INSTITUT VEDECOM

DU VÉHICULE DÉCARBONÉ ET COMMUNICANT ET DE SA MOBILITÉ

VIPSIM - Vedecom Integrated Personal Rapid Transit SIMulator

version 06/07/2018

CONTEXT

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**

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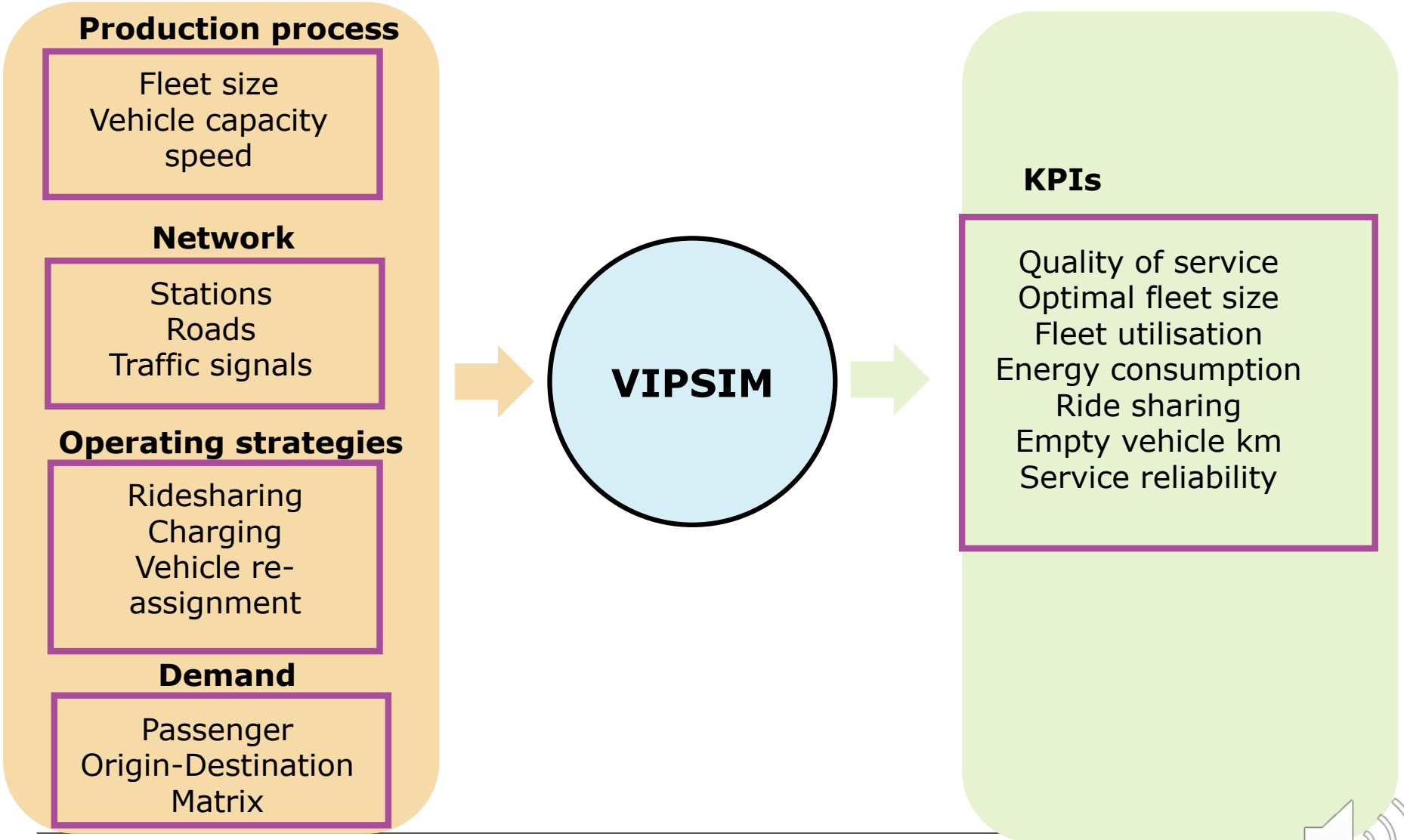
VIPSIM PROCESS



