Optimizing shared on-demand passenger and goods mobility

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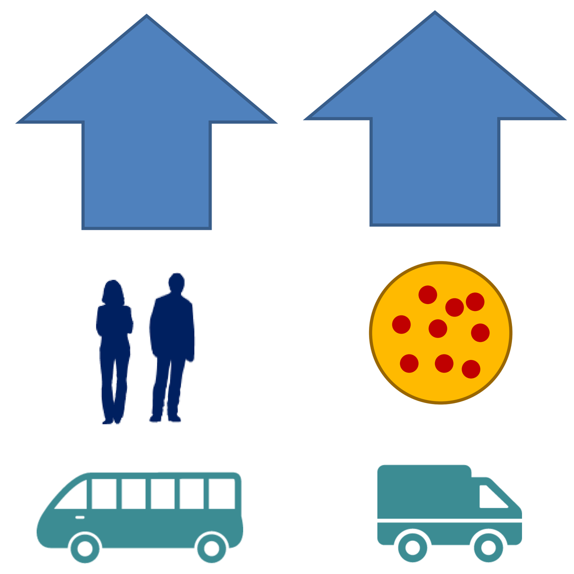
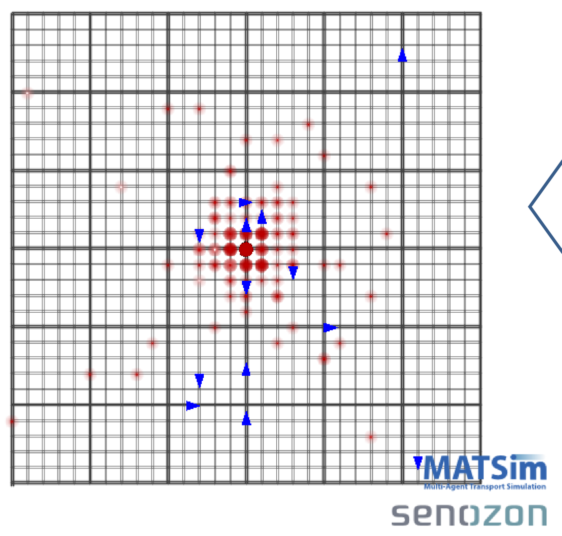


The market for **on-demand transport services** is rapidly growing, for both person and goods delivery. The ability to travel, or to order food or non-perishable products, conveniently without advance planning is attractive to those with unpredictable schedules or restricted mobility. Currently **passengers** and **goods** are travelling separately; combining the two could lead to **more efficient use of vehicles and road networks**.

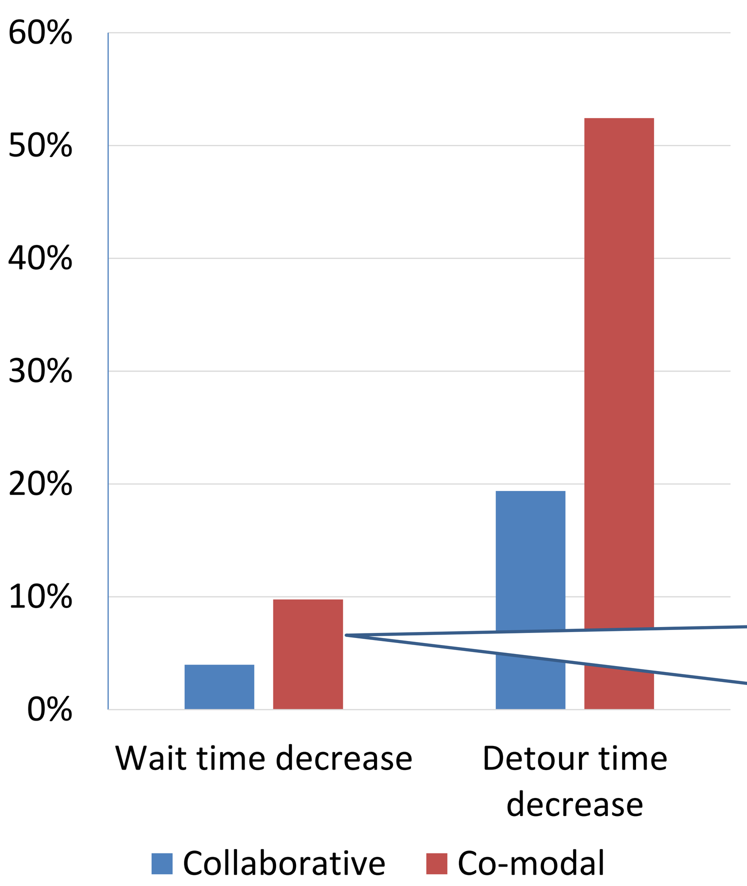
Research questions:
- What are the effects of combining passenger and goods in the same scheme?
- How can the performance of a co-modal system be improved?

