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Using Mobile Sensing and Analytics to Deliver the Goods

Transforming Freight Movements through ITS – Part III (SIS35)

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Outline

- Traffic flows are changing
- Smart solutions
  - Online Analytics for ‘Smart’ Deliveries
  - Approach: Online Bi-level Optimization
  - Autonomous Mobility/Freight On Demand
- Initial experiment using SimMobility
- Conclusion

Passenger and goods flows are changing

Passenger

- Smart mobility that is:
  - on-demand
  - shared
  - integrated
  - automated

Freight

- E-commerce deliveries
  - increasingly on-demand (e.g., same-day/2-hour)
  - Smart solutions?

Solutions

- **Efficient deliveries**
  - Use of passenger vehicles (ride-hailing, crowd-sourcing)
  - Virtual consolidation platform
  - Flexible freight on demand (menu-based assortment for shippers)
- **Managed traffic**
  - Incentives
  - Pricing and permits
  - Information

Online Analytics for Smart Deliveries

Prediction

- Short-term state predictions for proactive solutions

Optimization

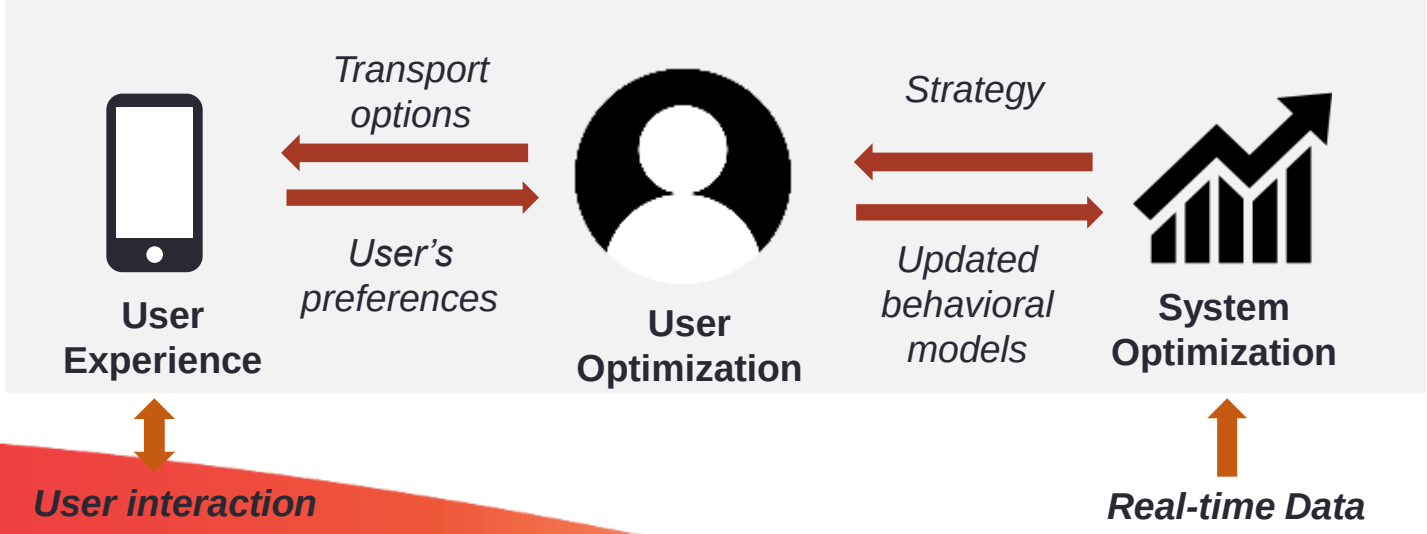
- System-level and User-level objectives, e.g.
  - min. travel time,
  - max. revenue,
  - max. consumer surplus