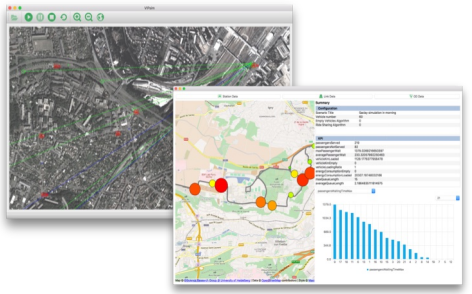
DEVELOPMENT STATUS

Modules available

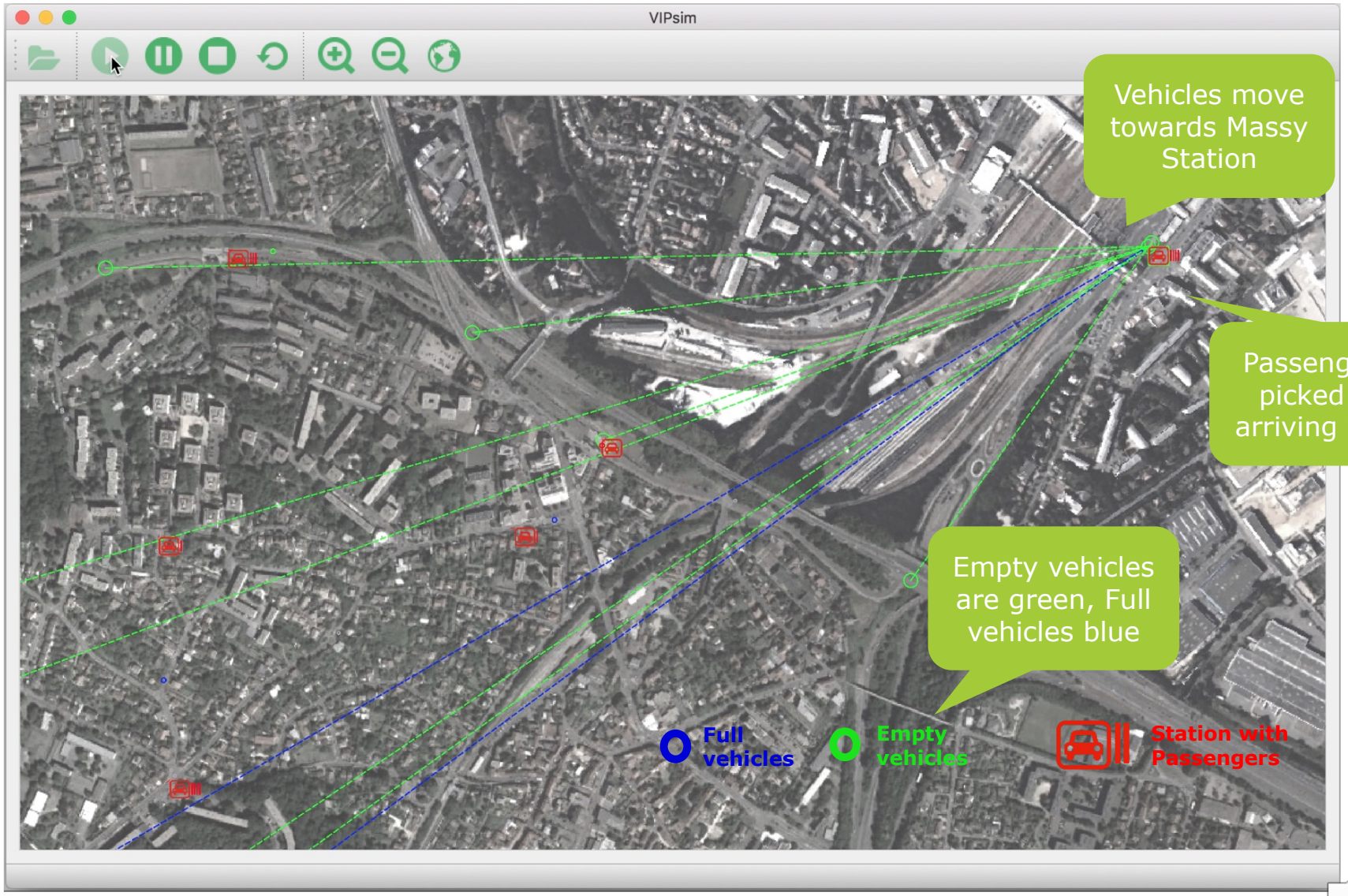
- **Simulation engine** : microscopic simulation of both passengers and vehicles
- **Detailed data to analyse** the performance (distribution of passengers waiting time, passenger flows on links, vehicle flows, vehicle utilization,
- **Scenario Analysis** module
- **Optimisation Interface**: connect 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



