Contents of Work Package 1-WP07 Artificial Intelligence for Improved Mobility

1-WP07: Artificial Intelligence for Improved Mobility

Coordinator of the WP

Czech Technical University in Prague, repr. by doc. Ing. Jiří Vokřínek, Ph.D.

Participants of the WP

FEE CTU, FME CTU

Main Goal of the WP

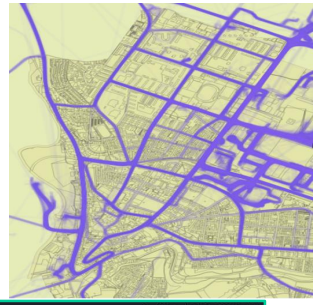
Mobility-as-a-service simulation, management, and optimization.

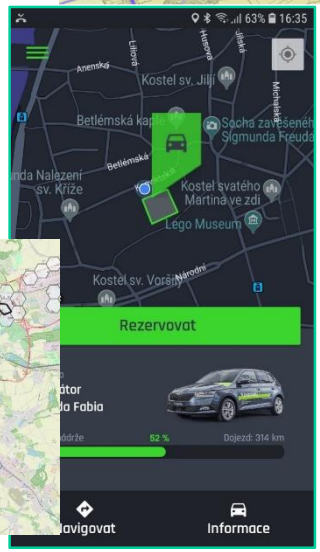
Partial Goals for the Current Period

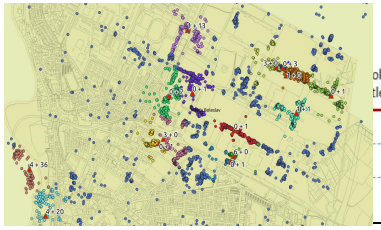
Complex software model of vehicle energy demands and fuel consumption prediction for application in car-sharing application. Simulation and optimization of vehicle fleet management with capacity constraints and car sharing. Optimization models for combination of individual transportation modes on routes with less passenger occupancy.

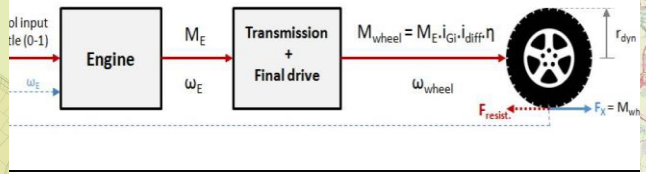
Activities in 1-WP07 Artificial Intelligence for Improved Mobility

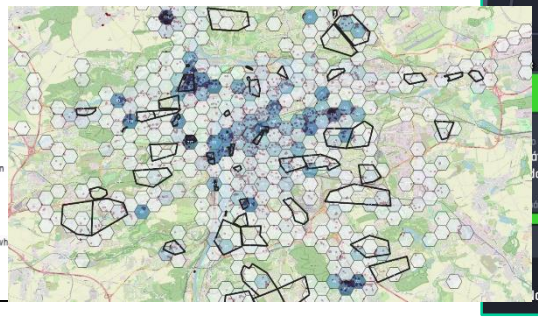
- Complex software model of vehicle energy demands and fuel consumption prediction for application in car-sharing application
- Comparison of various types of vehicles integrated in multimodal transportation mobility-as-a-service system
- Agent-based software simulation and optimization algorithms implementation for vehicle fleet management
- Analysis of potential and risks of mobility-on-demand systems
- Simulation with GIS data
- Extension towards EV
- Real car-sharing system/application tested
- Real fleet data analyzed



