Smart Mobility: Optimization and Behavioral Modeling

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Smart Mobility in Singapore

Source: SMART Mobility 2030: ITS Strategic Plan for Singapore, Land Transport Authority, Singapore, 2014

Smart Mobility in the US

"Hang on—I'll Uber us a school bus."

Source: The New Yorker, MAY 16, 2016

Outline

- Smart Mobility Research Agenda
- Laboratory Platforms: FMS and SimMobility
- Solutions: Using Optimization and Behavioral Modeling
- Future Urban Mobility

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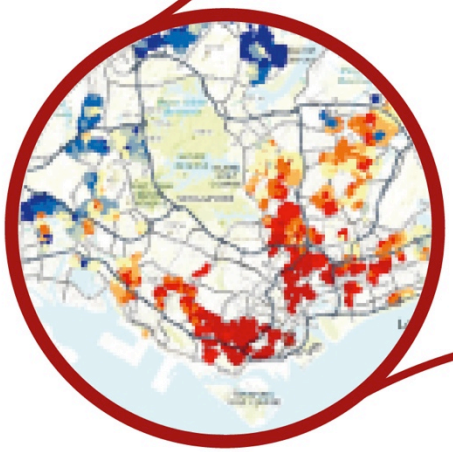
Smart Mobility

- Mobile / communication technology
- Real-time / on-demand
- Personalized
- Shared

Research Agenda

Behavioral Data

Behavioral Models/ Optimization



Solutions

Sponsors include Singapore NRF, US Department of Energy, US Department of Transportation, Ferrovial, Ford and Fujitsu

Designing Effective Smart Mobility Solutions

- Efficiency → Real-time optimization
- Personalization → Behavioral modeling
- Real Data → App-based behavioral laboratory

  http://its.mit.edu/future-mobility-sensing

- Testing → Computer simulation laboratory

  http://its.mit.edu/research/simmobility

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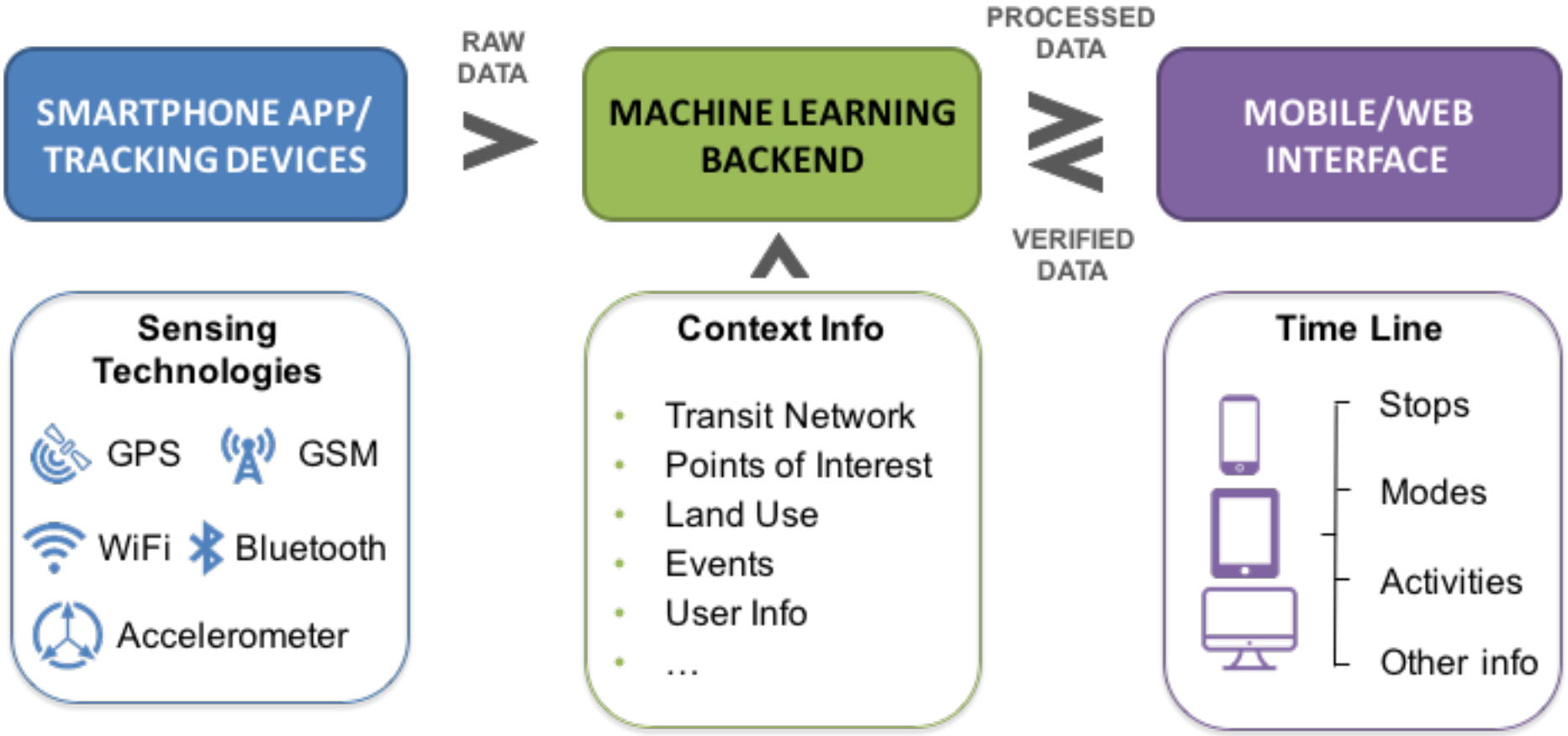
App-Based Behavior Laboratory: FMS

