DTU MLSM
Machine Learning for Smart Mobility

http://mlsm.man.dtu.dk

Autonomous and connected transportation systems workshop

IEEE ITSC 2020

Carlos Lima Azevedo

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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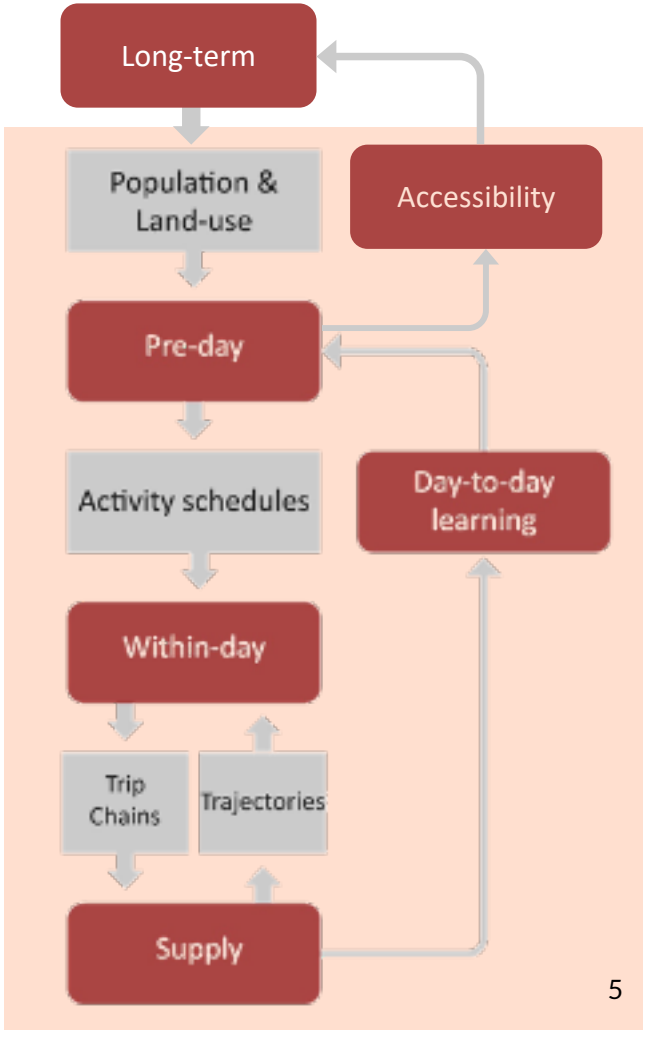
- A **laboratory** for analyzing future urban scenarios
- Multiple spatial-temporal **scales**
- **Integrated/modular** agent-based platform
- Mobility-sensitive **behavioral** dynamic plan/action models
- Local and city-wide multimodal **networks**
- **Open-source** development