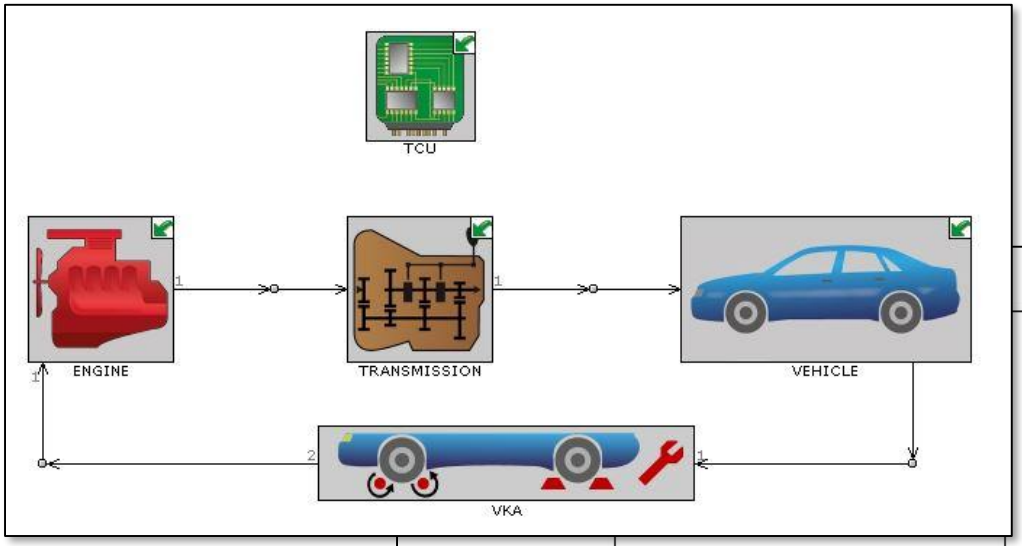




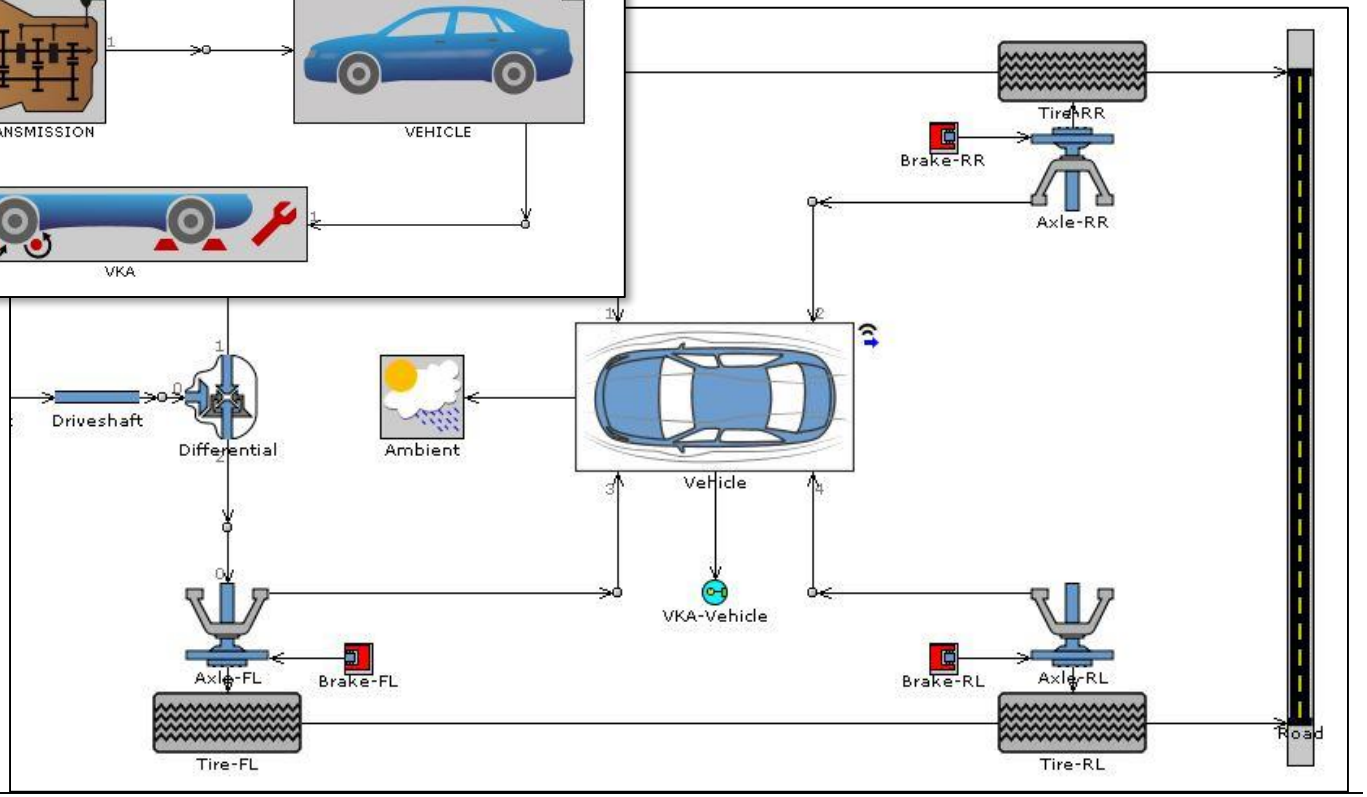




Activities in 1-WP07-001 Mobility-as-a-service energy usage optimization



- *relatively high detail*
  - *weather, suspension...*

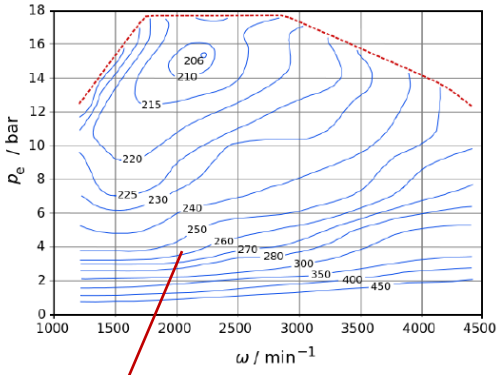


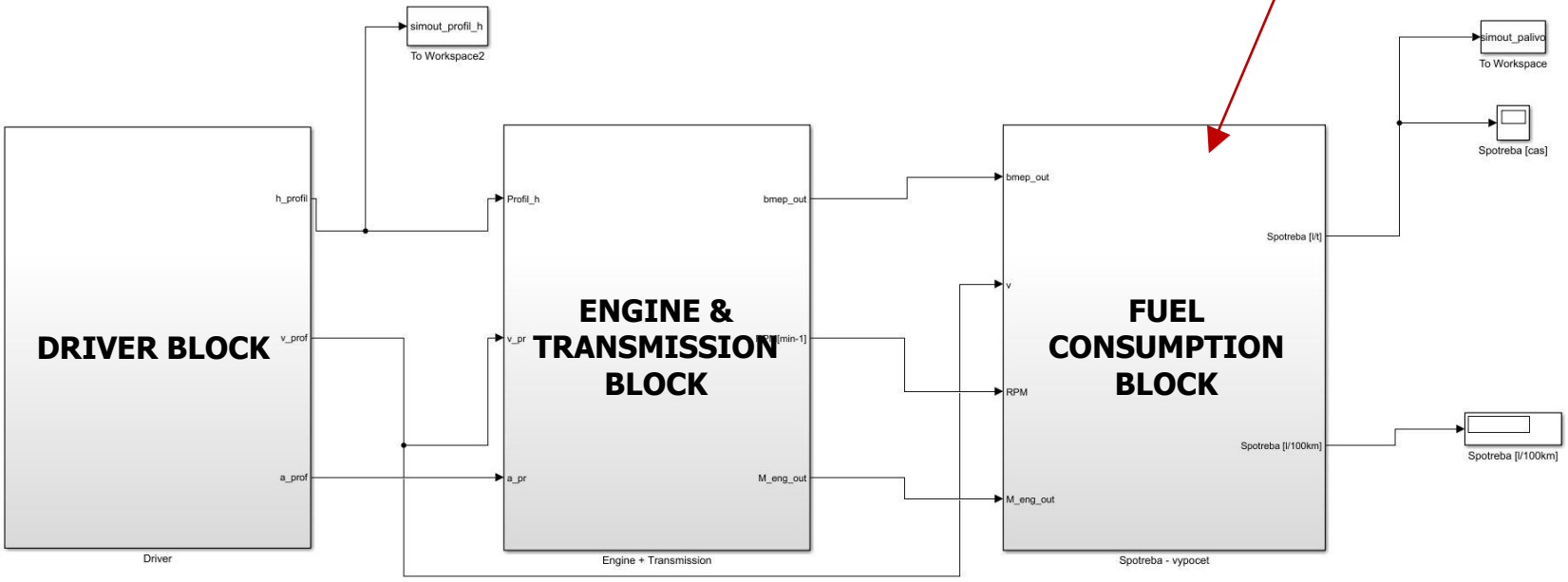
Simulation model
– GT Power

Activities in 1-WP07-001 Mobility-as-a-service energy usage optimization

Simulation model – MATLAB/Simulink

- reasonable model simplification

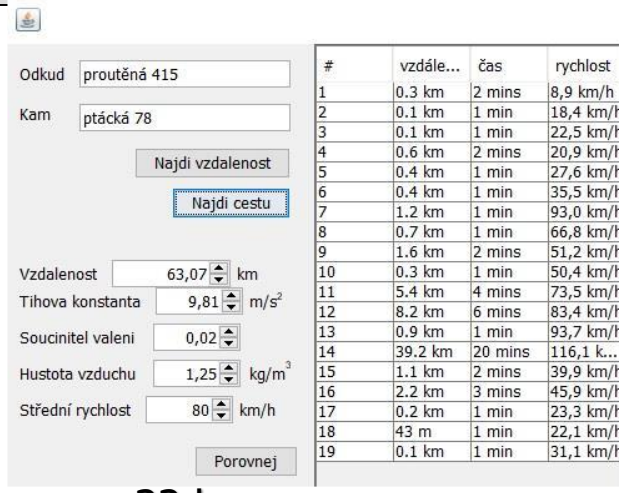




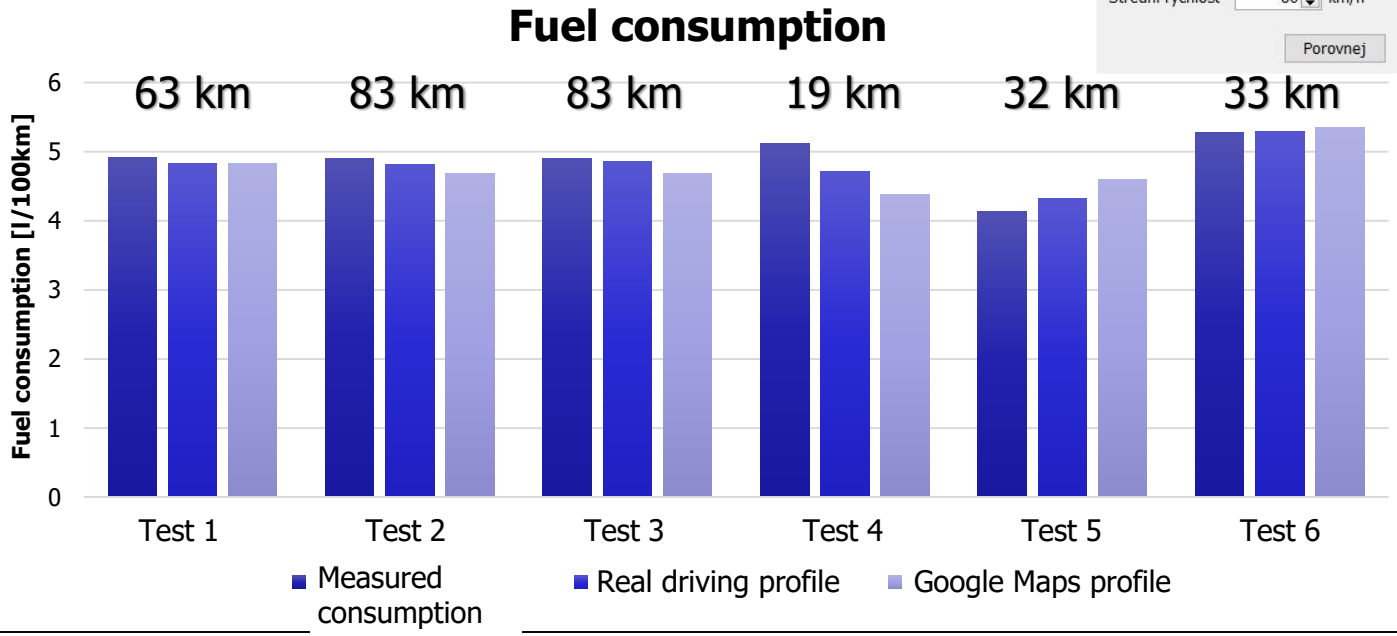
Activities in 1-WP07-001 Mobility-as-a-service energy usage optimization

Model verification

