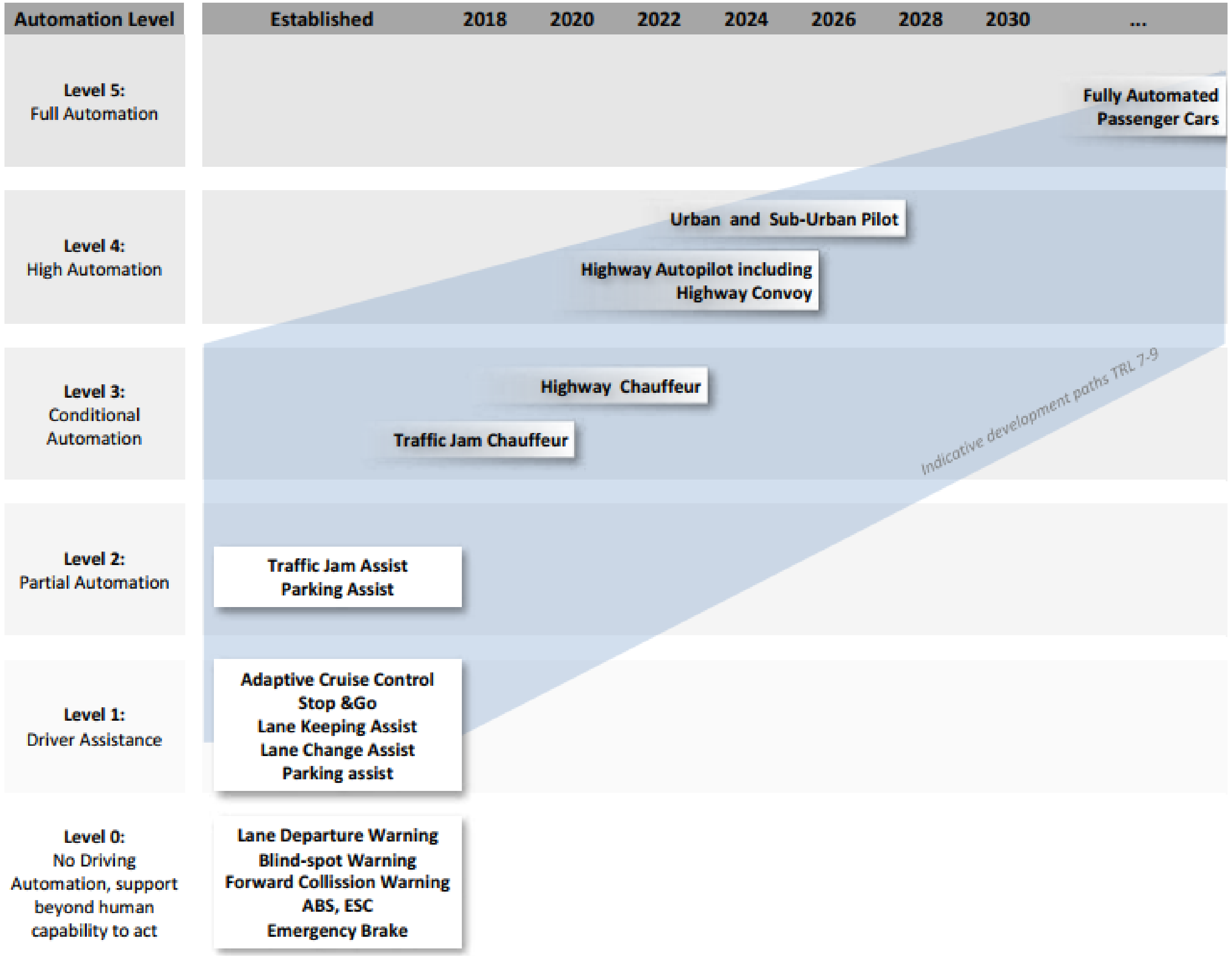
Automated vehicles in mixed traffic environments – the value of external HMI

Anna Schieben
Institute of Transportation Systems, DLR e.V.