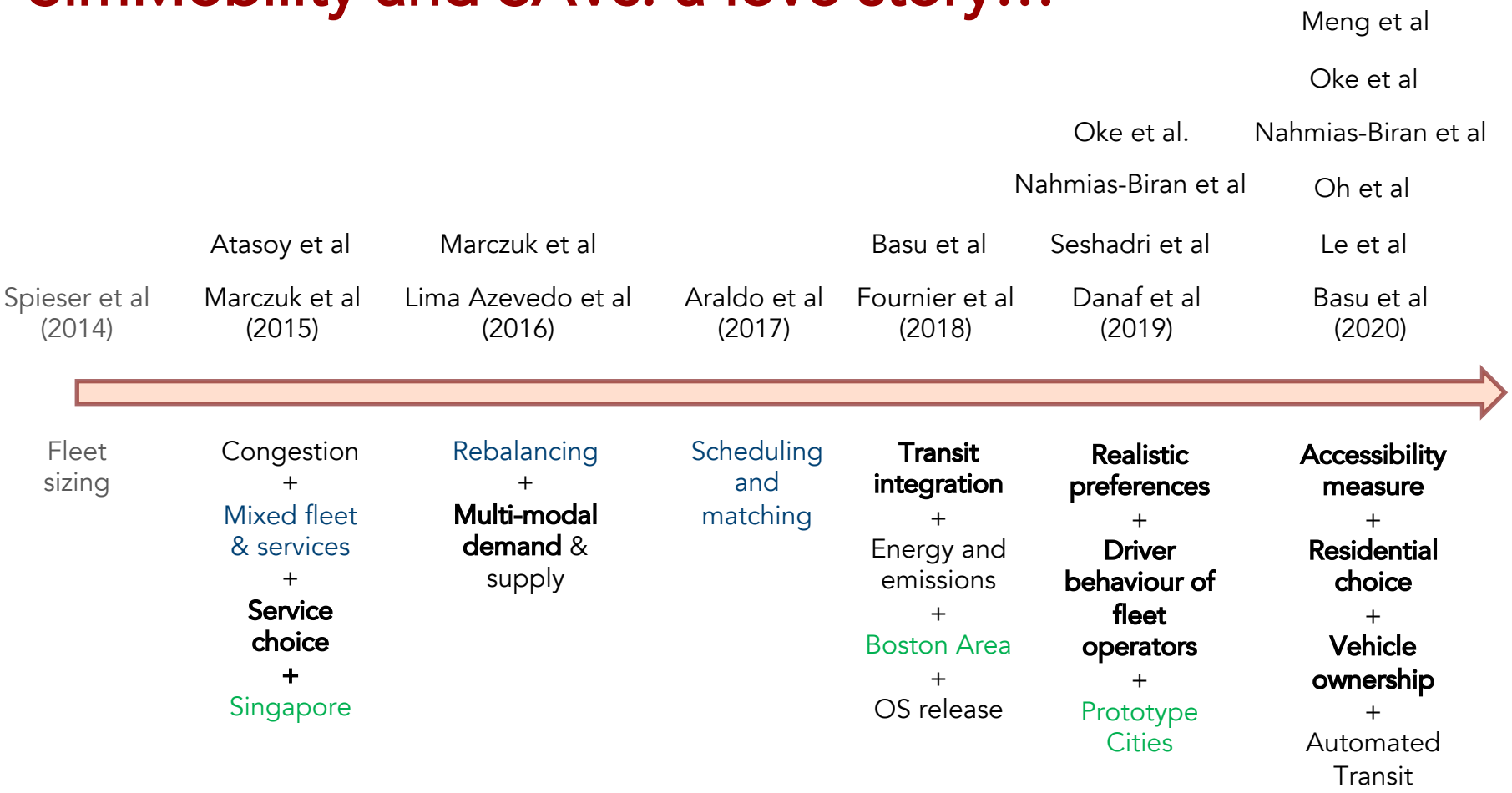
SimMobility Mid-term

- Activity-based demand with dynamic multi-modal assignment
- Three components:
  - Pre-day
  - Within-day
  - 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…

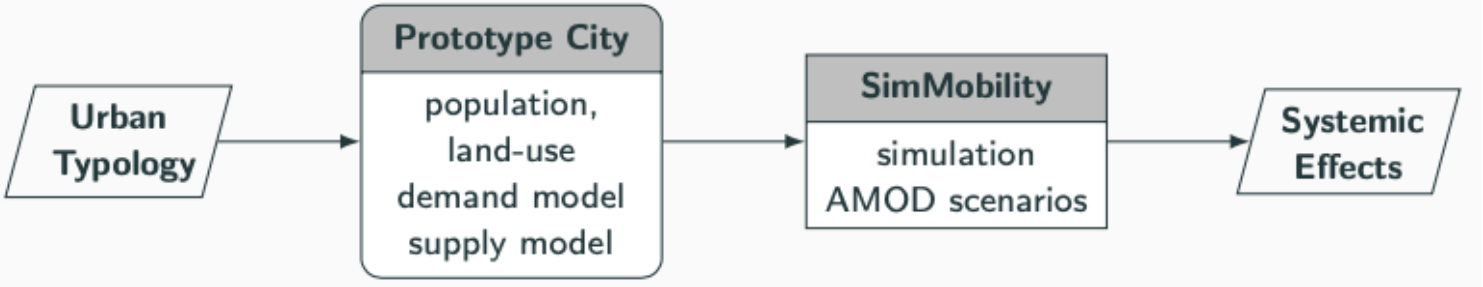


http://energy.mit.edu/research/mobility-future-study/

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



MITei MIT Energy Initiative

Massachusetts Institute of Technology

SMART Singapore-MIT Alliance for Research and Technology

UMass Amherst College of Engineering

DTU

Finding Urban Typologies (Oke et al, 2019)

http://its.mit.edu/typologies

- **Data**

Urban data from 331 cities (40% of global urban population)

