D-Vanpool

Dynamic Vanpool services: Passenger preferences, operations modelling, and simulation-based quantification of impacts

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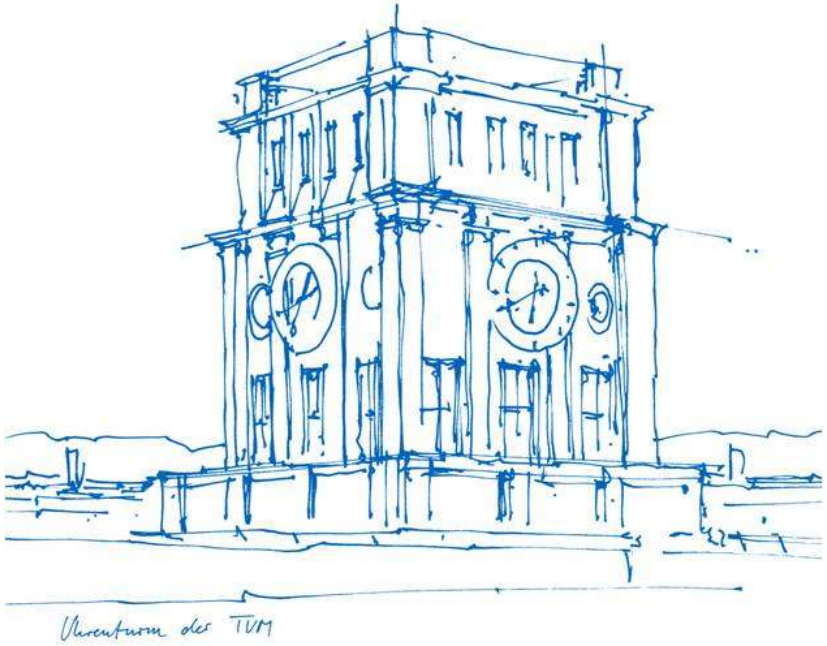
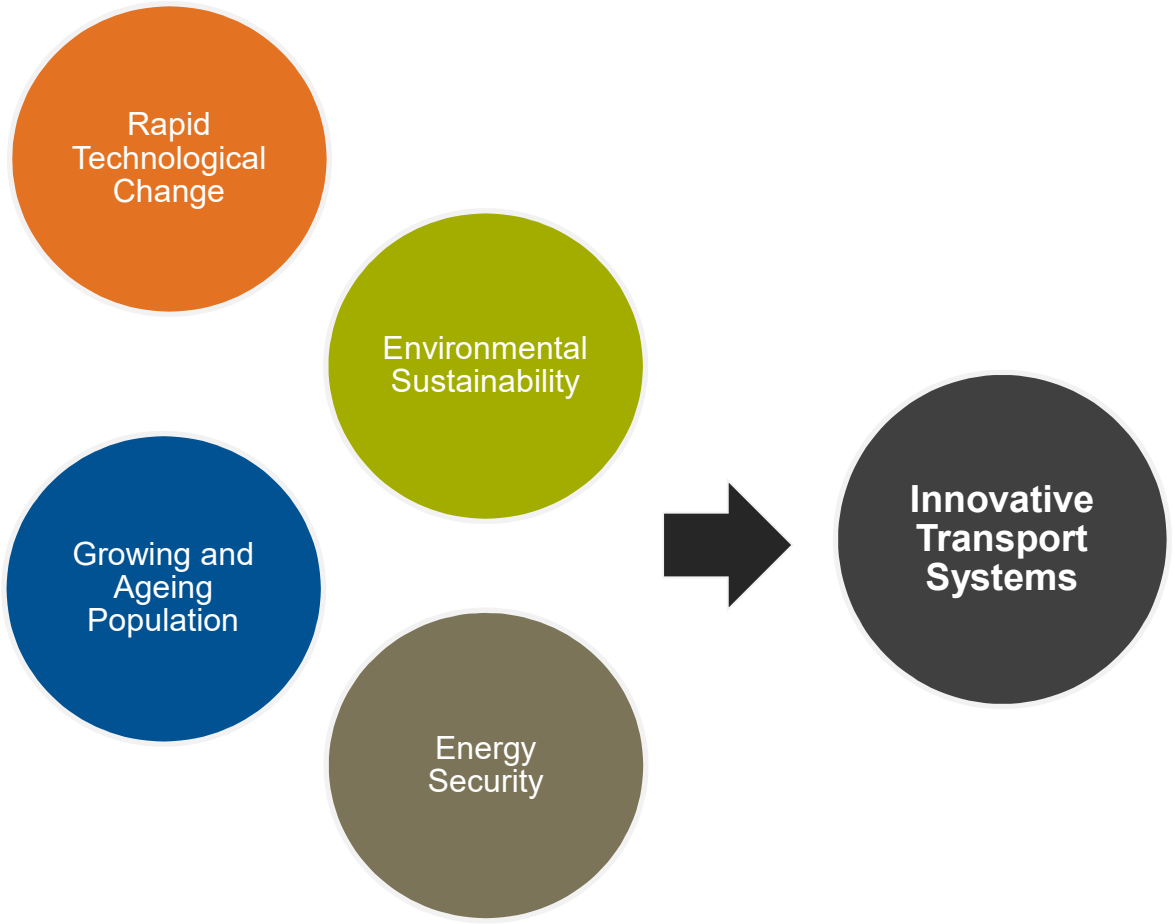
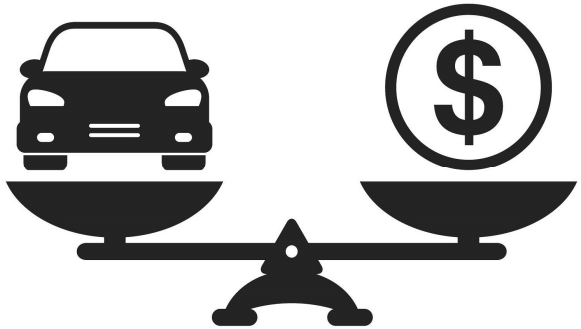


