Impact of Autonomous Vehicles in Cities

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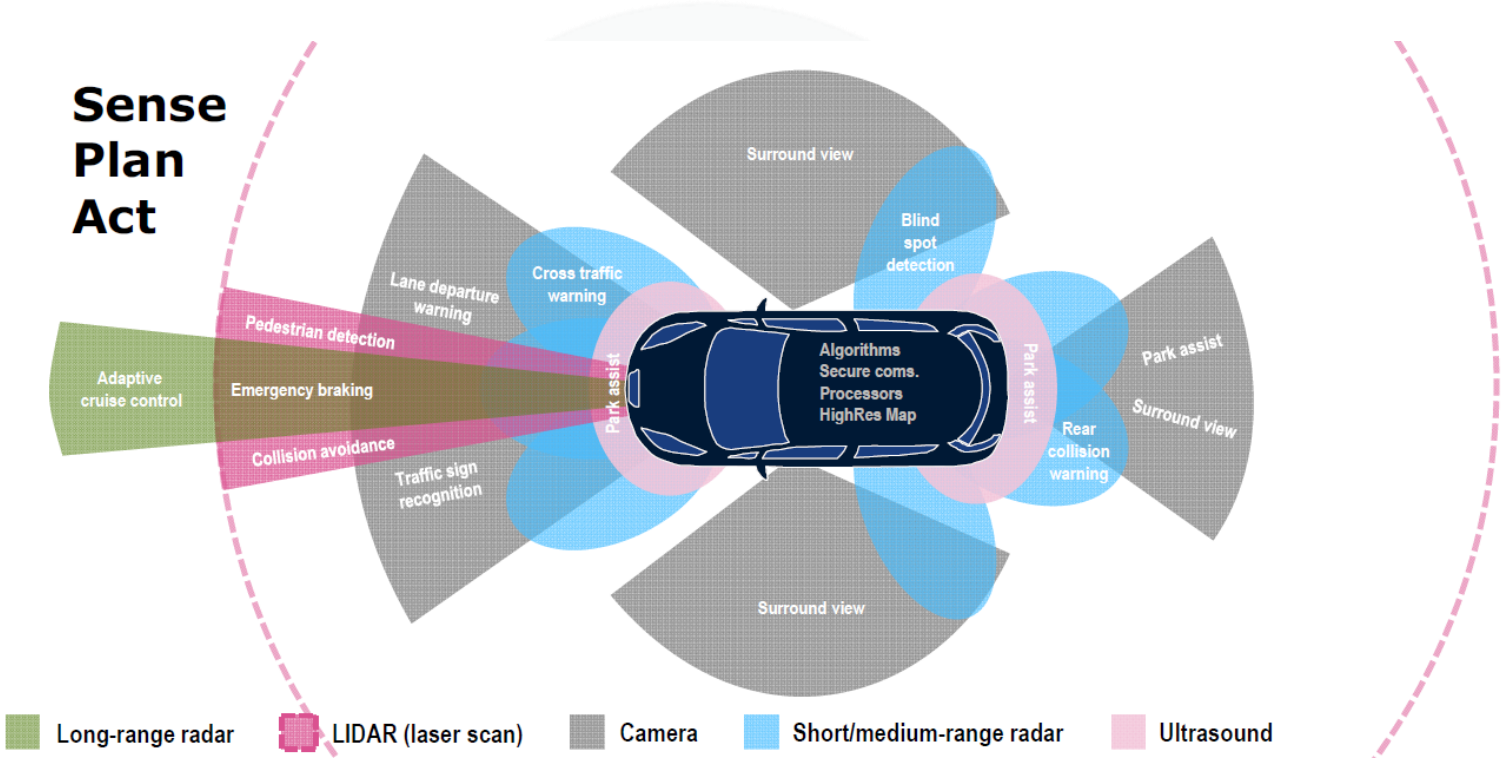
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690727

Introduction
Automated vehicles can do a lot…



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… but are the cities ready for automated driving?

- **What happens with an automated vehicle in the city?**
- **The fact that a car drives alone does not help. Is the infrastructure ready?**
- **Can we really use the potential of automated and connected vehicles?**

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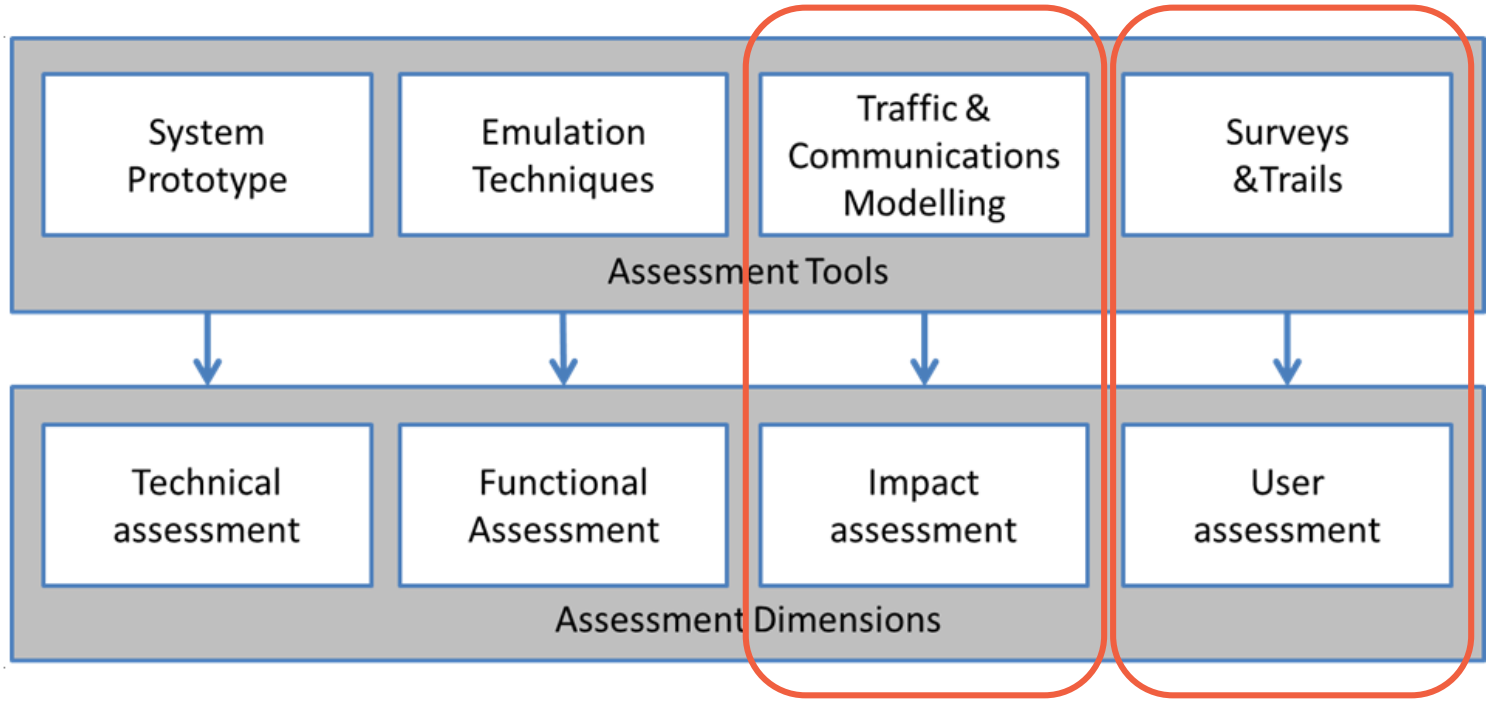
Project MAVEN

Impact assessment approach



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A. User assessment

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Online survey

Survey design

The questions (27, in total) were divided into the following main groups:

- Socio-demographic characteristics.
- Expected impacts / effects of autonomous vehicles in cities
- Integration into a city
- Transition from the current state to a state with higher penetration of autonomous vehicles.
- Perception of concerns, potential issues, etc.