A platform that leverages:

- pervasive smartphone ownership
- sensing technologies
- machine learning

to deliver high-resolution observations of travel and activity behavior

FMS: Architecture



FMS: Commercialization

- Mobile Market Monitor (established 2014, US & Singapore)

Awarded Projects	Description
Maricopa Association of Governments (Phoenix, Arizona metropolitan area)	• First 100% GPS-based travel survey in the U.S. • Smartphones and loggers
Israel Ministry of Transport	• Tel Aviv and Haifa • Smartphones and loggers
World Bank demonstration project	• Dar es Salaam, Tanzania • Android phones given to participants
Singapore Land Transport Authority	• 30,000 surveys in first year • 5,000 surveys in each of 3 subsequent years

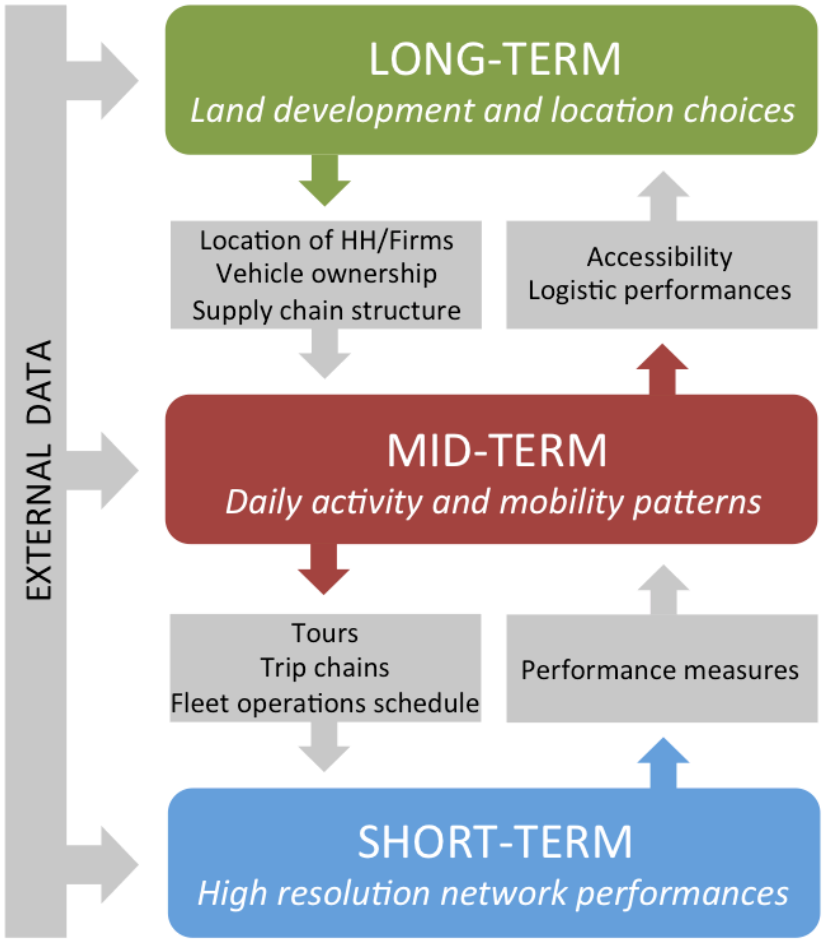
Computer Simulation Laboratory: SimMobility

