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FUTURE URBAN MOBILITY

Massachusetts Institute of Technology

SimMobility Freight: An Agent-Based Urban Freight Simulator for Evaluating Logistics Solutions

Presenters

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MIT-ITS Lab

Outline

- Overview of SimMobility (*Peiyu Jing)*
- Urban Freight Modelling (*Takanori Sakai)*
  - Business-to-Business
  - E-Commerce
- Application to Last-mile Solutions (*André Alho)*
- Conclusion

Overview of SimMobility

Adnan et al. (2016) SimMobility: a multi-scale integrated agent-based simulation platform. In: 95th Annual Meeting of the Transportation Research Board, Washington, DC
Oke et al. (2019). A novel global urban typology framework for sustainable mobility futures. *Environmental Research Letters*, 14(9), 095006. https://doi.org/10.1088/1748-9326/ab22c7
Oke et al. (2020). Evaluating the systemic effects of automated mobility-on-demand services via large-scale agent-based simulation of auto-dependent prototype cities. *Transportation Research Part A: Policy and Practice*, 140, 98-126. https://doi.org/10.1016/j.tra.2020.06.013
Oh et al. (2020). Assessing the impacts of automated mobility-on-demand through agent-based simulation: A study of Singapore. *Transportation Research Part A: Policy and Practice*, *138*, 367-388. https://doi.org/10.1016/j.tra.2020.06.004

SimMobility: Overview

- **SimMobility**
  An agent-based demand and supply urban transportation simulation platform including passenger and freight (B-to-B & E-commerce)

- **Key Features**

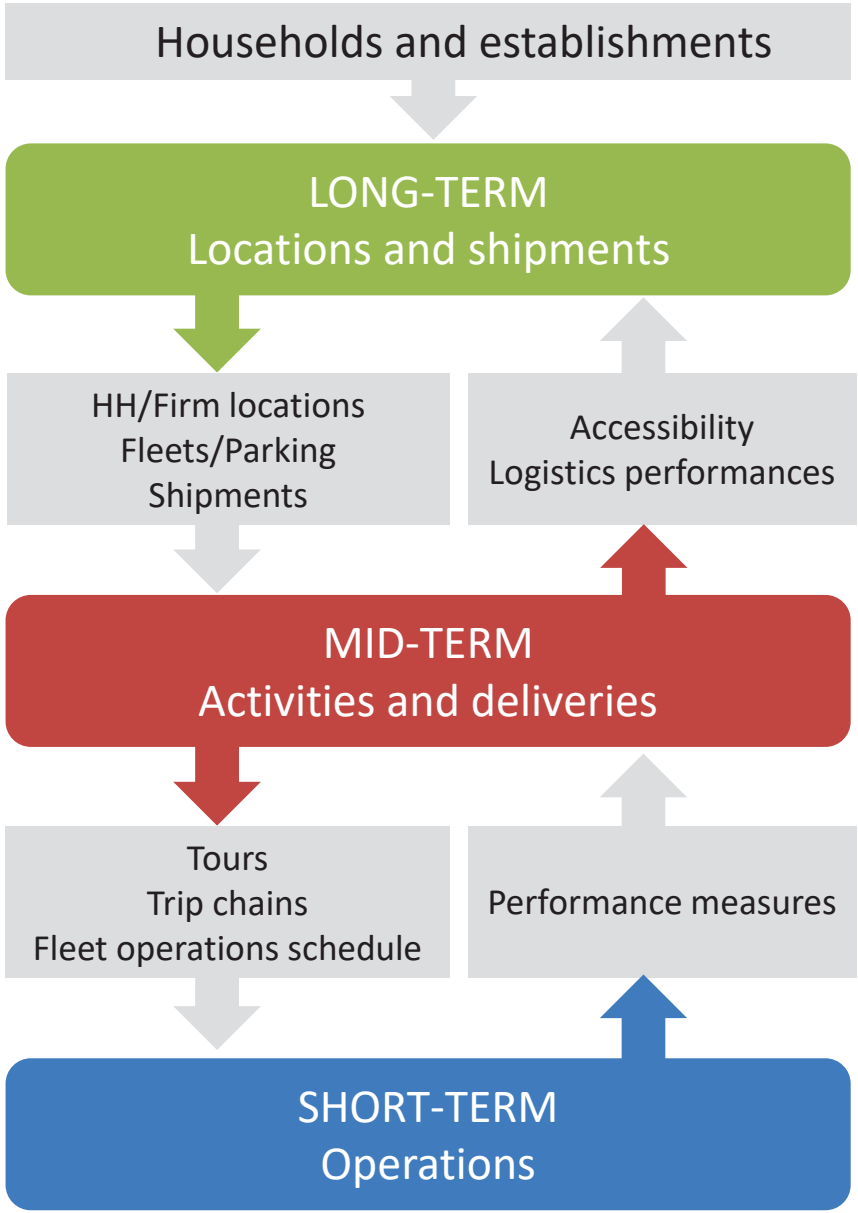
  - Temporal dimensions (long-term, mid-term, short-term)
  - 'Smart' mobility services (e.g. on-demand and shared)
  - Dynamic plan-action activity-based
  - Supply agents (inc. fleet/infrastructure management)
  - Open source