- To identify fundamental questions from other surveys and verify them (verification).
- To prepare unique set of questions, important and relevant for the MAVEN project (uniqueness).

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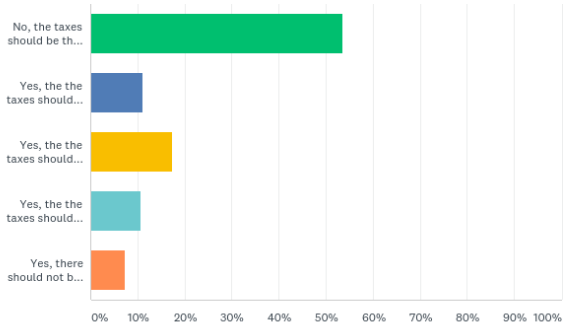
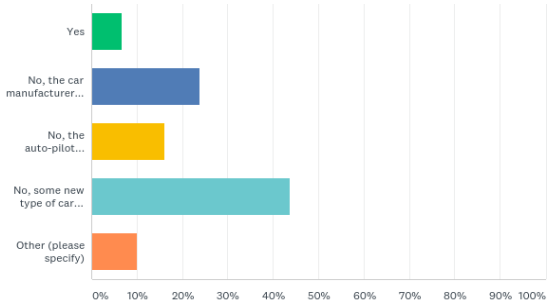
Selected survey results





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Online survey

Structure of respondents

Respondents come from more than 30 countries.

Working status

Answer Choices	Responses
Working for a public authority or municipality	19.90 %
Working for a university or a research organization	32.04 %
Working in a private sector	26.21 %
Self-employed or Entrepreneur	6.80 %
Unemployed	0.49%
Retired	0.00 %
Student	14.56 %

Source of information

Answer Choices	Responses
Information from news	80.29 %
Information from existing projects	59.62 %
Social Sites	36.06 %
Workshops	32.21 %
Conferences	49.52 %
Other	21.15%

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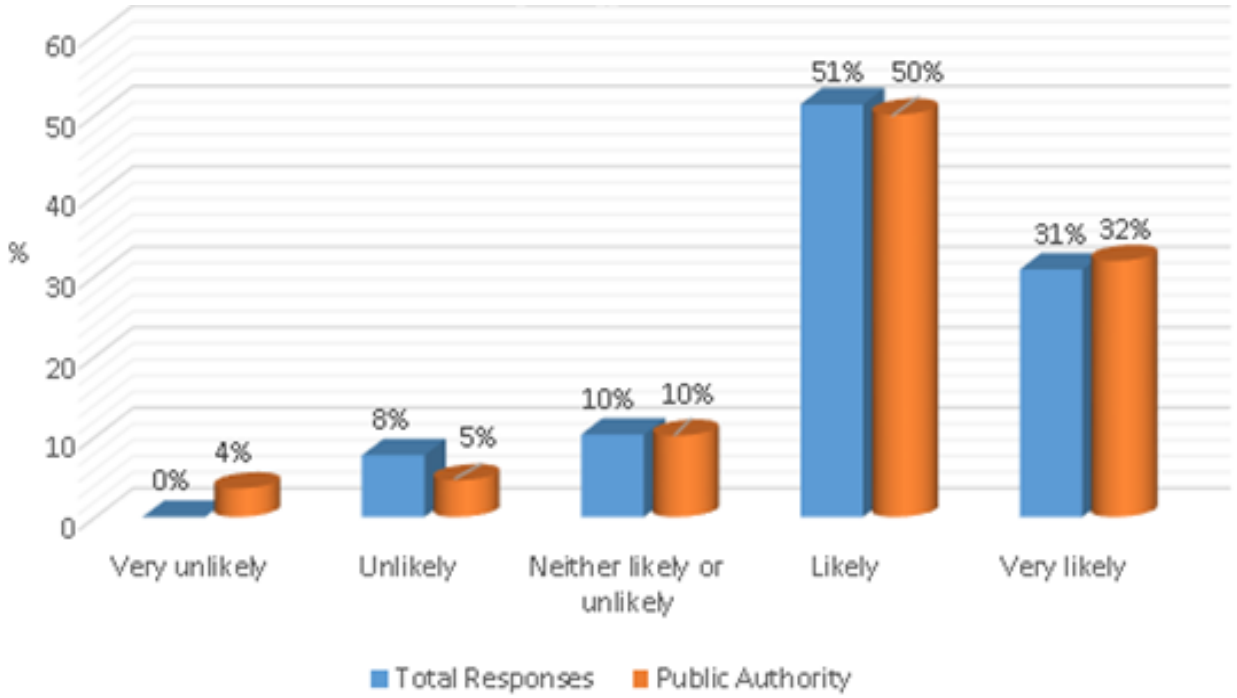
Q: Do you think that automated vehicles decrease the number of traffic accidents?



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Q: If you would ride in an automated vehicle, how would you use the extra time instead of driving?

Answer Choices	MAVEN	MoT CR
Reading e.g. book	52.41 %	39.50 %
Watching a movie	22.46 %	36.90 %
Working on laptop/tablet/smartphone	74.33 %	31.10 %
Playing games on laptop/tablet/smartphone	17.65 %	23.80 %
Sleeping/Relaxing	55.61 %	35.30 %
Social networking	31.55 %	48.30 %

Source: Research Report - Project: Autonomous driving in the CR – impact on infrastructure, mobility, safety and society. CDV and MoT ČR, 02/2018.

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Q: Do you agree that a platoon of five automated vehicles should get an extended green light to allow the full platoon to pass through the traffic signals?

Answer Choices	Total responses	Public authority
Strongly disagree	12.90 %	2.78 %
Disagree	15.59 %	22.22 %
Neither agree nor disagree	20.43 %	22.22 %
Agree	45.16 %	44.44 %
Strongly agree	5.91 %	8.33 %

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Q: You are a passenger in an automated vehicle. Would you accept the vehicle taking a detour to reduce congestion?

(and you don't have an appointment at a specific time at your destination)

Answer Choices	Total responses	Public authority
No, I always want my individually shortest travel time	17.84 %	11.11 %
Yes, maximum of 5% extra travel time	17.30 %	19.44 %
Yes, maximum of 10% extra travel time	38.38 %	47.22 %
Yes, maximum of 25% extra travel time	20.00 %	19.44 %
Yes, any delay is acceptable	6.49 %	2.78 %

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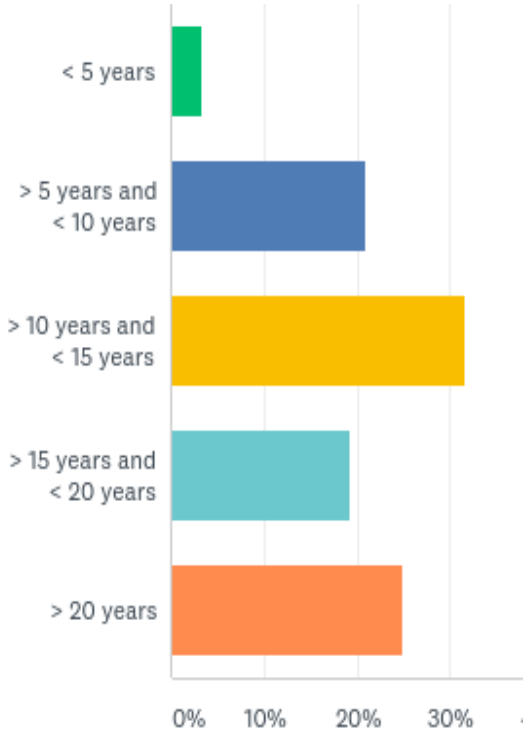
Q: In how many years do you expect 10 % of all vehicles in the cities to be automated?