- Google Maps API route details as data source for the model
- reali life driving tests with various routing
  - OBD data + GPS
- average error 0,12 l/100 km



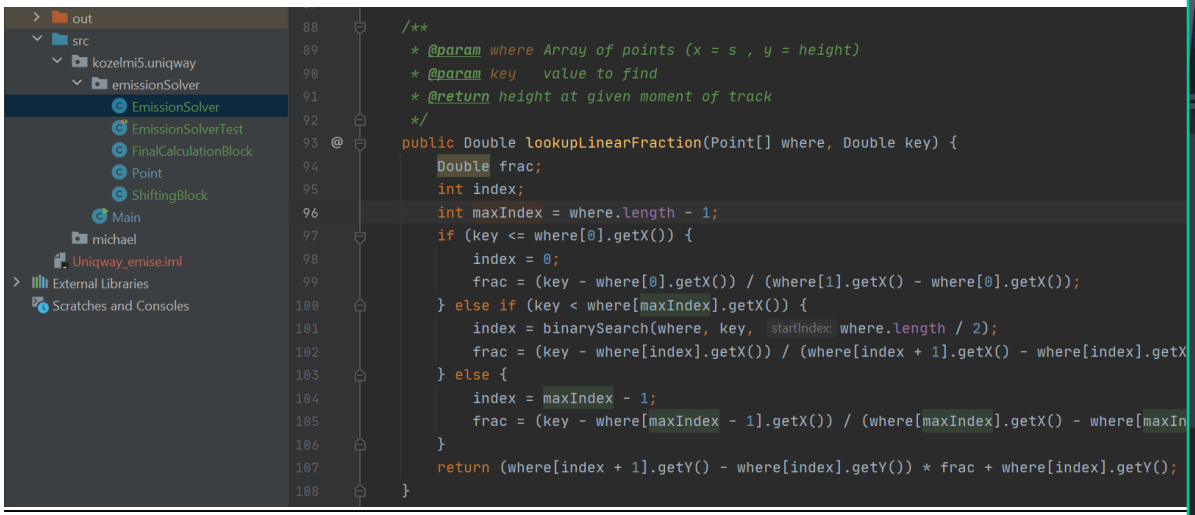
#	vzdále...	čas	rychlost
1	0.3 km	2 mins	8,9 km/h
2	0.1 km	1 min	18,4 km/h
3	0.1 km	1 min	22,5 km/h
4	0.6 km	2 mins	20,9 km/h
5	0.4 km	1 min	27,6 km/h
6	0.4 km	1 min	35,5 km/h
7	1.2 km	1 min	93,0 km/h
8	0.7 km	1 min	66,8 km/h
9	1.6 km	2 mins	51,2 km/h
10	0.3 km	1 min	50,4 km/h
11	5.4 km	4 mins	73,5 km/h
12	8.2 km	6 mins	83,4 km/h
13	0.9 km	1 min	93,7 km/h
14	39.2 km	20 mins	116,1 k...
15	1.1 km	2 mins	39,9 km/h
16	2.2 km	3 mins	45,9 km/h
17	0.2 km	1 min	23,3 km/h
18	43 m	1 min	22,1 km/h
19	0.1 km	1 min	31,1 km/h