Benefits of shared mobility

Shop-specific (base case)	Collaborative	Co-modal
Taxi Shop-specific van	Taxi Shared delivery van	Shared passenger/delivery van



Simulations using MATSim to explore effects of scenarios and changing demands, using realistic data from Melbourne

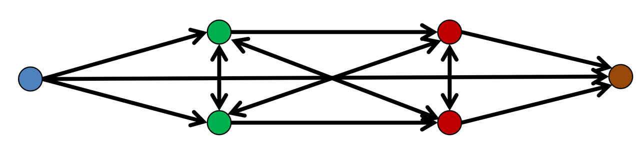


Preliminary findings:
- Combining schemes leads to improved performance for both passengers and deliveries
- Co-modal system more resilient to uneven or unexpected demands

Promising results despite crude routing optimization. Can we improve this further?

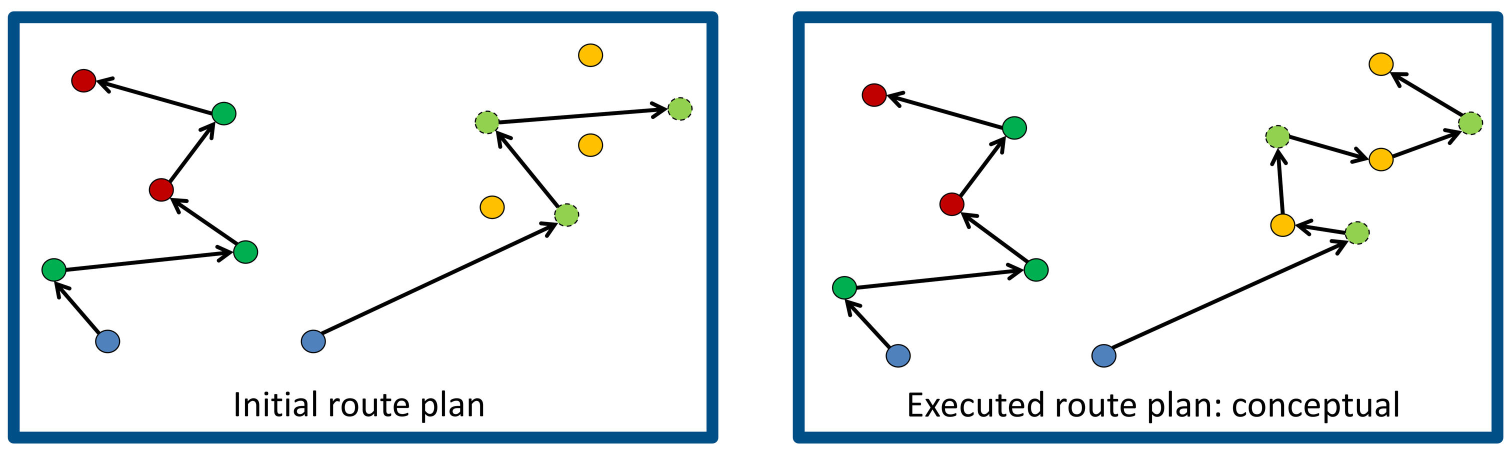
Proposed routing optimization method

1. Represent the problem as a directed graph network



Legend:
- vehicle starting point
- pick-up point
- drop-off point
- depot
- fictitious demand
- ad-hoc demand

2. Introduce fictitious demands based on historical data to anticipate ad-hoc demands



3. Create the initial route plan by using a robust optimization approach by treating the number of passengers of the fictitious demands as probabilistic.
4. Use an insertion algorithm during execution to incorporate ad-hoc demands.

Other features of the optimization

- Optimization of multiple vehicles.
- Generic optimization formulation to allow flexibility in objective trade-off (user vs. operator).
- Constraints can be either hard or soft.
- Considerations of: operating cost, user constraints, fleet size minimization

Expected outcome

The potential benefits of better ad-hoc demand anticipation:
- Decreased waiting time
- Increased service flexibility, i.e. fewer constraints violation and/or demand rejection.
- Savings from lower number of vehicles required to service non-typical demand.
- Higher average occupancy of each vehicle.

Conclusion & future work

- Co-modality, i.e. shared vehicles for passengers and goods, has the potential to improve the efficiency of a demand-responsive transport service.
- Careful routing optimization are required to guarantee service quality to customers and maintain the feasibility of such service.

Acknowledgements and references:
Ronald, N., Yang, J., & Thompson, R. (2015). Exploring co-modality using on-demand transport systems. Presented at the *9th International Conference on City Logistics*. Tenerife, Canary Islands, Spain.
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