SimMobility Agents

- **Demand**
  - Individuals
  - Households
  - Establishments/firms (shippers, receivers)

- **Supply**
  - Transit operators
  - Fleet operators/managers
    (on-demand services, taxis, freight carriers)
  - Network regulators
    (pricing, information, traffic control)
  - E-commerce vendors
  - Real-estate developers

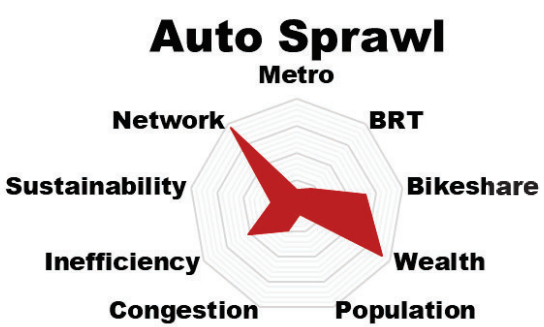
SimMobility Structure

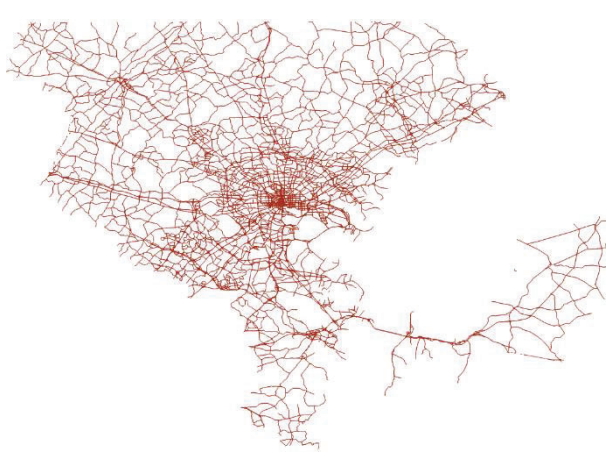


SimMobility Applications

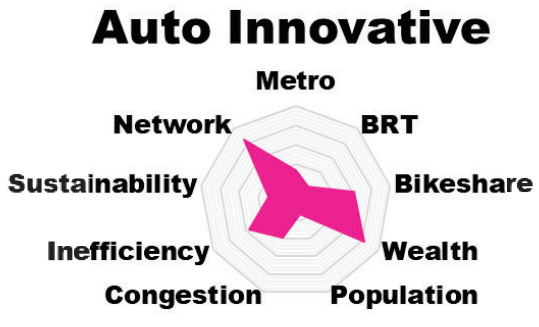
- New modes and services
- Traffic management
- Last-mile solutions
- Post-pandemic scenarios
- Disruptions
- Land-use
- Infrastructure