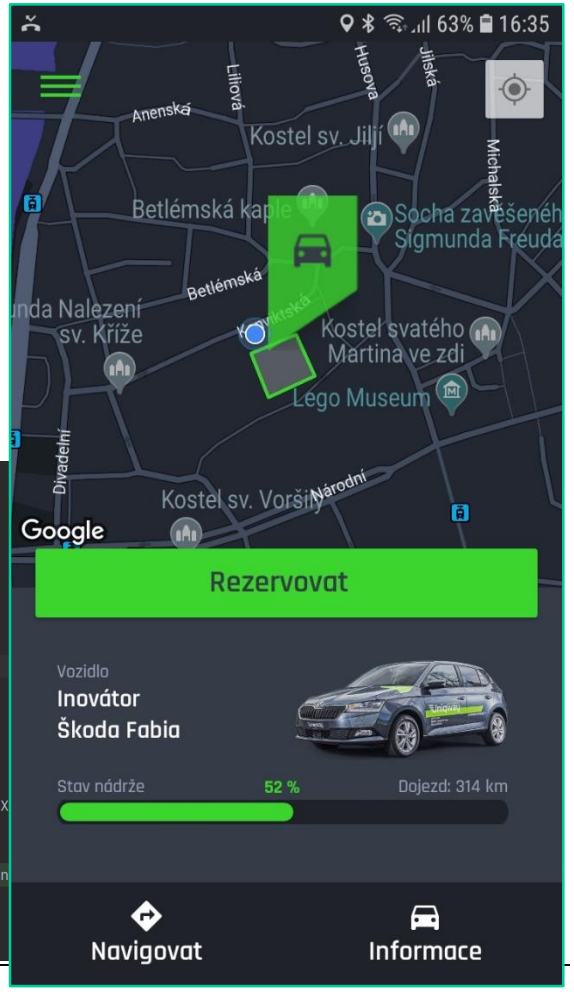


Activities in 1-WP07-001 Mobility-as-a-service energy usage optimization

Gamification tool (university carsharing uniqway)

- MATLAB/Simulink model is transcripted in Uniqway Java backend
- gamification tool is designed in user application
  - in progress
  - „race" against predicted consumption

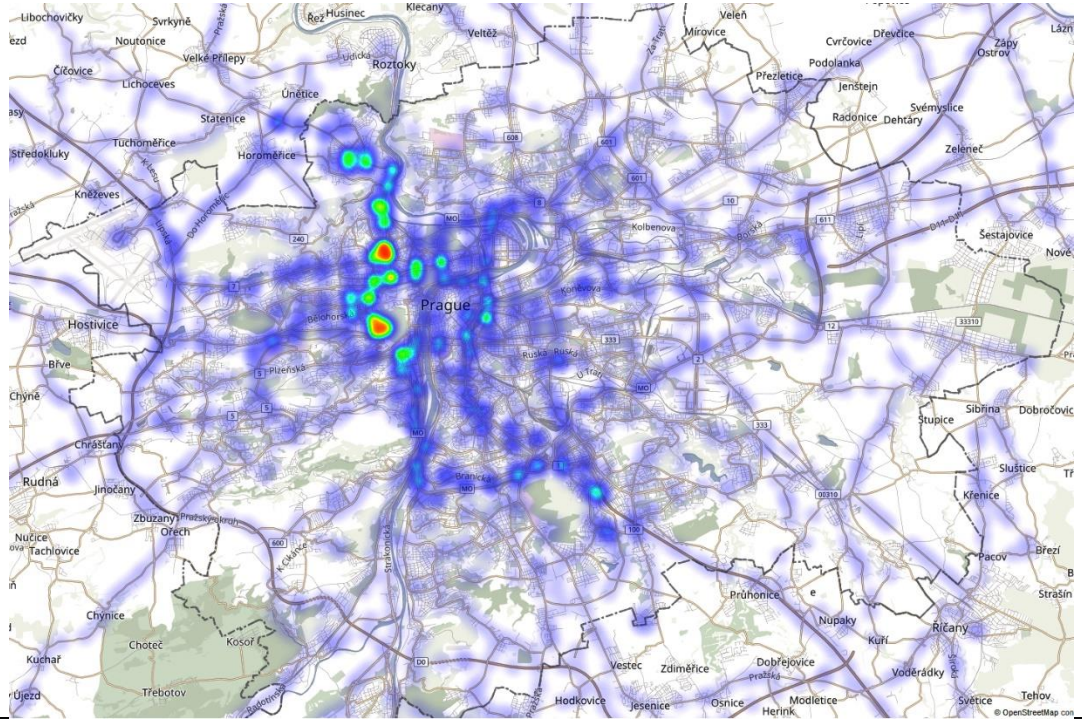




Activities in 1-WP07-002 Optimization models for mobility-as-a-service on routes with less passenger occupancy

Optimization for MaaS on routes with less ocupancy

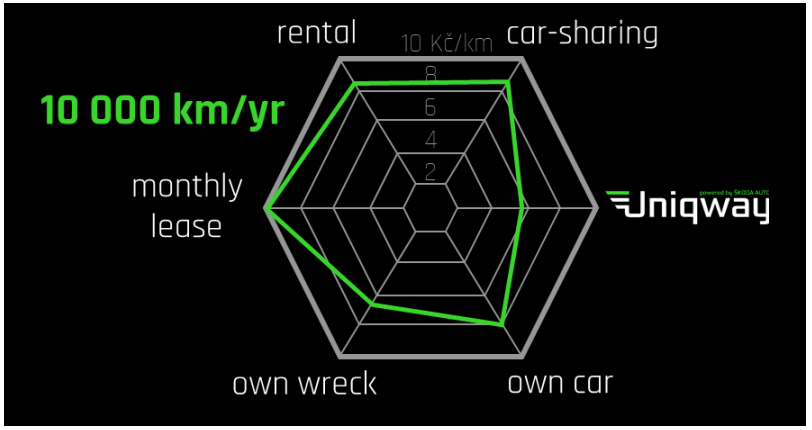
- carsharing user behavior analysis
  - focus on university students
- can we spare some rides?