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Online survey
Conclusions

An online survey was conducted within the MAVEN project

The survey was based on results of detailed literature review to gain new insight into the problematics

We were able to

- compare responses of general public to particular respondent groups (e.g. working for public authorities)
- to compare the results to other studies
- gather some new insights

The impact will be however measured in combination to other tools such as simulations, emulations and field tests

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B. Impact assessment

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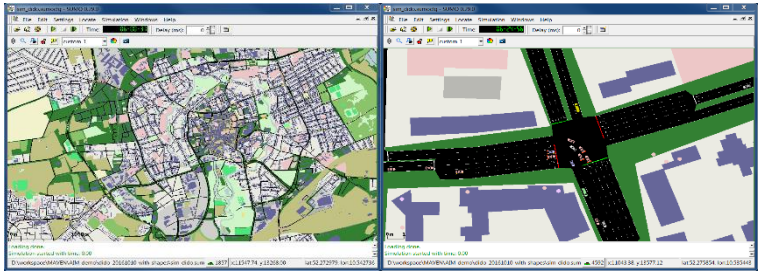
Traffic simulation

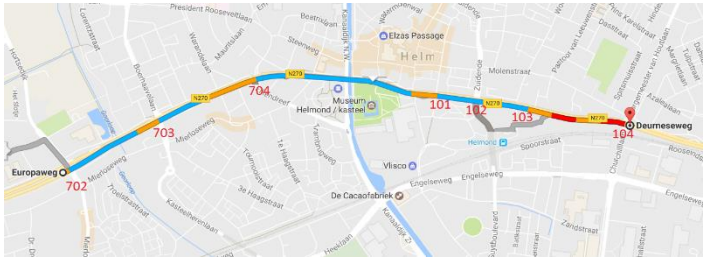
Overview

- Microscopic traffic simulation
- SW Tool - SUMO
- Suitable to model cooperative and autonomous vehicles

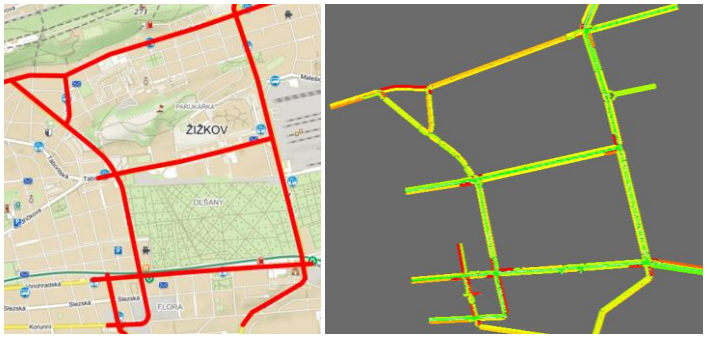
Braunschweig (DE)



Helmond (NED)



Prague (CZ)



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Task 7.2 – Simulation SUMO

Objectives

Based on simulation scenarios for

- *Different penetration levels of autonomous vehicles*
- *Different flows*
- *Particular use cases*
- *Control algorithms used*
- *And others*

Expected/possible impacts and performance indicators will be evaluated

- *Reduction of the number of stops at traffic lights*
- *Reduction of control delay time*
- *Decrease of produced emission*
- *Reduction of the overall fuel consumption*
- *Decreased travel time*
- *And others*

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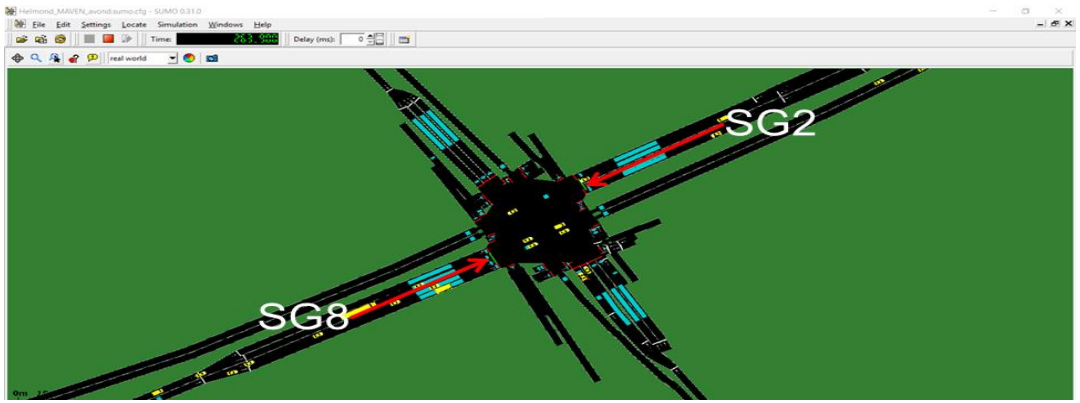
Selected simulation results



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Simulation SUMO

Presented Use Cases

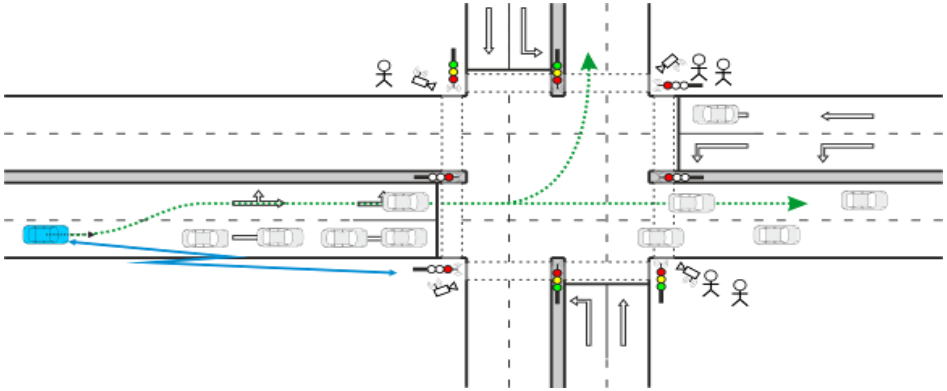
UC 1-6: Platooning

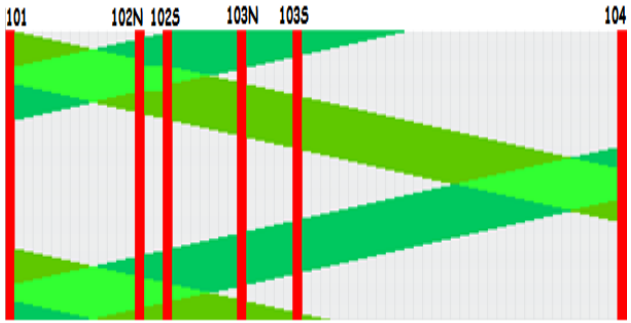
UC 7: Adaptive Green Light Optimized Speed Advisory (AGLOSA)

