Joint system as a guiding approach for driver-automation system design

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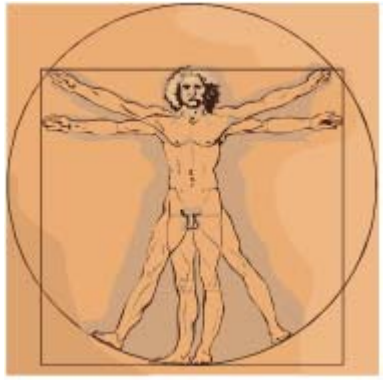
Overview

- Motivation for **Joint Driver-Automation System Design**

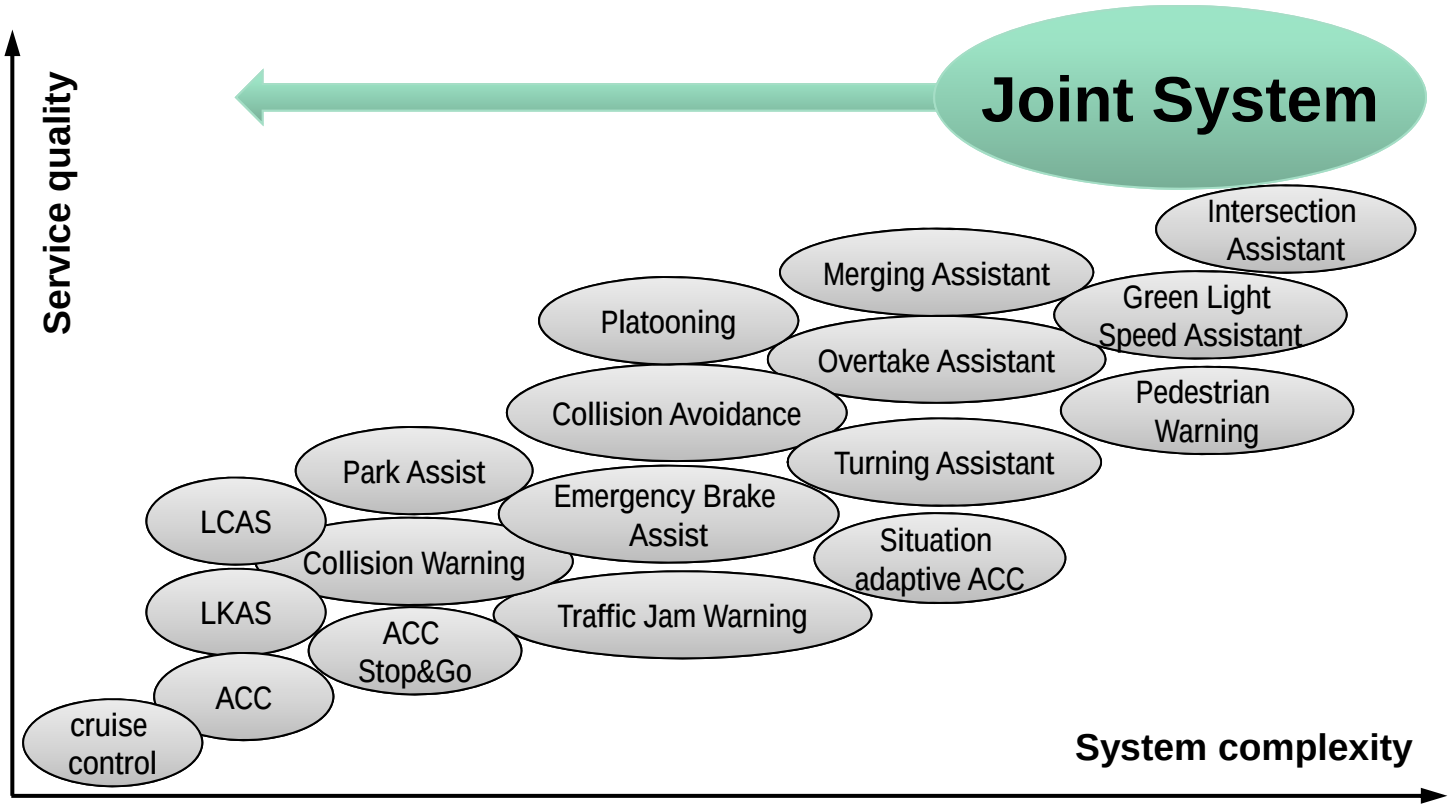
- Joint System components addressed in **EU-Projects and iMobility Forum**

- **Application examples** for highly automated road transport systems



picture source: http://office.microsoft.com

Motivation for Joint System Design



- Raising number of different assistance systems used in parallel
- Raising complexity of particular assistance systems

Toward Joint Human-Machine Systems Design

Technology centered system design

- Systems Engineering

Human and user centered system design

- Human Factors
- Assistance Systems

Joint System design

- Concepts?