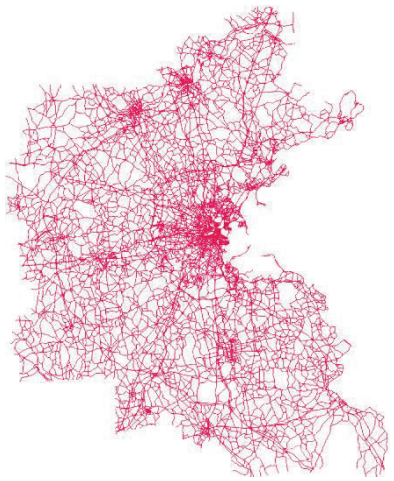
Prototype Cities



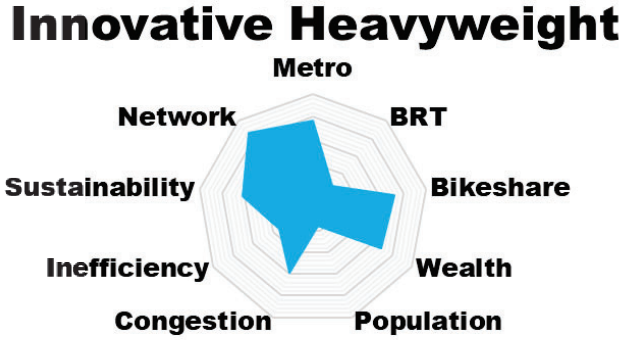


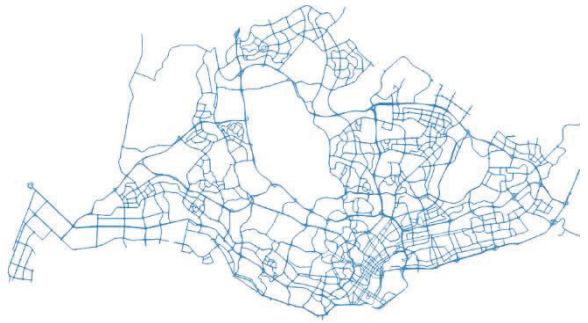
Baltimore





Boston





Singapore

Urban Freight Modeling

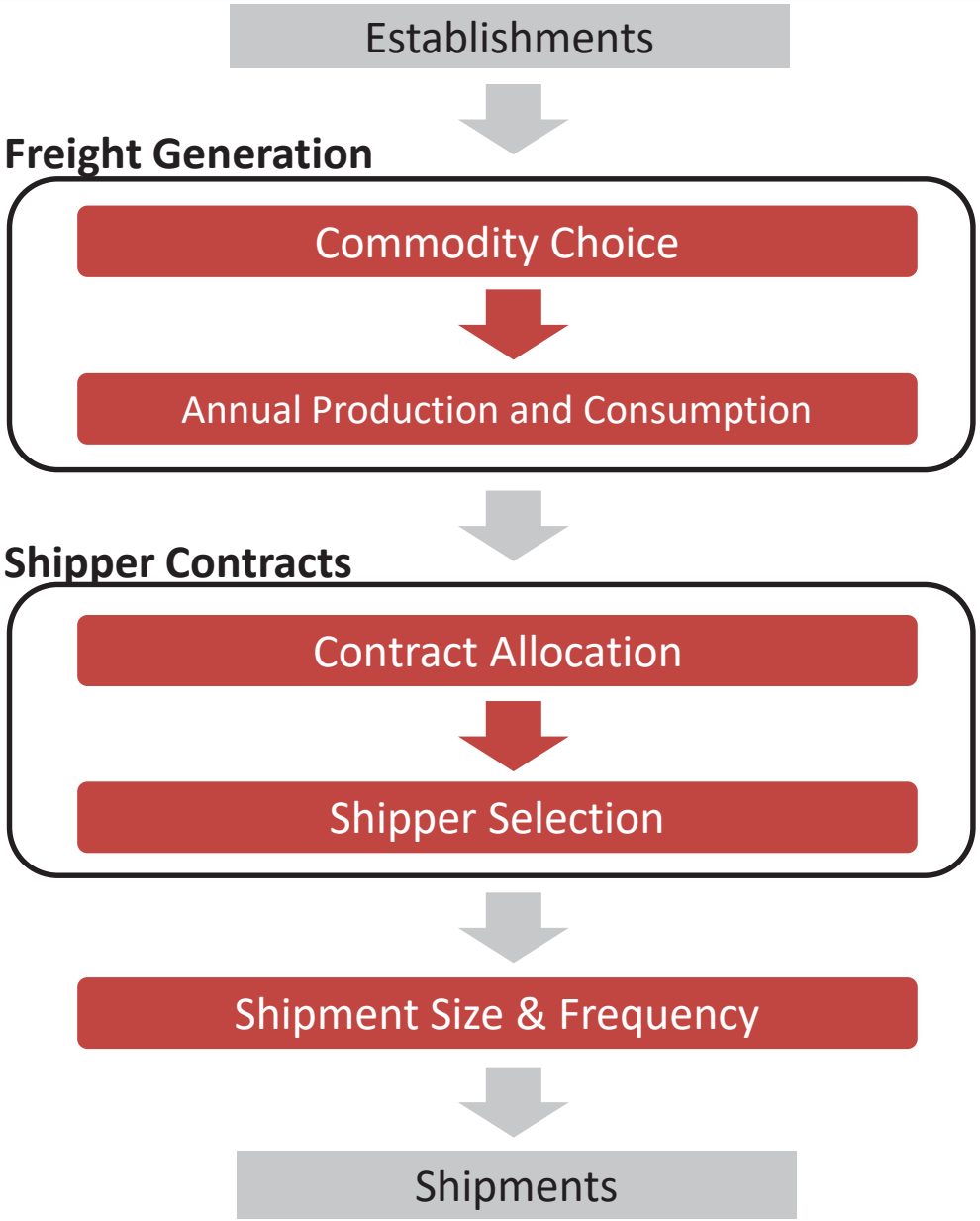
Sakai et al. (2020) SimMobility Freight: An agent-based urban freight simulator for evaluating logistics solutions. *Transportation Research Part E: Logistics and Transportation Review*, *141*, 102017. https://doi.org/10.1016/j.tre.2020.102017

Sakai et al. (2020) E-Commerce Delivery Demand Modeling Framework for An Agent-Based Simulation Platform. http://arxiv.org/abs/2010.14375

Freight Models

Long-term	Establishments/Fleets/Overnight Parking
	Shipments
Mid-term	Preday Logistics Planning
	Within-day Vehicle Operations
	Mesoscopic Traffic Simulation
Short-term	Microscopic Traffic Simulation

