



the mind of movement

CoExist

Preparing the transition to Automated Vehicles

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Agenda

1. Introduction to the Project
2. Study Locations
3. Core Tasks
4. Outcomes

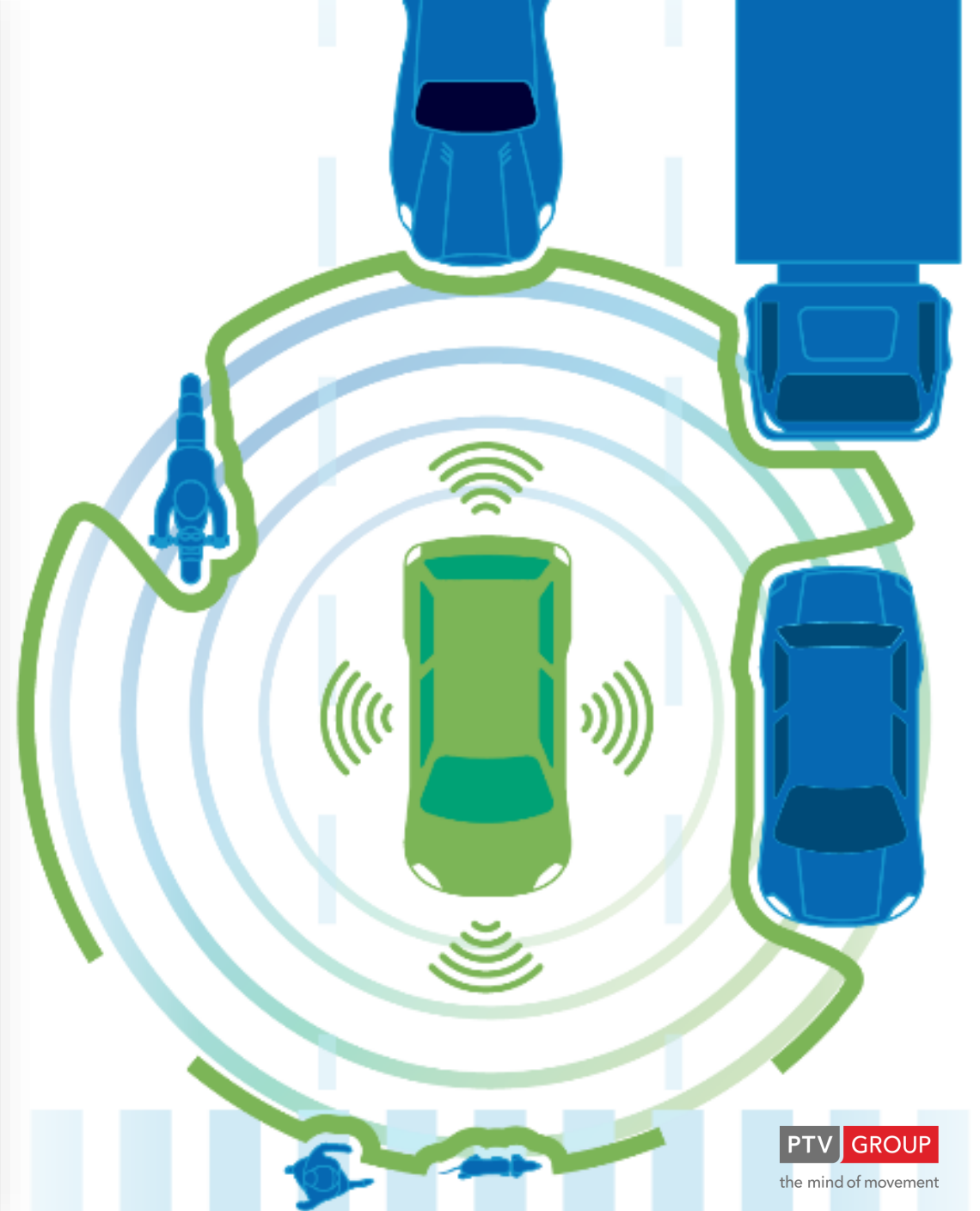
What is CoEXist?

A European Union funded Horizon 2020 Project.

CoEXist develops an AV-ready framework for road authorities and fosters technological development of traffic simulations tools.