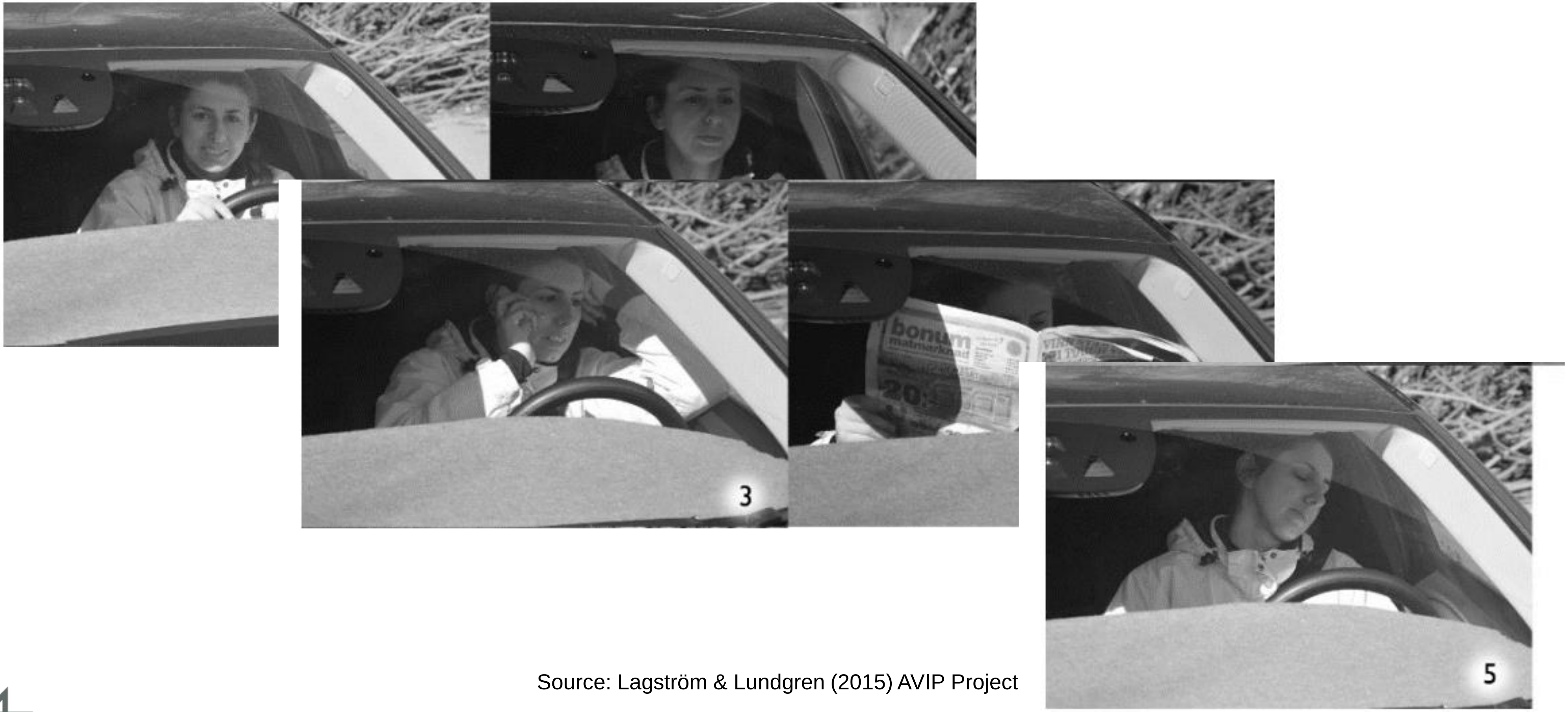
AUTOMATED VEHICLES

Deployment of automated vehicles



ERTRAC Roadmap (2017)

Automated vehicles in mixed traffic



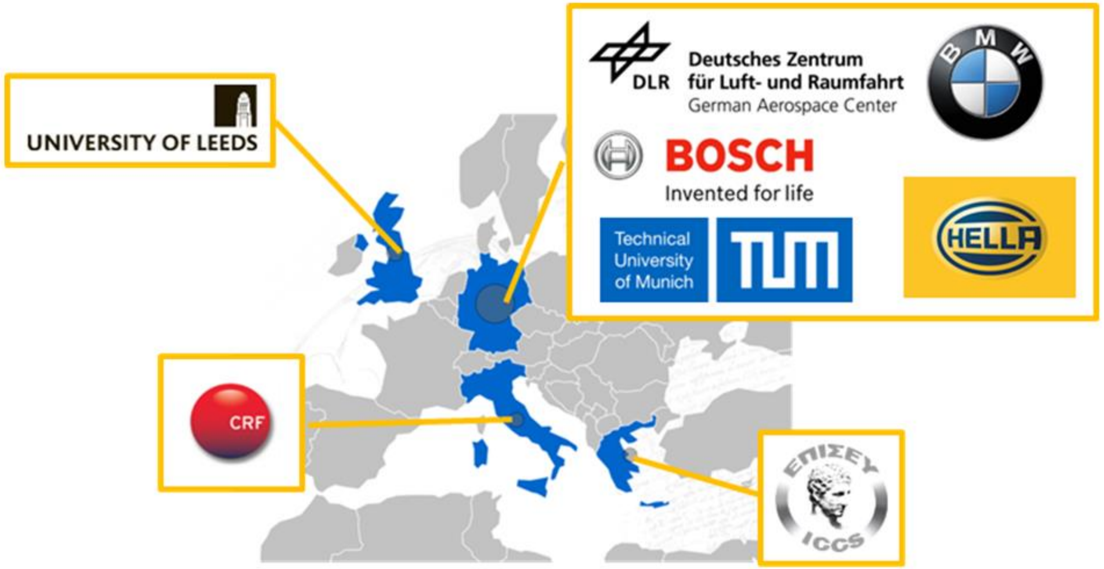
Source: Lagström & Lundgren (2015) AVIP Project

Integrating automated vehicles in mixed traffic

The interACT project

interACT – Designing cooperative interaction of automated vehicles with other road users in mixed traffic environments

Programme: EU/H2020-**ART04** - *Safety and end-user road automation in the transition period*
Period: May 2017 – April 2020
EU Funding: 5.527.581 €
Coordinator: Anna Schieben, DLR e.V.
Partners: 8 industrial and academic partners from 4 European countries (Germany, Italy, Greece, UK)
EU twinning project: AVIntent (NHTSA)



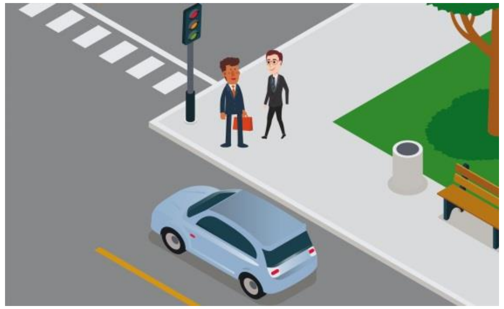
www.interact-roadautomation.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723395

The challenge

5th Enabler

Methodology for assessing the quality of interaction

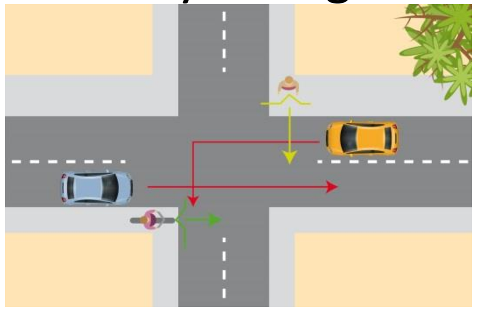


1st Enabler

Psychological models

4th Enabler

Novel HMI elements

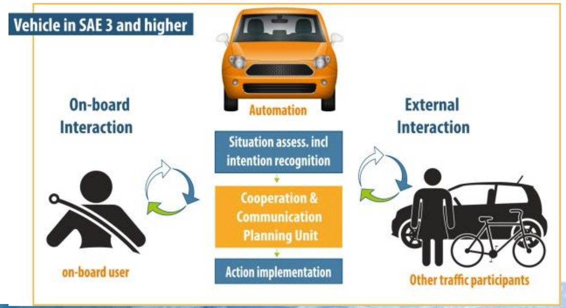


2nd Enabler

Intention recognition & behavioural predictions

3rd Enabler

CCPU & safety layer



interACT

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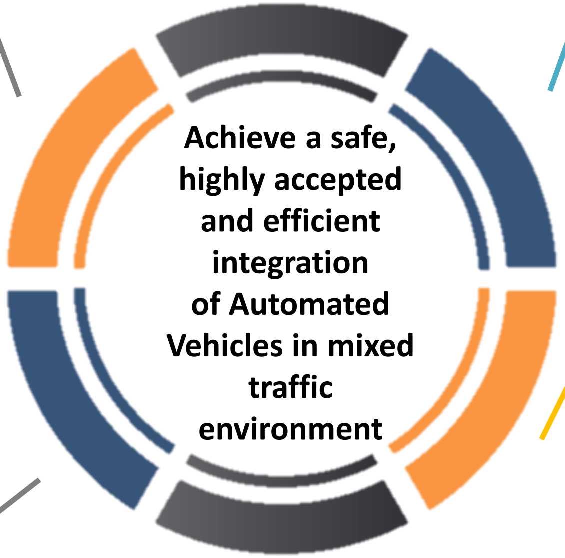