B-to-B Shipments



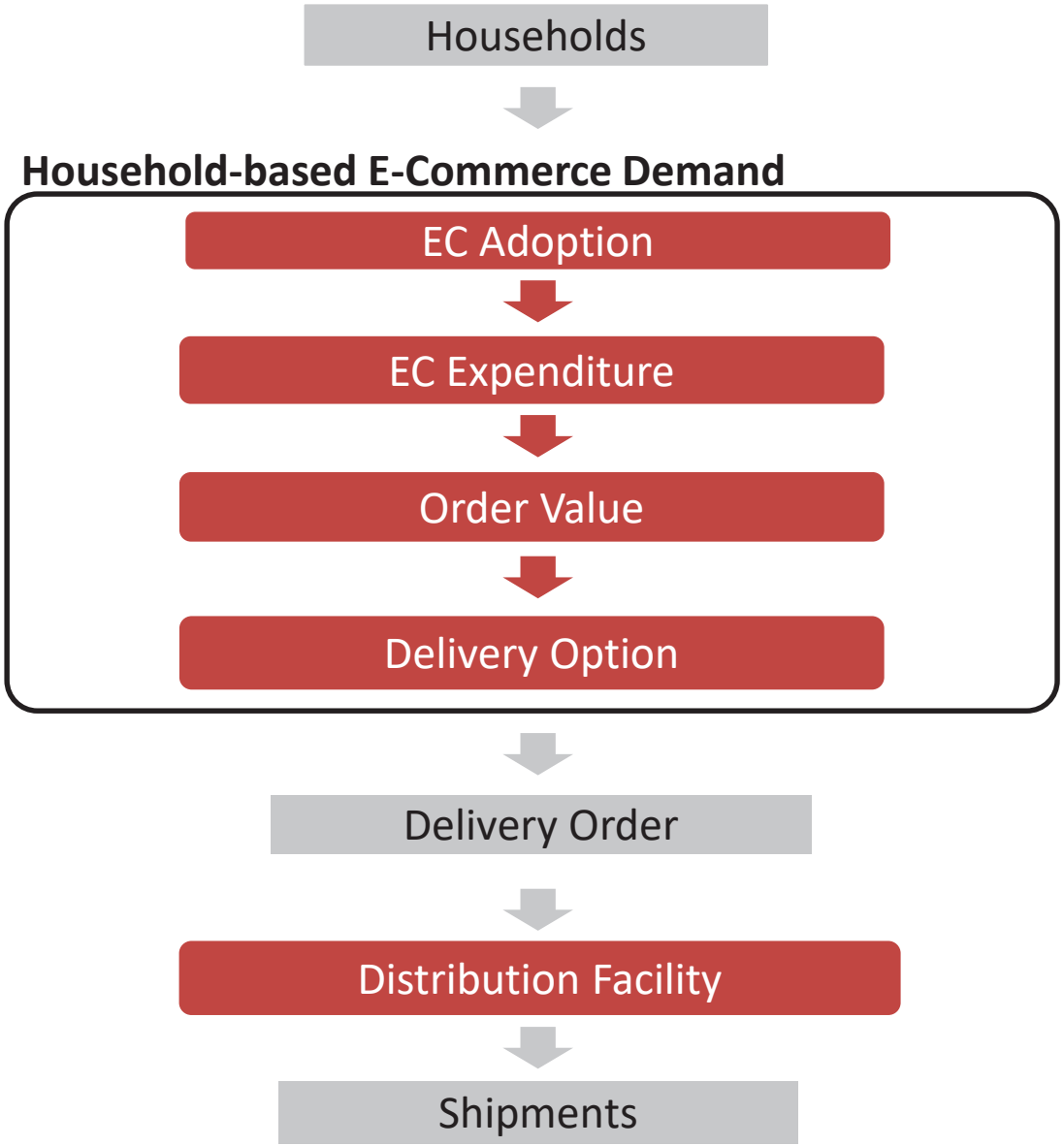
E-Commerce Demand

- E-commerce ***shipments*** to households
- ***Groceries***, ***HH Goods***, and ***Others***
- ***Demand*** (frequency, expenditure) is sensitive to ***delivery options*** (speed, fee, home delivery/pickup)