By simulating automated vehicles in four European cities, with different urban structures and traffic compositions, CoEXist analyses the effects of automated vehicles on urban road infrastructure, especially in a context of “co-existence” between automated and conventional vehicles.

The results of the project will enable road authorities to understand in detail the impact of increasing numbers of automated vehicles and to plan accordingly.



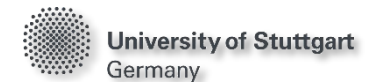
CoEXist Mission

The mission of CoEXist is to systematically increase the capacity of road authorities and other urban mobility stakeholders to get ready for the transition towards a shared road network with an increasing number of automated vehicles.

By simulating automated vehicles in four European cities, with different urban structures and traffic compositions, CoEXist analyses the effects of automated vehicles on urban road infrastructure, especially in a context of “co-existence” between automated and conventional vehicles.

CoEXist aims at enabling mobility stakeholders to get “AV-ready” (Automated Vehicles-ready).

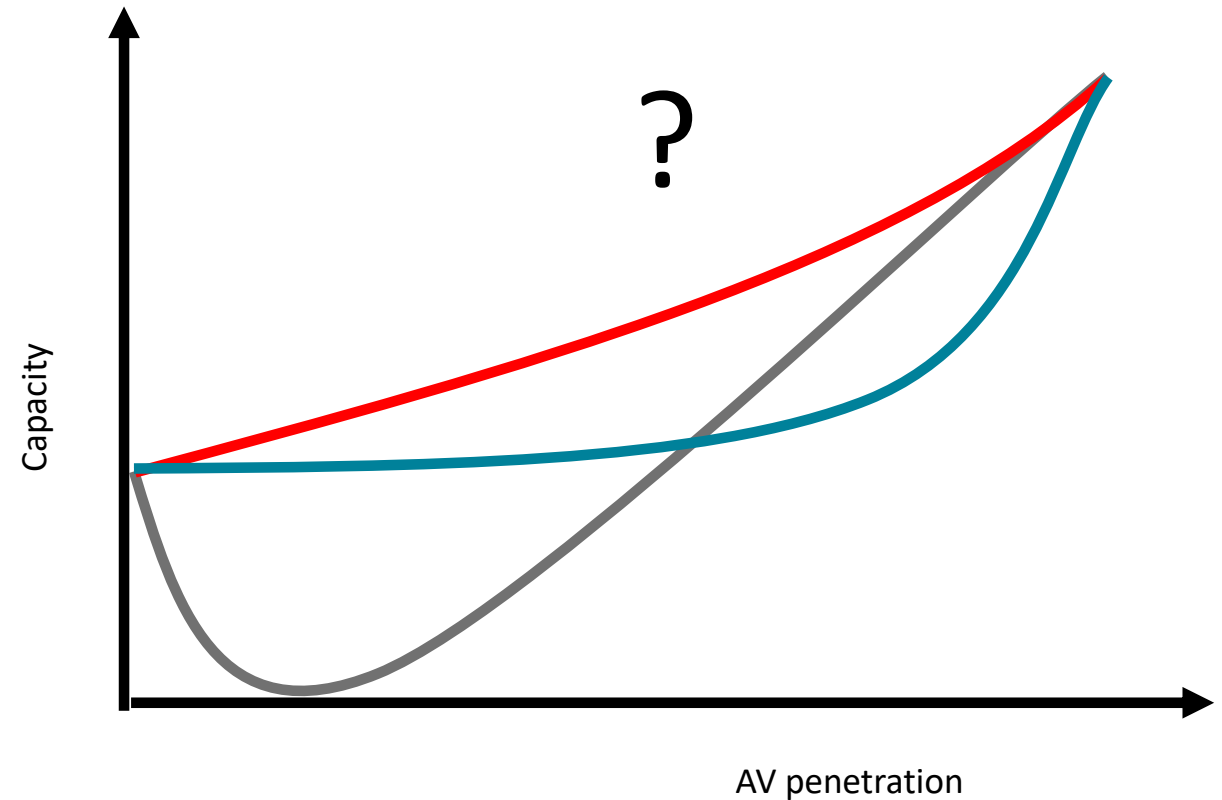
To achieve its objective, CoEXist develops a specific framework and both microscopic and macroscopic traffic models that take the introduction of automated vehicles into account.



Co-existence of AV & Conventional vehicles

Unclear transition to full (?) autonomy.