Behavior data from 225 cities, over 18000 individual samples — awareness of AV technology; perception on safety readiness of AVs

- **Exploratory step**

Factor analysis: 9 factors from 64 indicators: mobility, economy, environment, social development, urban form and geography

Hierarchical agglomerative clustering: 12 typologies

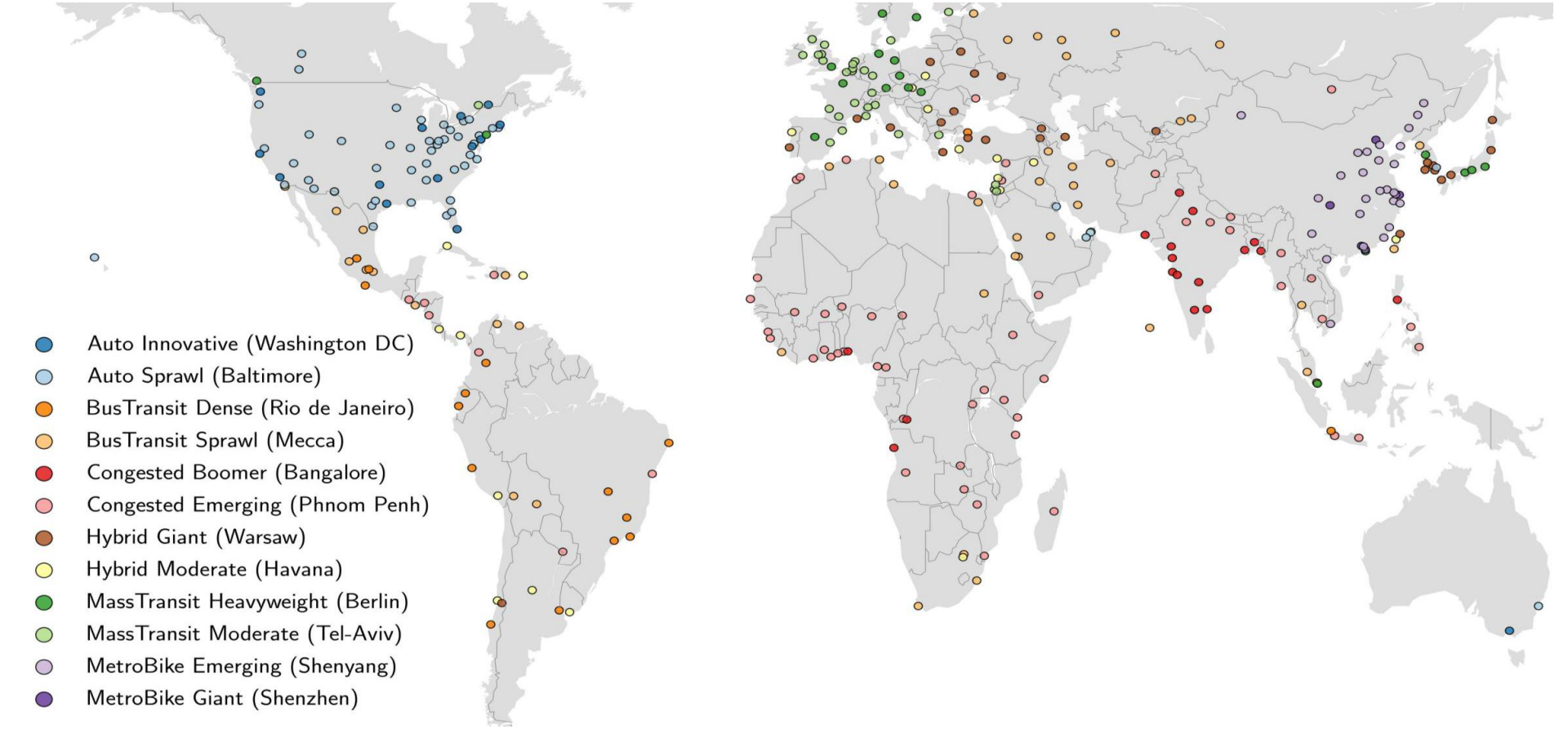
- **Confirmatory step**

Latent class choice model framework

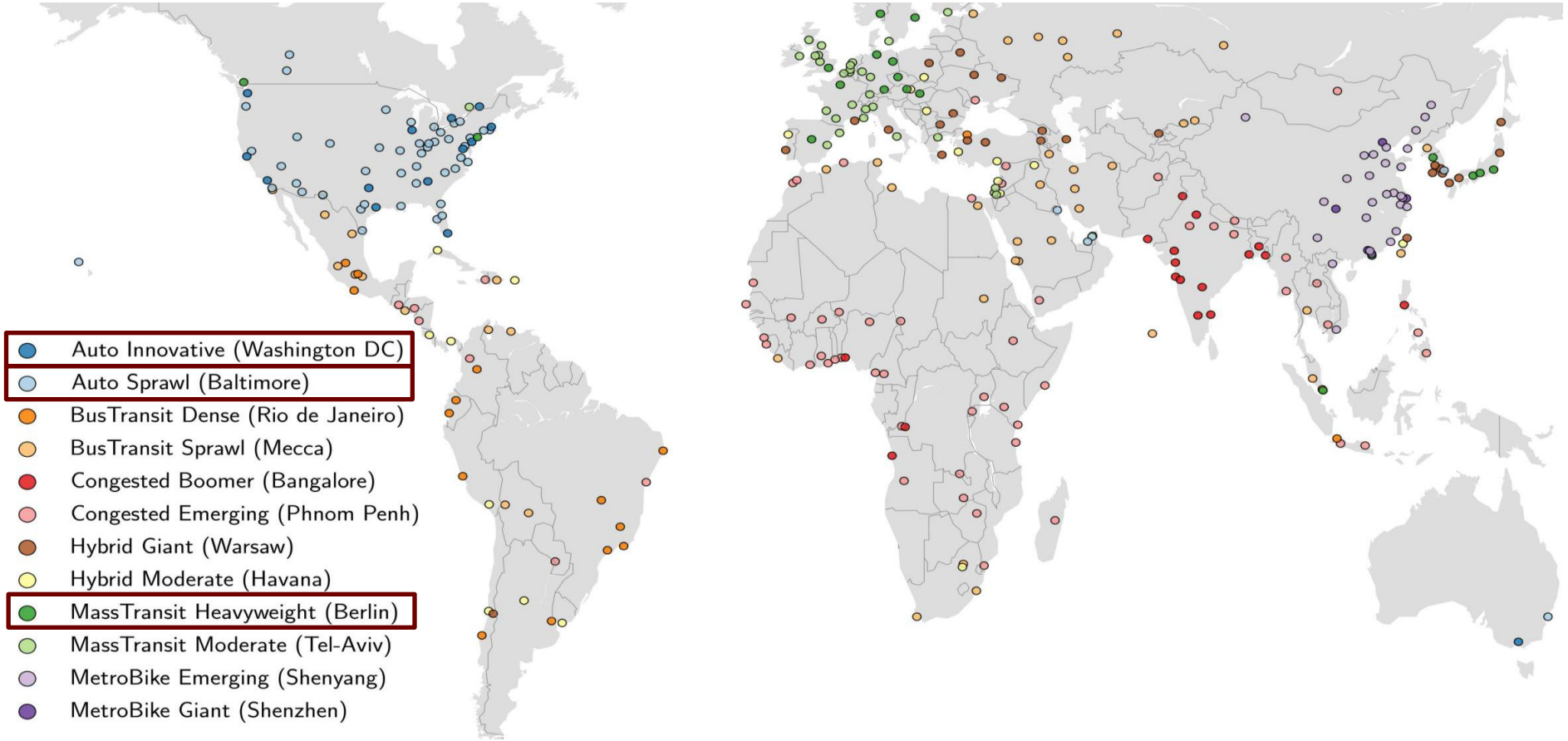
Segments behavior shaping city classification and provides choice parameters