Development and evaluation of smart mobility solutions

Demographic & Behavioral Shifts + Services and Operational Models + Infrastructure Investments + Land Use Plan

SimMobility Overview

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



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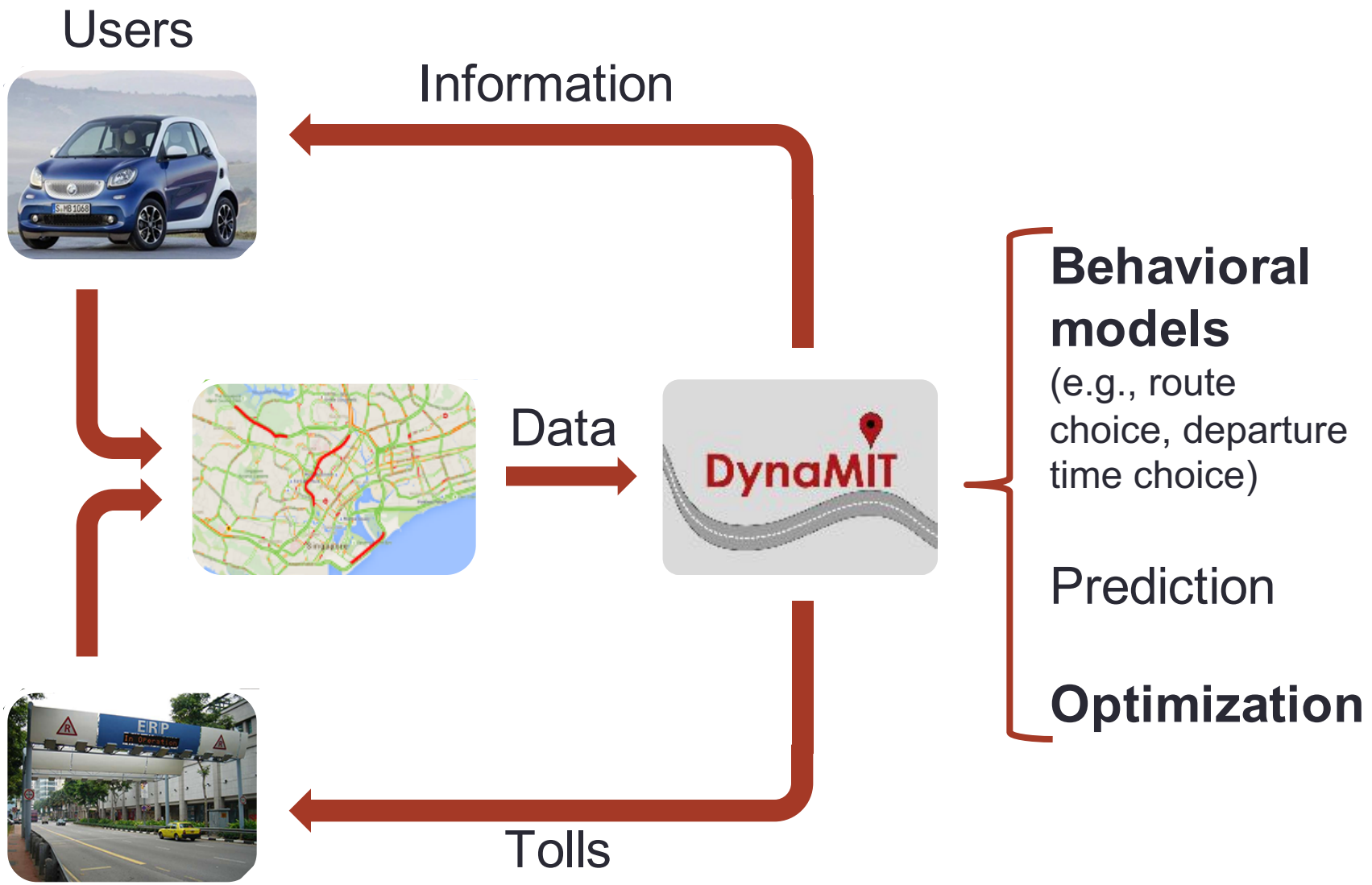
- Smart Mobility Research Agenda
- Laboratory Platforms: FMS and SimMobility
- Solutions: Using Optimization and Behavioral Modeling
  1. Real-time Toll Optimization
  2. Autonomous Mobility On-Demand (AMOD)
  3. Flexible Mobility On-Demand (FMOD)
  4. Tripod: Sustainable Travel Incentives with Prediction, Optimization and Personalization
- Future Urban Mobility