- Results strongly depend on assumptions made.
- Models needed to evaluate assumptions.



Core Tasks

Core Tasks: AV ready traffic modelling tools

Validated extension of existing microscopic transport models to include different types of automated vehicles.

Assessing the impact of automated vehicles on:

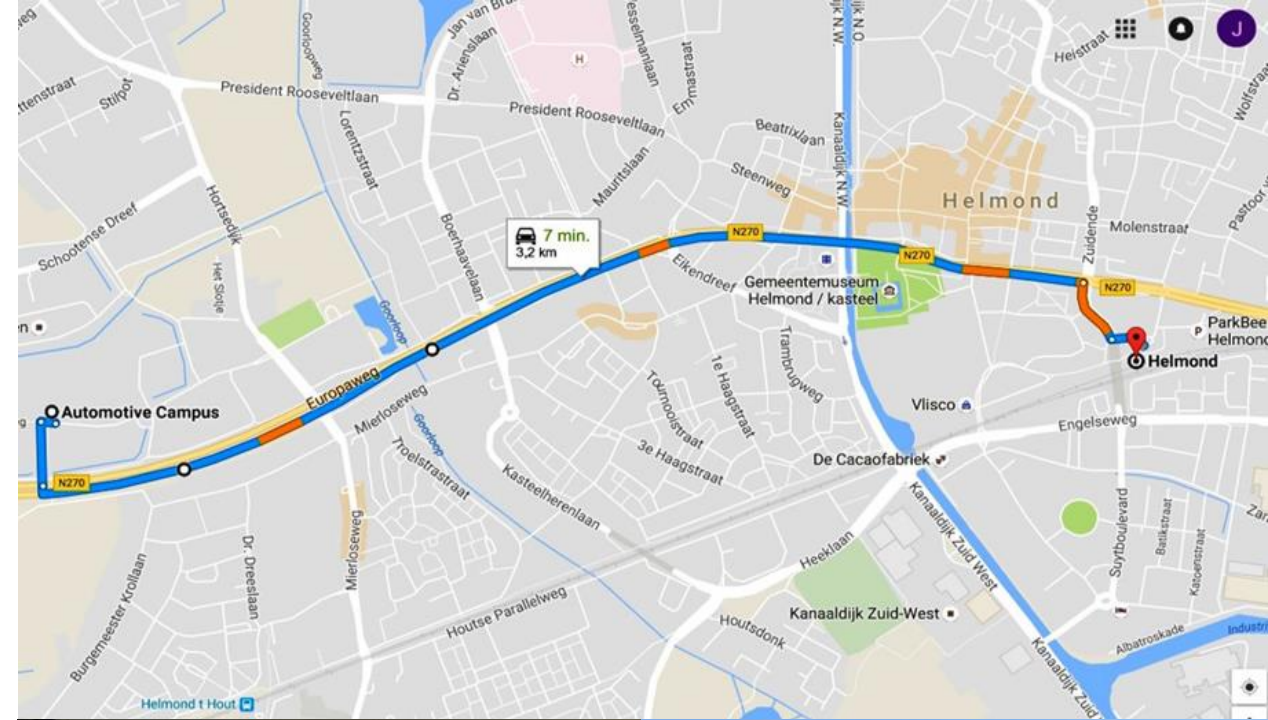
- Safety
- Traffic efficiency
- Space demand and development of design guidance for hybrid infrastructure



Core Tasks: AV ready traffic modelling tools

Define requirement for CAV-ready traffic flow simulation

- To establish a real-time and realistic connection between the AV-control logics, the AV-simulator and the microscopic modelling tool.
- To develop a set of model-based default values for AVs, including passenger car and light-freight vehicles.
- To collect data of two AVs on the public test site for validation of microscopic modelling tool.
- To extend micro- and macroscopic modelling tools to enable analysis of AV/CV-coexistence on the same network.



