VIPSIM - Vedecom Integrated Personal Rapid Transit SIMulator
Mobility as a Service (MaaS)
- New generation of mobility services made possible by automation
- New operations and business models
- New mobility services blur the boundaries between individual and shared needs
- New mobility services will be integrated into the public transport grid

Challenges
Assess the impacts on existing services
Identify the relevant operation strategies to sustain viable business models

VIPSim Project
Create a tool for simulation of mobility service networks, to define, test and evaluate operation strategies embedding all relevant economic factors, including the quality of service for users
Easily transferable to any location or service definition
VIPSIM PROCESS

Production process:
- Fleet size
- Vehicle capacity
- Speed

Network:
- Stations
- Roads
- Traffic signals

Operating strategies:
- Ridesharing
- Charging
- Vehicle re-assignment

Demand:
- Passenger
- Origin-Destination Matrix

KPIs:
- Quality of service
- Optimal fleet size
- Fleet utilisation
- Energy consumption
- Ride sharing
- Empty vehicle km
- Service reliability
DEVELOPMENT STATUS

Modules available
- **Simulation engine**: microscopic simulation of both passengers and vehicles
- **Detailed data to analyse** the performance (distribution of passengers waiting time, passenger flows on links, vehicle flows, vehicle utilization,
- **Scenario Analysis** module
- **Optimisation Interface**: connect any type of optimisation (e.g. ride-sharing, energy use, tariffs, reliability, traffic control, etc.) to the simulation

Algorithms available
- **Vehicle re-assignment**
  - **Index based redistribution**
  - Nearest neighbour
  - Surplus / Deficit redistribution
- **Ride-Sharing** algorithms: station based sharing
VIPSIM: VEHICLES APPROACHING STATION

Vehicles move towards Massy Station

Passengers are picked up by arriving vehicles

Empty vehicles are green, Full vehicles blue
Select Which Data to display: Station, Link or OD data

Scenarorio information

Key Performance Indicators

Select Data for Graph and Map

Largest values are shown Large and Red
SIMULATION RESULTS: WITH RIDESHARING
EXAMPLE: BENEFITS OF RIDE-SHARING

No ride-sharing

- More passengers served
- Shorter passenger queues
- Reduced waiting time

Ride-sharing
OPTIMISATION: EMPTY VEHICLE REDISTRIBUTION

• PODCity Conference 2017 (Las Vegas, USA), 3rd Martin Lowson best paper award for Tatiana Babicheva

• Problem: re-assign empty vehicles to achieve minimal passenger waiting times (or generalized cost).

• Typical solution **simple nearest neighbour** (SNN)
  1. Rank stations according to longest waiting passenger
  2. Assign nearest empty vehicle to each station on the list

• Proposed algorithm: **Index Based Redistribution** (IBR)
  1. Calculate for each station an index based on:
     • Current waiting passengers
     • Predicted passenger arrivals
     • Predicted vehicle arrivals
  2. Index = predicted deficit of vehicles
  3. In order of Index (deficit) send nearest empty vehicles

• **SNN + IBR combination** significant improvement over existing algorithms, and each algorithm separately
Combination of Index-Based and Nearest Neighbour best:
• Better than each algorithm on its own
• Robust for different demand (rush hour / off peak)
• Balance passenger disutility with operator cost
• Passenger disutility: waiting time $c_{\text{wait}}$
• Operator cost: vehicle fleet cost $c_{\text{vehicle}}$
• Operation loss: empty running of vehicles $c_{\text{empty}}$

$$F = \sum t_{\text{wait}} \cdot c_{\text{wait}} + \sum t_{\text{empty run}} \cdot c_{\text{empty run}} + N_{\text{vehicle}} \cdot c_{\text{vehicle}}$$
STATUS OF THE PROJECT

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- **Simulation engine**: microscopic simulation of both passengers and vehicles
- Detailed data to analyse the performance (distribution of passengers waiting time, passenger flows on links, vehicle flows, vehicle utilization,
- **Scenario Analysis** module
- **Optimisation Interface**: connect any type of optimisation (e.g. ride-sharing, energy use, tariffs, reliability, traffic control, etc.) to the simulation

Algorithms available
- Vehicle re-assignment
- Ride-Sharing

Next steps:
- **Demand-supply interactions**: how does passenger demand react?
- **Optimisation algorithms**: Ride-sharing, Energy use, Parking
- **Case studies**: Saclay, Martha’s wineyard, Gothenburg
- **Integrate/interface** with other VEDECOM models: Energy usage, V2I, Supervisor, Autonomous controller