UC 8: Lane change advisory

UC 7+13: Speed change advice and Green wave optimization

UC 7+14: Speed change advice and Signal optimization





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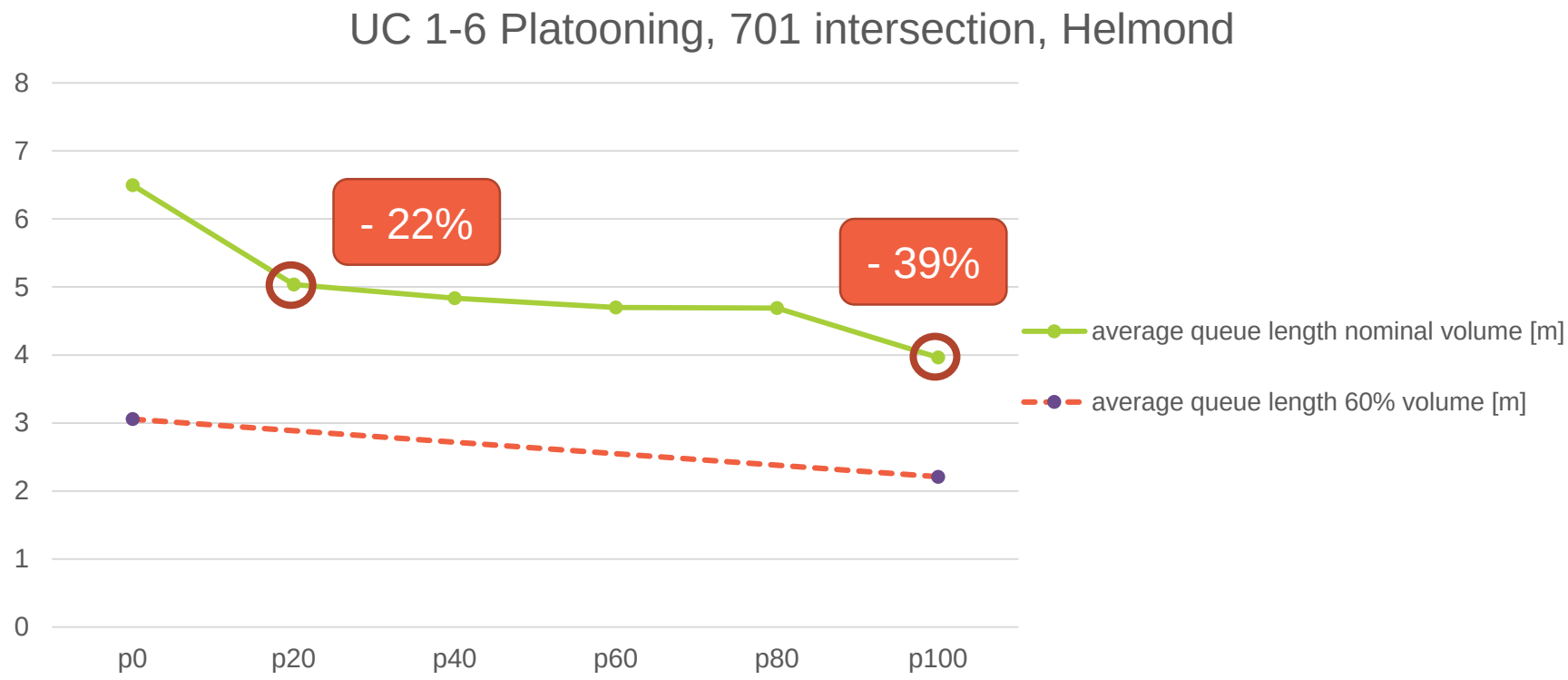
Simulation Results

Effect of Platooning



In line with other existing research (LIORIS, Jennie, et al. Platoons of connected vehicles can double throughput in urban roads. Transportation Research Part C: Emerging Technologies, 2017, 77: 292-305.)

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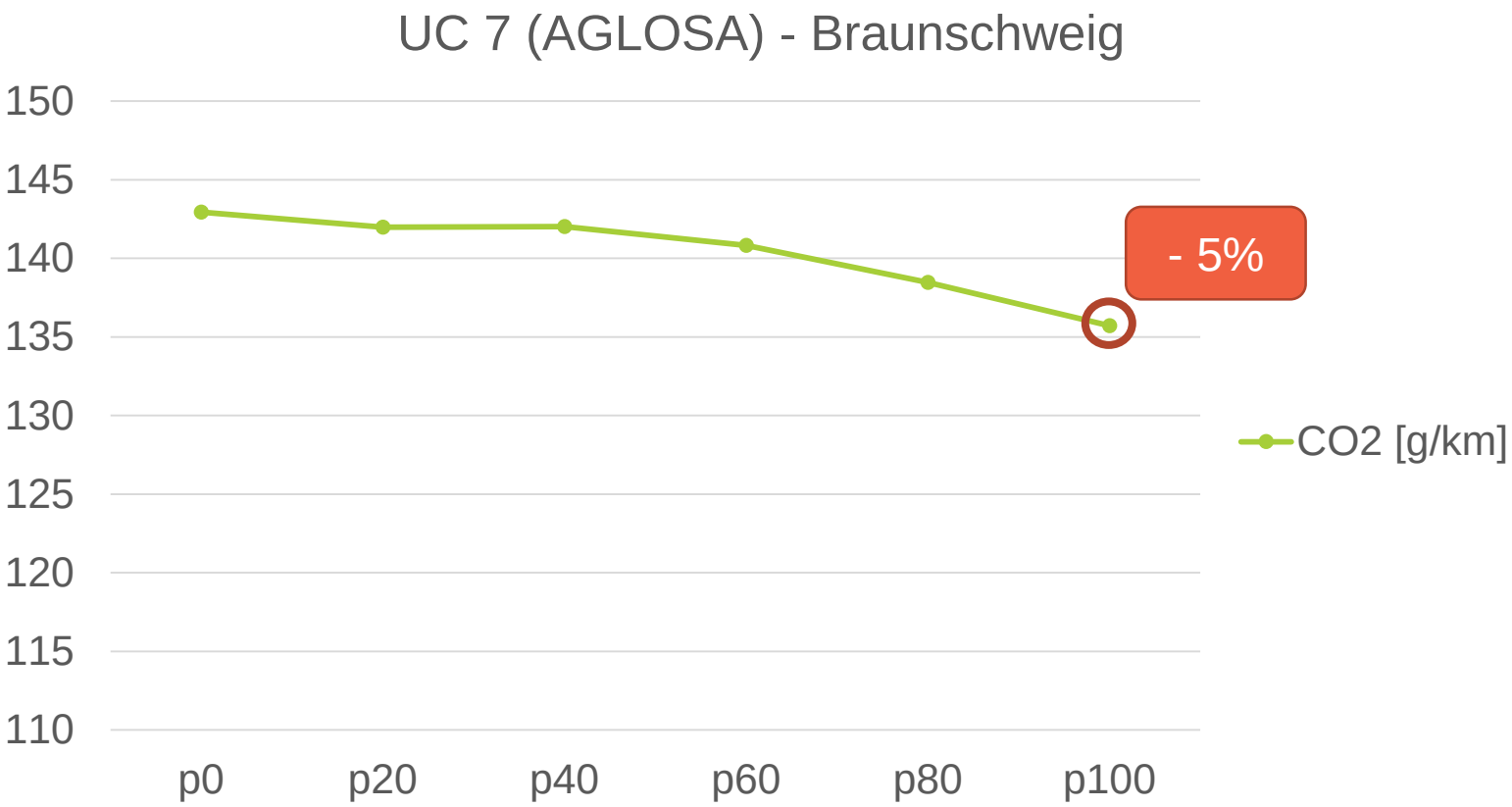
Simulation Results