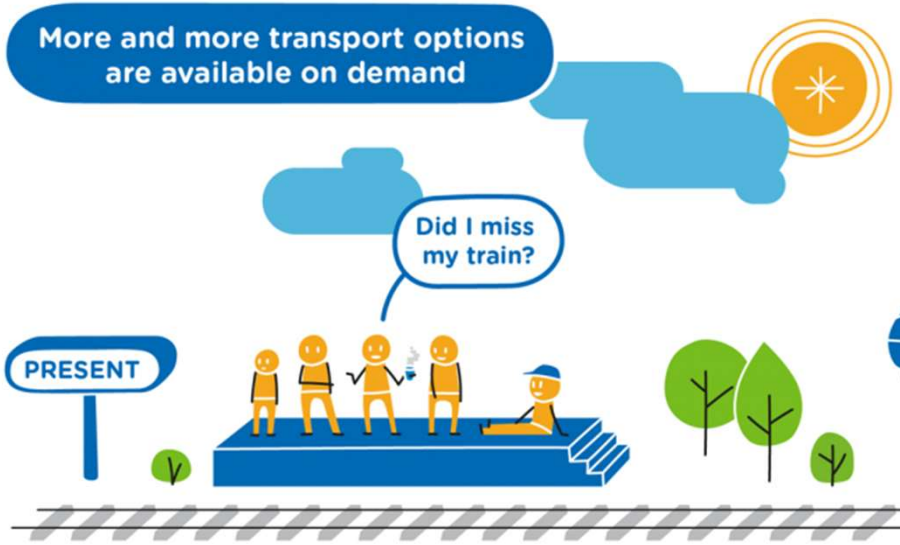
Munich, 14. May 2019

Motivation


Rapid Technological Change
Environmental Sustainability
Growing and Ageing Population
Energy Security
Innovative Transport Systems