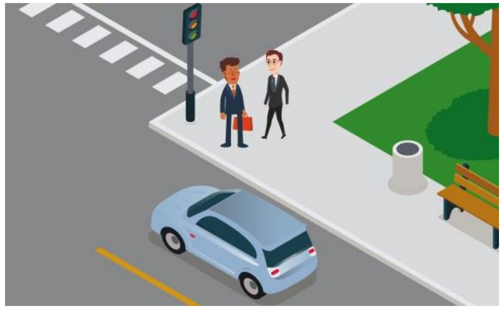

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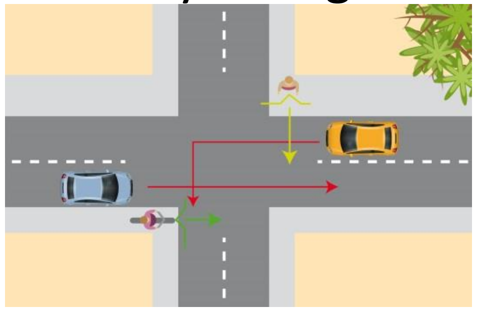

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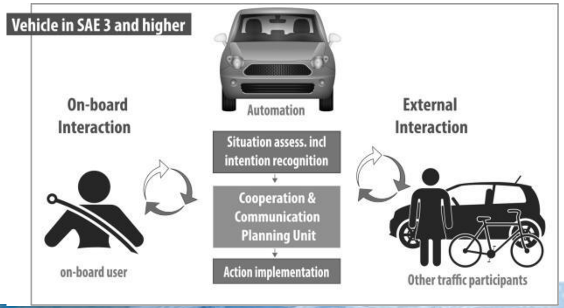

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OBSERVATIONAL STUDIES

Key objectives of the observational studies

- **Observe** human-human interactions in current complex urban environments

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- **Model the interactions** using different approaches:
  - Interaction vocabulary: *How do Traffic Participants communicate and anticipate intent*
  - Interaction sequences: *What is the general interaction process in specific use cases and scenarios and what are the cultural difference?*
  - Quantitative models: *How can interactions be mathematically formulated to allow model-in-the-loop simulations?*

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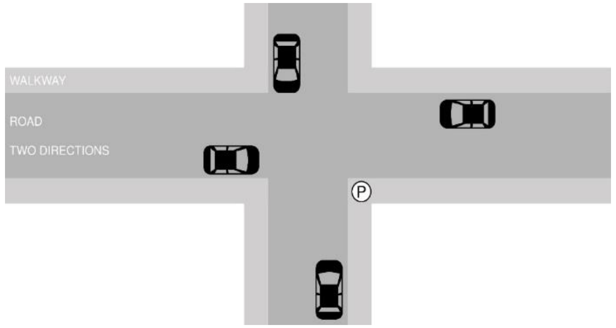
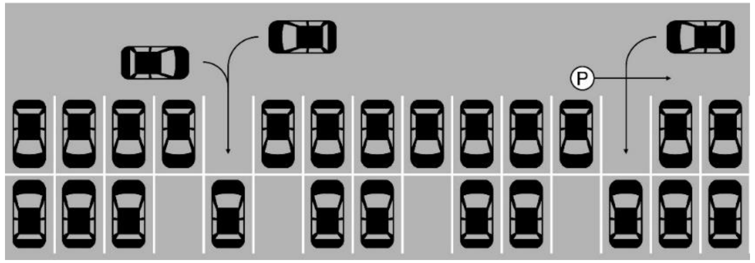
Observe, Model, Predict