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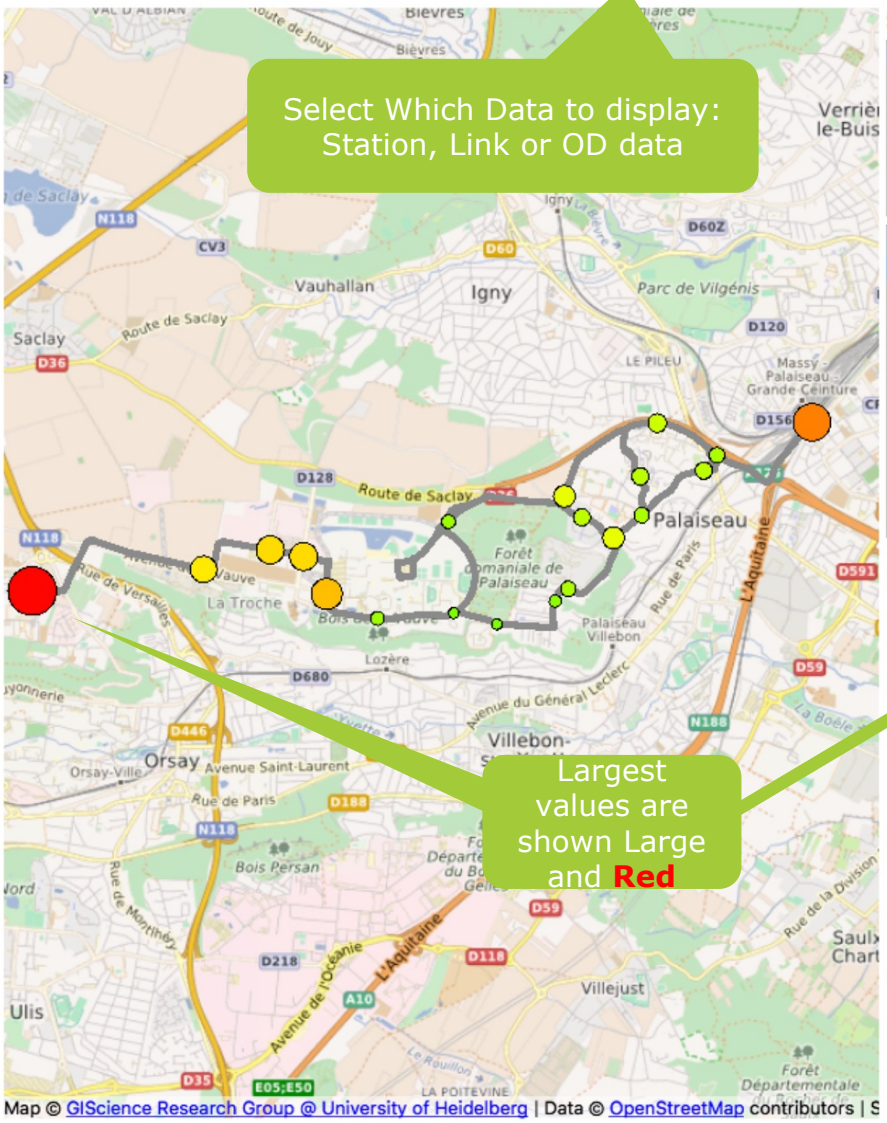
SIMULATION RESULT VIEW