Core Tasks: AV ready traffic modelling tools

Micro



Macro



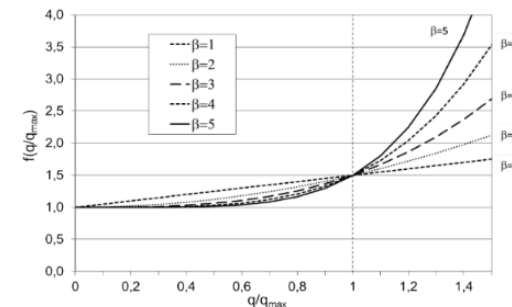
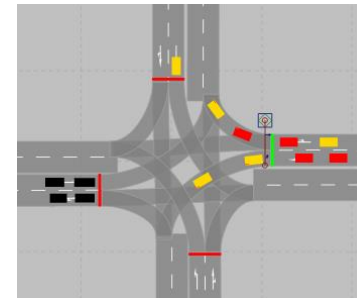
Interface approach:

- Improve APIs
- For users who have their own control algorithms (OEMs & Researchers)

Internal approach:

- Improve AV behavior
- For traditional Transportation Engineers (Planners, Consultants, Traffic Engineers)

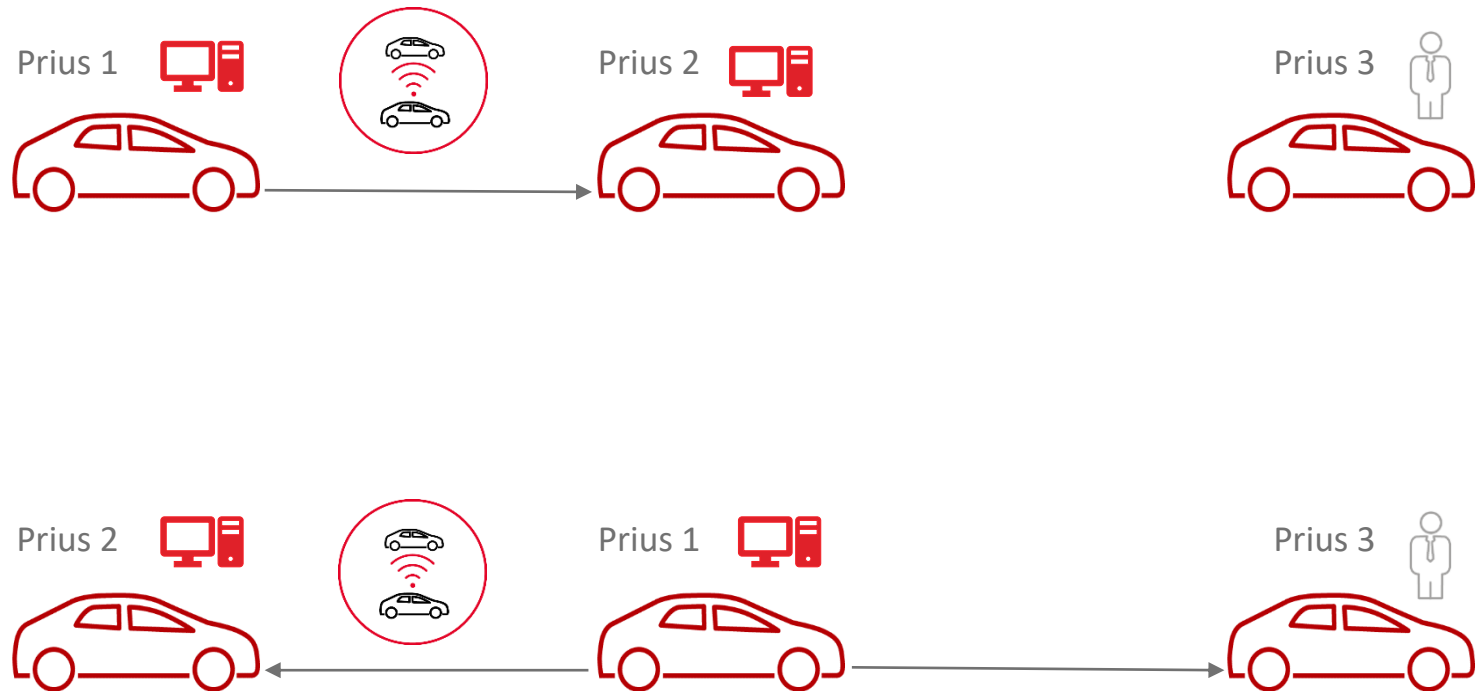
- Capacity
- Volume – Delay Function



Core Tasks: AV ready traffic modelling **tools**

Variations between the scenarios result in variations in the car following behavior:

- Prius 1 and Prius 2 switch positions.
- Prius 1 and 2 communicate or don't communicate.
- Predefined time gaps differ.