Methodology

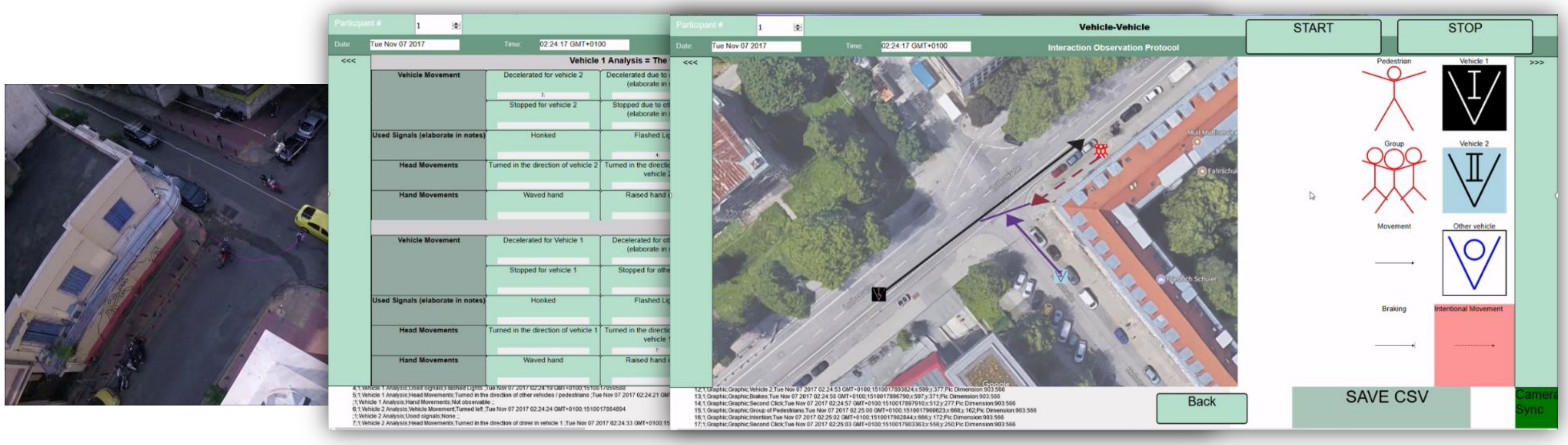
- 3 Countries: Greece, UK, Germany

- 4 urban use cases





Data assessment
- Videos
- Observation Protocols
- Questionnaires
- LiDAR



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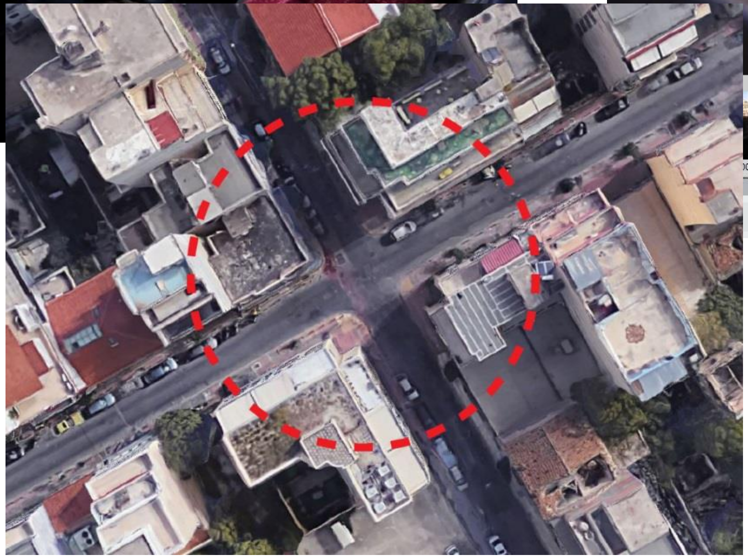

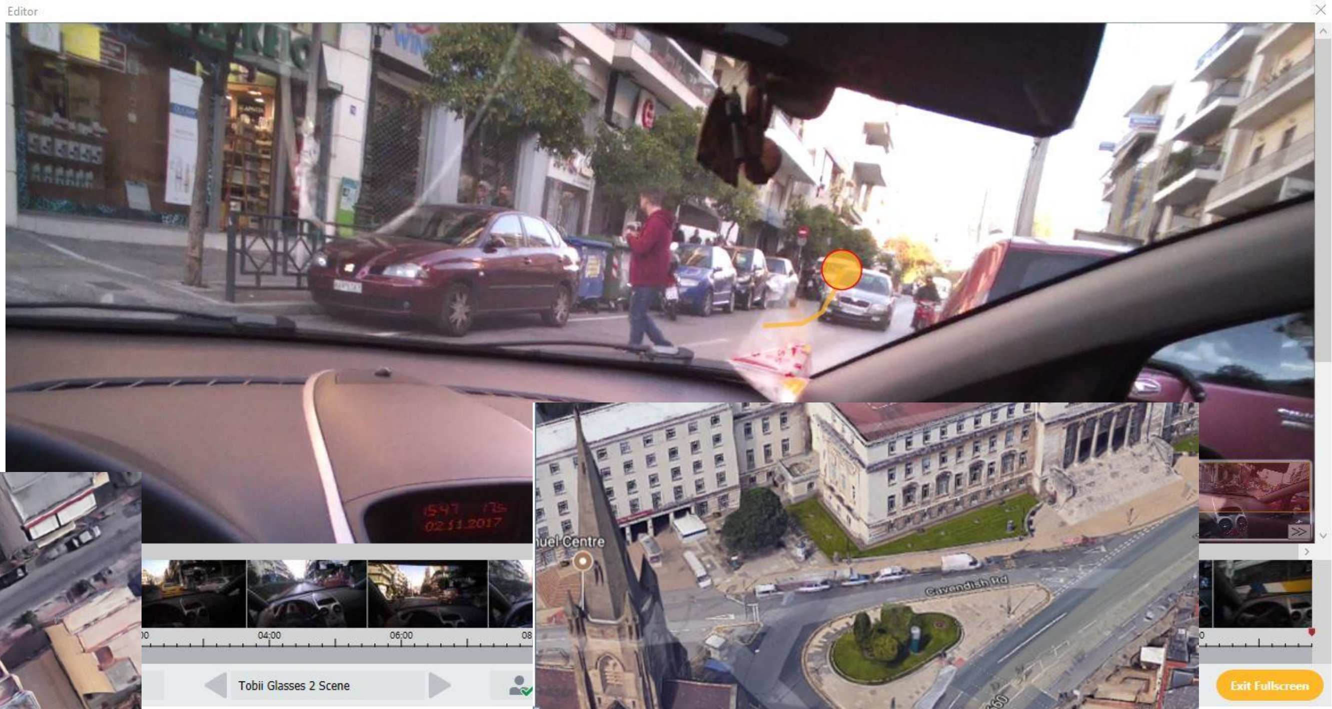
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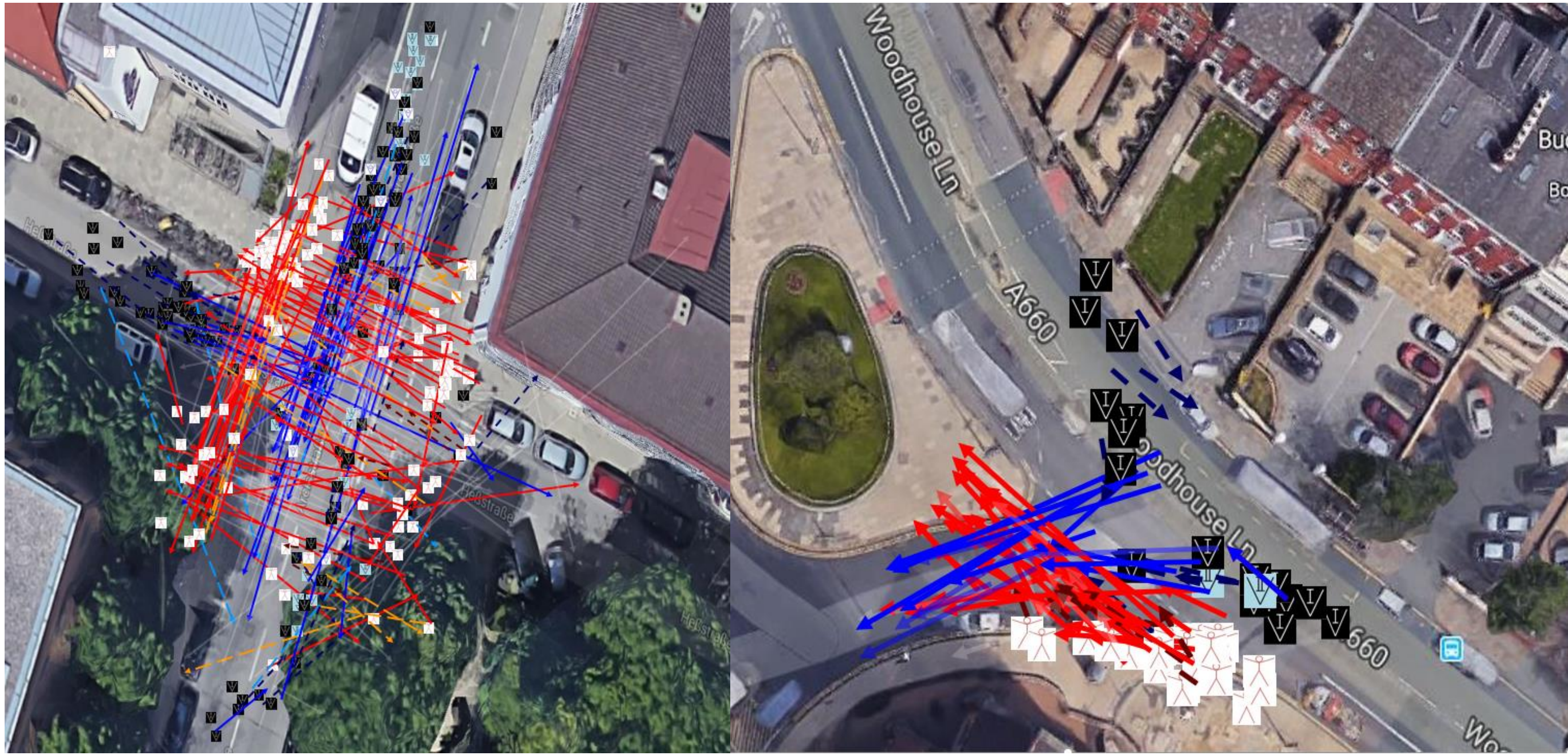
Preliminary Results – Manual Observation