Background





Sources: https://www.channelnewsasia.com/news/brandstudio/how-much-it-really-costs-to-own-a-car-in-singapore-9346730
https://future.transport.nsw.gov.au/sites/default/files/styles/expanded_1x/public/media/images/2018/2-customer-empowerment-12may_v2_0.png?itok=X-hw9-_E
https://www.dreamstime.com/stock-illustration-transportation-as-service-concept-illustration-taas-startup-business-image95214793

Background

- Vanpooling…??
- From a flexible transit service with fixed boarding stations e.g. Panda Bus (New York, Shanghai) and Jetty (Mexico)
- To dynamic vanpooling conceptually similar to a ride-hauling service with ridesharing e.g. Uberpool, lyft

Sources: https://www.bft.org/fall-2017-bft-vanpool-newsletter/

Literature

- No major efforts on dynamic vanpooling with microscopic simulations
- Mainly dynamically operated Shared Autonomous Vehicles (SAV) service systems with ride-sharing
- Mostly agent-based modelling with MATSim
- Prominent works include:
  - D. J. Fagnant and K. M. Kockelman, Dynamic ride-sharing and fleet sizing for a system of shared autonomous vehicles in Austin, Texas. Transportation (2018)
  - B. Jäger, C. Brickwedde, and M. Lienkamp. Multi-agent simulation of a demand-responsive transit system operated by autonomous vehicles. TRR (2018)
  - M. Lokhandwala and H. Cai. Dynamic ride sharing using traditional taxis and shared autonomous taxis: A case study of NYC. TR Part C (2018)

DVanpool Project

Project specifications

- **Title:** Dynamic vanpool services: passengers preferences, operations modeling and simulation based quantification of impacts
- Funded by DFG (Deutsche Forschungsgemeinschaft)
- Sino-German collaboration between:

Technische Universität München

Tsinghua University

- PI's:

  Prof. Constantinos Antoniou (TUM) & Prof. Hai Jiang (Tsinghua)