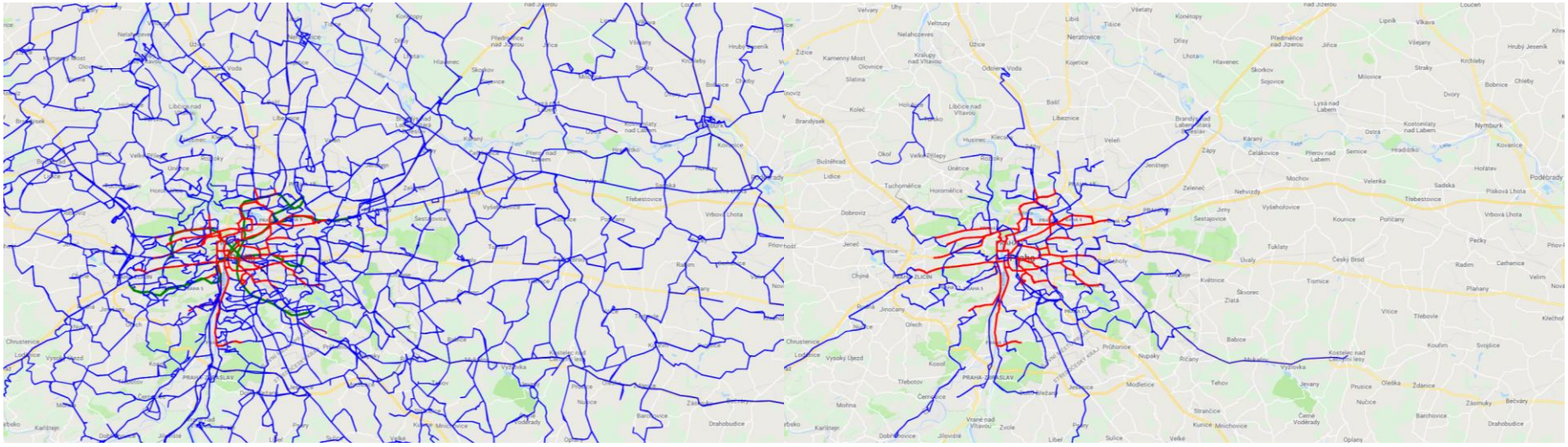


Activities in 1-WP07-002 Optimization models for mobility-as-a-service on routes with less passenger occupancy

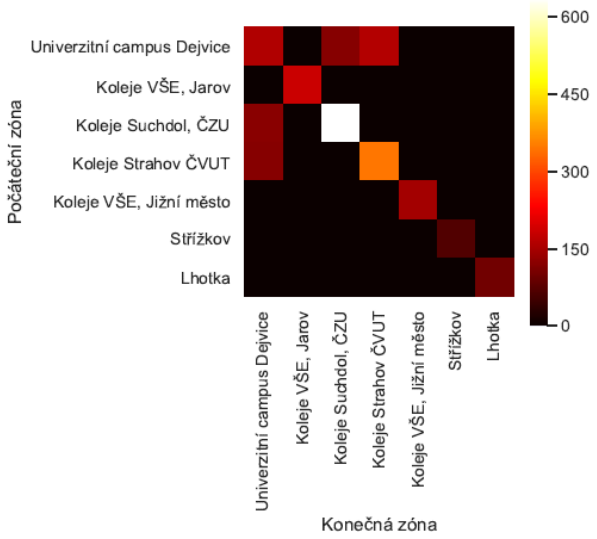
Maas area of interest

- low access to transport
  - location, time
- no need for own vehicle

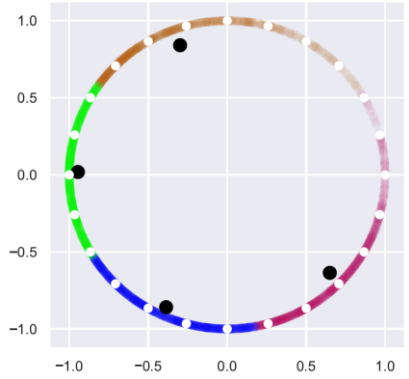


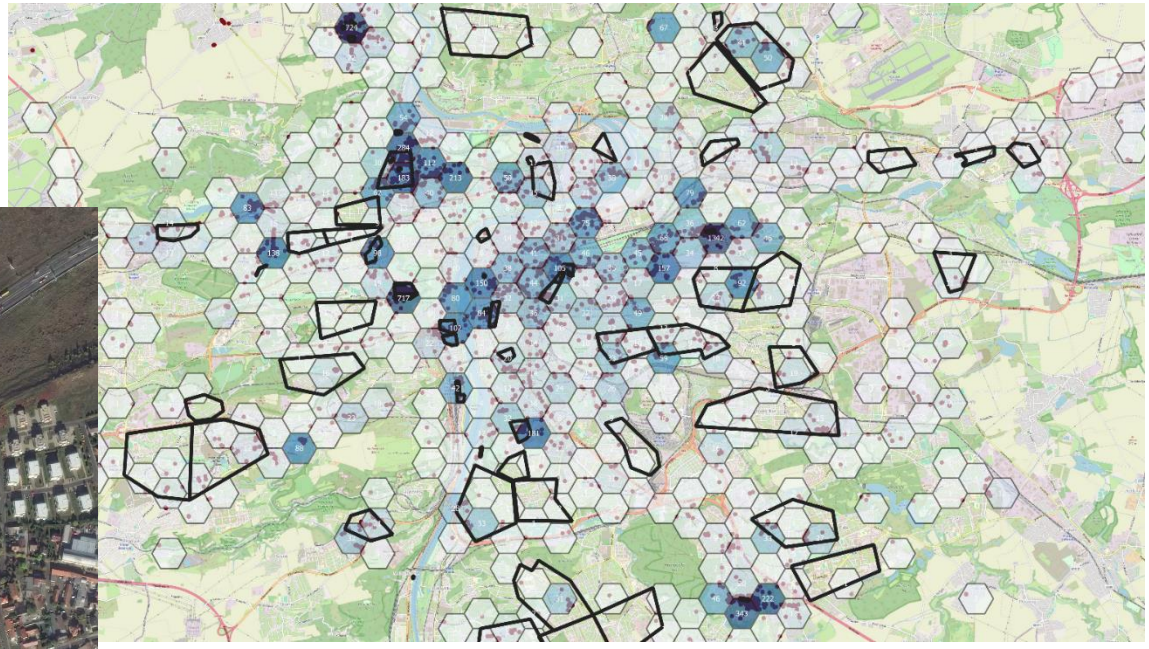


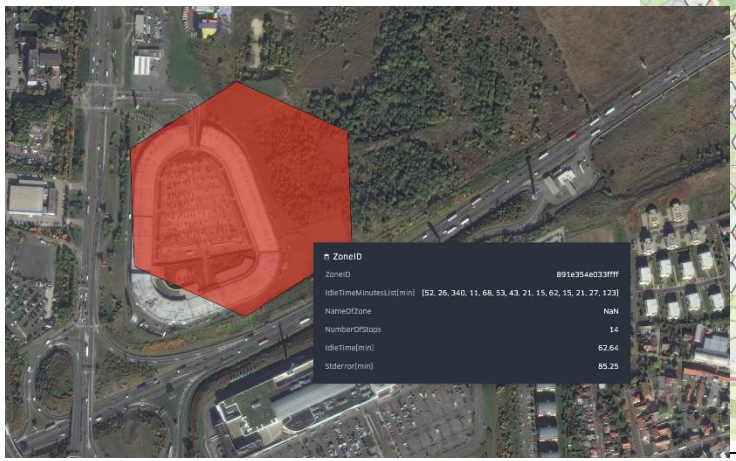
Activities in 1-WP07-002 Optimization models for mobility-as-a-service on routes with less passenger occupancy