1. Real-time Toll Optimization



Simulation Case Studies

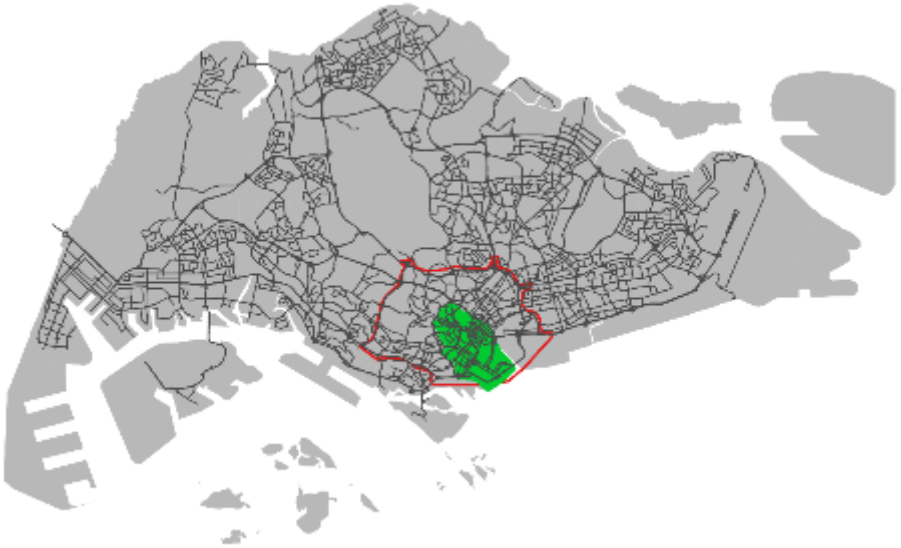
- Area-wide tolling in Singapore (with NUS)
- Managed lanes in Texas (with Cintra / Ferrovial)