Probabilistic classification to confirm exploratory results

Urban Typologies (Oke et al, 2019)

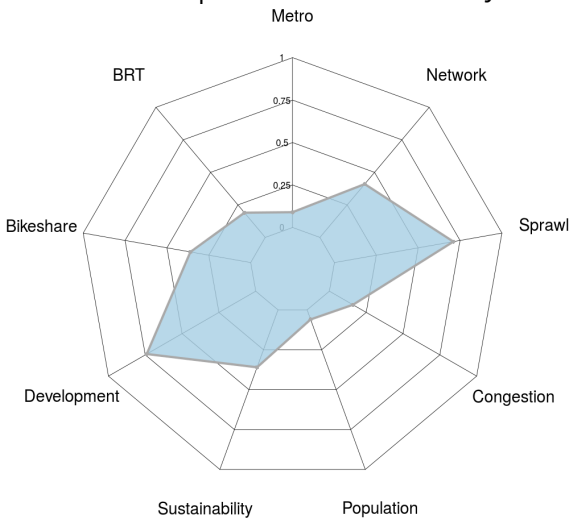


Urban Typologies (Oke et al, 2019)

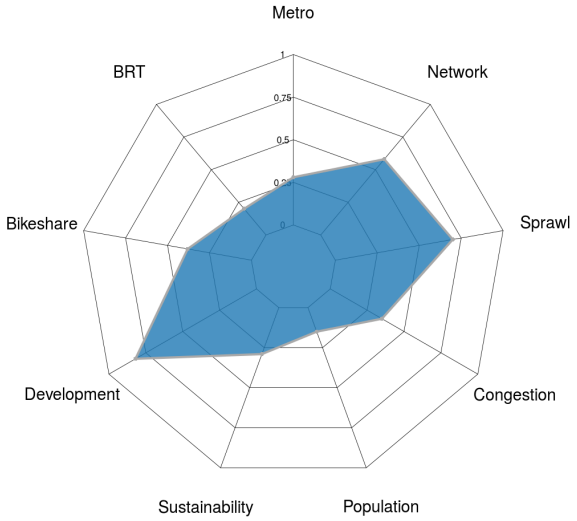


AMoD scenarios in 3 prototype cities (Oke et al, 2020a & b)