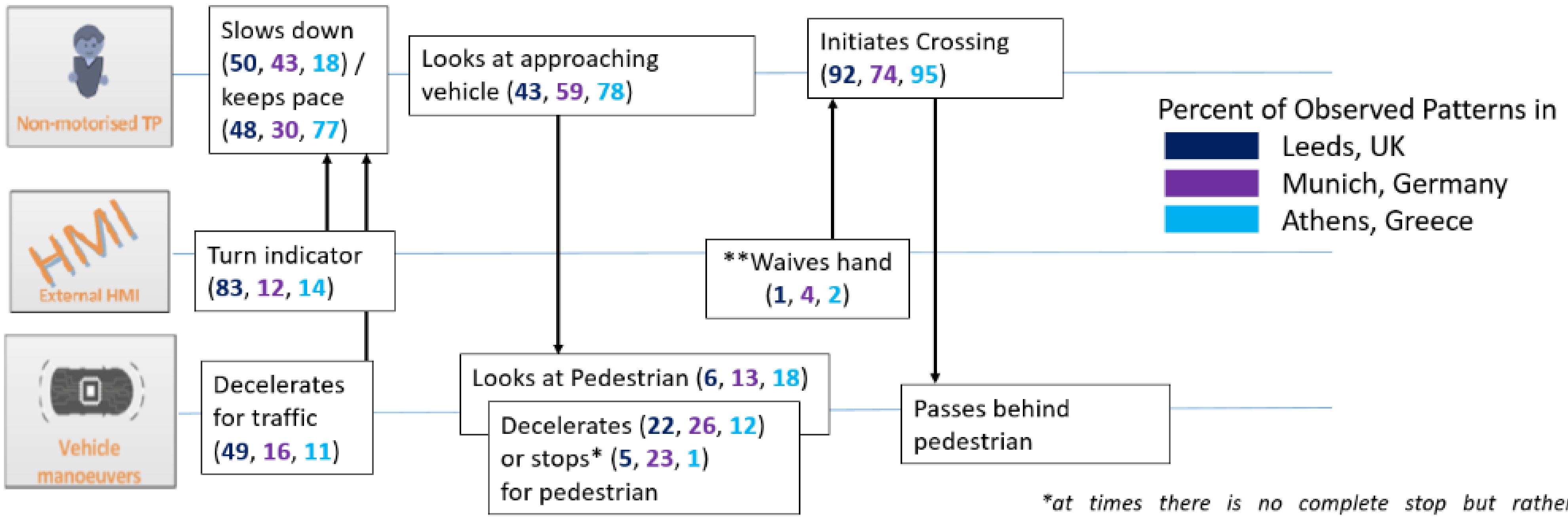
- Over 100 Protocols per use case and country

- Also: combined 100+ hours of videos, 20+ hours of LiDAR Data and 150+ people interviewed



Preliminary Results – Manual Observation

"Interaction Sequence" - Intersection – pedestrian goes first:



**at times there is no complete stop but rather a continuation of the movement at a very slow pace*

***in some cases there was no hand waiving and the scenario played out comparably*

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Overall findings

- The occurrence and necessity of interactions depends on the situation and a variety of **other factors**, such as traffic density, time of day and specific traffic conditions
- **Explicit communication (e.g. gesturing, flashing lights etc.) happens rarely** - most potential interaction-demanding situations are resolved before they actually arise, mostly by adjusting *kinematic motion*
- **Cooperation, communication** and thus **interaction** between human road users takes place at **low speeds**, usually below 20 km/h
- At **higher speeds, conflict avoidance** is predominant – pedestrians use large enough inter-vehicle gaps to cross without expecting the second vehicle to adapt