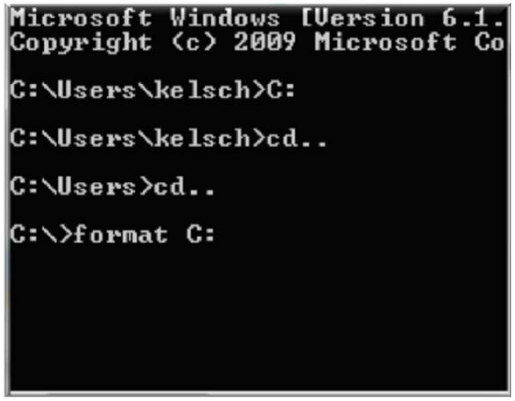


Diagram concept: Denis Javaux

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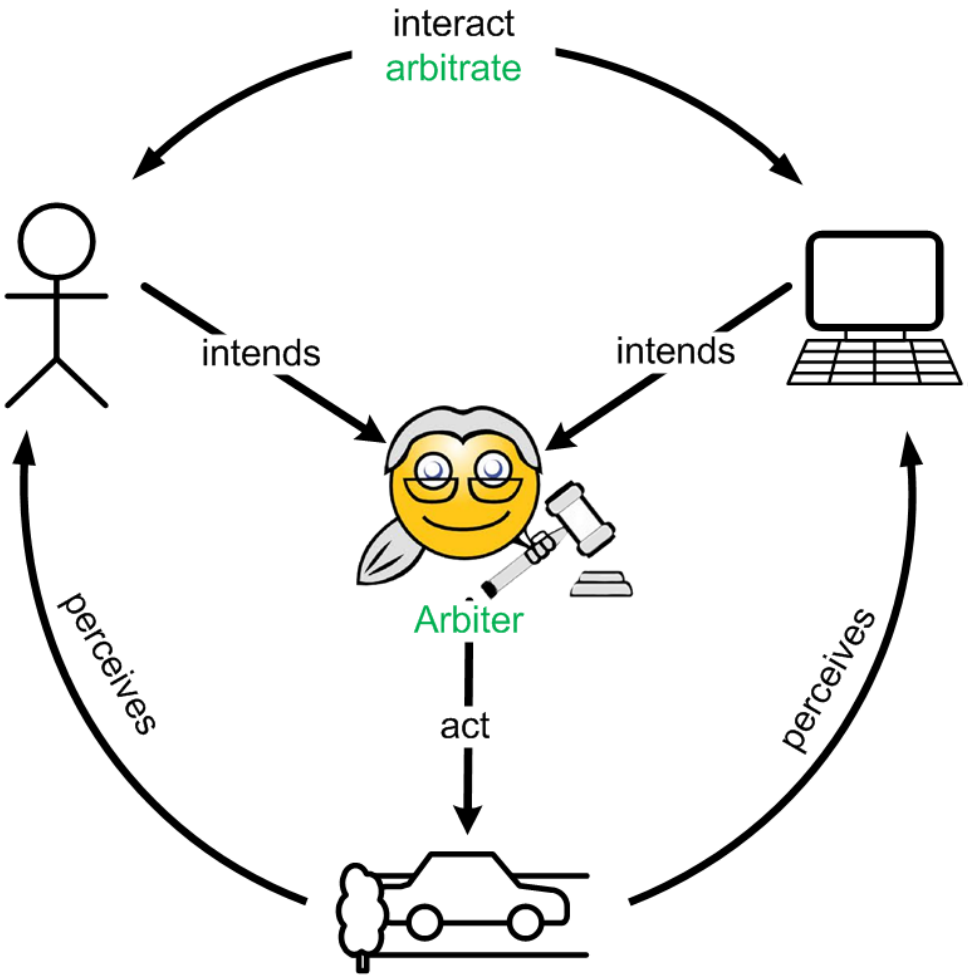
Joint Driver-Automation System: Concepts