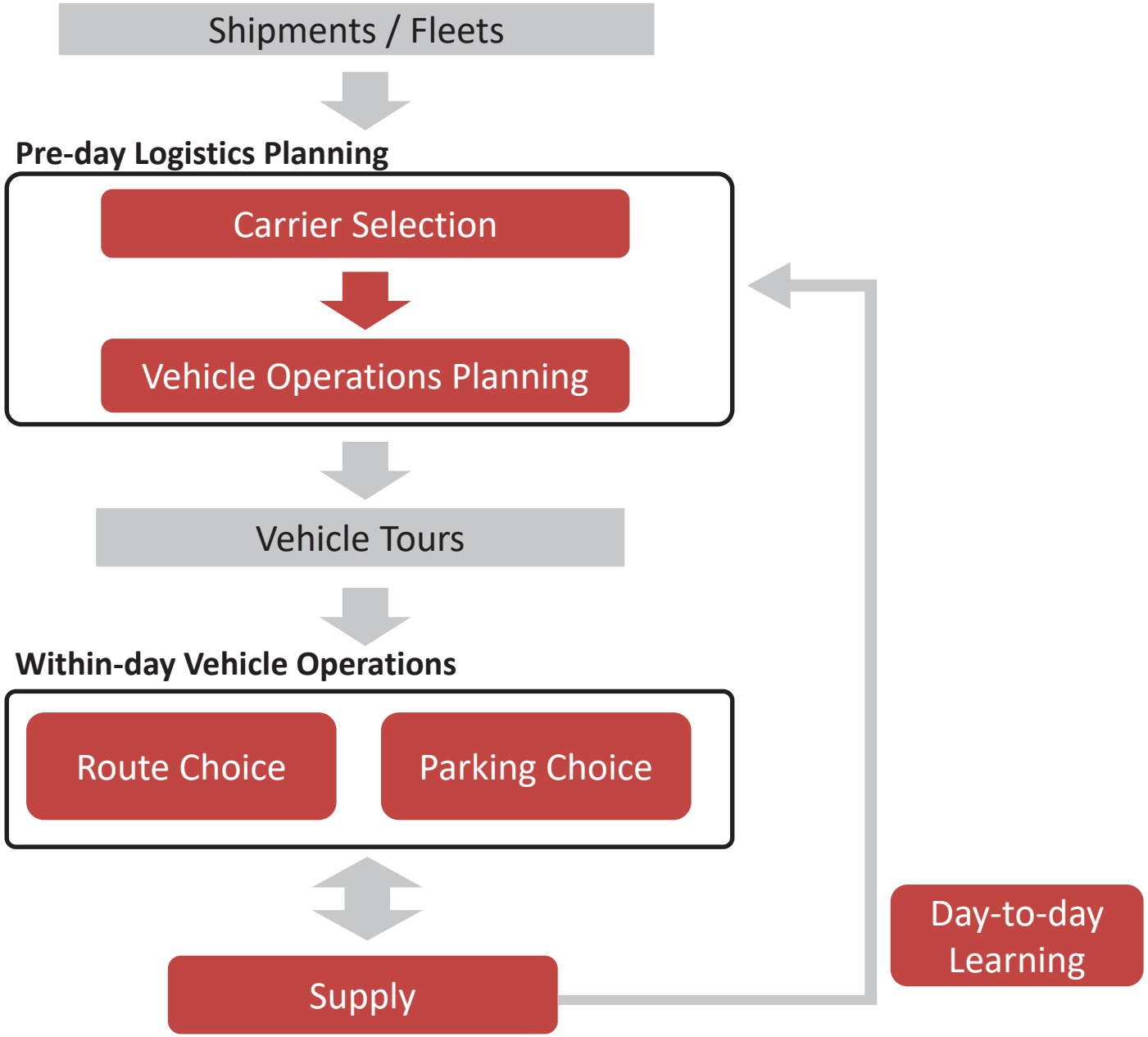
Example of Home Delivery Options

Option	Speed	Fee	Window	Time
1	2-5 days	US$0	No window	Daytime
2	One day	US$12	No window	Daytime
3	Same day	US$18	4 hr	Daytime and evening