Outcomes

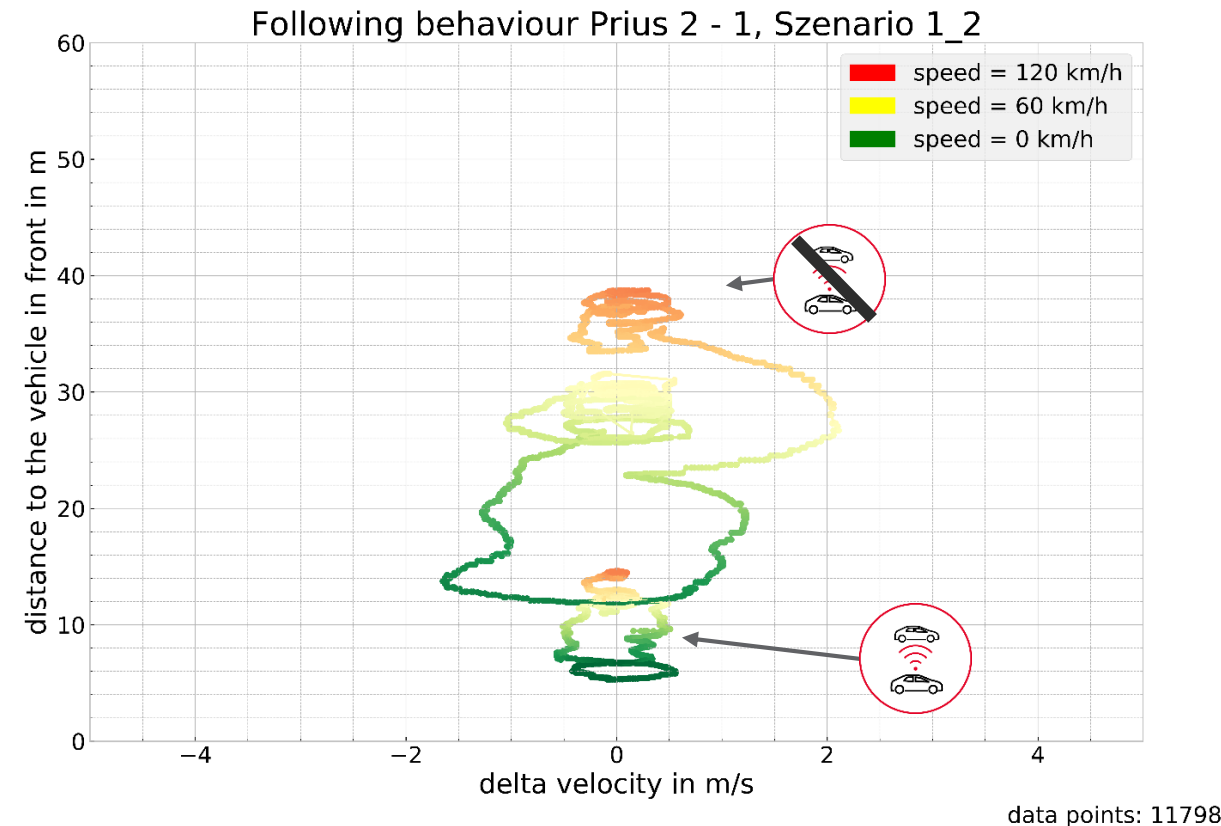
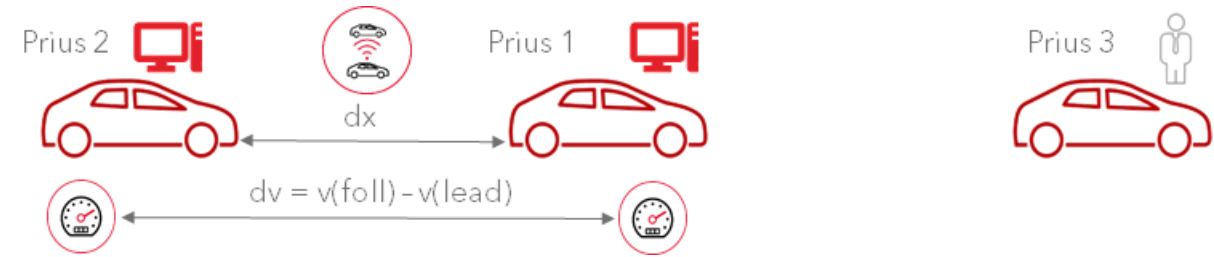
Test track data **output**

Vehicle trajectory and behavior data recorded from the public test track and analyzed to determine following behavior.

