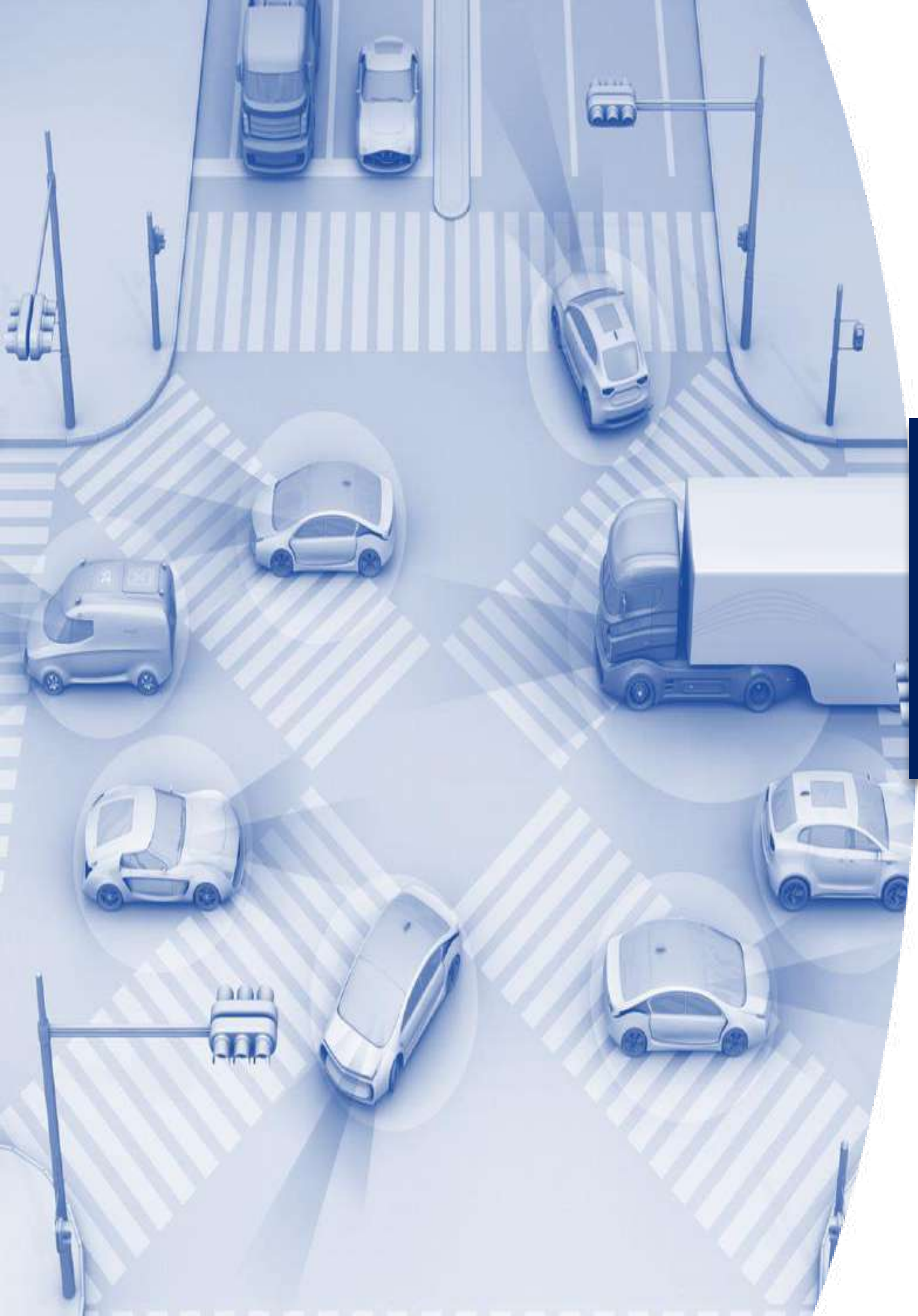

10th INTERNATIONAL CONGRESS ON TRANSPORTATION RESEARCH

ICTR 2021

September 1-3
Rhodes, Greece

Impacts of autonomous transit services on urban networks: The case of Athens, Greece