- Simplified **human** perception-action model
- **Machine** as a **cognitive agent***
- Human and machine **interacts** with each other

- Human and machine **compete** for vehicle control (shared control)
- **Arbitration** using
  - self-organization
  - role, task, control allocation



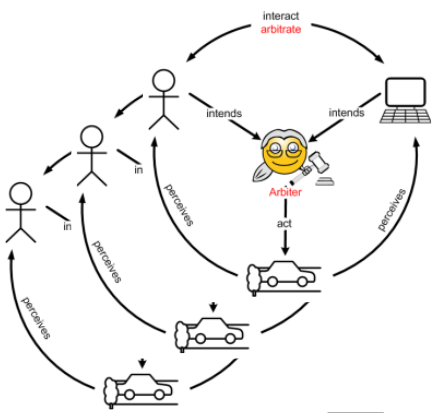
(*) Hollnagel & Woods, 1983

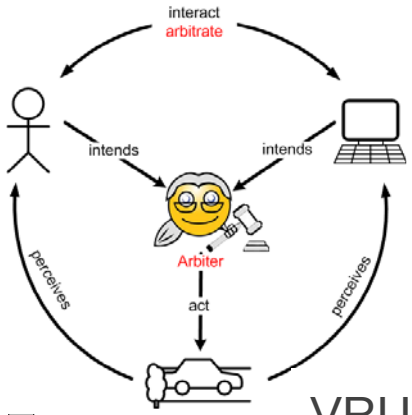
Joint Driver-Automation System: Elements

HMI

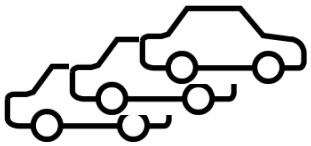
Co-driver

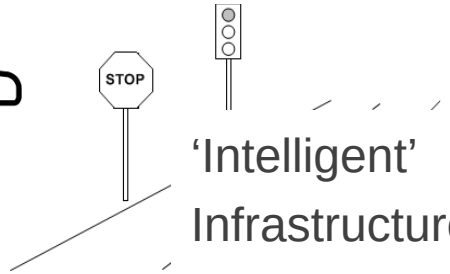
Mobile Devices





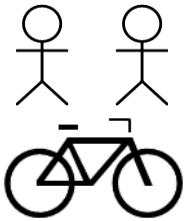
Traffic Management





‘Intelligent’
Infrastructure

VRUs



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Human Factors Subgroup

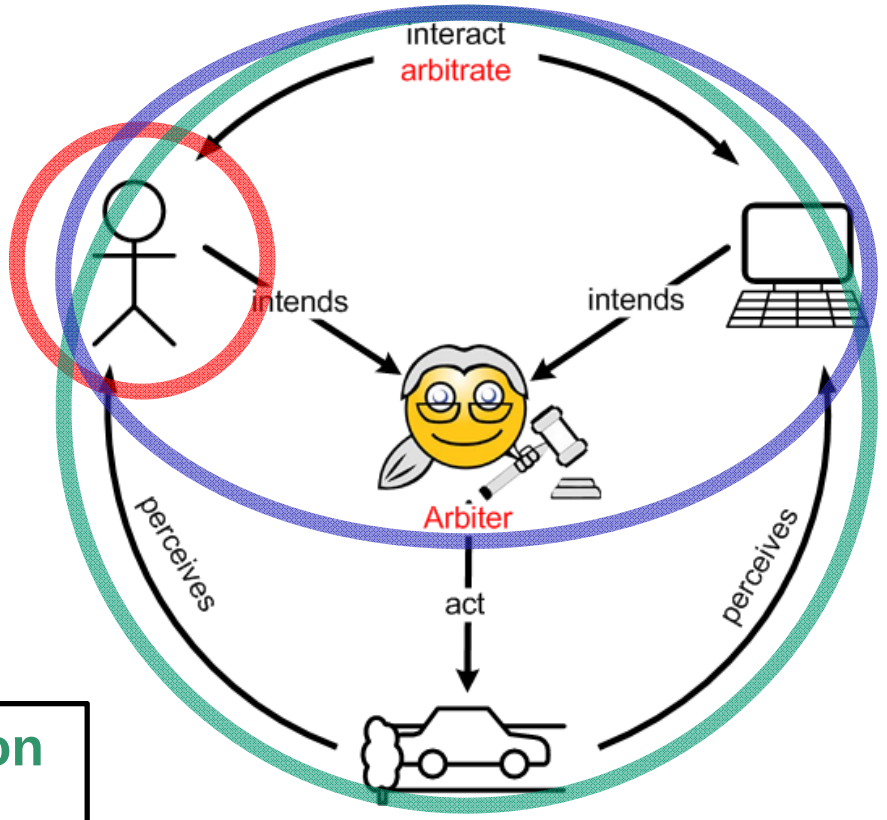
- Supported by European Commission & ERTICO (Brussels)