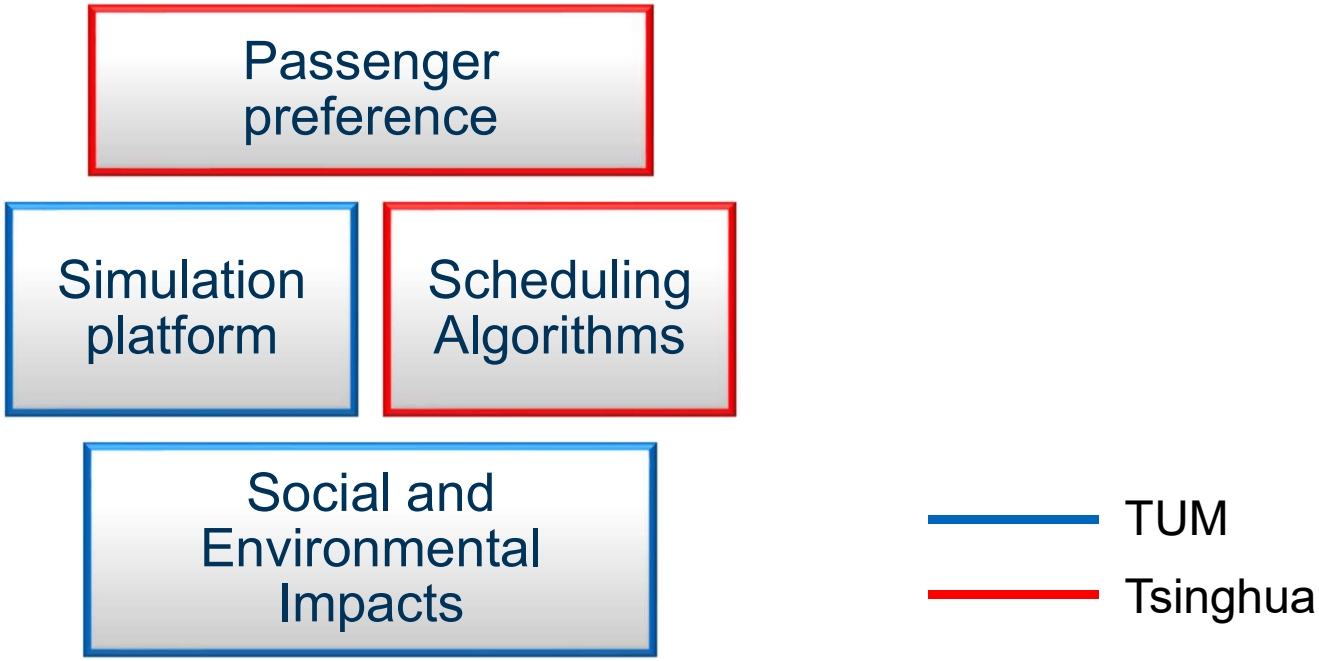
Project Aim

To investigate and identify fundamental characteristics of dynamic vanpooling service in perspective of passengers, operators and policy makers.

Source: https://future.transport.nsw.gov.au/sites/default/files/styles/expanded_1x/public/media/images/2018/2-customer-empowerment-12may_v2_0.png?itok=X-hw9-_E

Project Structure

The project is divided into four major areas:



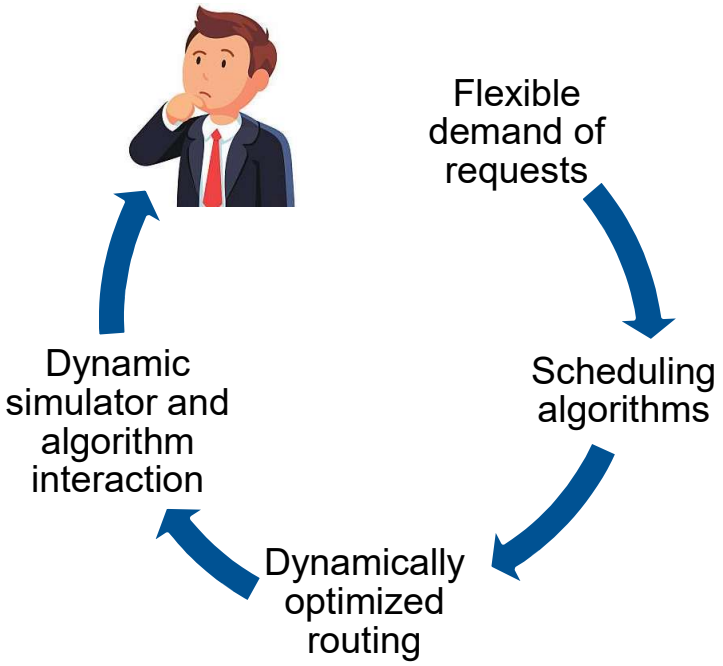
Simulation Platform

Simulation Platform

Enhancing a simulation platform to simulate and evaluate dynamic vanpooling services.

Challenges:

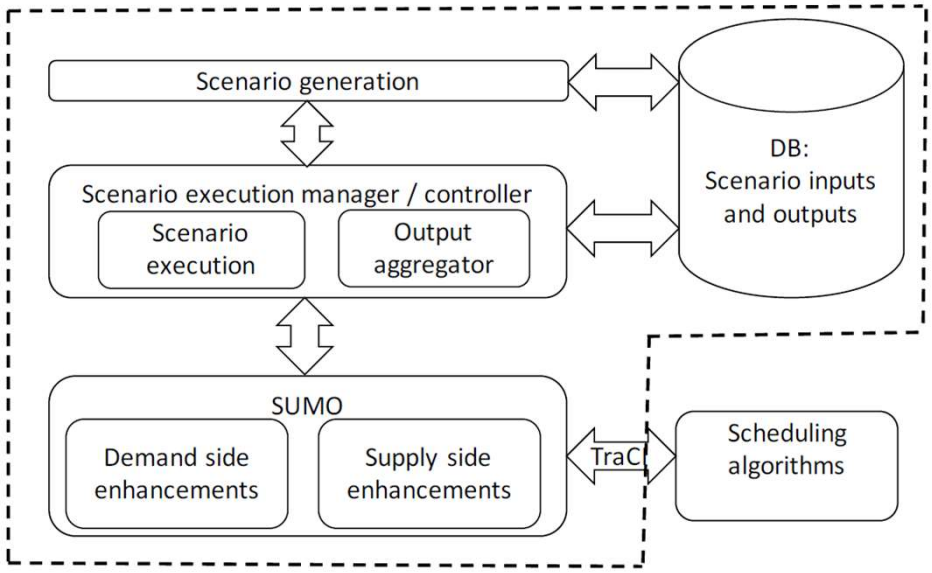
- Modeling autonomous vanpooling behavior
- Incorporating passenger preferences
- Interfacing rerouting scheduler and modeling online dynamic van rerouting
- Model passenger trips
- Dynamic pricing