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Together with:
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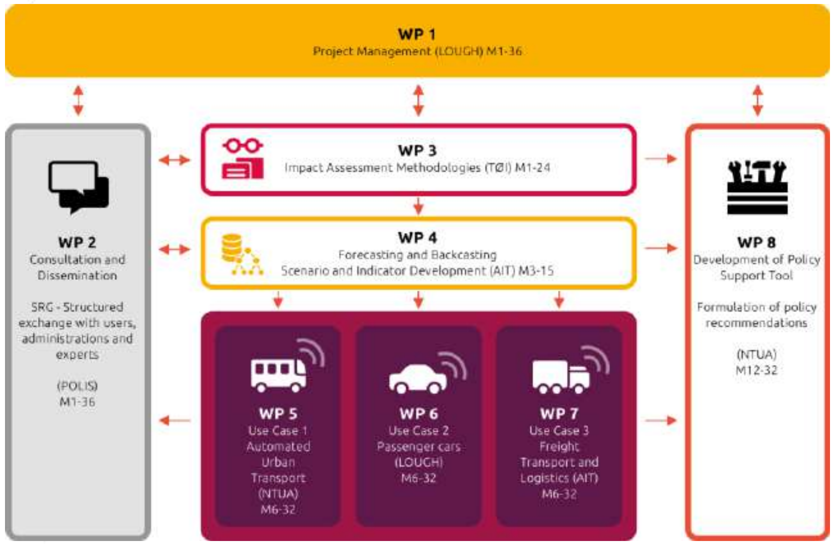
The LEVITATE Project

LEVITATE focuses on the development of a new impact assessment framework, in order to enable policymakers to manage the introduction of connected and automated transport systems, maximise the benefits and utilise the technologies to achieve societal objectives.

- **Project partners**:
  LOUGH (UK), AIT (AT), AIMSUN (ES), NTUA (EL), POLIS (BE), SWOV (NL), TOI (NO), TfGM (UK), City of Vienna (AT), QUT (AU), TJU (CN), UMTRI (US)
- **Duration of the project**:
  36 months (December 2018 – December 2021)
- **Framework Program**:
  Horizon 2020 - The EU Union Framework Programme for Research and Innovation – Mobility for Growth

levitate



HORIZON 2020

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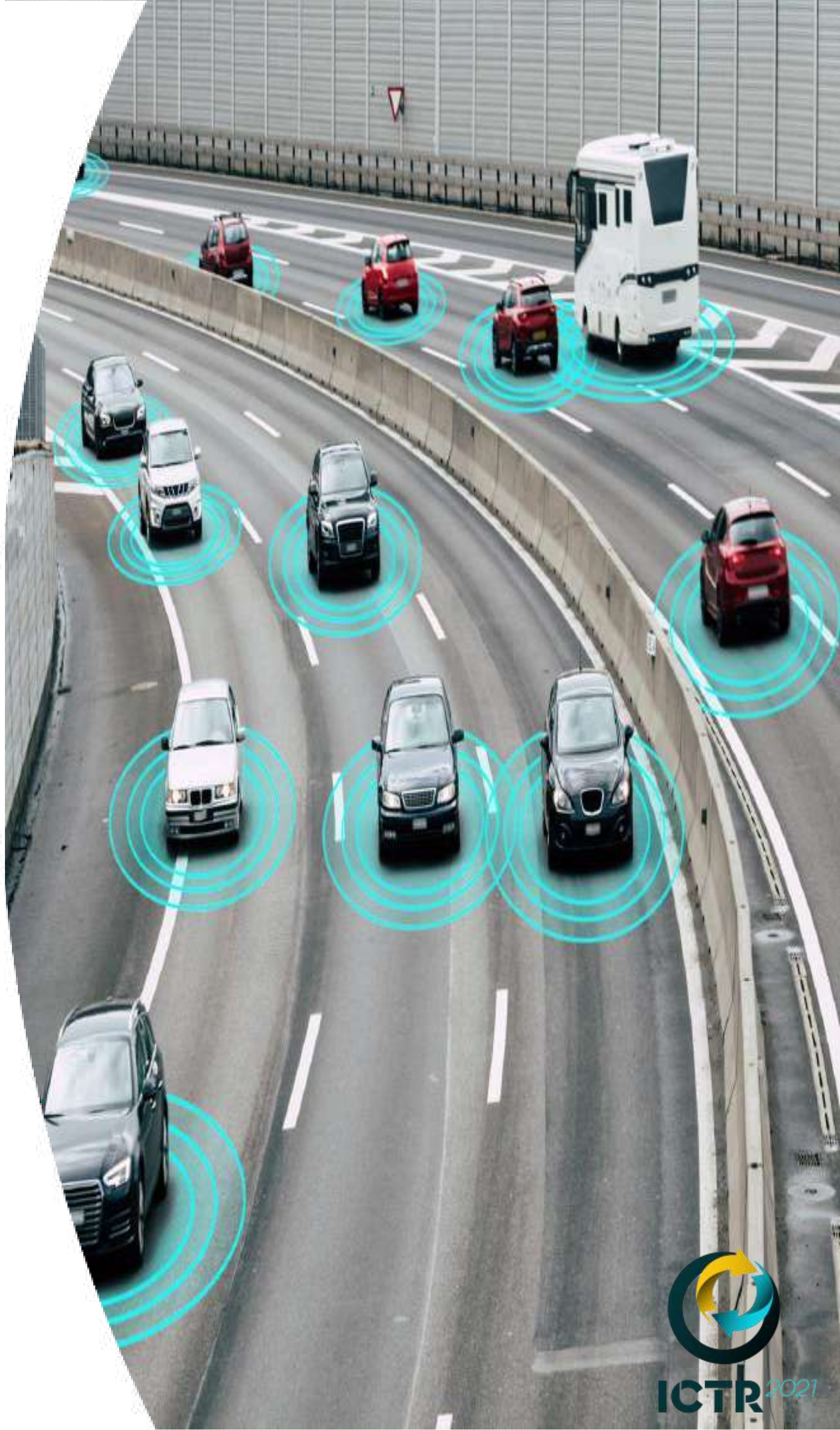
Introduction

