Enabling "*Automation-Ready*" Transport Planning

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#H2020CoEXist
@H2020_CoEXist

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201

What is CoEXist?

- European project, H2020-ART05
- Duration: May 2017 – April 2020

- Aim: Prepare **cities** for the transition phase during which automated vehicles (AVs) and conventional vehicles will coexist on the roads.

- Mission: Build the capacity of road authorities and other urban mobility stakeholders to get ready for this transition

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CoEXist approach

Automation-Ready Transport Modelling

Automation-Ready Road Infrastructure

Automation-Ready Road Authorities

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How to model AVs in traffic simulation models?

- What is an automated vehicle?
- How do it behave?
- Are all automated vehicles the same?

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Level of automation

- SAE levels focus on
  - To what extent the vehicle drive itself,
  - Where it can drive itself
  - Who is responsible for the driving

SAE level	Short description
0 – No automation	Full-time performance by a human
1 – Driver Assistance	Assistance system of either steering or acceleration/deceleration
2 – Partial Automation	Automation of **some parts** of the driving task
3 – Conditional Automation	Self driving but **driver responsible** and required to intervene if necessary
4 – High Automation	Self driving in **some** environment – driver not responsible
5 – Full Automation	Self driving **everywhere**

- but do not specify how driving behavior vary between or within the levels

- **CoEXist focus**: driving behavior when an **automated driving system (ADS) is responsible** for the vehicle operation

  → AVs comply with the road regulation and the rode code, e.g. comply with speed limit

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Challenges

- Limited data on first generation AVs
- No data on future AVs
- Transition towards full automation will be long

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Large uncertainties w.r.t.

- Driving behaviour of AVs
- Evolution of AV technology and penetration rates
- Behaviour of other road users in response to AVs
- Traveller behaviour adaptation (e.g., travel time perception)
- …

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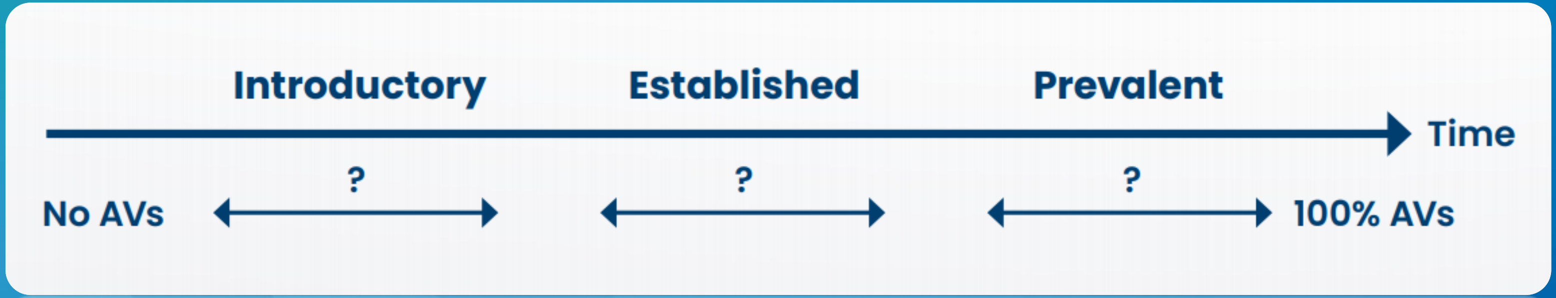
Operational specification of AV driving behaviour

Stages of automation characterised by:

- **AV market shares:** *how common are AVs?*
- **AV capabilities:** *where can they drive?*
- **AV driving behaviour:** *how do they drive?*



CoExist Driving Logics

Rail-Safe

Stops if anything is on collision course. The vehicle follows a pre-defined path for the whole trajectory.

Cautious

Calculates gaps accurately and only merges when gaps are acceptable, and it slows down every time its sensors can have blind angles to have no surprises.

Normal

Behaves as an average driver but with the augmented (or diminished) capacities of the sensors for the perception of the surroundings.