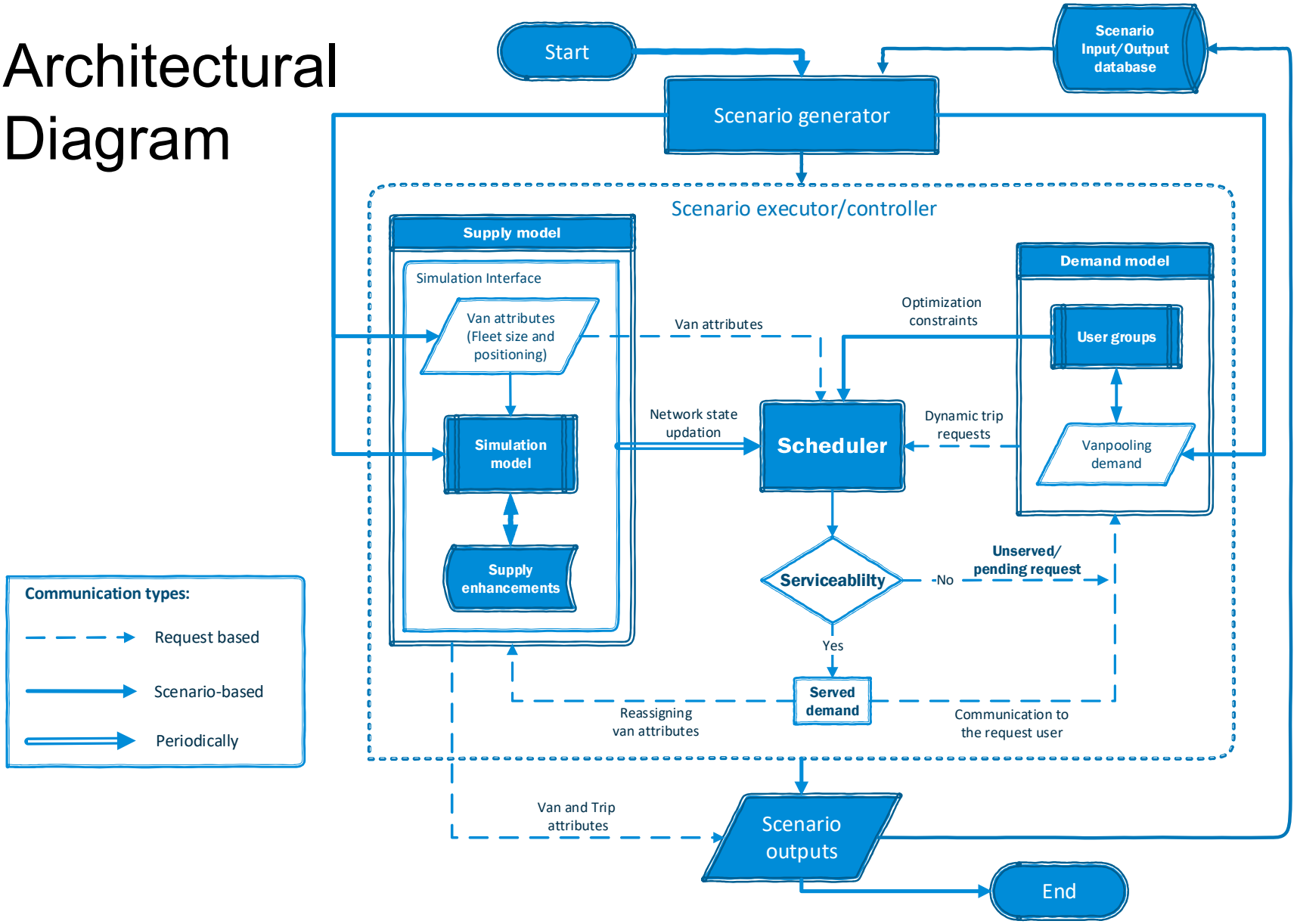
Simulation Platform

Solution:

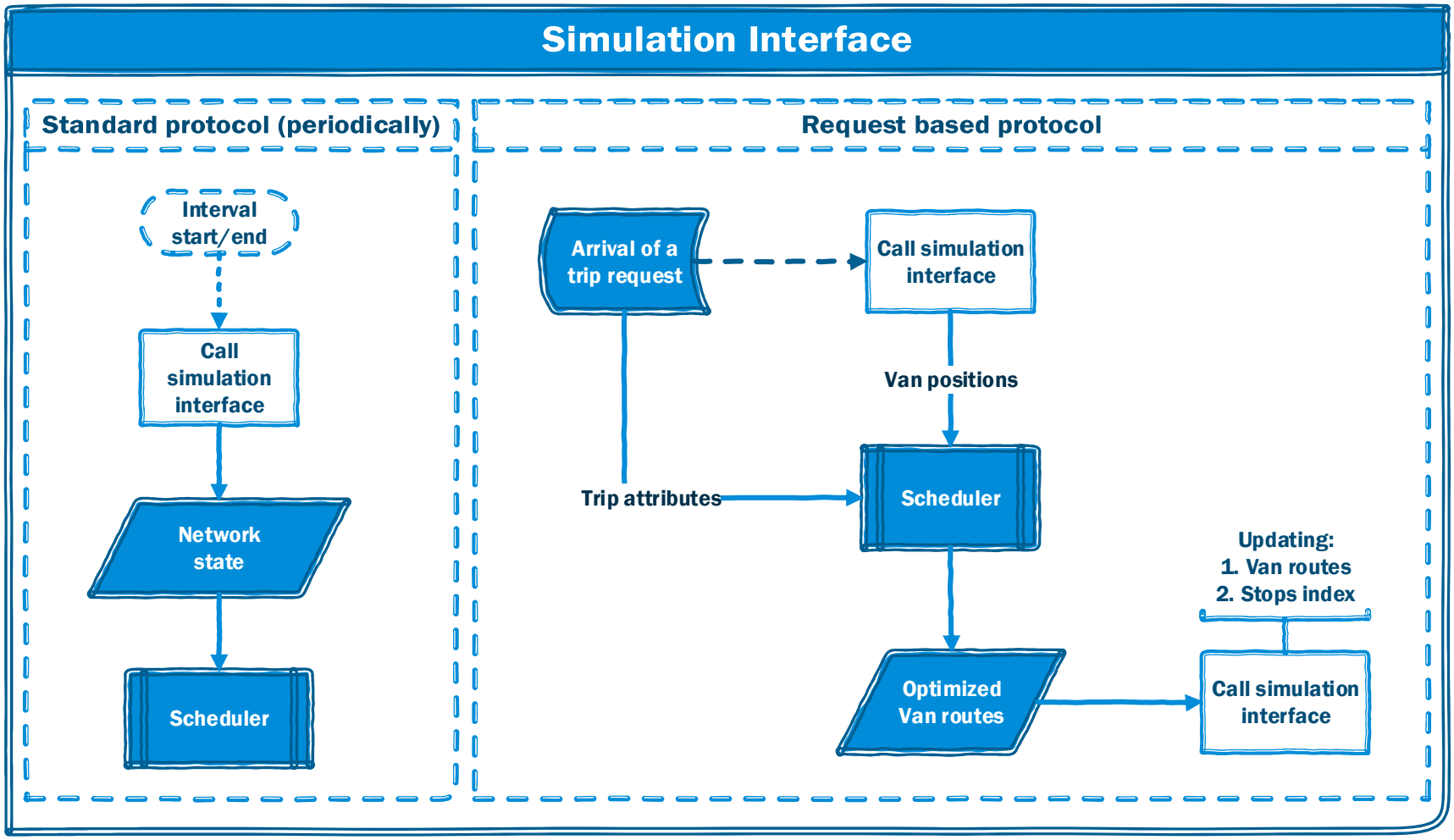
- Supply side enhancements:
  - Vehicle class
  - Flexible infrastructure
  - Individual person trips
- Demand side enhancements:
  - User preference groups
  - Dynamic trip pricing module
- Scenario generator
- Scenario executer/controller
- Scheduler interfacing module