Scenerario information

Station Data | Link Data | OD Data

Select Which Data to display: Station, Link or OD data



Largest values are shown Large and **Red**

Summary

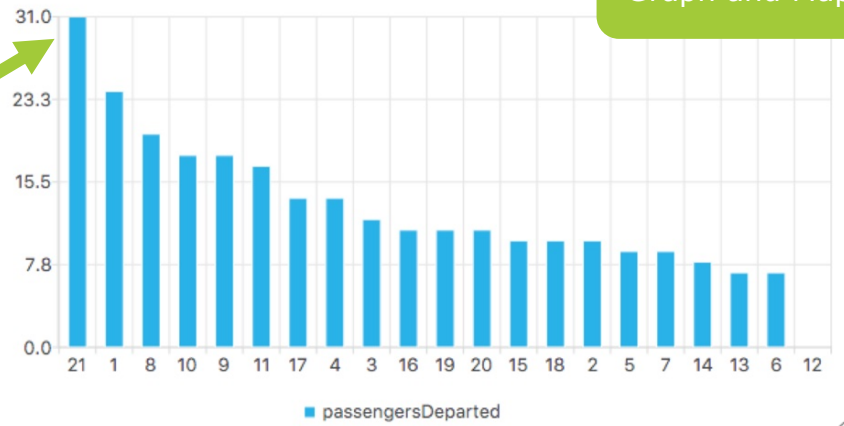
Configuration	
Scenario Title	Saclay simulation in morning
Vehicle number	60
Empty Vehicles Algorithm	1
Ride Sharing Algorithm	1

KPI	
passengersServed	271.0
passengersNotServed	39.0
maxPassengerWait	775.8
averagePassengerWait	149.3
vehicleKmLoaded	1044.1
vehicleKmEmpty	313.8
vehicleLoadingRatio	0.8
energyConsumptionEmpty	5648.6
energyConsumptionLoaded	18794.6
maxQueueLength	14.0
averageQueueLength	1.7