- DLR, TRL, ITS LEEDS, ICCS, IFSTTAR, UNIROMA, VEDECOM, TU EINDHOVEN, UNI CHALMERS, TU DELFT, EUCAR, VALEO, HIT

- **Human Factors in Highly Automated Road Transport**
- Automation effects on driver & other traffic participants (e.g. pedestrians)
- HF related Joint System design issues (e.g. usability)
- HF related **roadmaps & recommendations** for the European Commission

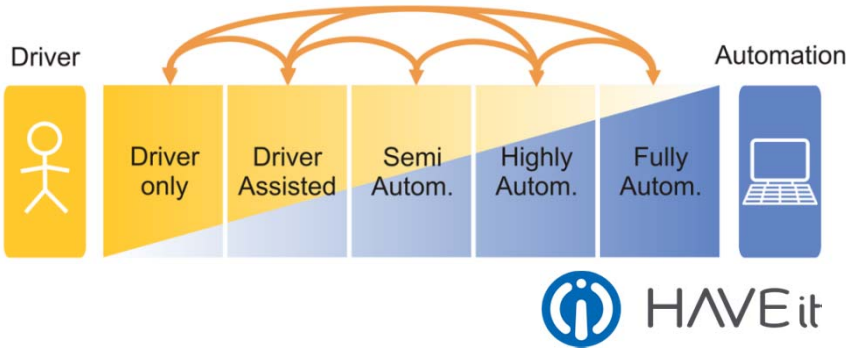
Joint Driver-Automation System: Taxonomy

- **Human Factors** is about human related system **problems**
- **Human Factors** is about human related system **solutions** as well
- **Interaction Design**
  - technical requirements meet Human Factors

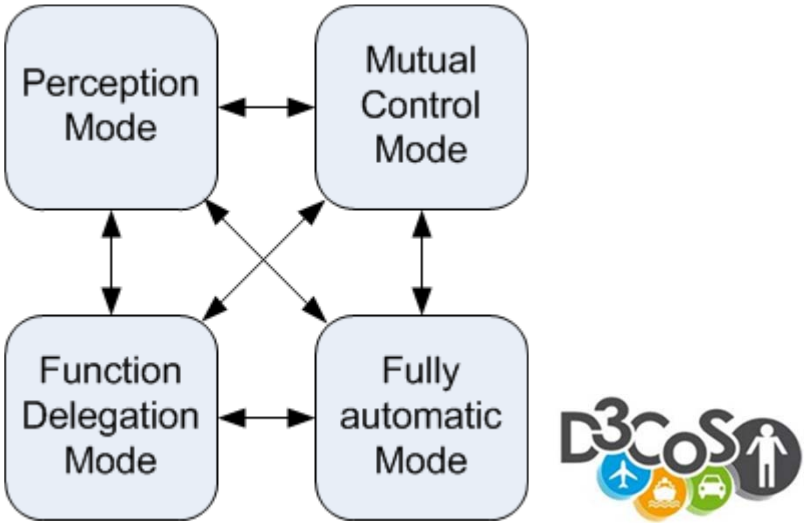


Generic **problem** + generic **solution**
= **Design Pattern**

Joint Driver-Automation System: Design Patterns



- **Automation Levels*** and transitions
  - Problem of correct human-machine **control distribution**
  - **Quantitative** solution
  - How much automation is there?



- **Cooperation Modes****
  - Problem of correct human-machine **task allocation**
  - **Qualitative** solution
  - Who does what and how?