- Connected and automated vehicles are becoming widely diffused as road transport technology increasing road capacity by improving road safety and reducing pollution.
- Automated shuttle bus services are expected to be the first to align with their large scale business cases and will increase urban transport activities making transit systems more attractive to passengers.
- Research related to user acceptance have shown high levels of trust and comfort for automated shuttle services.

Research scope

- The aim of the present study is to examine the impacts of different **autonomous transit services** on traffic, environment and safety in urban environment.
- Through a series of use cases and realization scenarios, this research provides **in-depth investigations** for the impacts of CAVs on a network level.
- The **microscopic simulation analysis** method was selected and different scenarios were formulated using the Aimsun Next mobility modelling software.



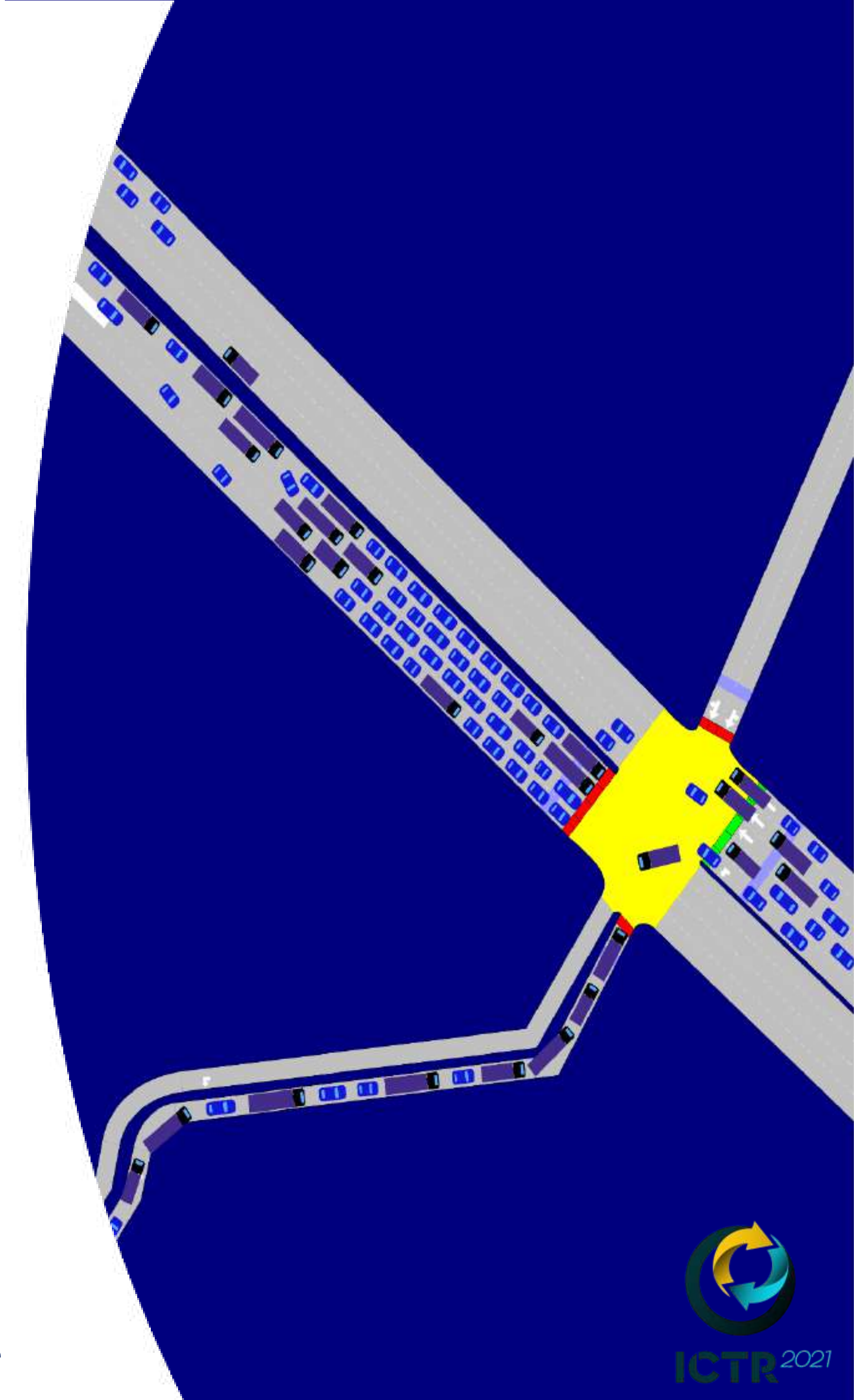
Methodology

- The microscopic simulation method was selected to examine the impacts of CAVs and autonomous transit services mainly on traffic, environment and energy efficiency.
- Three different use cases concerning different automated public transit services were implemented in the Athens network using the Aimsun Next mobility modelling software:

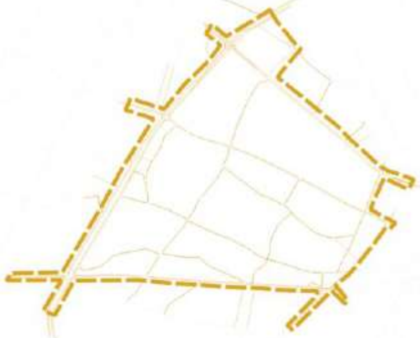
Use case 1: a point-to-point automated shuttle bus service connecting two modes in a small-scale network

Use case 2: a point-to-point automated shuttle bus service connecting several points in a large-scale network

Use case 3: an on-demand mobility automated shuttle service in a large-scale network



Simulated scenarios



Use case 1

1) Baseline (no transit service operation)
2) Mixed traffic conditions during peak hour
3) Dedicated lane for the shuttle service during peak hour
4) Mixed traffic conditions during peak hour while an incident occurs
5) Mixed traffic conditions during off-peak hour
6) Dedicated lane for the shuttle service during off-peak hour

- 59×59 OD matrices
- 158 nodes
- 356 road segments

Use case 2

1) Baseline (no transit service operation)
2) Mixed traffic conditions during peak hour
3) Dedicated lane during peak hour
4) Mixed traffic conditions during off-peak hour

Use case 3

1) Baseline (no transit service operation)
2) 5% of the demand to be served by 50 shuttle buses of 8 passengers
3) 5% of the demand to be served by 50 shuttle buses of 15 passengers
4) 10% of the demand to be served by 100 shuttle buses of 8 passengers
5) 10% of the demand to be served by 100 shuttle buses of 15 passengers

- 292×292 OD matrices
- 1,137 nodes
- 2,580 road segments

Modelling CAVs

- Two main driving profiles were simulated for modelling connected autonomous vehicles:

  1st Generation (Cautious)
  limited sensing and cognitive ability, long gaps, early anticipation of lane changes and longer time in give way situations