Effect of Adaptive Green Light Optimized Speed Advisory (AGLOSA)



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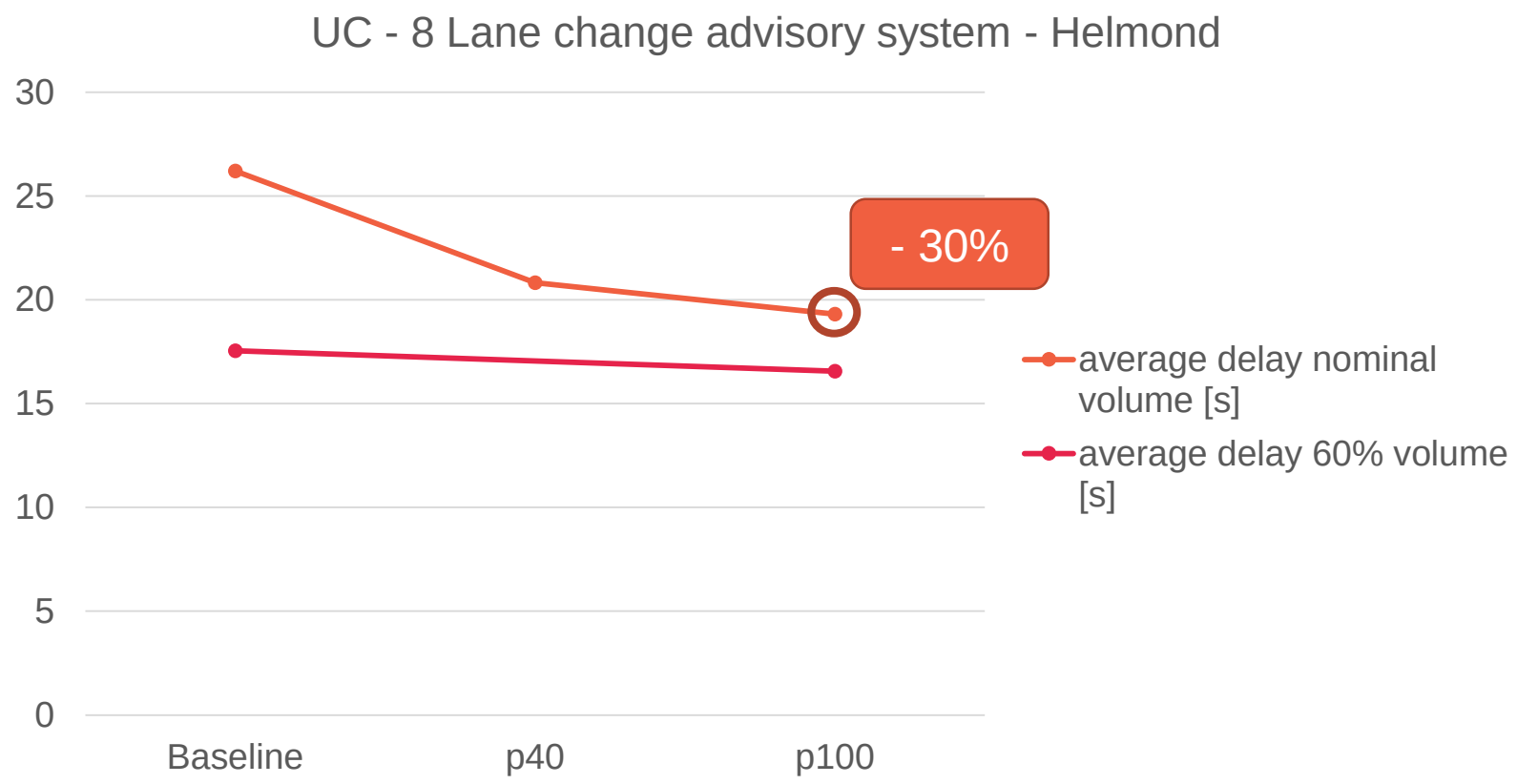
Simulation Results

Effect of Lane Change Advisory



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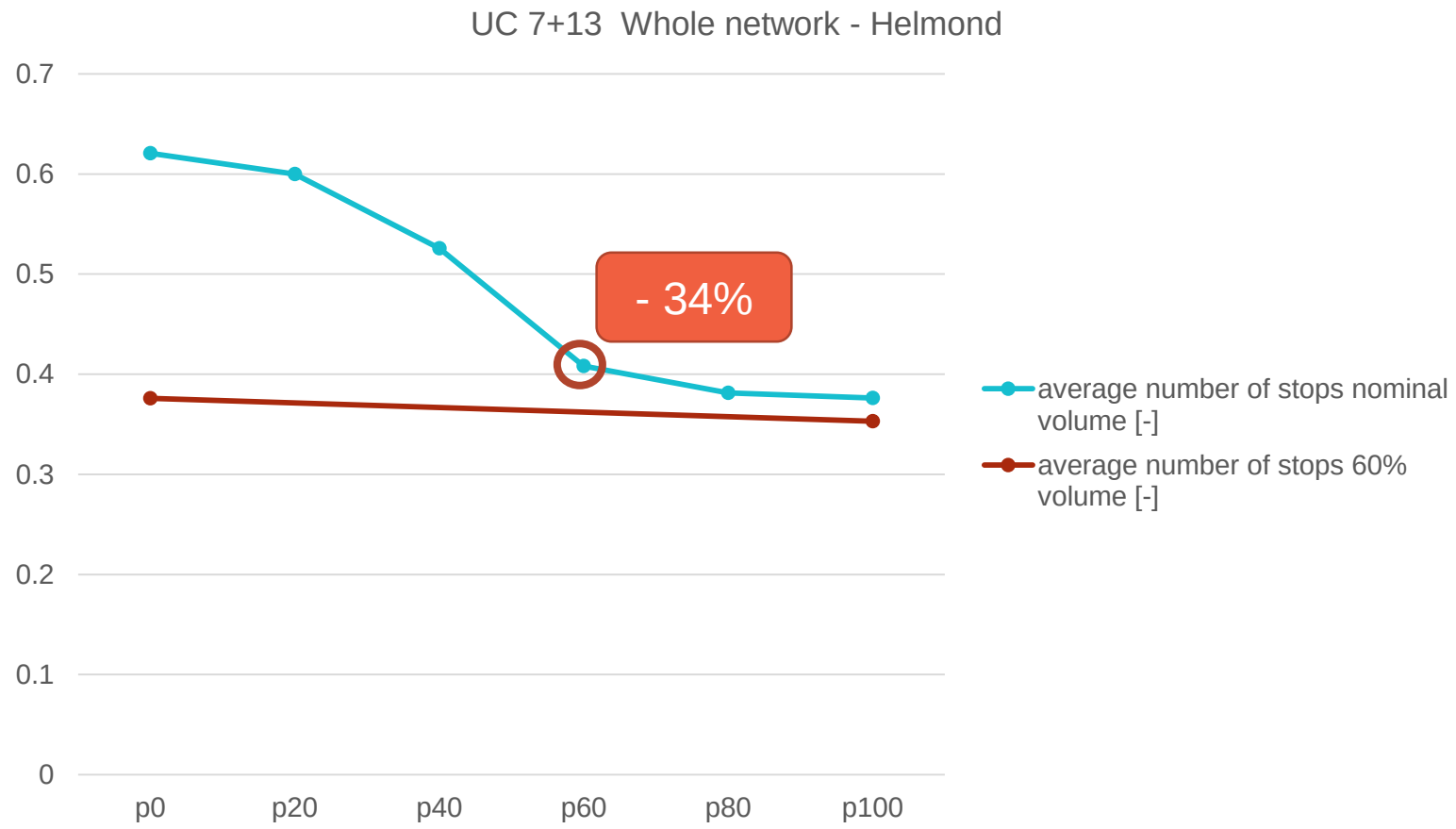
Simulation Results