Comparison of vehicle following behaviour for 'connected' and 'non-connected' scenarios. Distance to vehicle in front recorded for a variety of vehicle travelling speeds.

Key results of public road test:

- Safety distance in 'non-connected' scenario significantly higher than in 'connected' scenario.
- Reduced velocity in safety distance in 'connected' scenario compared to 'non-connected' scenario.



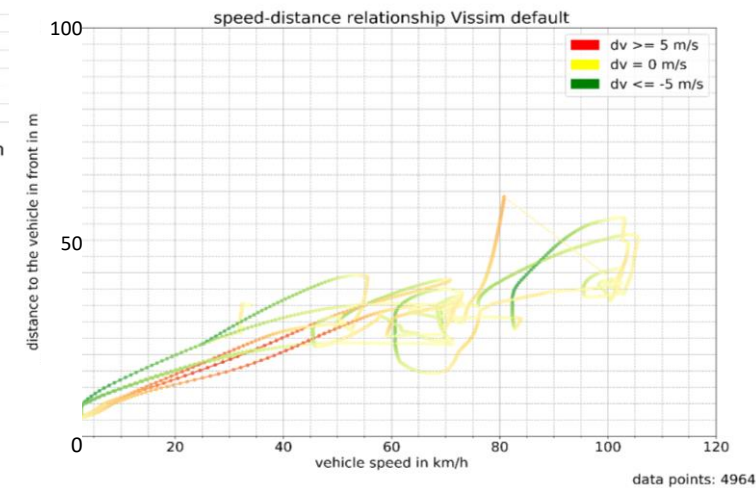
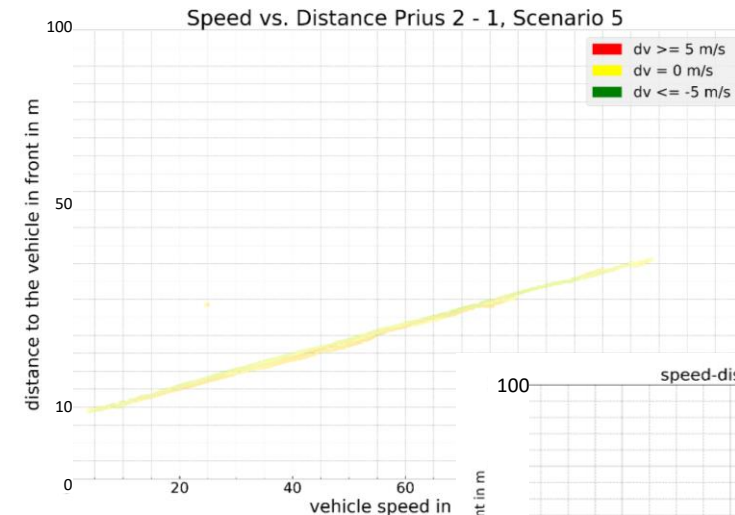
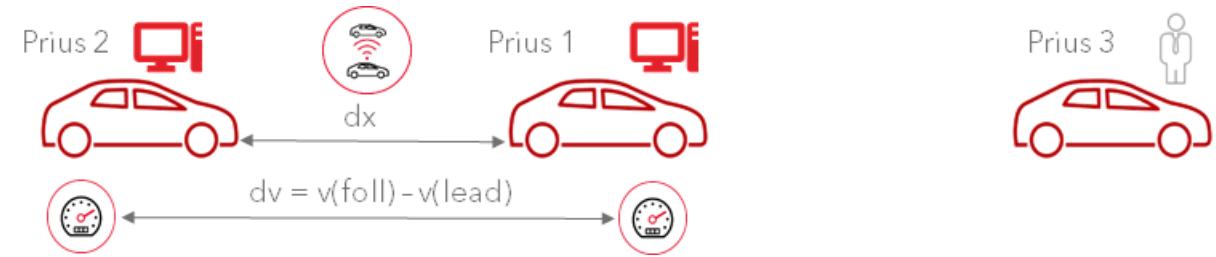
Validation of microscopic traffic modelling tools

Vehicle trajectory and behavior data compared and validated against microscopic simulation (PTV Vissim) driving behaviors.