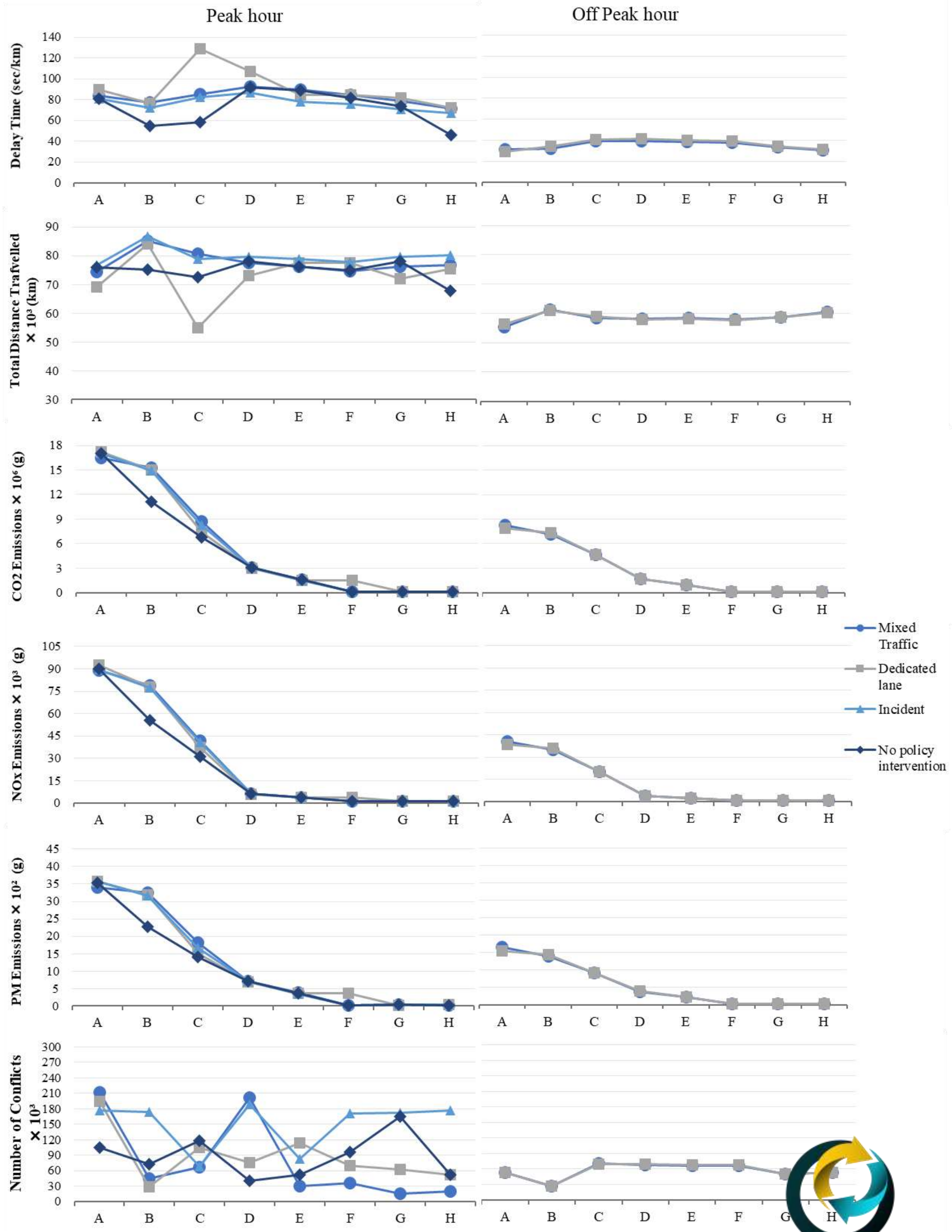
  2nd Generation (Aggressive)
  advanced sensing and cognitive ability, data fusion usage, confident in making decisions, small gaps, early anticipation of lane changes and less time in give way situations

- The autonomous shuttle buses of the three services were simulated as 1st generation CAVs.
- Regarding the implementation of CAVs, different penetration rate scenarios were simulated.

Type of Vehicle	A	B	C	D	E	F	G	H
Human-driven Car	100%	80%	60%	40%	20%	0%	0%	0%
1st Generation CAV	0%	20%	40%	40%	40%	40%	20%	0%
2nd Generation CAV	0%	0%	0%	20%	40%	60%	80%	100%
Human-driven Truck	100%	80%	40%	0%	0%	0%	0%	0%
Freight CAV	0%	20%	60%	100%	100%	100%	100%	100%