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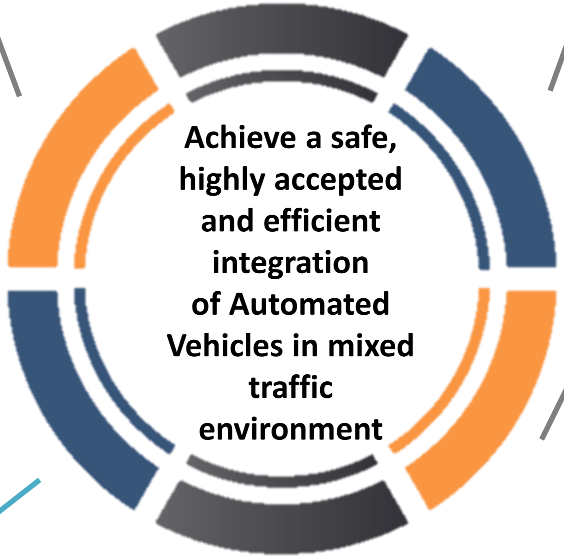
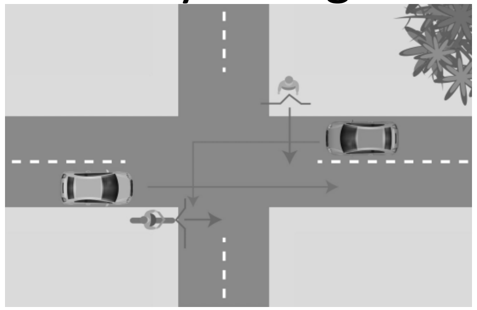


Achieve a safe, highly accepted and efficient integration of Automated Vehicles in mixed traffic environment

1st Enabler
Psychological models



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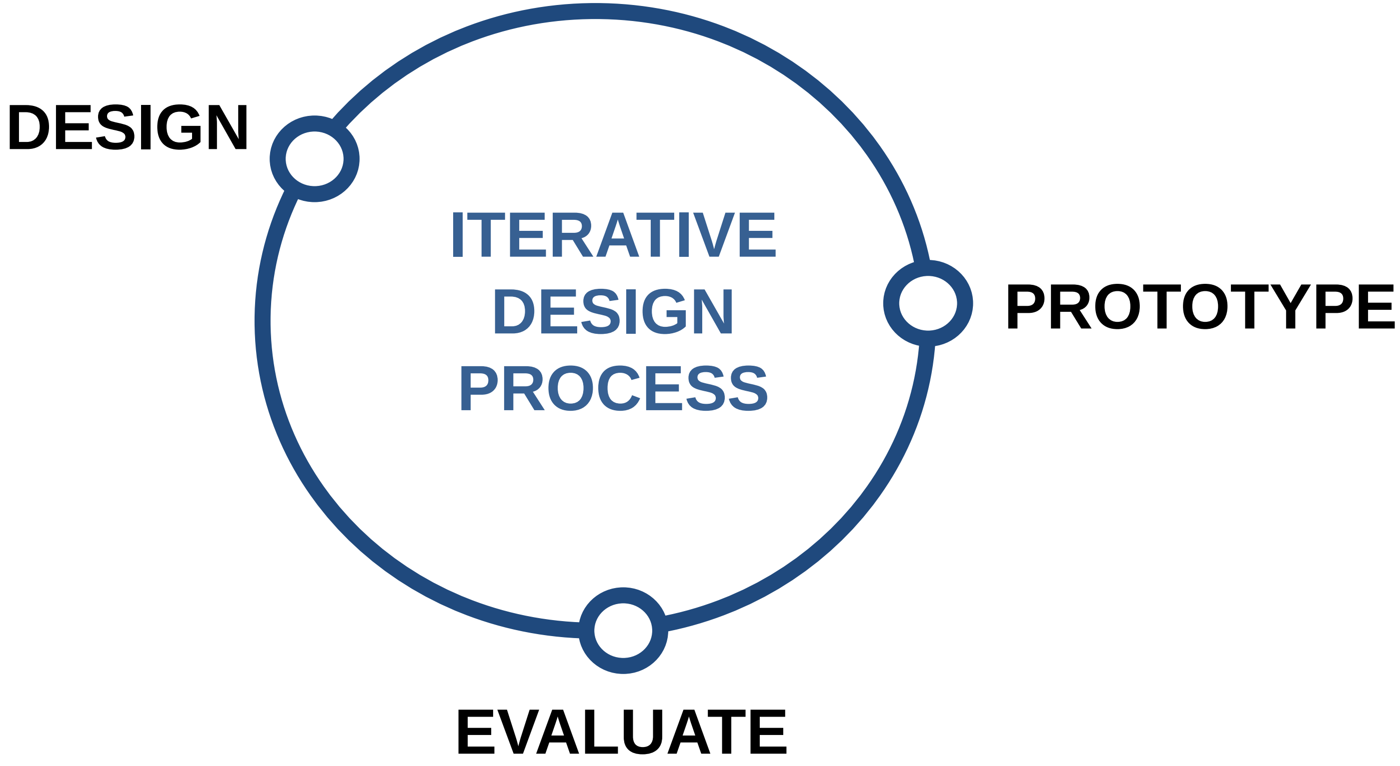
HMI DESIGN

Design considerations for automated vehicles



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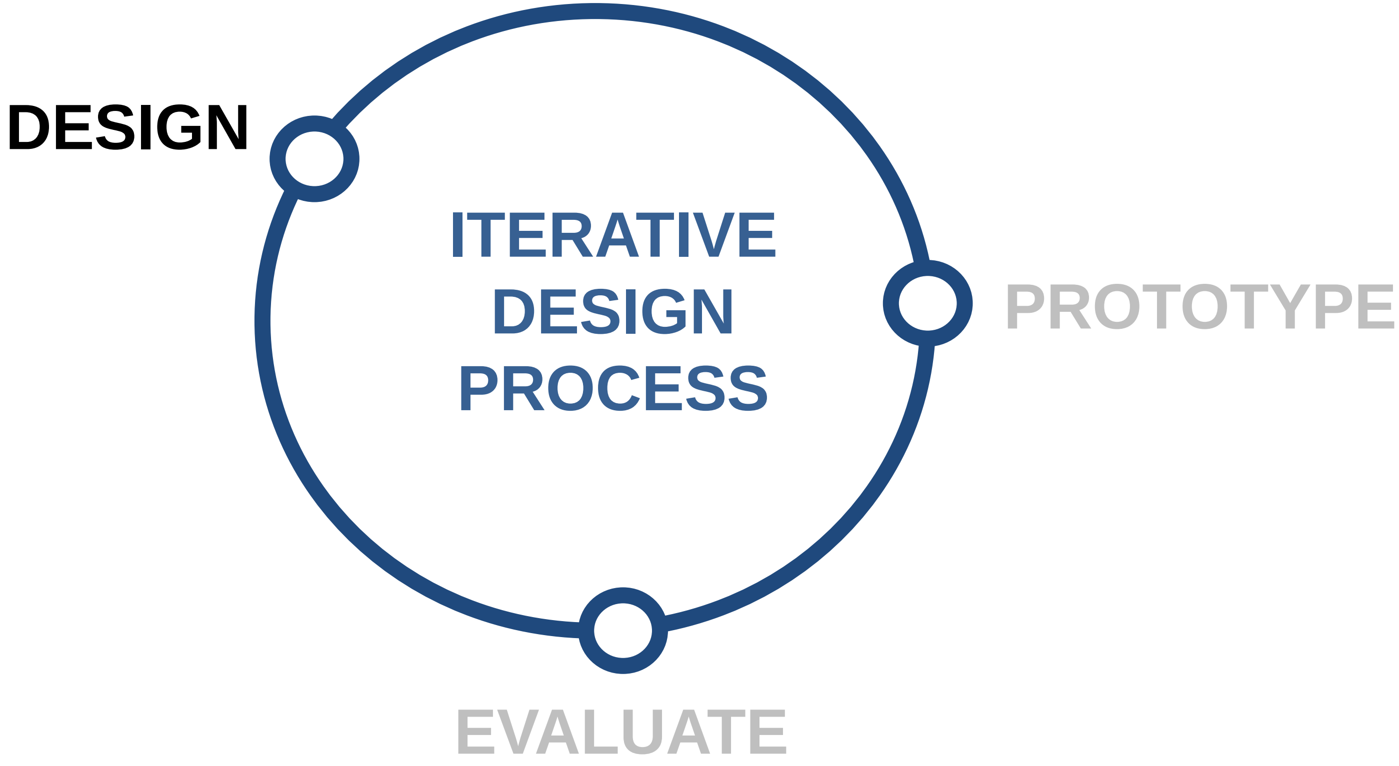