E-Commerce Shipments



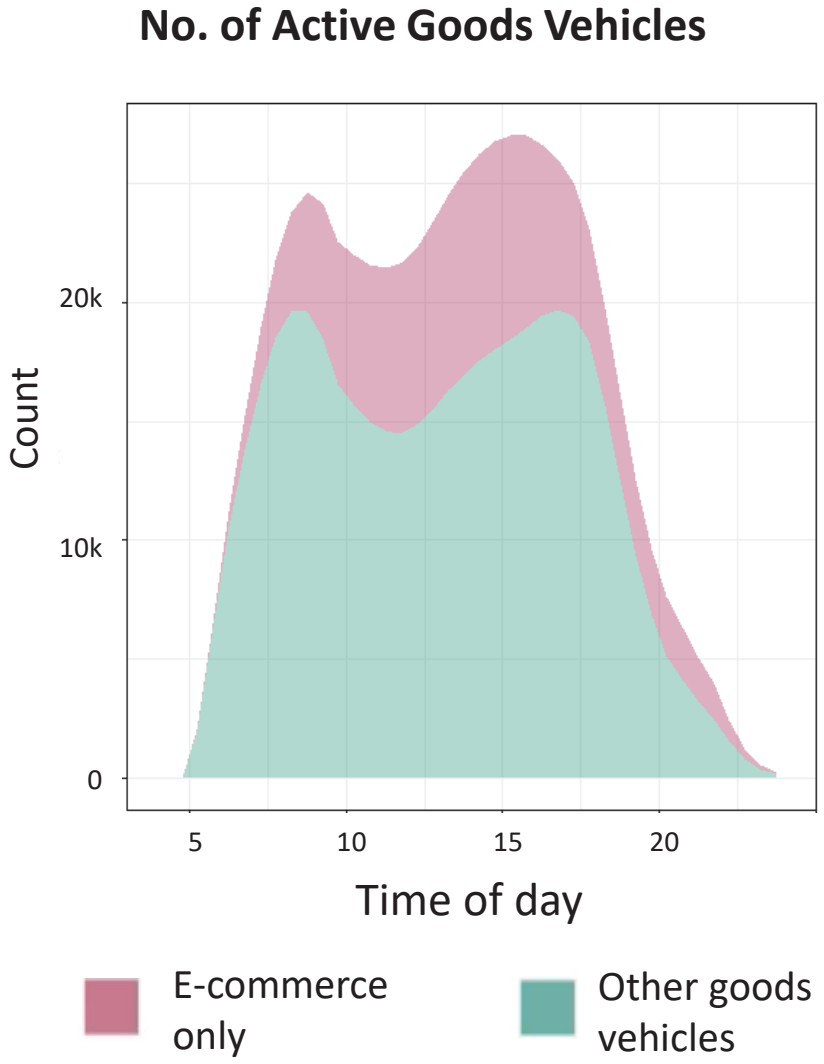
Freight Mid-term



Freight Demand Example

- Freight (& Passenger) models applied to Auto-Innovative Prototype City (Boston as archetype)

- B-to-B and E-commerce demand were calibrated based on available statistics



Recent Freight Applications

- Overnight freight vehicle parking
- Freight consolidation centres
- Night/Off-peak deliveries
- Route restrictions

In this presentation

- Freight-on-Demand

Application to Last-mile Solutions

Alho et al. (2020) A simulation-based evaluation of a Cargo-Hitching service for E-commerce using mobility-on-demand vehicles. https://arxiv.org/abs/2010.11585
Basu et al. (2018) Automated Mobility-on-Demand vs. Mass Transit: A Multi-Modal Activity-Driven Agent-Based Simulation Approach. *Transportation Research Record*, https://doi.org/10.1177/0361198118758630

Case Study: Freight on Demand

Coronavirus: Cabbies, private-hire car drivers turn to food and grocery deliveries

APR 18, 2020

Mr Toh Kian Seng has spent almost 25 years as a cabby driving passengers across the island, but these days, what is in his backseat ...

Taxi, private-hire drivers tapped to meet demand for food and grocery deliveries

MAR 30, 2020

Taxi and private-hire car drivers can now help make grocery and food deliveries, said Transport Minister Khaw Boon Wan yesterday in a Facebook post. The ...