Effect of Speed change advice and Green wave optimization



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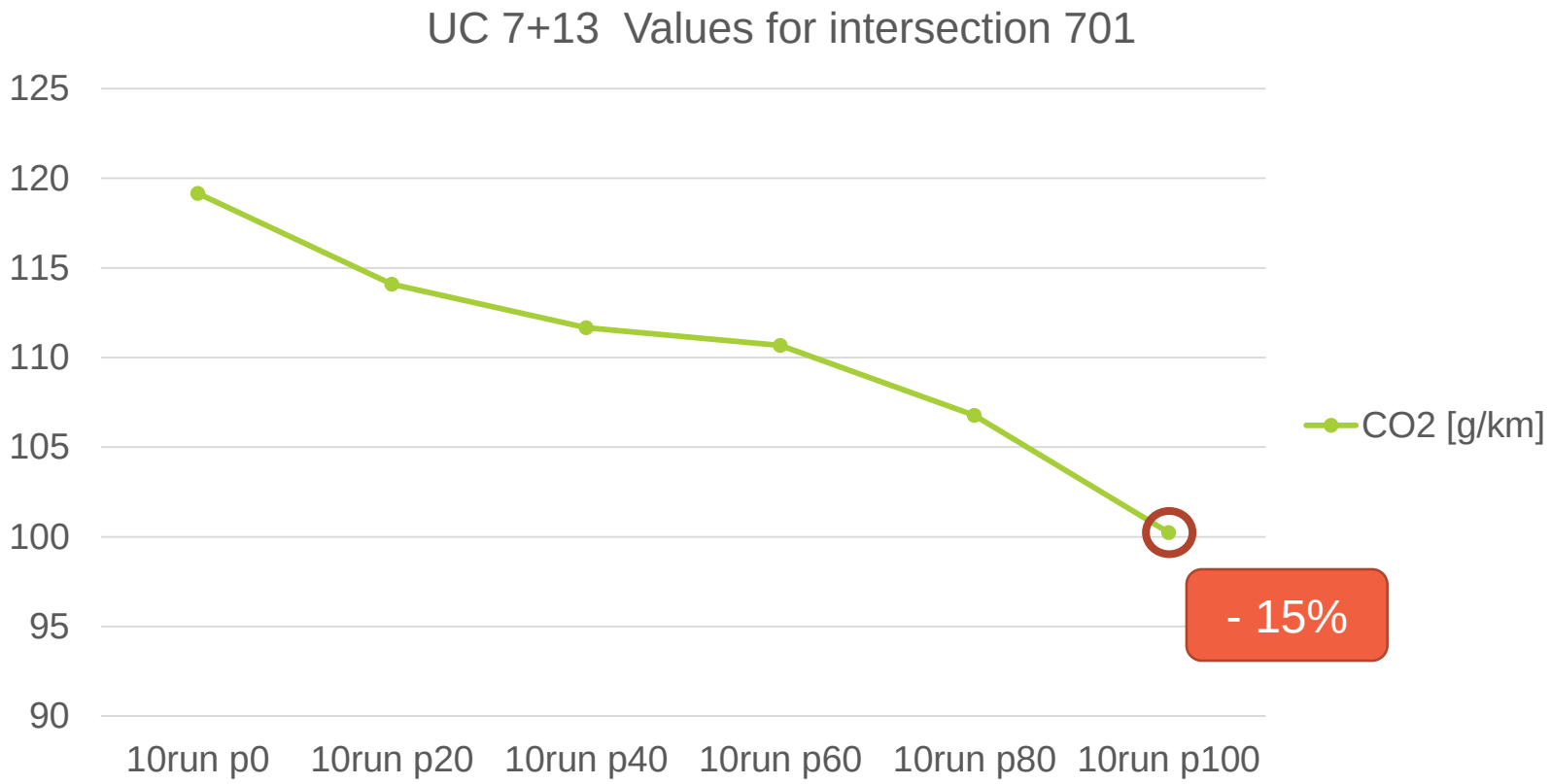

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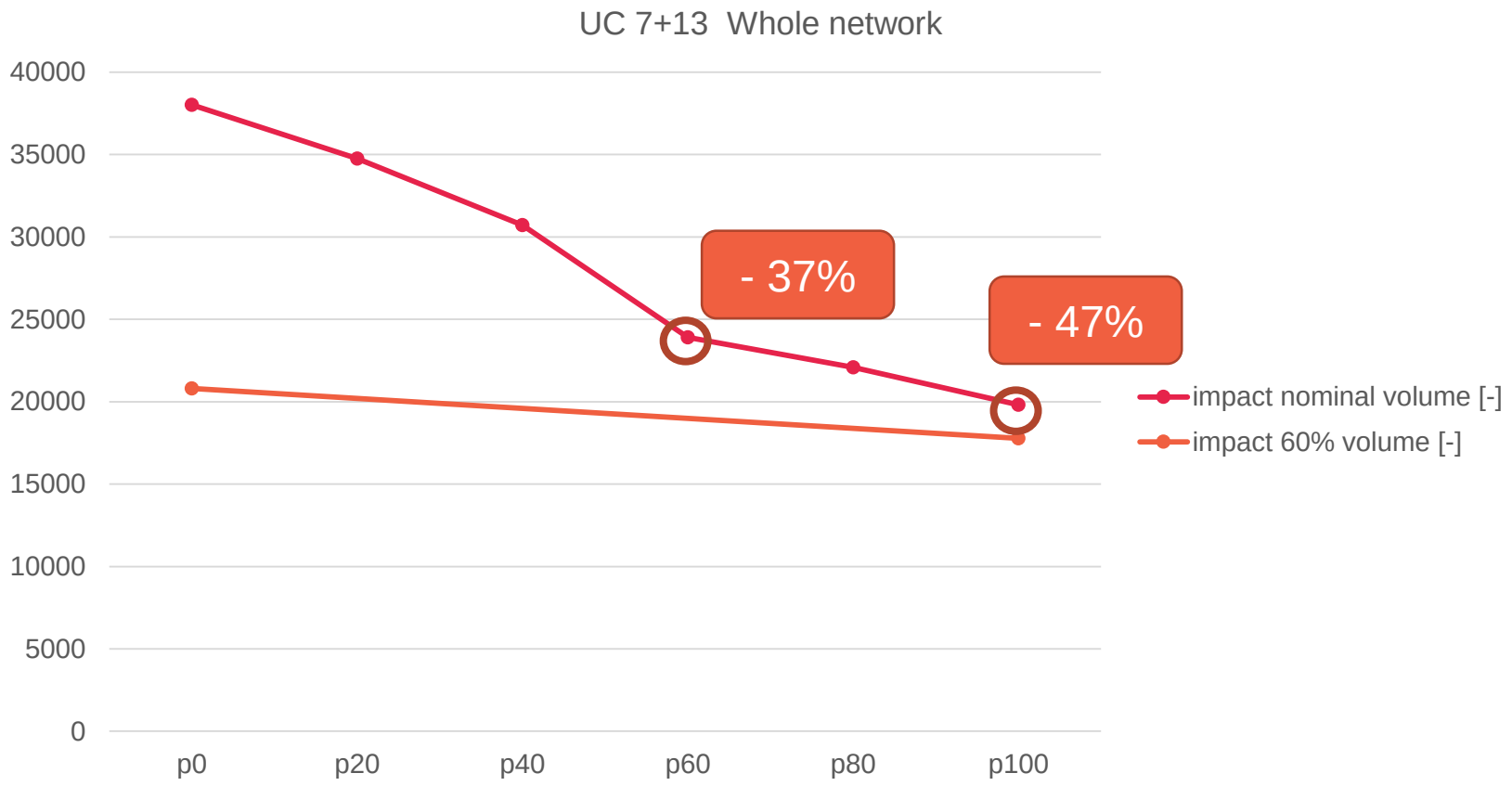