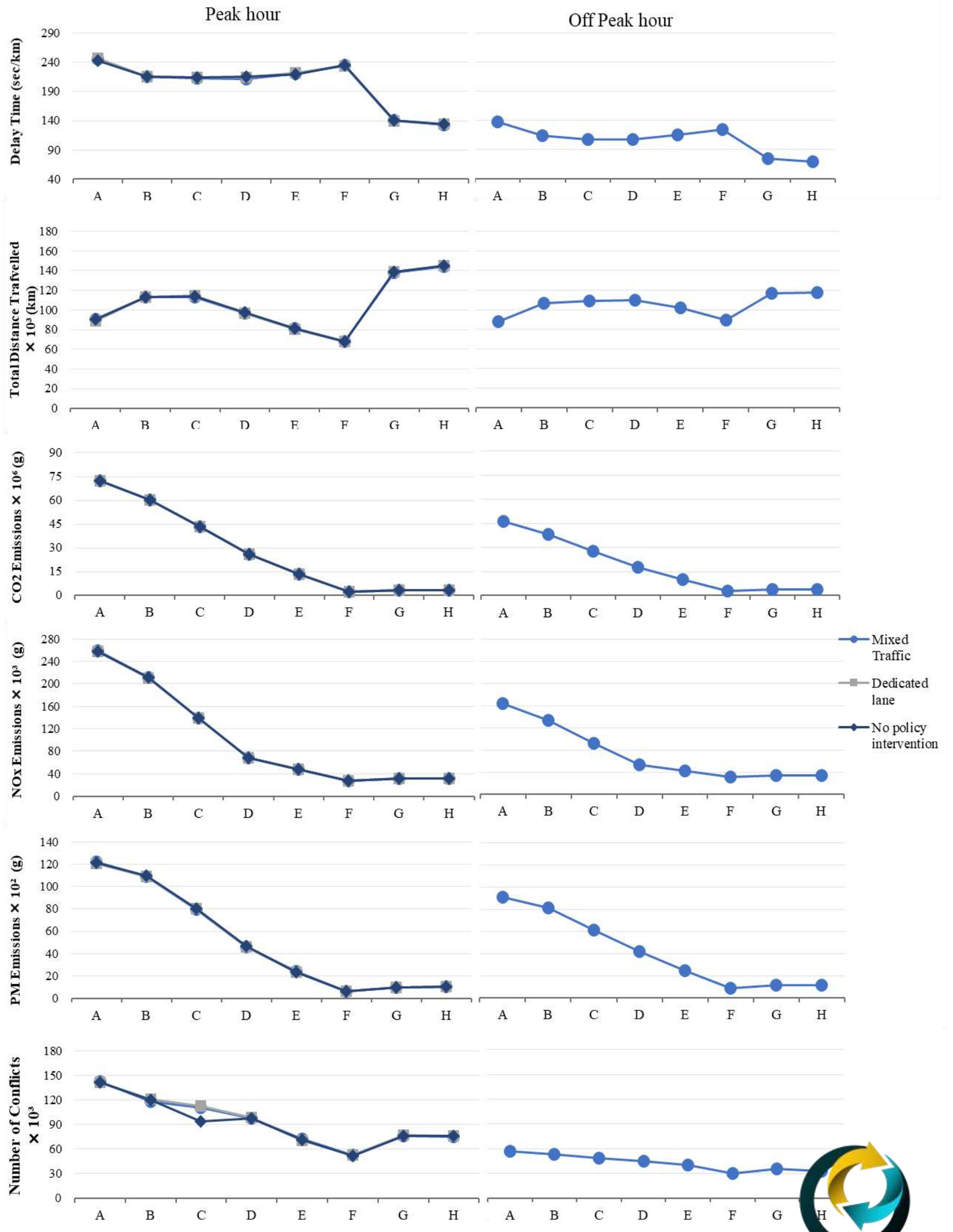
Use case 1 results

- In general, the existence of the shuttle bus service led to increased delays and total distance travelled for most market penetration scenarios.
- The existence of a dedicated lane significantly increased delays and decreased travelled distances during peak hour, while remain the same during off peak hour.
- Emissions were found to be significantly lower when the number of CAVs was increased, while the different implementation types of the service did not present any significant differences.
- Automation appears to decrease conflicts during peak hour conditions except for the scenario in which an incident occurs as well as the one in which the second generation of CAVs was introduced.



