from 64 indicators: mobility, economy, environment, social development, urban form and geography
Hierarchical agglomerative clustering: 12 typologies

• Confirmatory step
Latent class choice model framework
Segments behavior shaping city classification and provides choice parameters
Probabilistic classification to confirm exploratory results

http://its.mit.edu/typologies
Urban Typologies (Oke et al, 2019)
Urban Typologies (Oke et al, 2019)
AMoD scenarios in 3 prototype cities (Oke et al, 2020a & b)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Auto Sprawl</th>
<th>Auto Innovative</th>
<th>MassTransit Heavyweight</th>
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<tbody>
<tr>
<td>Car</td>
<td>86%</td>
<td>79%</td>
<td>32%</td>
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<tr>
<td>Mass Transit</td>
<td>3.5%</td>
<td>11%</td>
<td>37%</td>
</tr>
<tr>
<td>Walk</td>
<td>3.3%</td>
<td>3.3%</td>
<td>23%</td>
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<tr>
<td>Population Density (1000/sq. km)</td>
<td>1.0</td>
<td>1.3</td>
<td>3.9</td>
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<tr>
<td>CO₂ / hab. (metric tonnes per year)</td>
<td>16</td>
<td>15</td>
<td>10</td>
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<tr>
<td>Examples</td>
<td>Baltimore, Tampa, Raleigh</td>
<td>Washington DC, Atlanta, Boston</td>
<td>Berlin, Madrid, Seoul</td>
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</tbody>
</table>

Auto Sprawl: auto-dependent, low-density
Auto Innovative: auto-dependent, multimodal
MassTransit Heavyweight: transit-oriented, dense
Scenarios

• **Base Case**
  o existing on-demand services; mass transit and private modes

• **AMoD Intro (AMOD)**
  o AMoD (Single and Shared) replaces existing MoD
  o AMoD fare is 50% that of MoD in 2016

• **AMoD No Transit (AMOD NT)**
  o Transit abandoned
  o Simulated only in Auto Sprawl and Auto Innovative

• **AMoD Transit Integration (AMOD TI)**
  o AMoD restricted to local trips and 20% discounted access/egress to mass transit

• **AMoD + Car Reduction (AMOD CR)**
  o 25% reduction in household car ownership (via ownership tax)
  o Simulated only in MassTransit Heavyweight
Impacts: Demand

Auto Sprawl

Auto Innovative

MassTransit Heavy.

Mode share (%)

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<tr>
<th></th>
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<th>AMOD</th>
<th>AMOD NT</th>
<th>AMOD TI</th>
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<tr>
<td>3.5%</td>
<td>4%</td>
<td>6%</td>
<td>6.5%</td>
<td>5%</td>
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<tr>
<td>3%</td>
<td>3%</td>
<td>13%</td>
<td>15%</td>
<td>7%</td>
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<td>5%</td>
<td>10%</td>
<td>8.5%</td>
<td>16%</td>
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<td>4%</td>
<td>4%</td>
<td>13%</td>
<td>12%</td>
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<tr>
<td>86.5%</td>
<td>77%</td>
<td>77%</td>
<td>75%</td>
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<tr>
<td>MassTransit Heavy</td>
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<td>25.5%</td>
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<td>25%</td>
<td>38%</td>
<td>36%</td>
<td>41%</td>
<td>39.5%</td>
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<tr>
<td>25%</td>
<td>33.5%</td>
<td>32%</td>
<td>26.5%</td>
<td>32%</td>
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Impacts: Congestion and VKT

Auto Sprawl
- Base: VKT (million km) = 100
- AMOD: +9%
- AMOD NT: +14%
- AMOD TI: +13%

Auto Innovative
- Base: VKT (million km) = 100
- AMOD: +26%
- AMOD NT: +150%
- AMOD TI: +29%

Mass Transit Heavy
- Base: VKT (million km) = 100
- AMOD: +29%
- AMOD CR: +380%
- AMOD NT: +480%
- AMOD TI: +190%

Travel Time Index
- Base:
- AMOD:
- AMOD NT:
- AMOD TI:
- AMOD CR:
- AMOD T1:

On-Demand
Private Car
Impacts: Energy and emissions
Conclusions

• Urban typologies have been discovered for cities across the globe using the latest available urban and behavioral data

• AMoD introduction is detrimental to all prototypes studied
  o Cannibalizes transit by up to 20%
  o Increases VKT by up to 30% and congestion by up to 50%
  o Energy and emissions impacts are city-dependent

• AMoD cannot substitute transit in denser cities

• Congestion increases significantly by 65% over Base Case

• Impacts of “unrestricted” AMoD could be mitigated through policy interventions

• The road ahead: adding preferences information (Oh et al, 2020), accessibility-based measures (Nahmias-Biran et al, 2020) and long-term choices (Le et al & Basu et al, 2020)
Topologies study: Moshe Ben-Akiva, Jimi Oke, Arun Akkinepally, Carlos Lima Azevedo, Bat-hen Nahmias-Biran, Ravi Seshadri, Chris Zegras, Joseph Ferreira, Sean Hua, Michael Choi, Yafei Han, Eytan Gross, Youssef Medhat, Iveel Tsogsuren, Siyu Chen, Randy Field and the MITei team.

Teams exploring SimMobility for SAV related studies:
References