User rides analyses

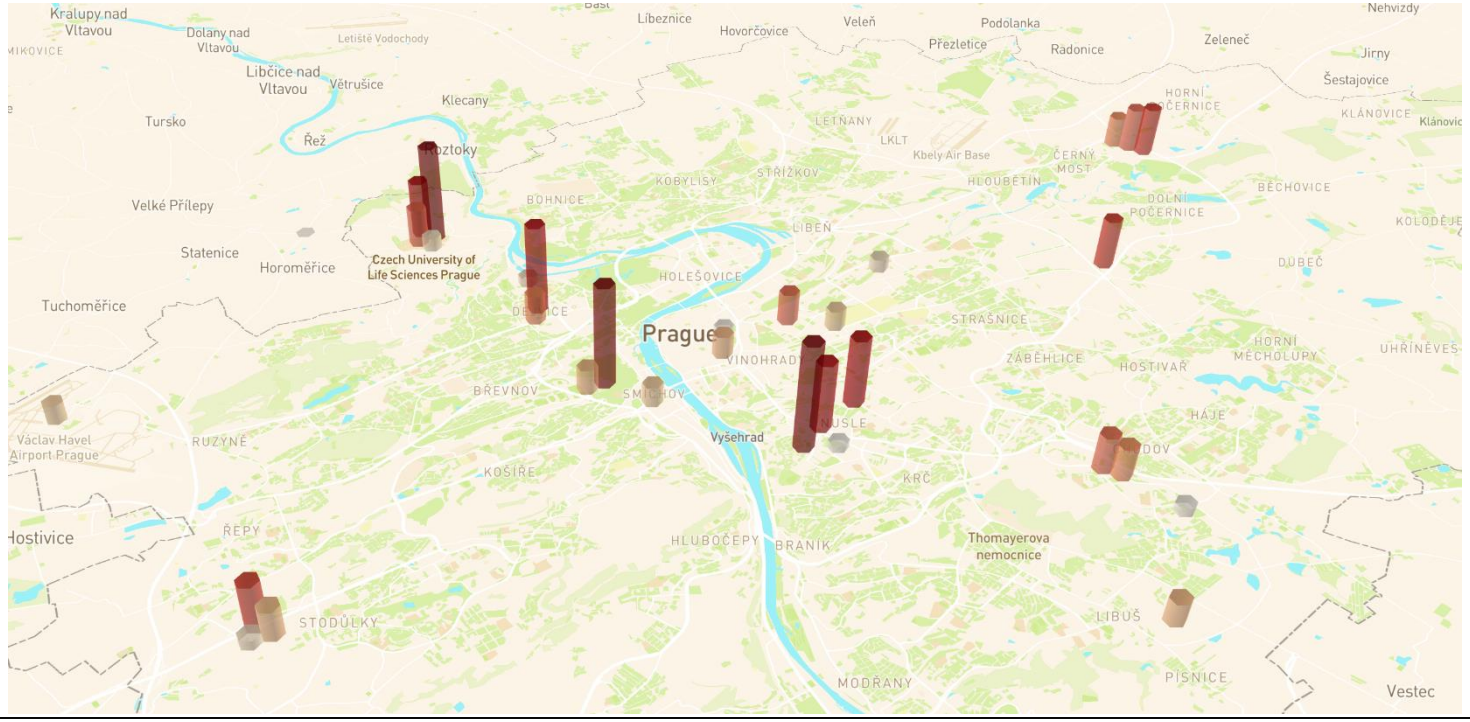






Activities in 1-WP07-002 Optimization models for mobility-as-a-service on routes with less passenger occupancy

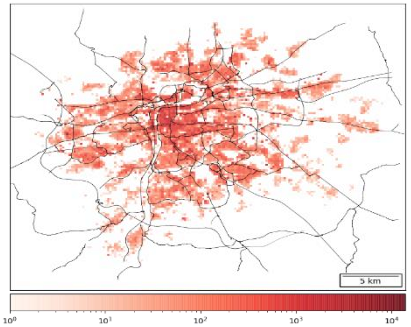
- Minimum number of local rides could be spared
  - rides are expected to be already shared
  - rides fulfill the need of transport, which cannot be realized by public transport (usually shopping, late night rides
- Further work will focus on balancing vehicle powertrain type in fleet with regards to optimal emissions

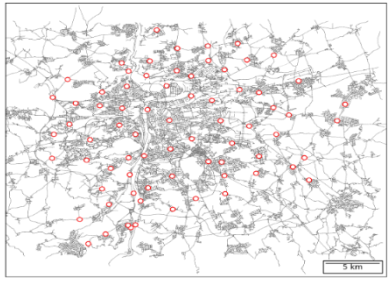


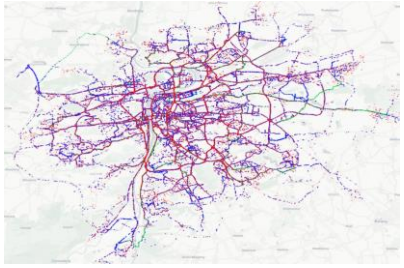
Activities in 1-WP07-003 Simulation and optimization of vehicle fleet management with capacity constraints and car sharing

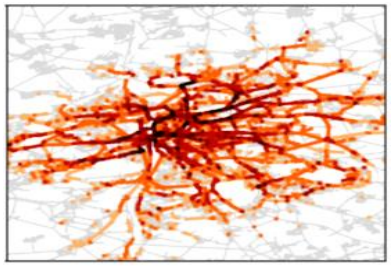
- Analysis of potential and risks of mobility-on-demand systems using simulation
- Real metropolitan-scale experiment with realistic demand on real road network of Prague (2019) and Mladá Boleslav (2020)
- Simulation tool for fleet analysis and its electrification (who can use EV?)
- Analysis on real Škoda fleet data