Architectural Diagram



Interfacing Scheduler



Social and Environmental Impacts

Social and environmental impacts

Evaluating the social and environmental impacts from dynamic vanpooling services

Aim:

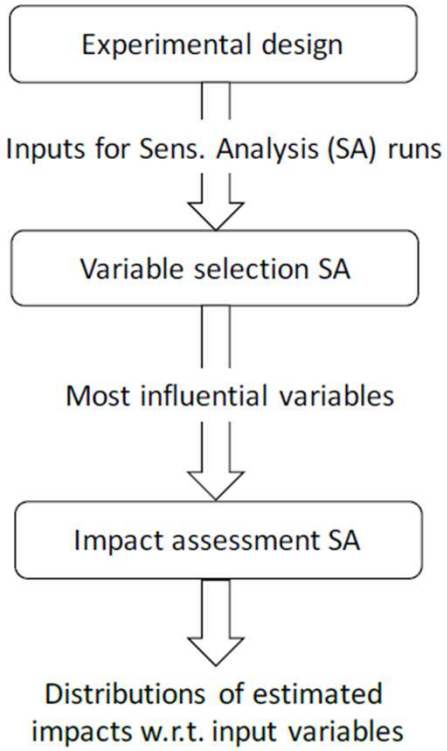
- Get a robust global assessment of the service to guide its application upon general networks