Design considerations for automated vehicles

Which information could be needed by other road users?

- Category A: **Vehicle driving mode**
  - Automated or manually driven vehicle
- Category B: **Vehicle’s next manoeuvres**
  - E.g. Vehicle will start moving
- Category C: **Perception of environment**
  - E.g. pedestrian is detected
- Category D: **Cooperation capability**
  - E.g. Vehicle willing to cooperate, gives right of way

Cited from *Schieben, Wilbrink, Kettwich, Madigan, Louw & Merat* (2018): Designing the interaction of automated vehicles with other traffic participants: Design considerations based on human needs and expectations. Cognition, Technology and Work. pp 1-17. https://doi.org/10.1007/s10111-018-0521-z

Design options

Design of infrastructure

- Seperated tracks, signs

...nna.Schieben@dlr.de

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Design of vehicle shape

  - E.g. Google car

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Design of external HMI

- Visual, acoustic signals

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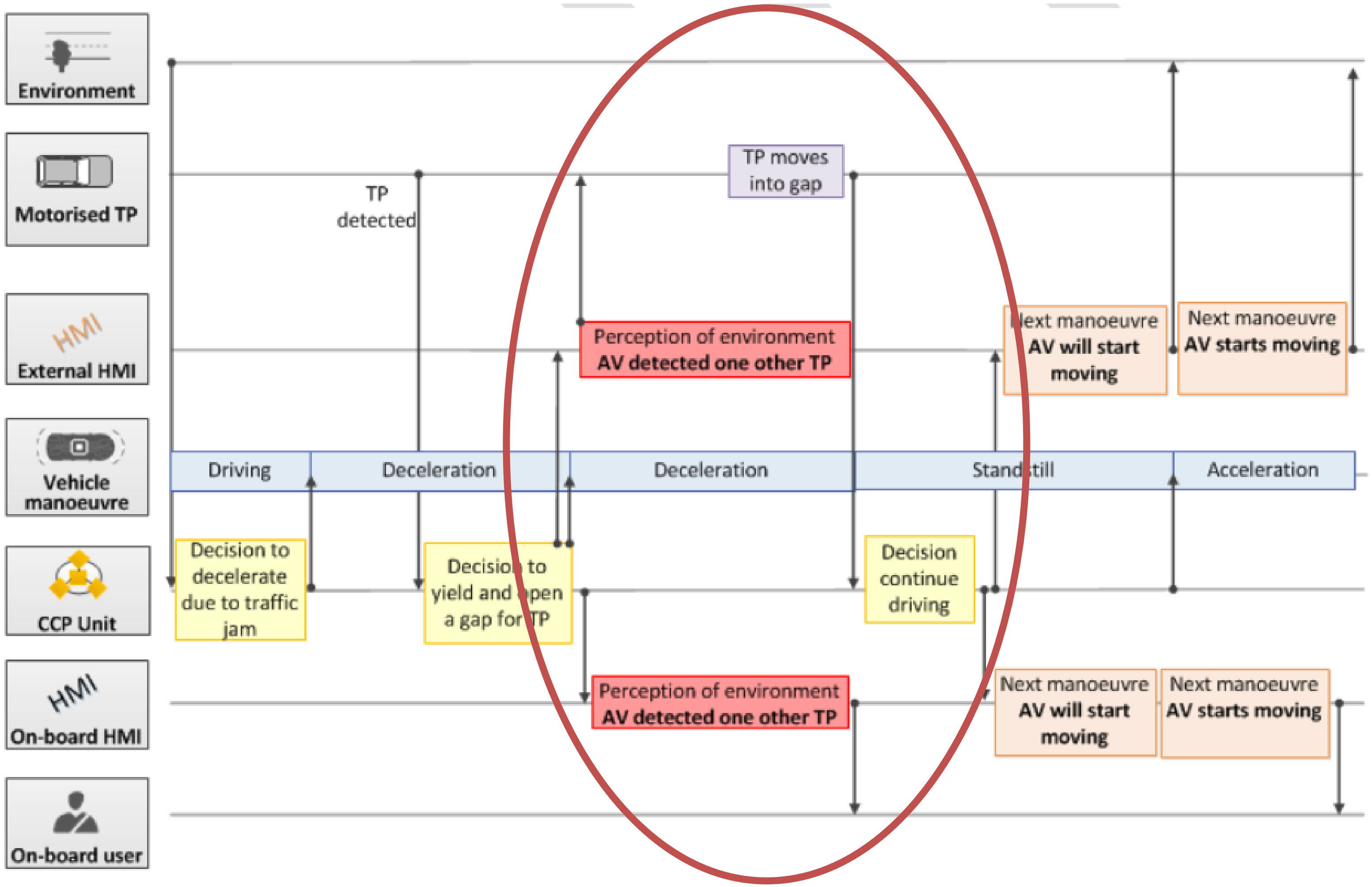
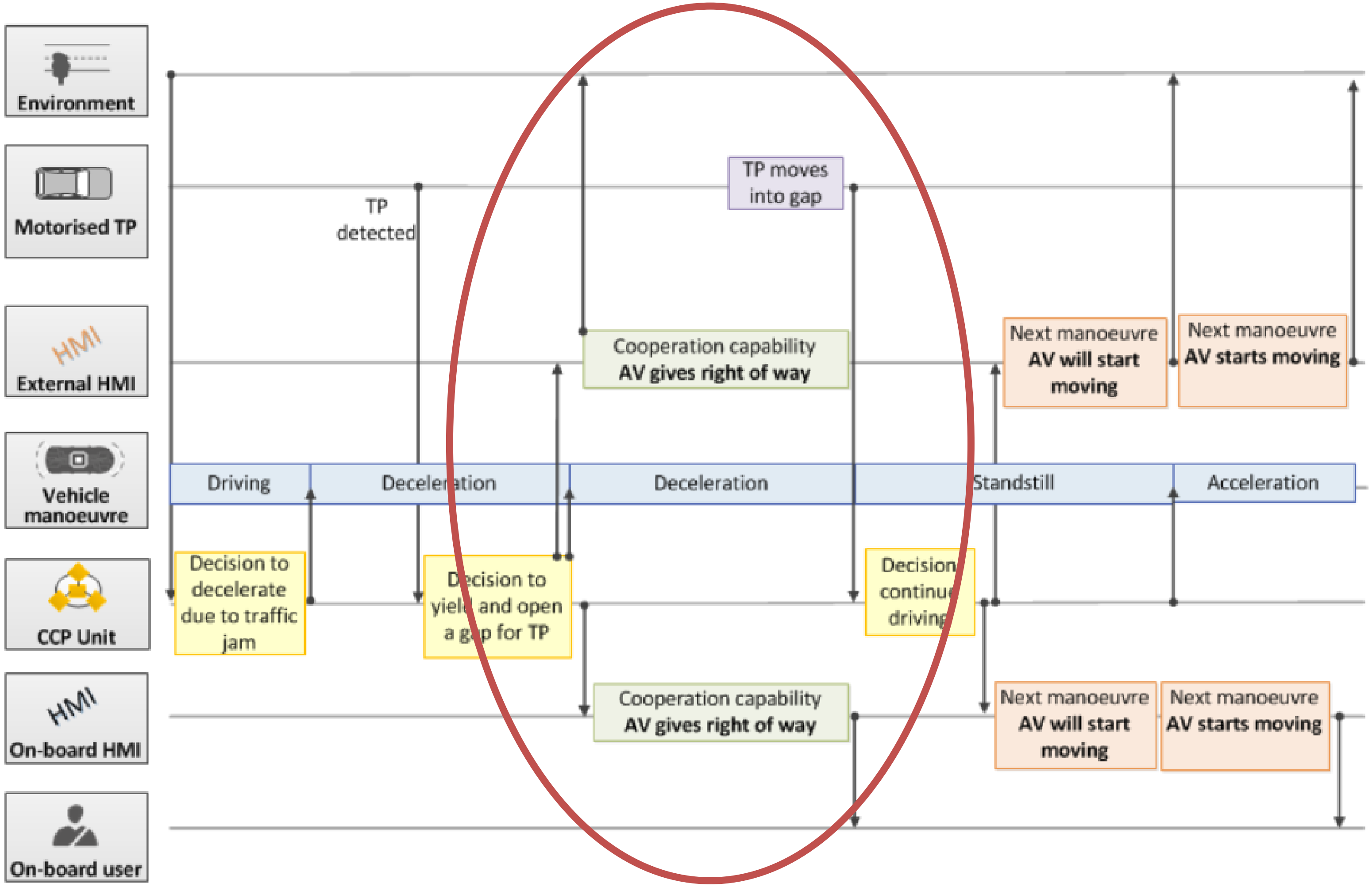
Interaction strategies: Perception-signalling design