Key Performance Indicators

passengersDeparted

Select Data for Graph and Map



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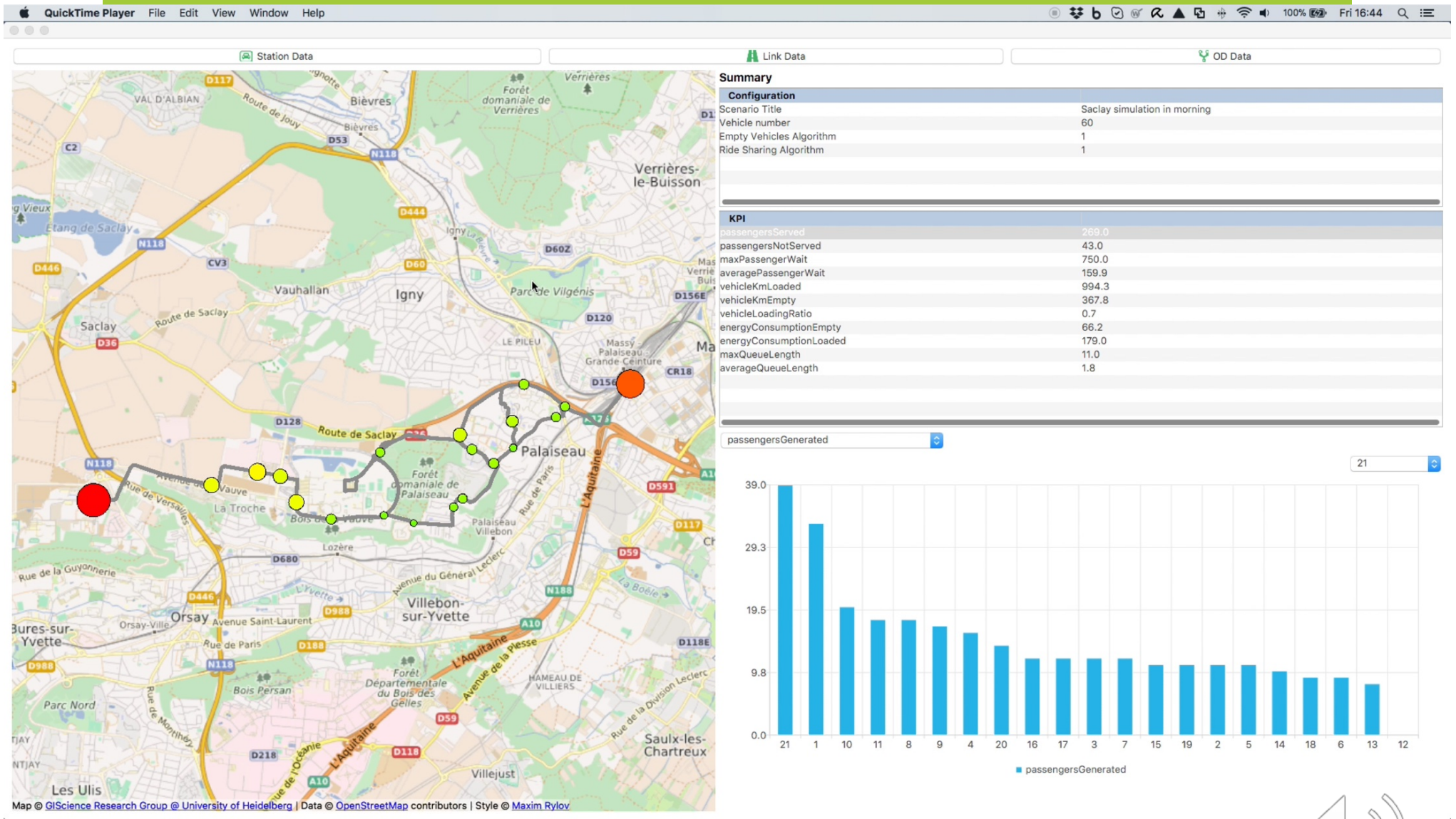
SIMULATION RESULTS: WITH RIDESHARING