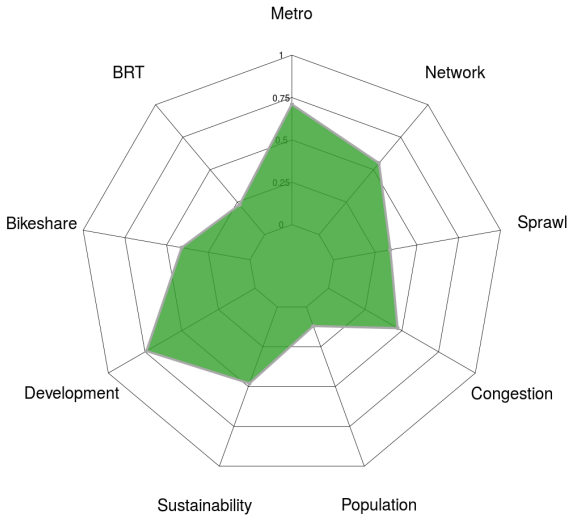
Auto Sprawl
auto-dependent, low-density



Auto Innovative
auto-dependent, multimodal



MassTransit Heavyweight
transit-oriented, dense

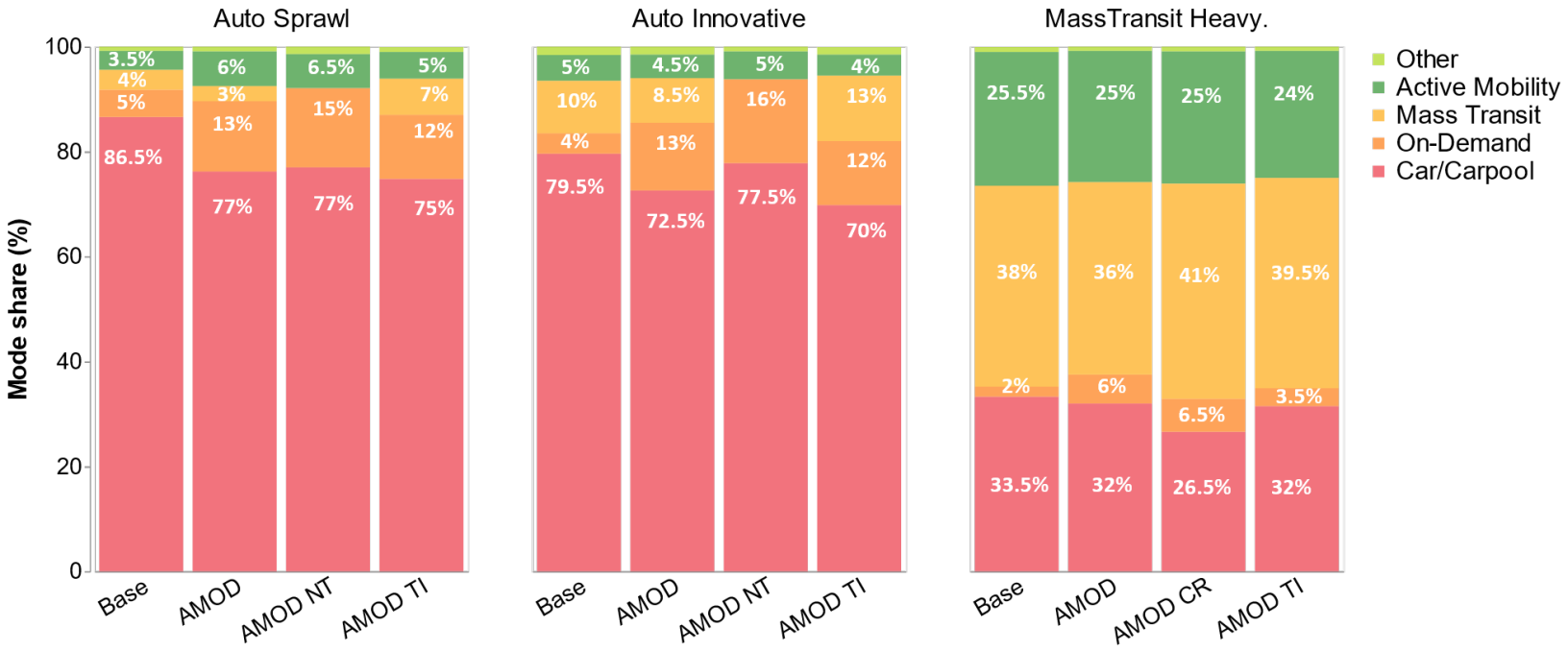


Characteristics	Auto Sprawl	Auto Innovative	MassTransit Heavyweight
Car	86%	79%	32%
Mass Transit	3.5%	11%	37%
Walk	3.3%	3.3%	23%
Population Density (1000/sq. km)	1.0	1.3	3.9
CO_2 / hab. (metric tonnes per year)	16	15	10
Examples	Baltimore, Tampa, Raleigh	Washington DC, Atlanta, Boston	Berlin, Madrid, Seoul