Interaction strategies: Intention-signalling design



CONCLUSIONS

Some (preliminary) conclusions

- The use of “external Human Machine Interfaces” is seems to be especially relevant in **ambiguous situations**, when explicit communication is necessary above and beyond *kinematic cues*

- **BUT** – Unlike manually driven vehicles, in addition to adapting their movement, perhaps Automated Vehicles could **enhance acceptance, safety and traffic flow** by communicating to other traffic participants earlier.

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interACT

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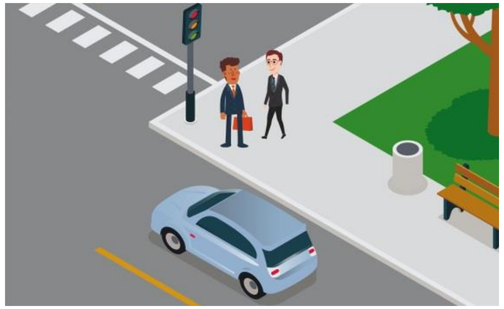

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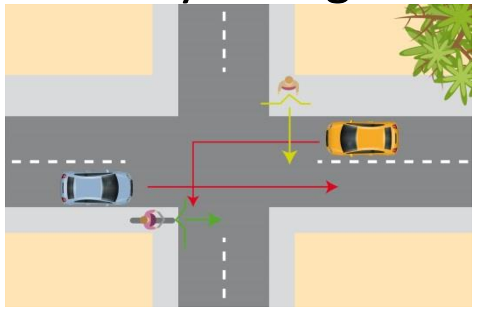

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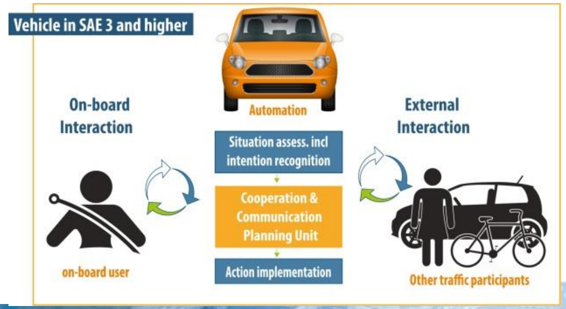

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Thank you for your kind attention!

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Project info:
www.interact-roadautomation.eu

Webinar: https://www.interact-roadautomation.eu/cad-webinar-series-ix-interact-project/

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