All-Knowing

Perfect perception and prediction of the surroundings and the behaviour of the other road users. It is capable of forcing its way on other drivers whenever is needed without however ever causing accidents.

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AV classes

- **Basic:** Self driving only in one directional traffic with physical separation to active modes.
- **Intermediate:** Self driving in structured traffic.
- **Advanced:** Self driving in most environments

- All three prioritize safety, but the more advanced are able to safely drive more offensively than the less advanced.
- All comply with the road regulation and the rode code, e.g. comply with the speed limit

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Example relation between AV-class, driving logics and operational design domain (ODD)

Road type	Basic AV	Intermediate AV	Advanced AV
Motorway	Cautious	Normal	All-knowing
Arterial	Cautious	Cautious / Normal	All-knowing
Urban street	Human	Cautious	Normal
Shared space	Human	Rail-safe / Human	Cautious

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Example of AV penetration rates & shares

Stage	AV penetration (%)	Basic AV share (%)	Intermediate AV share (%)	Advanced AV share (%)
Introductory	10-40			
Established	30-70			
Prevalent	60-90			

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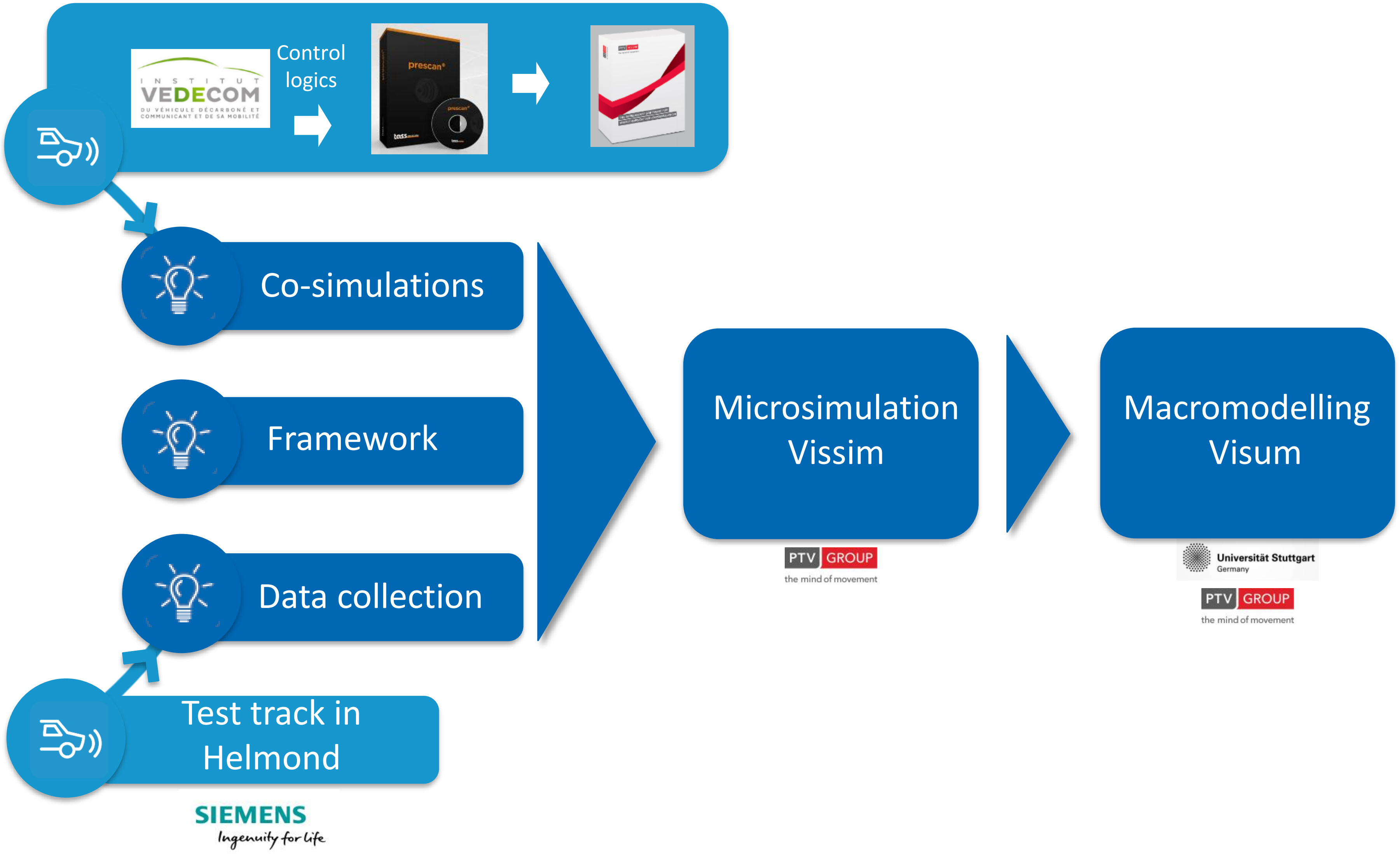
Automation-Ready Modelling: Approach