Personalization

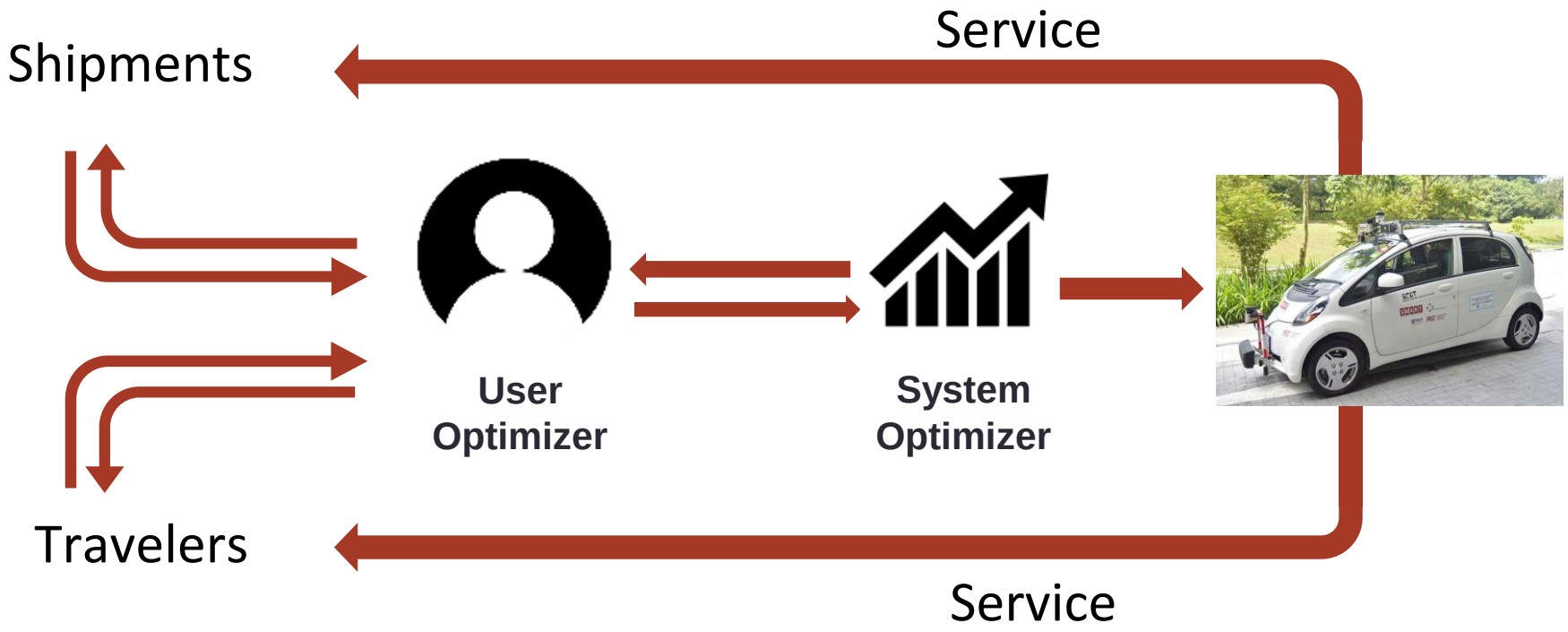
- Customized solutions

Approach: Online Bi-level Optimization

- Incorporates Sensing and Online Analytics
- User-level optimization
  - determines options for an individual, subject to current strategy
  - runs at every query
- System-level optimization
  - decides the optimal strategy to attain the system-level objectives
  - runs in real-time at every estimation period



Automated Mobility and Freight On Demand (AMOD/AFOD)



Initial experiment using SimMobility

- Applied SimMobility (Mid-term) Singapore 2030
- Use existing[1] AMOD controller
  - Schedule solo and shared passenger rides
- Assign e-commerce shipments (expanded 2019 data from a carrier) to previously committed AMOD travel

[1] Basu, R., Araldo, A., Akkinepally, A.P., Basak, K., Seshadri, R., Nahmias-Biran, B.H., Deshmukh, N., Kumar, N., Azevedo, C.L., and M. Ben-Akiva (2018) Implementation and Policy Applications of AMoD in multi-modal activity-driven agent-based urban simulator SimMobility. Transportation Research Record Journal of the Transportation Research Board, 2018, DOI: 10.1177/0361198118758630

Scenarios: AMOD/AFOD Operations

Scenario	Passenger	Freight
AMOD	AMOD (in addition to transit and private modes)	”Conventional” trucks, vans, etc.
AMOD+AFOD	Same	Same + AFOD for e-commerce deliveries

Results

Agent	Indicator	AMOD	AMOD+AFOD
AMOD Fleet (22.5k vehicles)	Passengers and shipments (total)	529k	588k (+11%)
	Empty distance (Km)	2.4M	2.5M
	Service distance (Km)	5.1M	5.4M
	Total distance (Km)	7.5M	7.9M (+5%)
Passengers (577k requests)	Passengers (%)	91	93
	Avg. trip distance travelled (Km)	12	12
	Avg. request-to-pickup time (minute)	5	5
	Avg. travel time (minute)	17	17
Deliveries (126k requests)	Freight (total)	-	51k
	Total distance – Freight vehicles (Km)	18M	17M (-4%)

Conclusion

- Developed simulation laboratory to test a variety of solutions for freight.
- Applied to study use of AMOD fleets extra capacity for e-commerce deliveries.
- No impact on passenger trips duration, distance, and travel speeds.
- Freight shifted from conventional vehicles to AMOD with small reduction of total VKT (1%).
- Ongoing…collect e-commerce data and develop e-commerce demand models for SimMobility.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