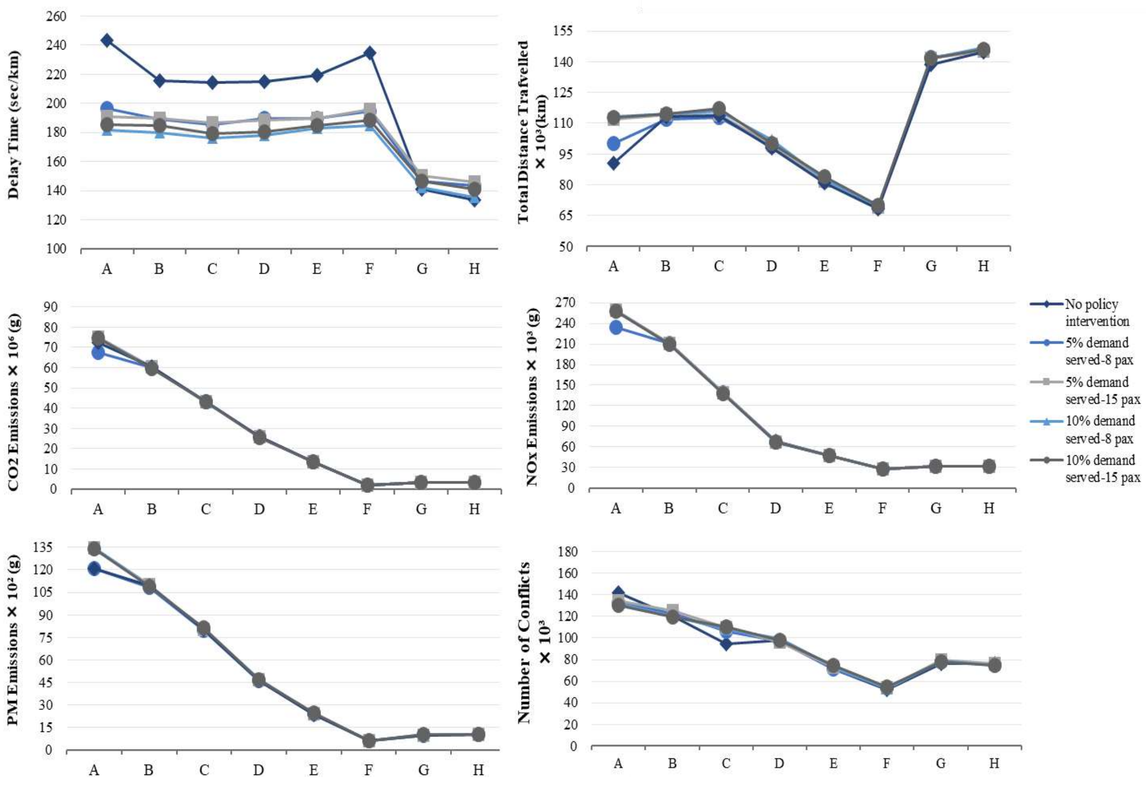
Use case 2 results

- Automation **decreased delay time** and **increased travelled distance** during both peak and off peak hour for the last two market penetration scenarios.
- Emissions **were significantly lower** when the number of CAVs was increased, while the different implementation types of the shuttle bus service did not present any significant differences.
- **Conflicts was reduced** when more CAVs existed in the network during peak hour conditions and remained constant during off peak hour.



Use case 3 results

- The implementation of the service led to decreased delay times and did not show any significant differences in total distance travelled.
- Emissions were significantly lower when the number of CAVs was increased. In addition, the different implementation types of the service did not present any significant differences.
- Conflicts was reduced when more CAVs were existing in the network. Also it is revealed that, conflicts were approximately the same for the different services.