- Both perspectives are **compatible** to each other***

(*) Parasuraman et al. 2000, (**) Hoc 2001, (***) EU-Project D3CoS D3-03

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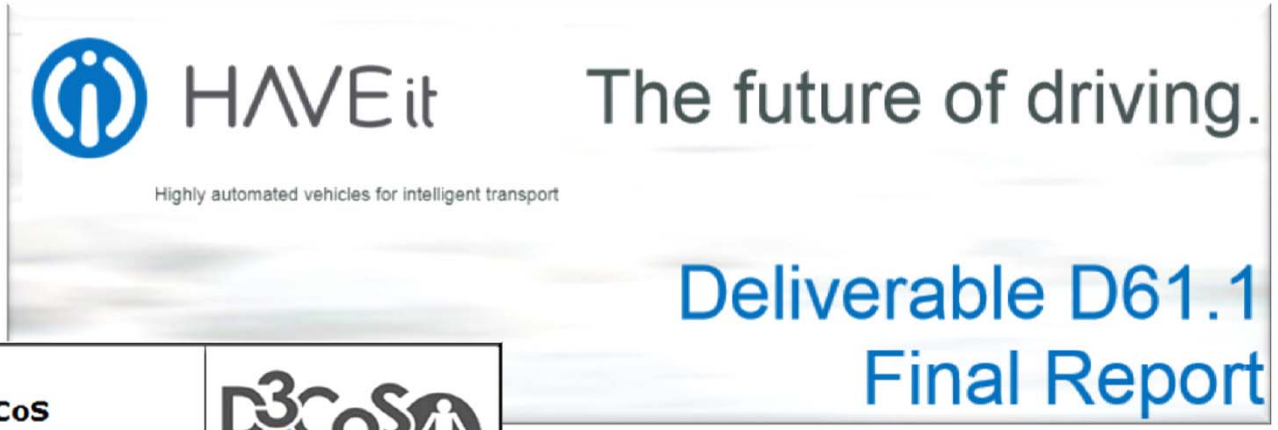
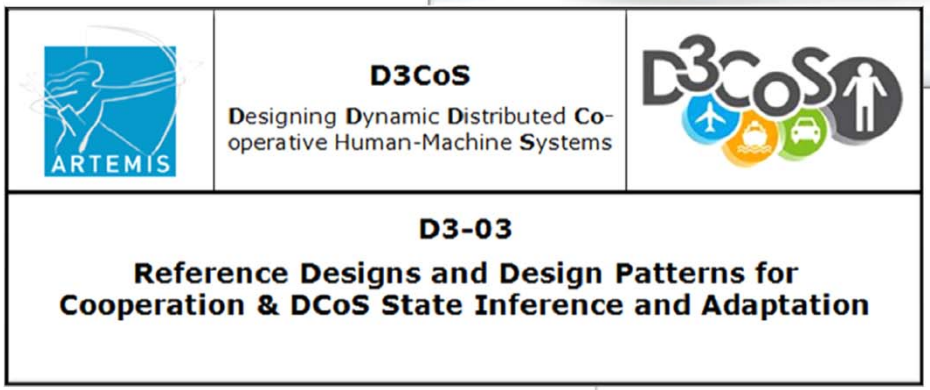
Joint Driver-Automation System in EU-Projects