Demand model → MoD system → Multi-agent simulation → Simulation results analysis



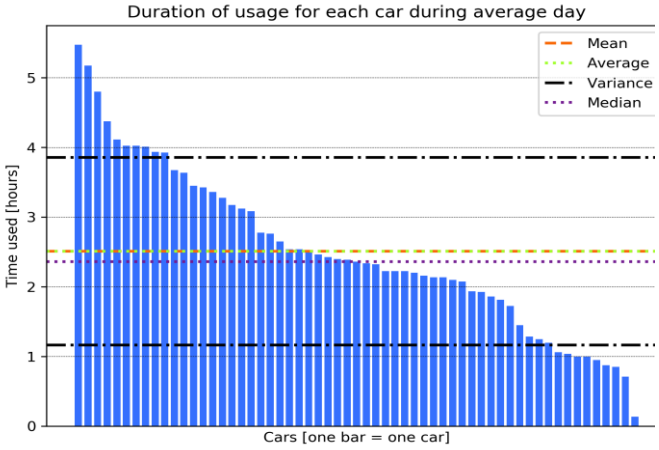


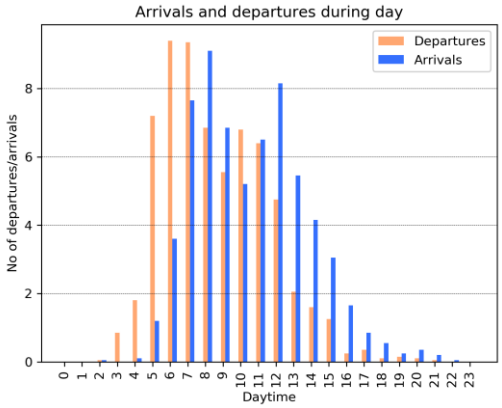


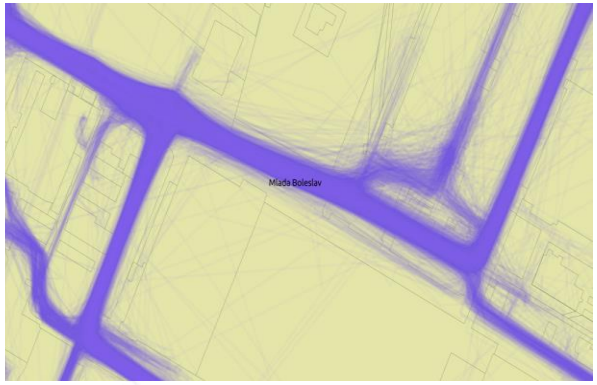


Activities in 1-WP07-003 Simulation and optimization of vehicle fleet management with capacity constraints and car sharing

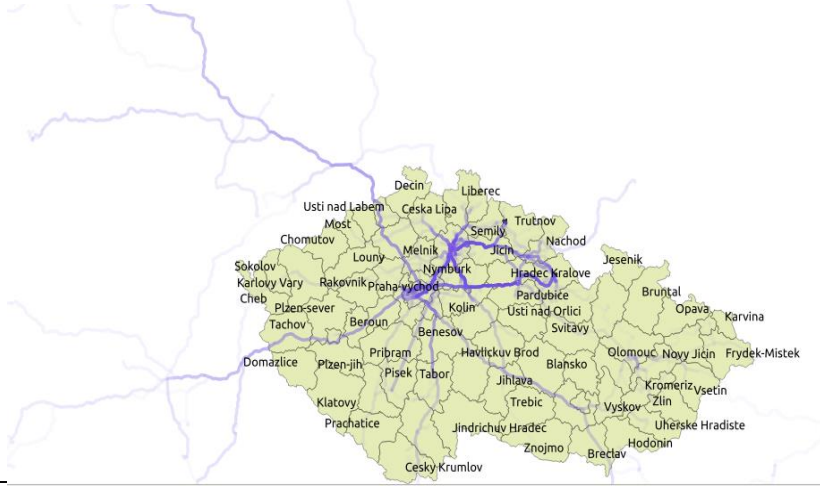
Tool for fleet analysis and optimizaton





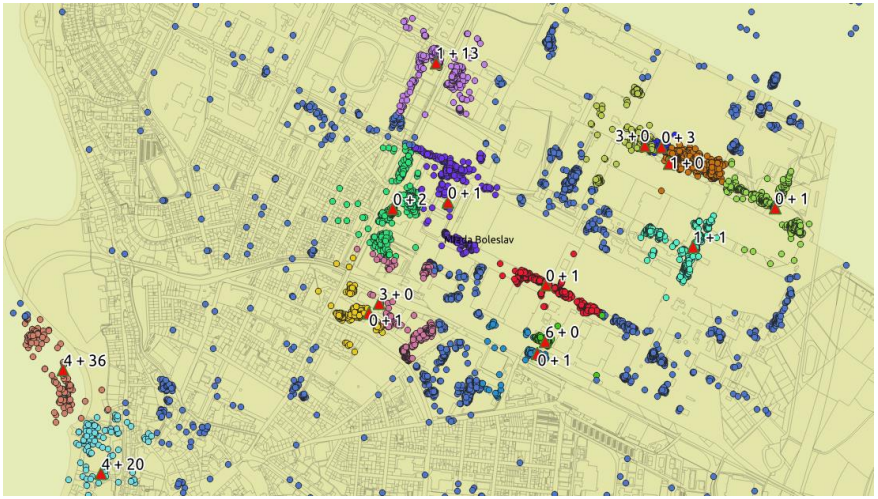


- Analysis of mobility demand and fleet operation
- Mobility model based on Real Škoda fleet data
- Analysis of Škoda Click carsharing
- Further extended and used for fleet optimization
- Simulation with GIS data



Activities in 1-WP07-003 Simulation and optimization of vehicle fleet management with capacity constraints and car sharing

Tool for fleet analysis and optimizaton



A tool extension towards fleet electrification

- Analysis of mobility coverage in case of EV adoption
- Analysis of charging stations placement
- Fleet optimization to given mobility demand
- Simulation with GIS data

Fulfillment of goals and deliverables of 1-WP07 Artificial Intelligence for Improved Mobility

Current State of Deliverables, Milestones and Fulfillment of Goals

All milestones and goals are planned for 2020. The works will successfully finish in December 2020.

- 1-WP07-001 (ZV) | Mobility-as-a-service energy usage optimization. (• R - software)
- 1-WP07-002 | Optimization models for mobility-as-a-service on routes with less passenger occupancy. (• O – ostatní výsledky)
- 1-WP07-003 | Simulation and optimization of vehicle fleet management with capacity constraints and car sharing. (• R – software)