Scenarios

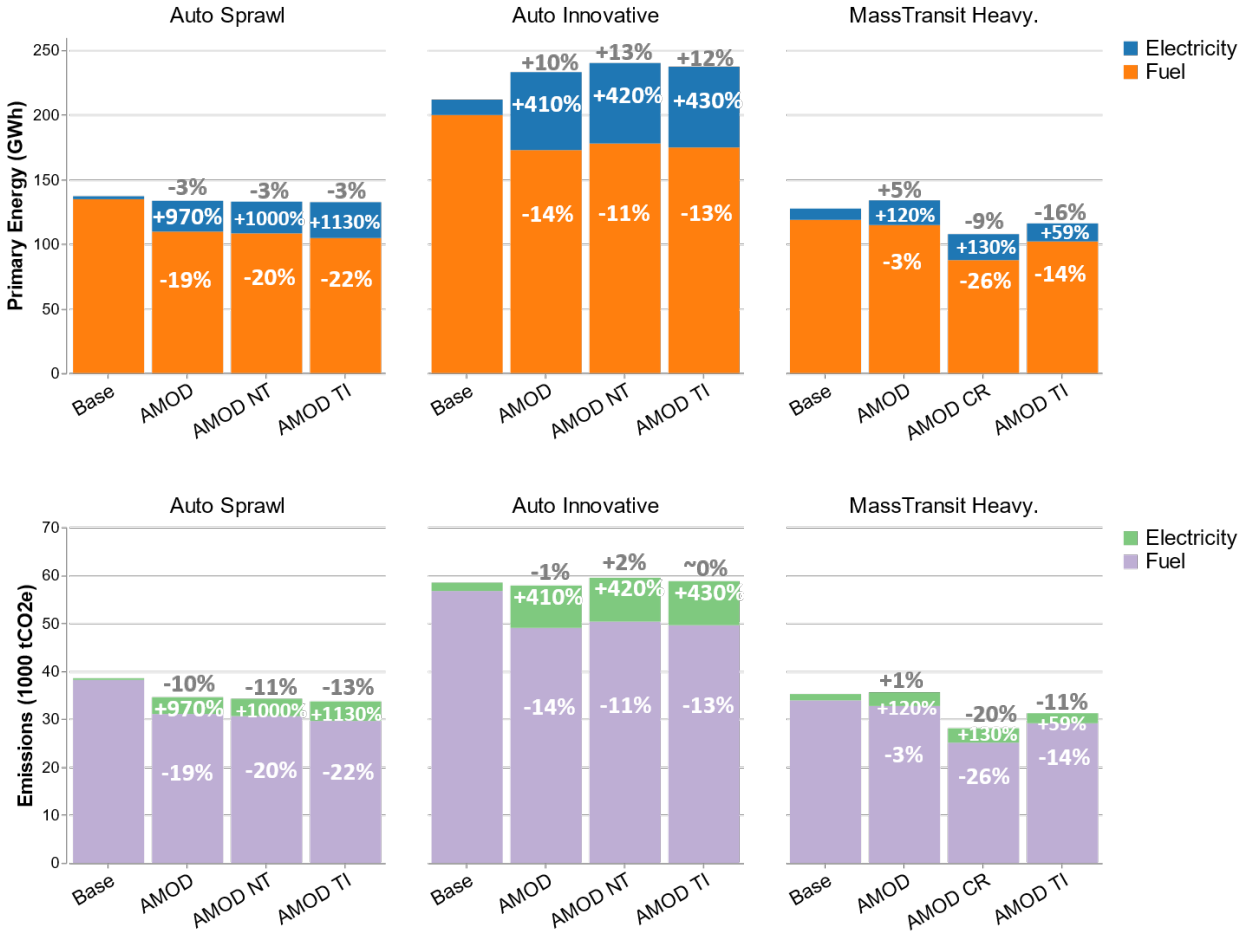
- **Base Case**
  - existing on-demand services; mass transit and private modes
- **AMoD Intro (AMOD)**
  - AMoD (Single and Shared) replaces existing MoD
  - AMoD fare is 50% that of MoD in 2016
- **AMoD No Transit (AMOD NT)**
  - Transit abandoned
  - Simulated only in Auto Sprawl and Auto Innovative
- **AMoD Transit Integration (AMOD TI)**
  - AMoD restricted to local trips and 20% discounted access/egress to mass transit
- **AMoD + Car Reduction (AMOD CR)**
  - 25% reduction in household car ownership (via ownership tax)
  - Simulated only in MassTransit Heavyweight

Impacts: Demand



Impacts: Congestion and VKT

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
  - Cannibalizes transit by up to 20%
  - Increases VKT by up to 30% and congestion by up to 50%
  - 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:

SMART
Singapore-MIT Alliance for Research and Technology

DTU

UNIVERSITY OF MASSACHUSETTS AMHERST 1863

ARIEL UNIVERSITY

Aalto University

MIT

FORD MOBILITY

UCL

MINISTRY OF TRANSPORT
CONNECTING SINGAPORE

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