⟶ Reduced travel time and increased revenues

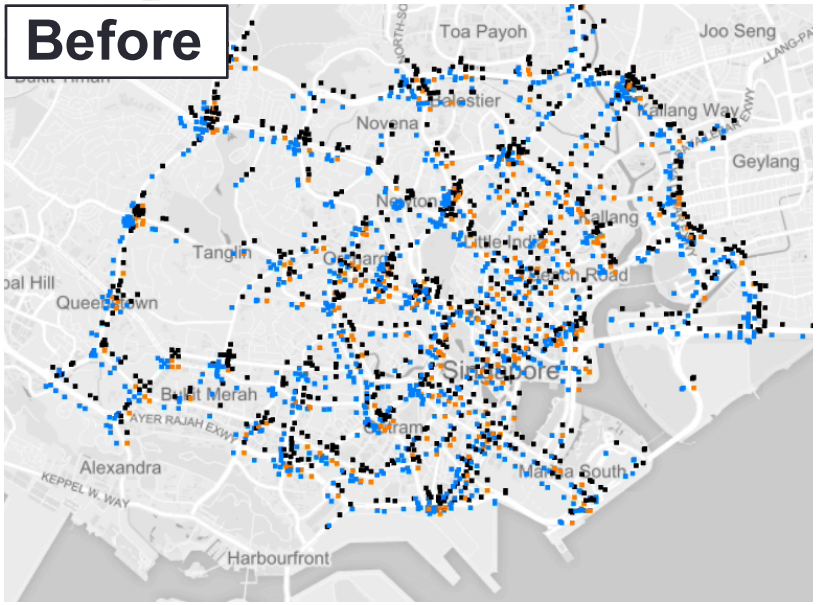
2. Autonomous Mobility On-Demand (AMOD)

- Taxi service with optimized fleet size and rebalancing in a defined area
- Used for last-mile/first-mile and other local trips

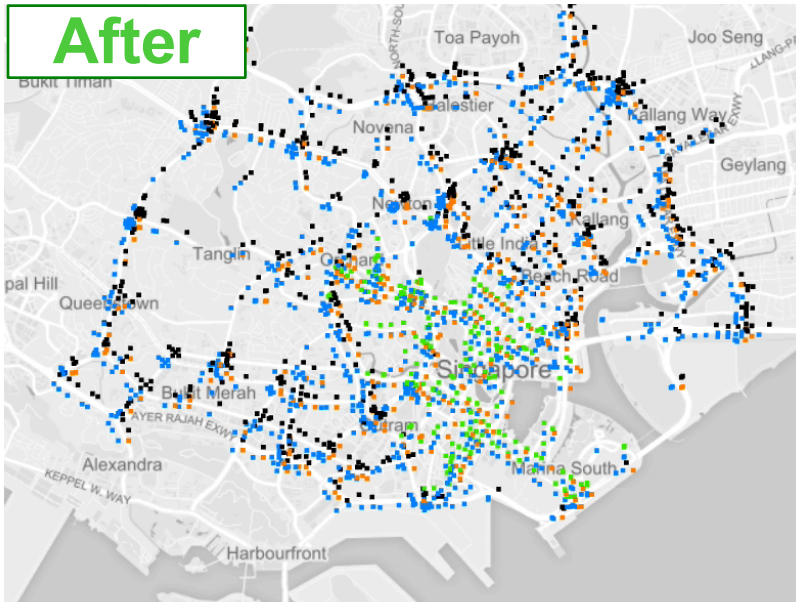
Simulation Case Studies



- Less than 5 minutes waiting time with optimal fleet size and predictive rebalancing



● Bus ● MRT ● Taxi ● Private vehicles



● Bus ● MRT ● Taxi ● ~~Private Vehicles~~ ● **AMOD**

3. Flexible Mobility On-Demand (FMOD)

Provides a personalized menu of paratransit options

TAXI

DEPARTURE TIME 09:30 AM - 09:40 AM
ARRIVAL TIME 10:00 AM - 10:17 AM
30-37 min
10-12 min > 20-25 min
16 SGD

SHARED-TAXI

DEPARTURE TIME 09:30 AM - 09:35 AM
ARRIVAL TIME 10:05 AM - 10:16 AM
35-41 min
10-13 min > 25-28 min
8 SGD

MINI BUS

DEPARTURE TIME 09:40 AM - 09:45 AM
ARRIVAL TIME 10:25 AM - 10:38 AM
45-53 min
10 min > 5-8 min > 20-25 min > 10 min
5 SGD