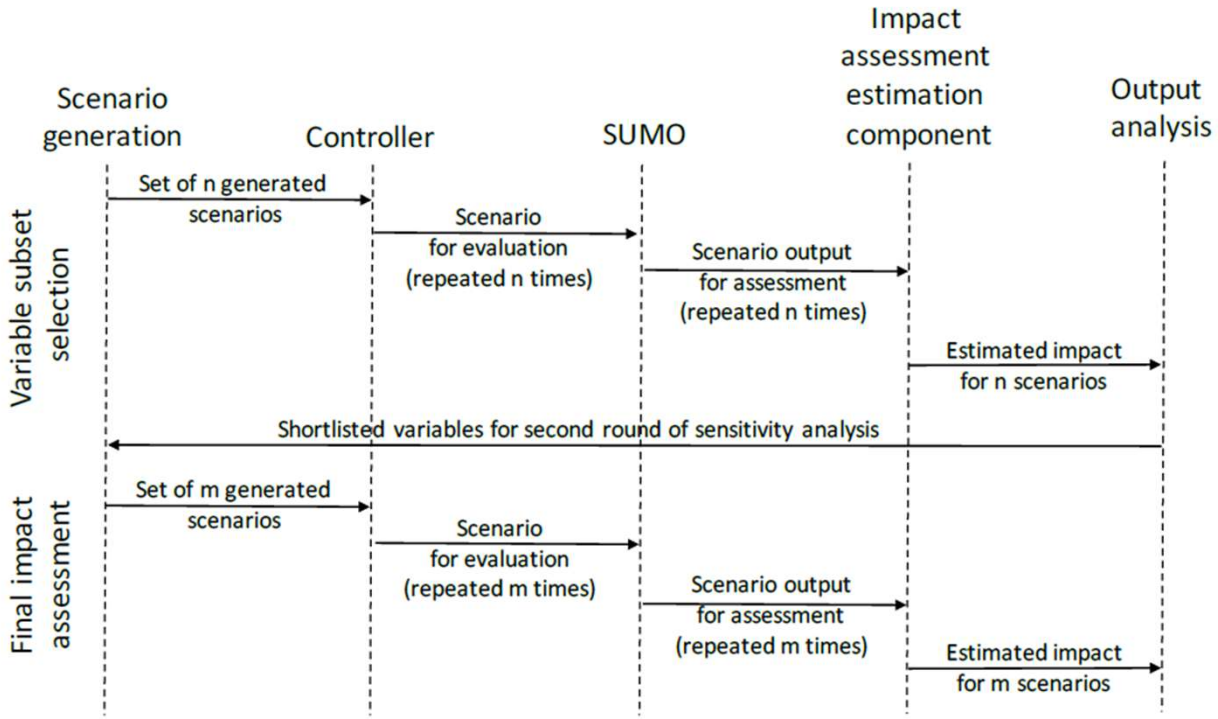
Method:

- A multi-level sensitivity analysis conducted upon multiple demand and supply variables.
- Elaborate experimental design to identify the correlation between the estimated impacts with different network and service variables.

Source: https://www.zazzle.com/carpool+office+gifts

Multi-level sensitivity analysis

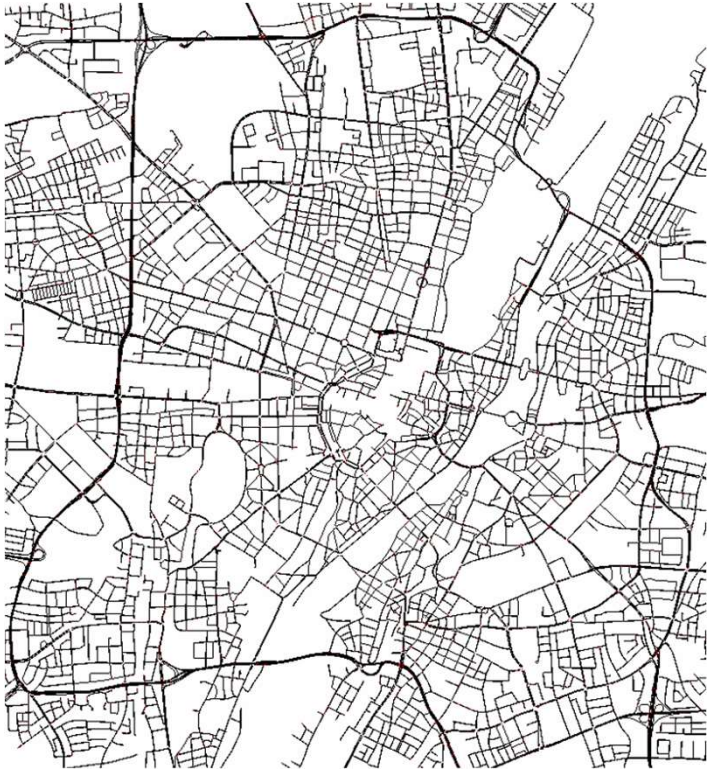




Networks

Munich city

Mittlerer Ring



Experimental variables

Supply:

- Network size
- Network topology
- Traffic conditions (Network demand)
- Fleet size
- Fleet positioning/relocation
- Vehicle characteristics (type, capacity)

Demand:

- Passenger preferences
- Service pricing
- Vanpooling usage demand

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