Existing microscopic simulator driving behaviours have much more oscillation than automated vehicles from road test.

Automated vehicle behaviour in microscopic simulation:

- Clear linear, deterministic relationship between following distance and speed.
- New automated vehicle behavior parameters added to microscopic simulation (PTV Vissim) to achieve validation against real world public test automated vehicle data.



Automated vehicles simulation

Addition of new driving behaviors to PTV Vissim to replicated connected & automated vehicles.

AV Cautious

- AV All-knowing
 - Respects the road-code
 - maintains safe behaviour
 - Existing average driver
 - behaviour based on ability to
 - brick wall stop; distance always
 - communicate with other
 - maintained
 - vehicles.
 - measure the distance and
 - speed of other vehicles



Automated vehicles simulation

Addition of new driving behaviors to PTV Vissim to replicated connected & automated vehicles.

- ▶ Following behaviour can be altered depending on whether leading vehicle is human, AV or CAV.
- ▶ All automated vehicles adopt the same driving characteristics as the rest of the fleet, i.e. no variation between vehicles.

The screenshot displays the PTV Vissim interface. The top part shows a road layout with two lanes, each containing a sequence of vehicle icons labeled 'AV' (Automated Vehicle) and 'CAV' (Connected Automated Vehicle). A scale bar indicates 20 m. The bottom part shows the 'Driving Behaviors / Vehicle Class Following Behaviors' window. This window contains a table with columns for 'Count', 'No', 'Name', 'CarFollowModType', 'W74ax', 'W74bxAdd', 'W74bxMult', 'UselmplicStoch', 'EnforcAbsBrakDist', 'W99cc0', and 'W99cc1Distr'. The table lists various driving behaviors, including 'Urban (motorized)', 'Right-side rule (motorized)', 'Freeway (free lane selection)', 'Footpath (no interaction)', 'Cycle-Track (free overtaking)', and 'AV Cautious', 'AV Normal', 'AV All-knowing', and 'CAV / AV'. The 'CAV / AV' row is highlighted in yellow. To the right of the table, there is a summary table with columns for 'Count', 'VehClass', 'W99cc0', 'W99cc1Distr', and 'IncrsAccel'. The summary table shows two rows: '70: CAV - Yellow' and '80: AV - Purple'.

Count	No	Name	CarFollowModType	W74ax	W74bxAdd	W74bxMult	UselmplicStoch	EnforcAbsBrakDist	W99cc0
1	1	Urban (motorized)	Wiedemann 74	2.00	2.00	3.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.50
2	2	Right-side rule (motorized)	Wiedemann 99	2.00	2.00	3.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.50
3	3	Freeway (free lane selection)	Wiedemann 99	2.00	2.00	3.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.50
4	4	Footpath (no interaction)	No interaction	2.00	2.00	3.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.50
5	5	Cycle-Track (free overtaking)	Wiedemann 99	2.00	2.00	3.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	0.50
6	101	AV Cautious	Wiedemann 99	2.00	2.00	3.00	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1.50
7	102	AV Normal	Wiedemann 99	2.00	2.00	3.00	<input type="checkbox"/>	<input type="checkbox"/>	1.50
8	103	AV All-knowing	Wiedemann 99	2.00	2.00	3.00	<input type="checkbox"/>	<input type="checkbox"/>	1.00
9	1005	CAV / AV	Wiedemann 99	2.00	3.00	0.00	<input type="checkbox"/>	<input type="checkbox"/>	1.50

Count	VehClass	W99cc0	W99cc1Distr	IncrsAccel
1	70: CAV - Yellow	1.50	103: 0.6 s	100.0 %
2	80: AV - Purple	1.50	102: 1.5 s	100.0 %

Next Steps

Application of microscopic simulation tools.

Taking the automated vehicle driving behaviour models and applying them in the use cases of the four partner cities of CoEXist.

- Simulate impact of co-existence of automated vehicles in mixed fleets.
- Assess required infrastructure to inform transition & facilitation of automation.



Innovation with PTV Vissim

- First application of automated vehicle behavior embedded in commercially available software.
- Based on real world data from public test track with autonomous vehicle control algorithms.



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