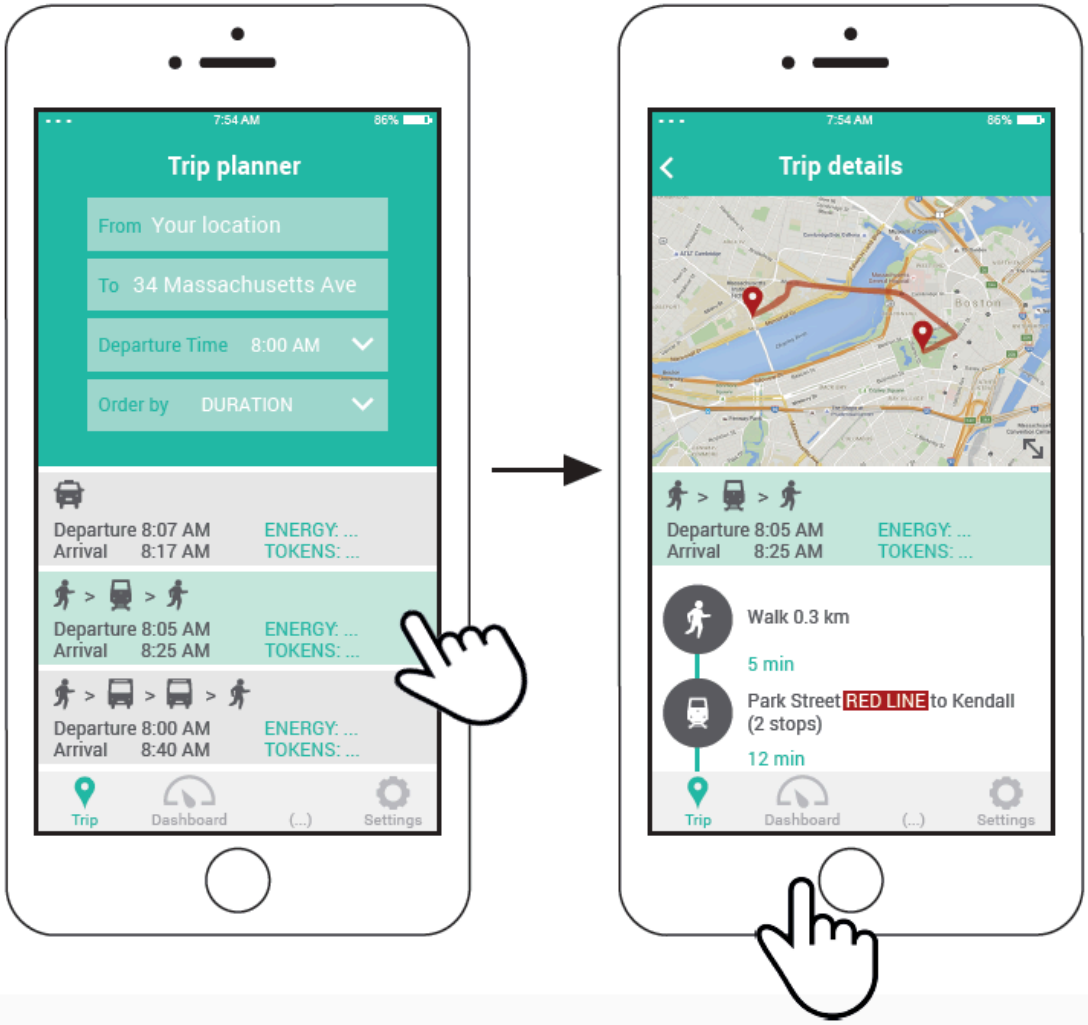
Simulation Case Studies

- Tokyo (with Fujitsu Research)
- Singapore

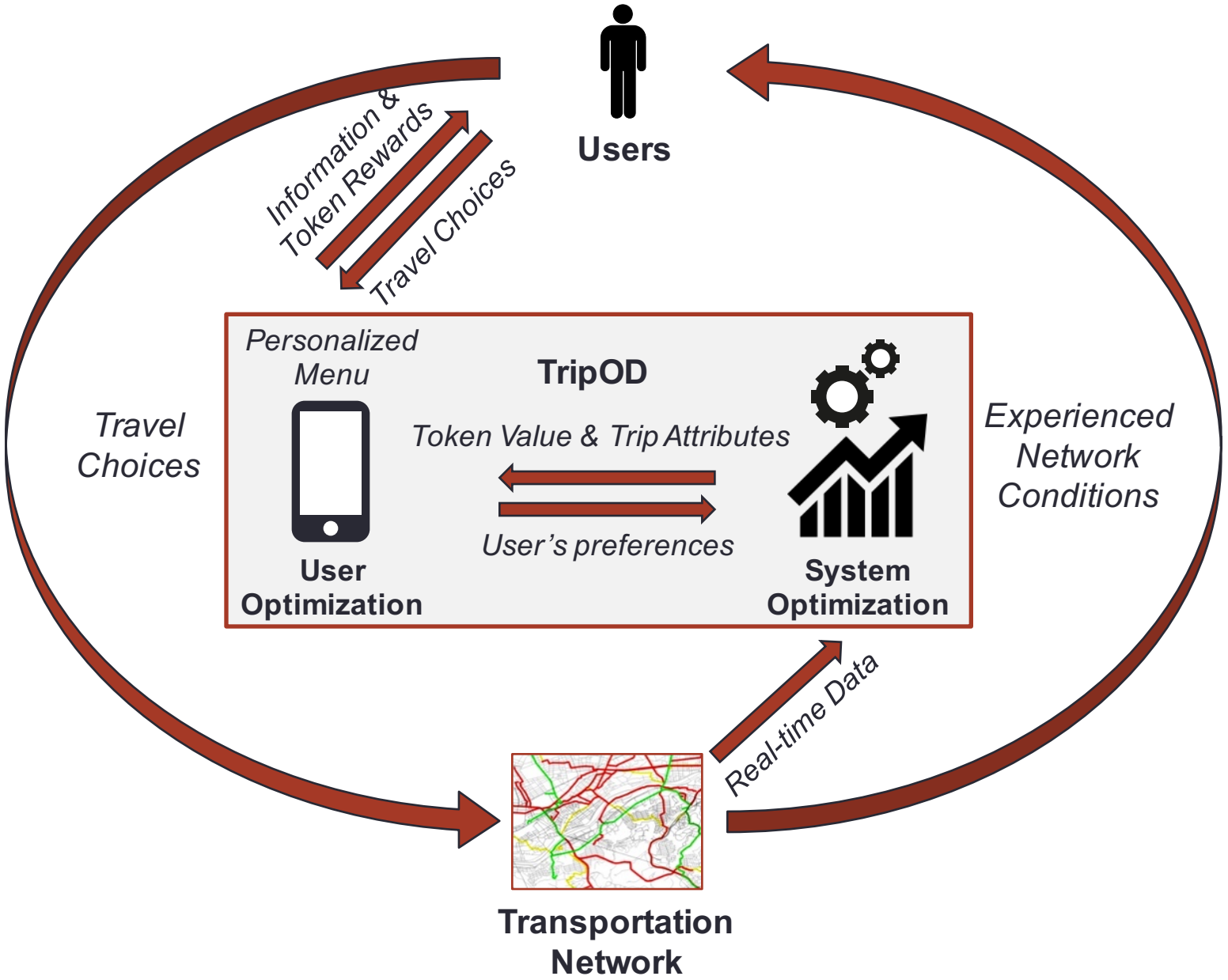
- Menu optimization increases user benefit and vehicle fleet utilization
- Learning about travelers' preferences from repeat choices