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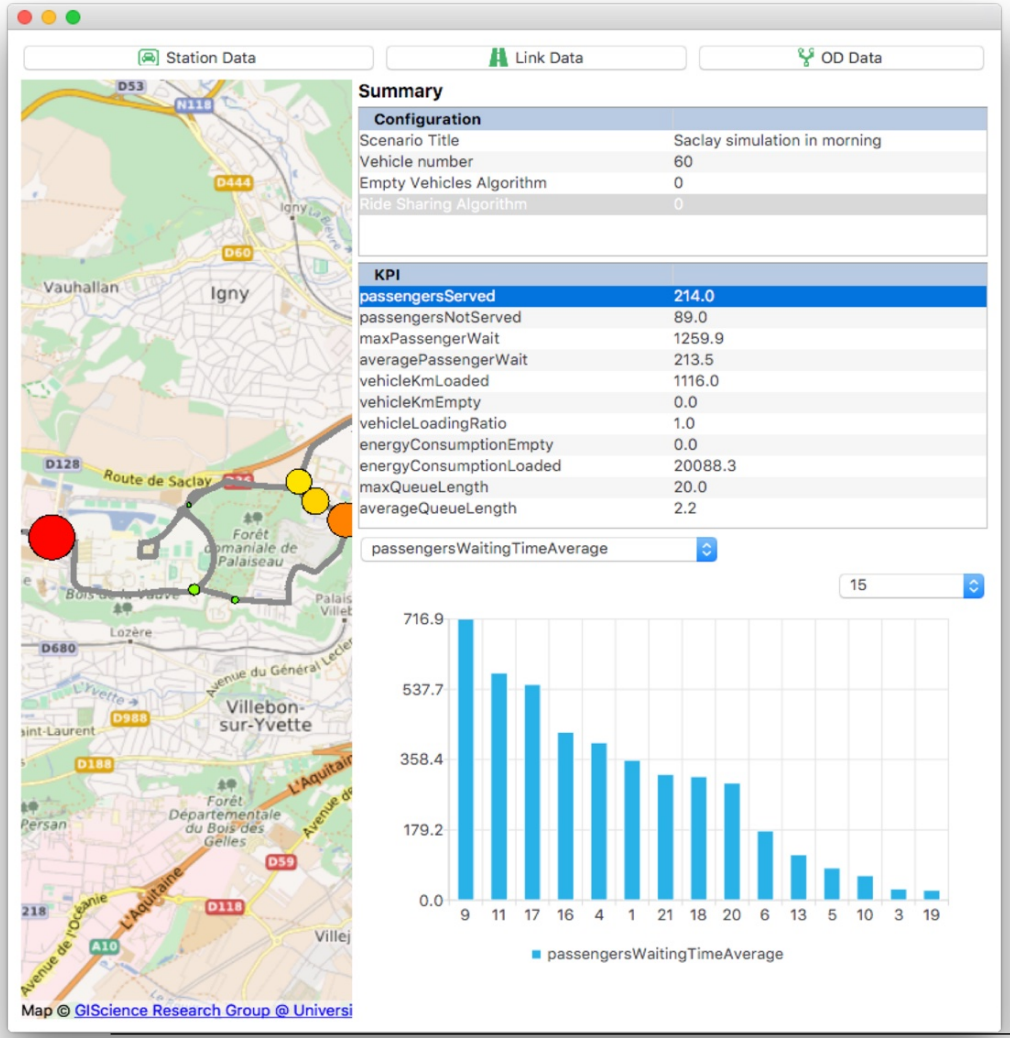
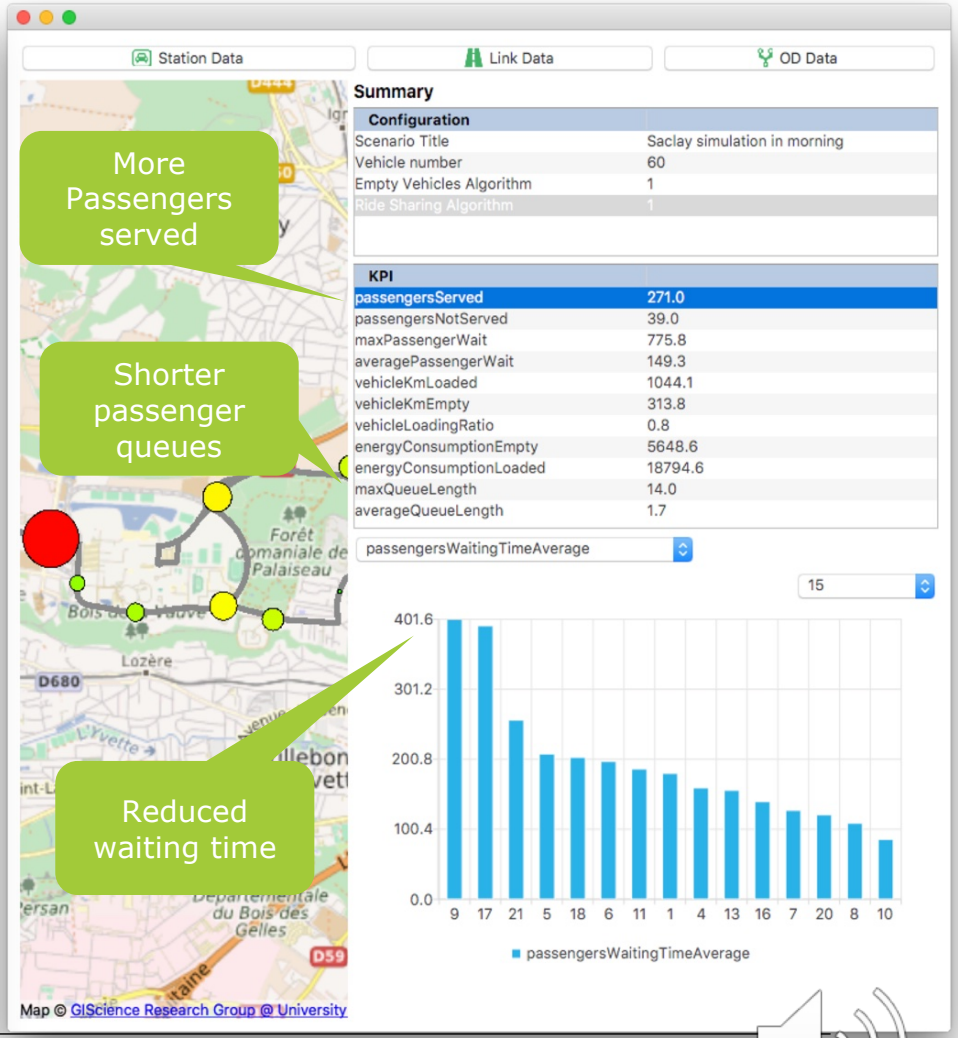
EXAMPLE: BENEFITS OF RIDE-SHARING