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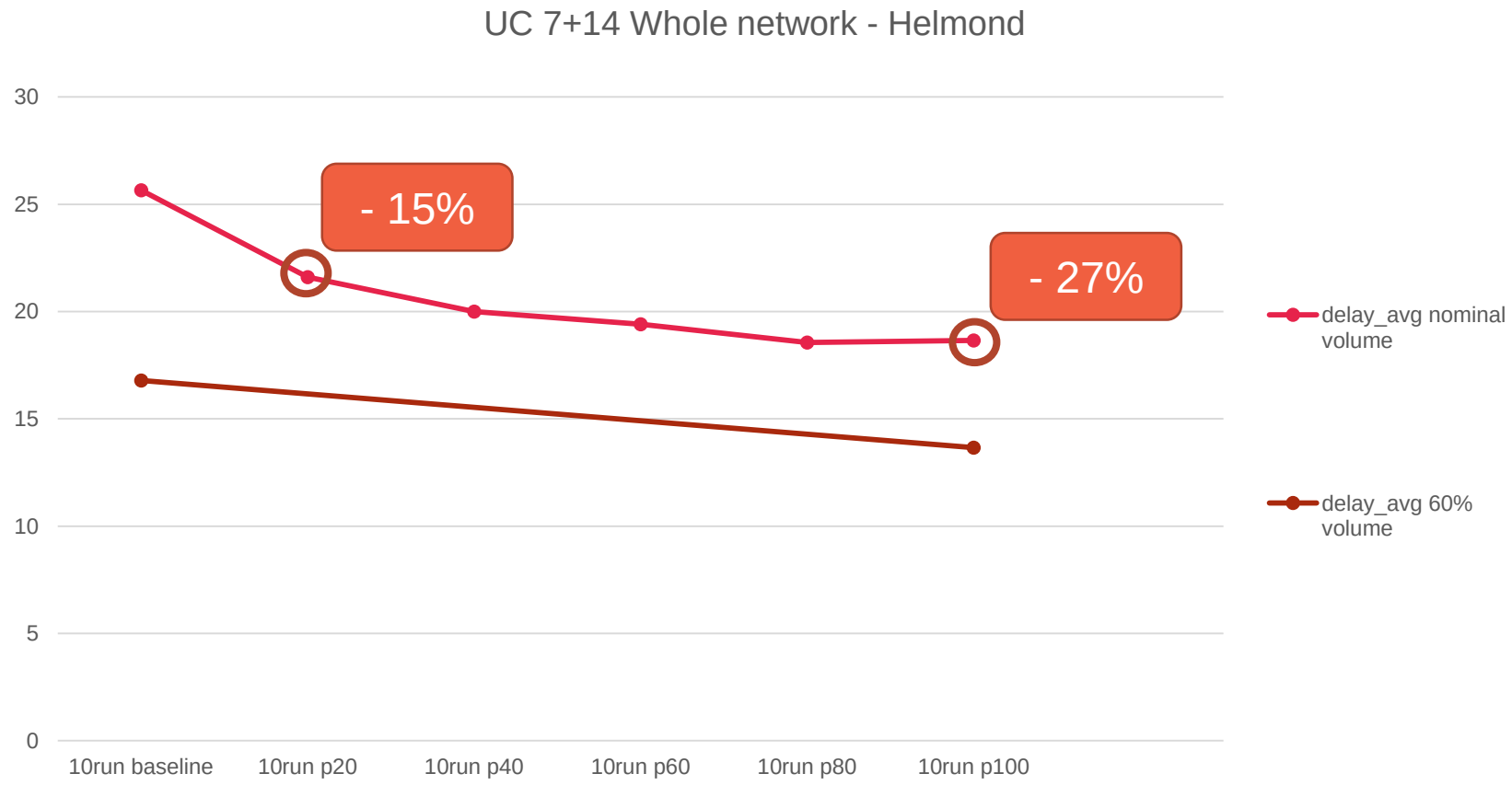
Effect of Speed change advice and Signal optimization



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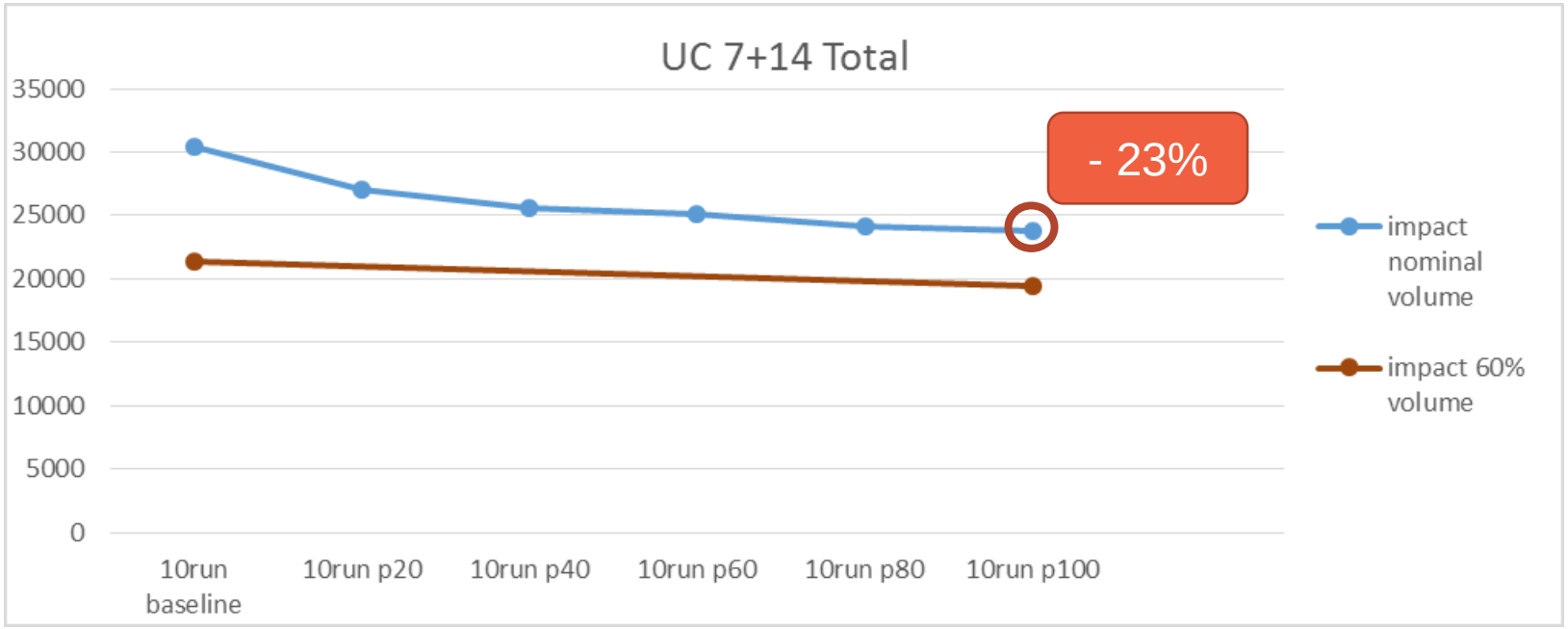
Simulation Results