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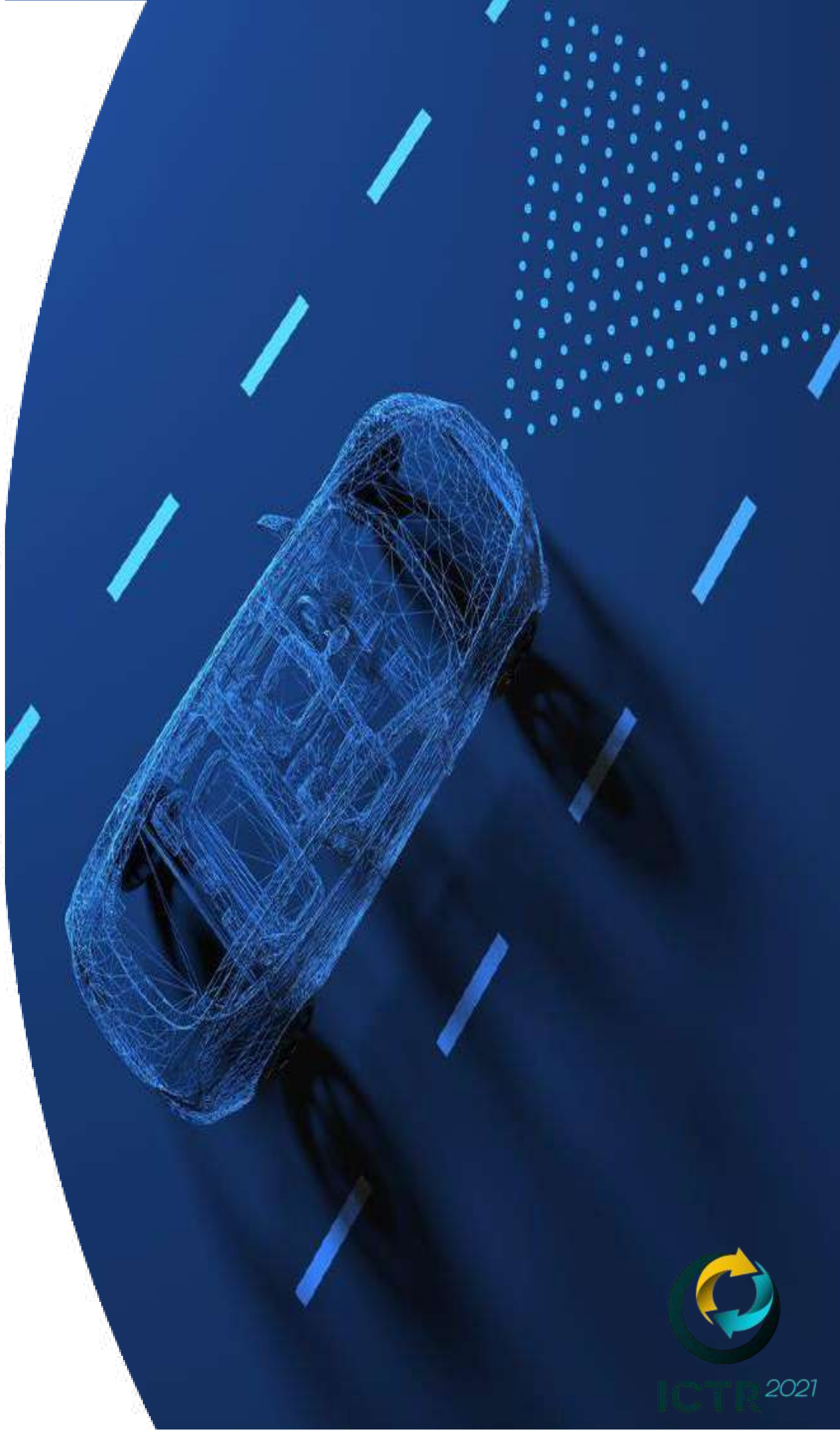
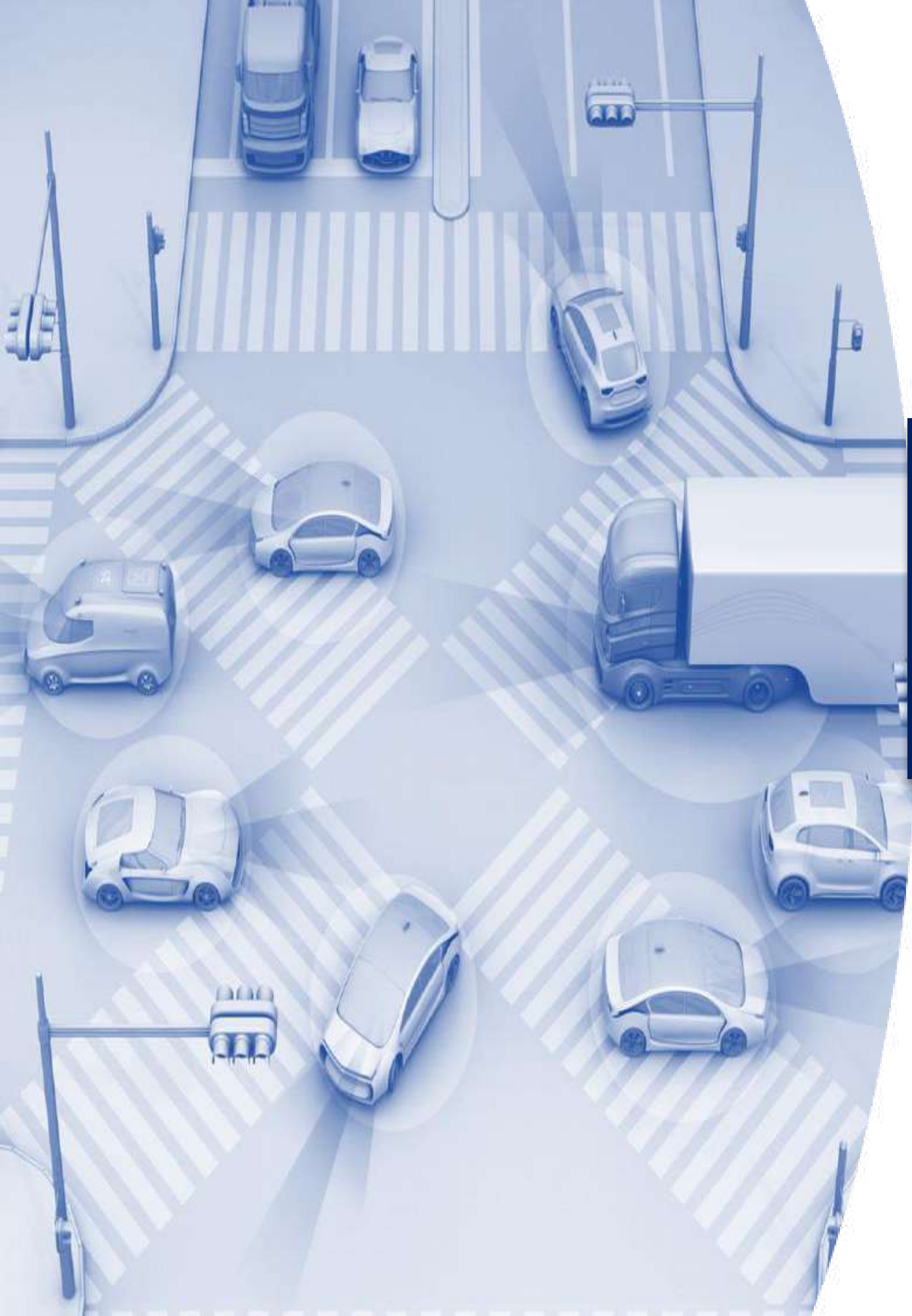
Conclusions

- The point-to-point shuttle bus services led to increased delays and total distance travelled, while on the contrary the on-demand service showed decreased delays and constant driven kilometers.
- The introduction of the different shuttle bus services did not significantly affect conflicts as well as emissions, which were significantly lower when the number of CAVs was increased.
- In a small-scale urban network, automation did not affect traffic-related measurements, while in a large-scale urban network decreased delays, increased distance travelled and reduced conflicts were noticed.





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