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Automation-ready Road Authorities

Microscopic

Macroscopic

8 Use cases in
4 European Cities

Test of micro- and
macroscopic
modelling tools

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CoEXist Use Cases

Gothenburg, Sweden

- Shared spaces
- Accessibility during long-term construction works

Helmond, the Netherlands

- Signalised intersection including pedestrians and cyclists
- Transition from interurban highway to arterial

Milton Keynes, United-Kingdom

- Waiting and drop-off areas for passengers
- Priority Junction Operation (roundabouts)

Stuttgart, Germany

- Impacts of CAVs on travel time and mode choice on a network level
- Impact of driverless car- and ridesharing services

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General single infrastructure level effects

- Decreased traffic performance in the Introductory stage due to the cautious AVs
  - magnitude varies substantially between sites
  - large decrease in traffic performance for less structured traffic environments, like roundabouts and shared space
  - smaller decrease for highly structured traffic environments like highways, arterials and signal-controlled intersections.
- The negative effects are reduced as the AVs get more advanced
  - Several ways in the Prevalent stage to amplify positive effects, such as redistributing green time in intersections to active modes or introducing V2V based control in roundabouts.
  - harder to reduce the negative effects during the Introductory stage, when AVs are cautious

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General network level effects

- Decreased traffic performance in the Introductory stage
- Improved traffic performance in the Established and Prevalent stages
- Change in travel time perception leads to modal shift to car and longer travel distance and time per trip.
- Driverless car- and ridesharing services have a potential large impact in reducing privately owned vehicles. Among all three types of sharing services, direct ridesharing services achieve the highest modal share.

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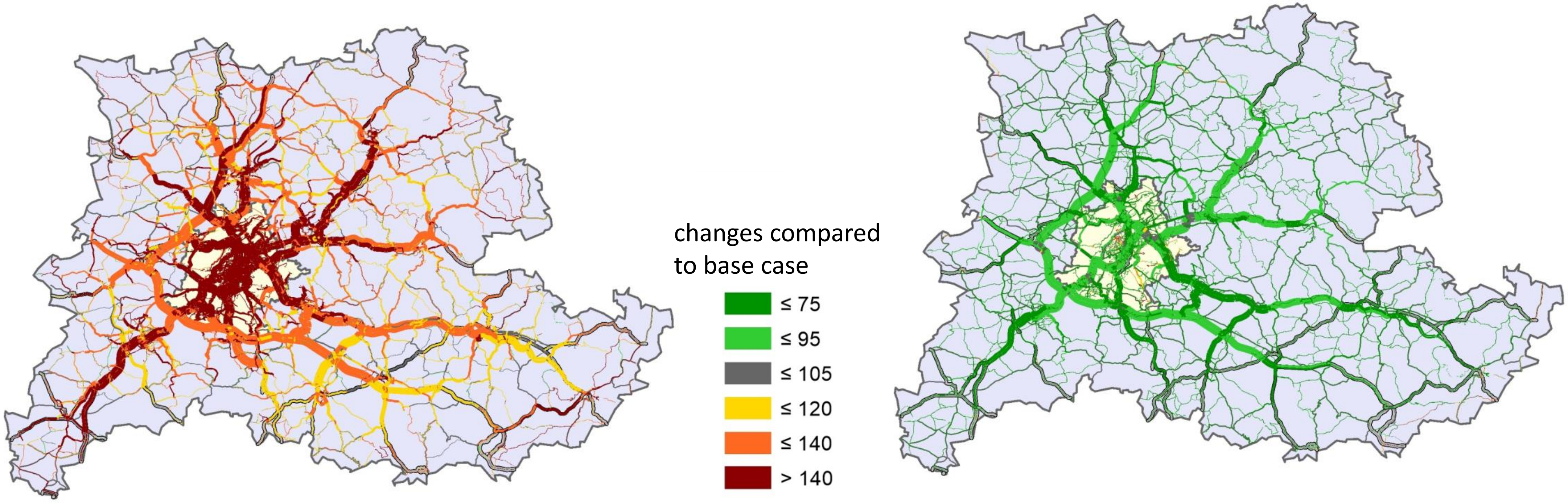
How will AV change the way we travel?