- E-commerce deliveries
  - Increasingly on-demand
  - Smart solutions…leverage Mobility-On-Demand (MOD) capacity?

Source: https://www.straitstimes.com/

Freight on Demand Questions

- Potential deliveries by MOD vehicles:
  - how many deliveries can be handled?
  - time gap between request and pickup/delivery?

- Impact on passenger trips: how service levels may change when adding freight demand?

Freight on Demand Scenarios

- Singapore 2030
- MOD algorithm by the ITS Lab
  - Schedule solo and shared passenger rides
- Assign E-commerce shipments to previously committed and/or idle MOD vehicles

Scenario	Freight in MOD
MOD only (Base)	None
A	MOD shared
B	MOD shared and idle vehicles
C	Restricted "B"

Freight on Demand Results

- Increase in requests handled by the MOD operator
  - Small change to MOD passenger service.

- Scenario
  - A: ~50% delivery demand; long waiting times
  - B: ~100% delivery demand; shorter waiting times
  - C: reduces impact on passenger peak period travel

- Small reduction in total VKT observed

- Potential for emissions reduction by using electric MOD vehicles

Conclusion

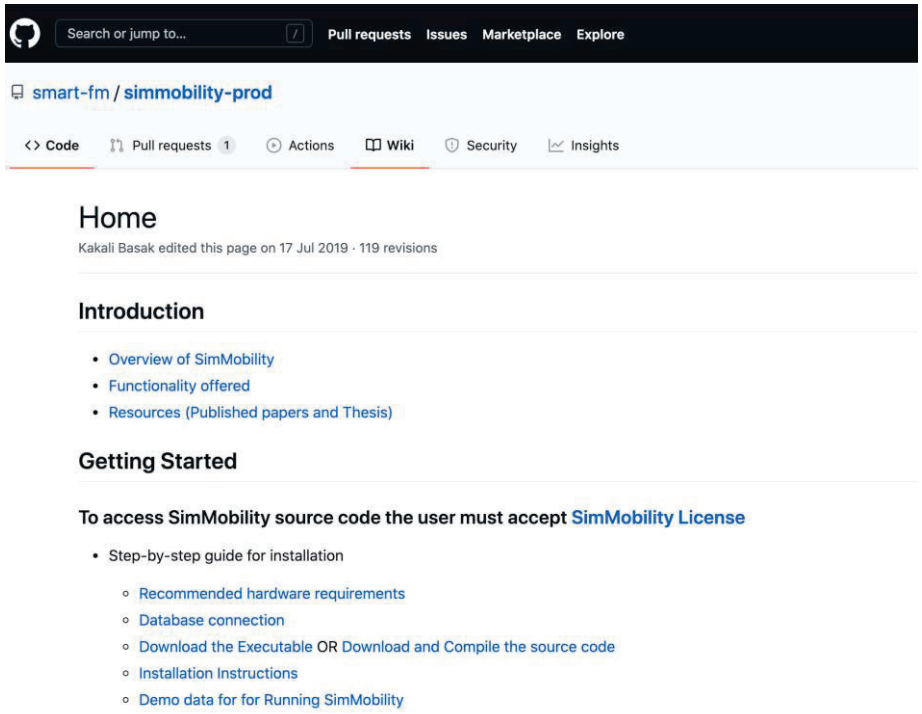
- **SimMobility is a comprehensive platform that jointly simulates passenger, B-to-B, and E-commerce flows.**

- Ongoing research:
  - Enhance E-commerce model (supply-side, trip/E-commerce interaction)
  - Application to congestion pricing with passenger and freight
  - New technologies for last-mile solutions
  - Post-pandemic scenarios

Open Source Release

- MT Models code
- Input Demo data (low computational requirement)
- Wiki and User Forum

https://github.com/smart-fm/simmobility-prod



Thank you for listening

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