4. Tripod: Sustainable Travel Incentives with Prediction, Optimization and Personalization

Menu-based trip planner with optimized incentives



Tripod: Framework



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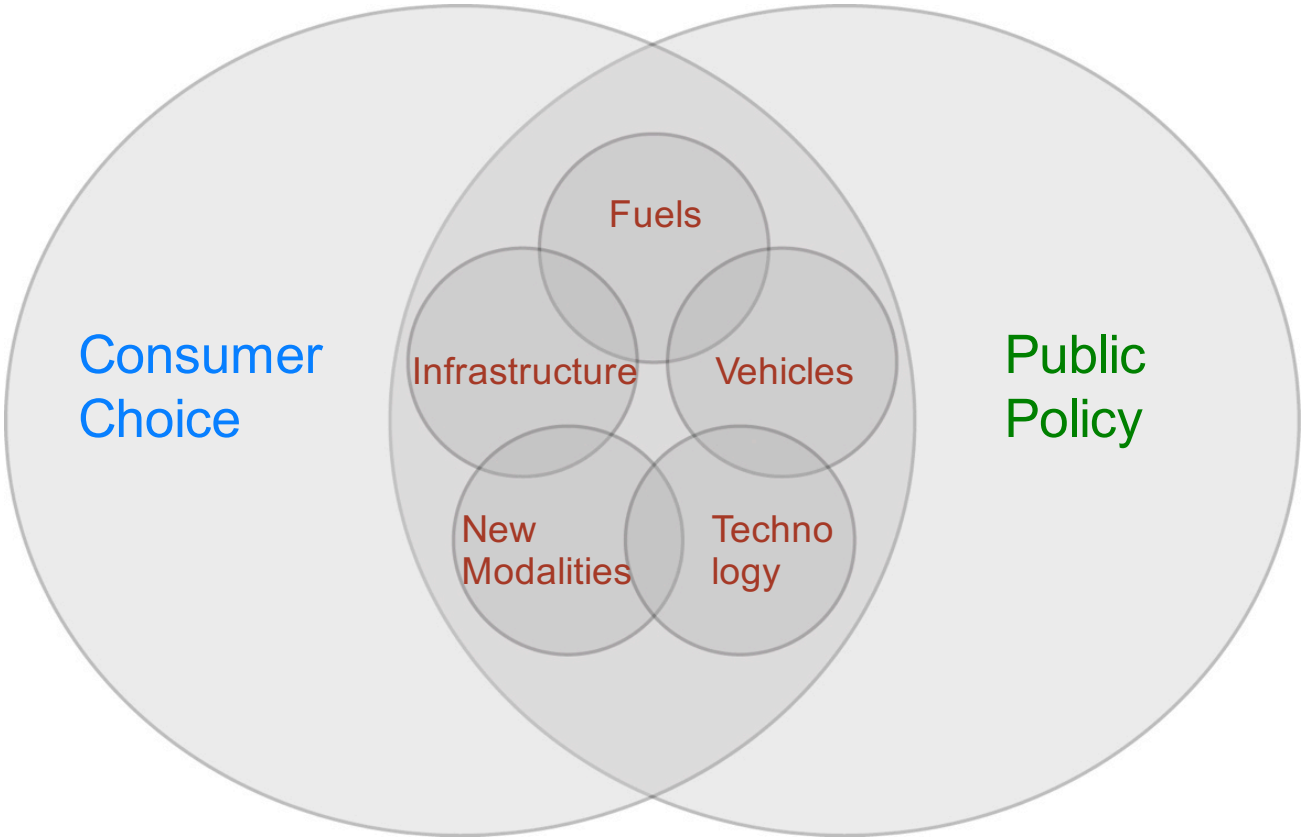
Future Urban Mobility

- How would…
  - Smart mobility
  - Vehicle and fuel technologies
  - Energy and environmental policies

  …affect future mobility?
- Apply SimMobility to prototypical cities representing world-wide clusters of major metropolitan areas

Future Mobility Consortium of the MIT Energy Initiative

- Alfa
- Aramco
- BP
- Chevron
- ExxonMobil
- Ferrovial
- GM
- Toyota



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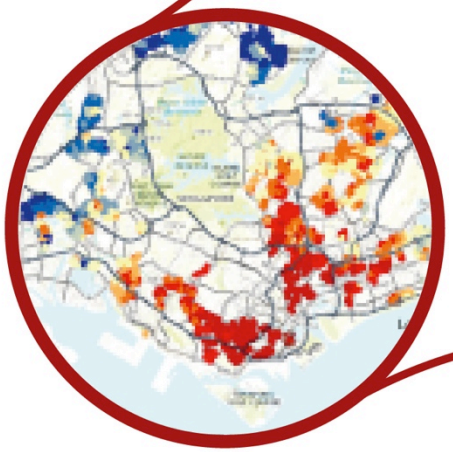

Solutions

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Thank you

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