No ride-sharing



Ride-sharing



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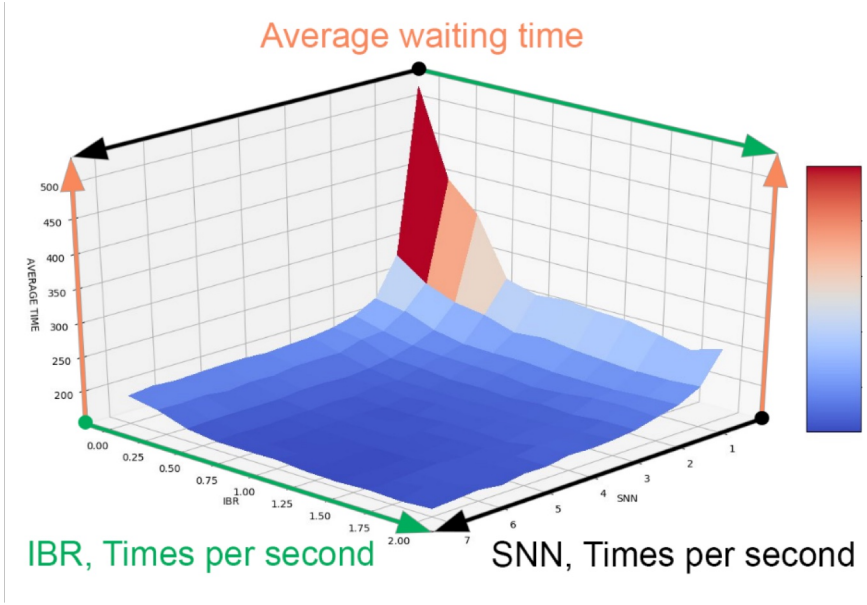
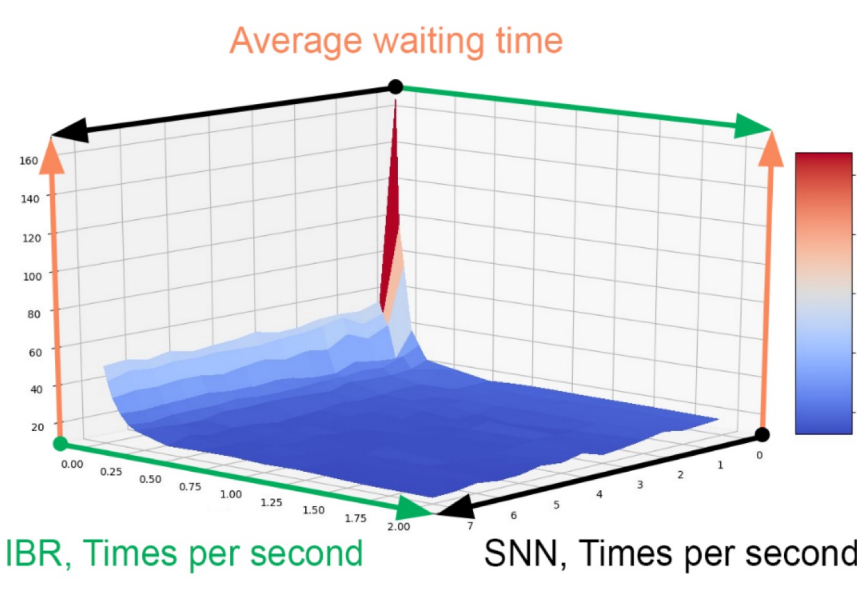
OPTIMISATION: EMPTY VEHICLE REDISTRIBUTION