Effect of Speed change advice and Signal optimization



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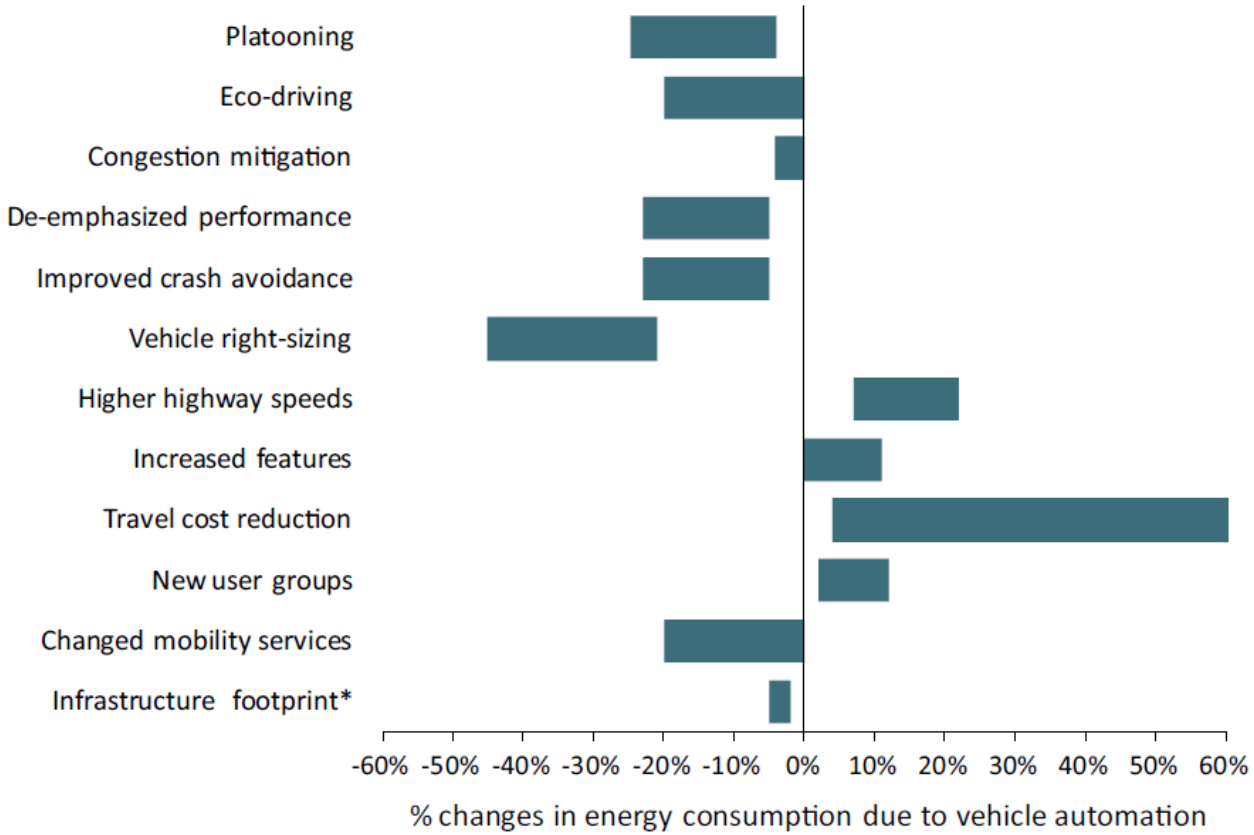
The big picture

Impact depends on integration and policies!



Wadud Z, MacKenzie D and Leiby P (2016). Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles. Transportation Research Part A: Policy and Practice 86, 1-18.

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MAVEN - Impact assessment

Conclusions

- **People have high expectations on the positive impact of automated vehicles (AVs)**
- **Proper integration of AVs into a road infrastructure has clear positive effects on**
  - Emissions
  - Travel time
  - Traffic flow harmonization
  - Safety
  - And many others
- **Already lower levels of penetration influence positively the travel experiences**
  - 20% penetration (Effect of Speed change advice and Green wave optimization)
    - - 9% delays
    - - 6% queue length
    - - 4% CO2
- **The transition phase however plays an important role**
  - The penetration rate of AVs clearly determines the impact
  - Other impacts of AVs depend on policies that are enabled by automation (car sharing, electro-mobility, and others)

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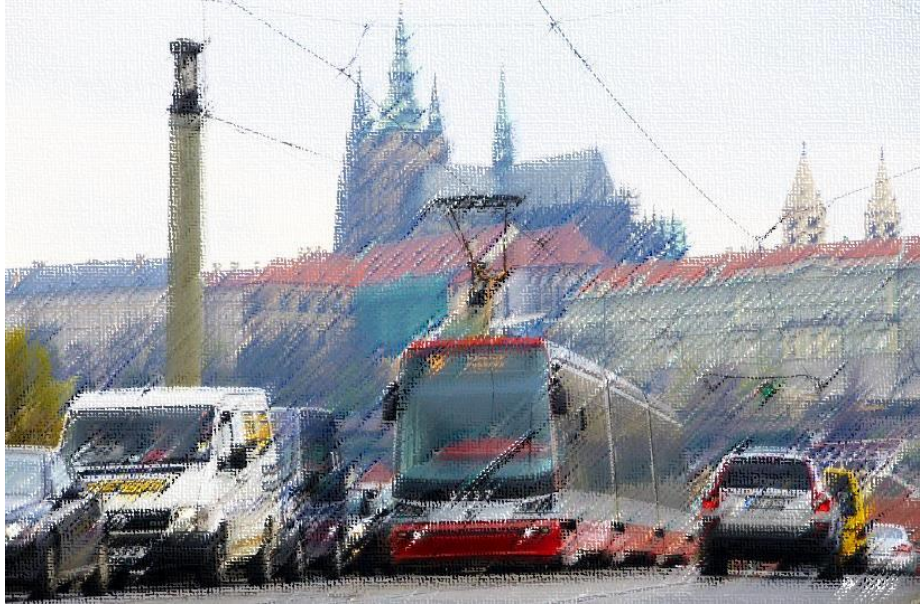

Thank you for your attention!

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