Current contribution of 1-WP07 Artificial Intelligence for Improved Mobility

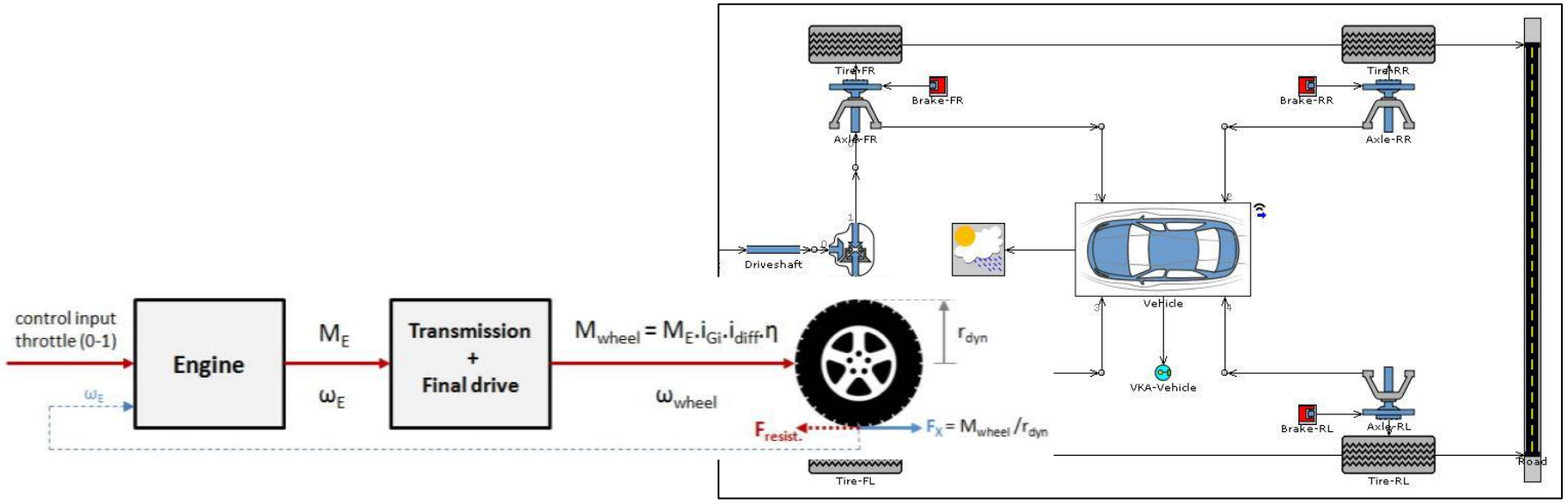
Assessment of the Contribution of Deliverables

- Simulation tools show a potential for practical use
- Tested and validated on real data
- Extension towards electrification and charging optimization has great practical use potential
- Robust mobility model build using part of real data

Results of 1-WP07 Artificial Intelligence for Improved Mobility – Achieved 2019-2020

1-WP7-001 - complex software model for prediction of fuel consumption of a carsharing vehicle and its implementation in a real carsharing application serving for validation

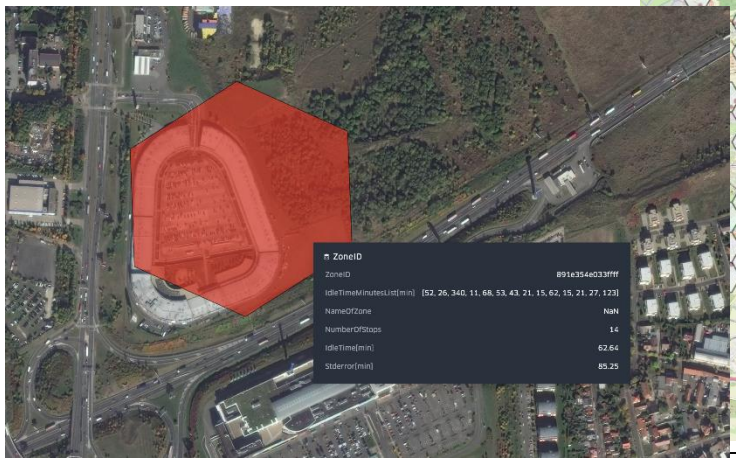
- complex software model for prediction of fuel consumption of a carsharing vehicle and its implementation in a real carsharing application serving for validation
- Škoda Fabia III (1.0 TSI, 81 kW) model as an example, as it is being used in Uniqway project
- model in GT Suite and MATLAB/Simulink was created

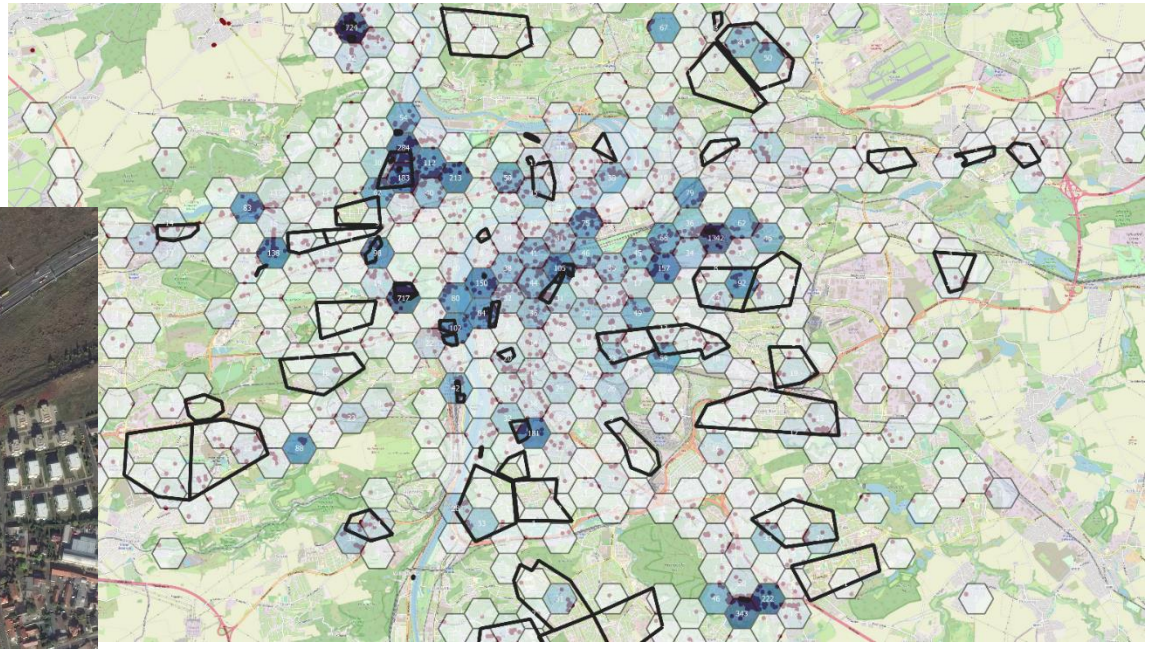


Results of 1-WP07 Artificial Intelligence for Improved Mobility – Achieved 2019-2020

1-WP07-002 Optimization models for mobility-as-a-service on routes with less passenger occupancy

- comprehensive study of possibilities of the MaaS for less populated routes was performed
- approach has to be further studied and implemented in carsharing system Uniqway





Results of 1-WP07 Artificial Intelligence for Improved Mobility – Achieved 2019-2020

1-WP07-003 Simulation and optimization of vehicle fleet management with capacity constraints and car sharing

- analysis of potential and risks of mobility-on-demand systems
- mobility on demand simulation
- potential tested in multi-agent simulation of the whole vehicle lifetime
- real metropolitan-scale experiment with realistic demand
- simulation with GIS data
- extension towards EV

Demand model ➡ MoD system ➡ Multi-agent simulation ➡ Simulation results analysis