- 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

COMBINING INDEX-BASED AND NEAREST NEIGHBOURS STRATEGIES



Rush hour



Off peak

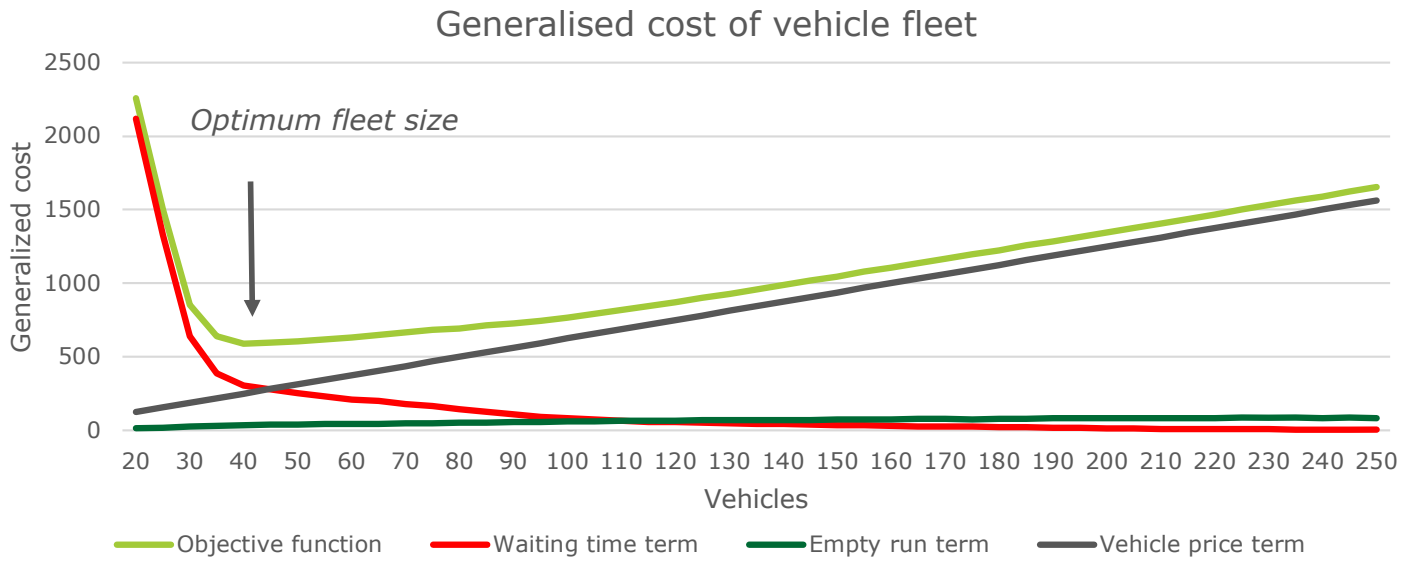
Combination of Index-Based and Nearest Neighbour best:

- Better than each algorithm on its own
- Robust for different demand (rush hour / off peak)

OPTIMISATION: OPTIMAL VEHICLE FLEET SIZE

- Balance passenger disutility with operator cost
- Passenger disutility : waiting time c_{wait}
- Operator cost : vehicle fleet cost $c_{vehicle}$
- Operation loss: empty running of vehicles c_{empty}

$$F = \sum t_{wait} \cdot c_{wait} + \sum t_{empty\ run} \cdot c_{empty\ run} + N_{vehicle} \cdot c_{vehicle}$$



STATUS OF THE PROJECT

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- 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

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