- better cars
- more carsharing

- better cars
- more ridesharing
- better public transport

more car traffic

less car traffic



General conclusions and recommendations

- Traffic Performance first decrease before it increase again
- Decreased/Increased Traffic Performance lead to modal shifts between car and public transport
- The only investigated **measure** that reduce the negative traffic performance effects in the **Introductory stage** is to **only allow AVs** in highly structured traffic environments like **motorways**.
- The results emphasise the importance of careful modelling of future partly automated traffic when planning infrastructure that are likely to remain through most of the era of coexistence of conventional and automated vehicles.

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CoEXist Partners

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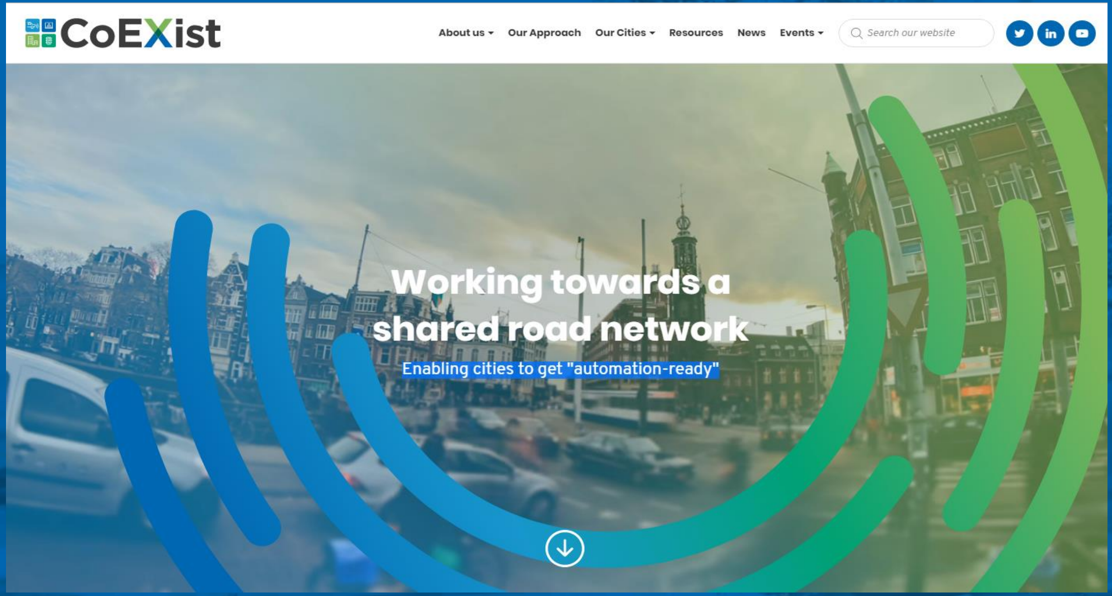
Get in touch!



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