- Joint System
- Automation Levels
- Transitions…





- Design patterns for cooperation
- Cooperation modes
- Methods & Tools…

- Inform/Warn/Intervene strategies
- Joint HMI Concepts
- Arbitration…

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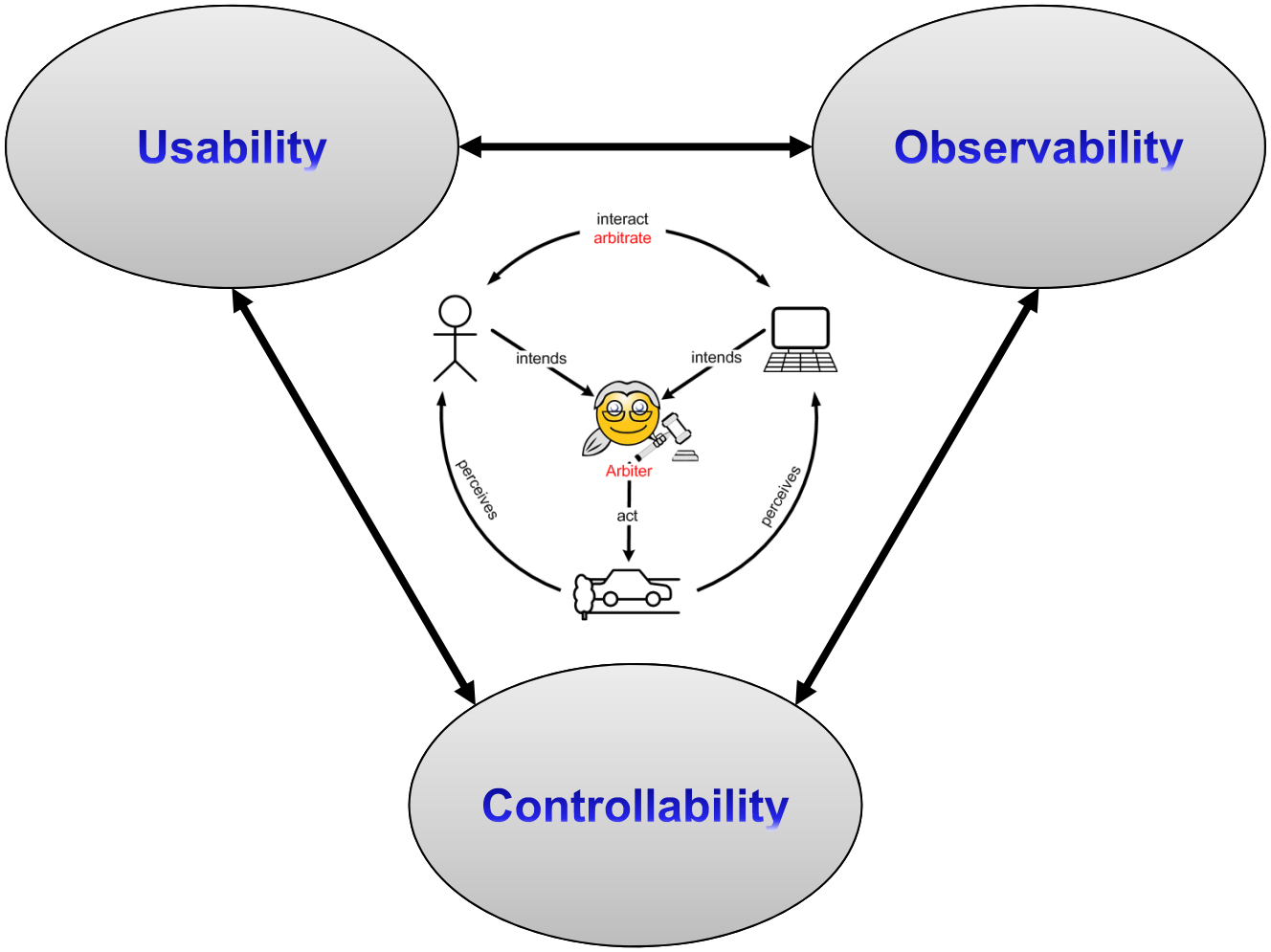
Joint Driver-Automation System Design Aspects

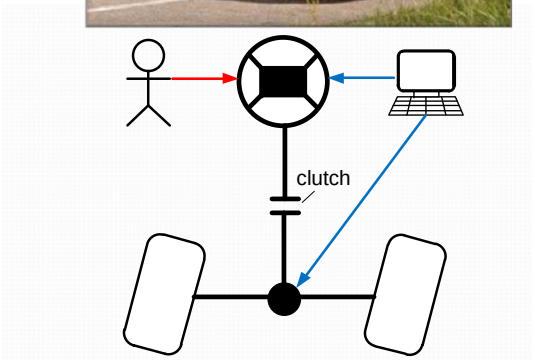


Join D-A System Controllability: Decoupling Concept

- Joint D-A System performance in conditions
  - no automation
  - steering intervention (coupled)
  - steering intervention (decoupled)
  - **true vs. false** decoupling

- **FASCar II** from the German Aerospace center (DLR)
- equipped with **steer-by-wire** system
- Possibility to **decouple** the driver from vehicle control

- Obstacle covering half the lane
- Unfolds in 0.8 sec.



interactive

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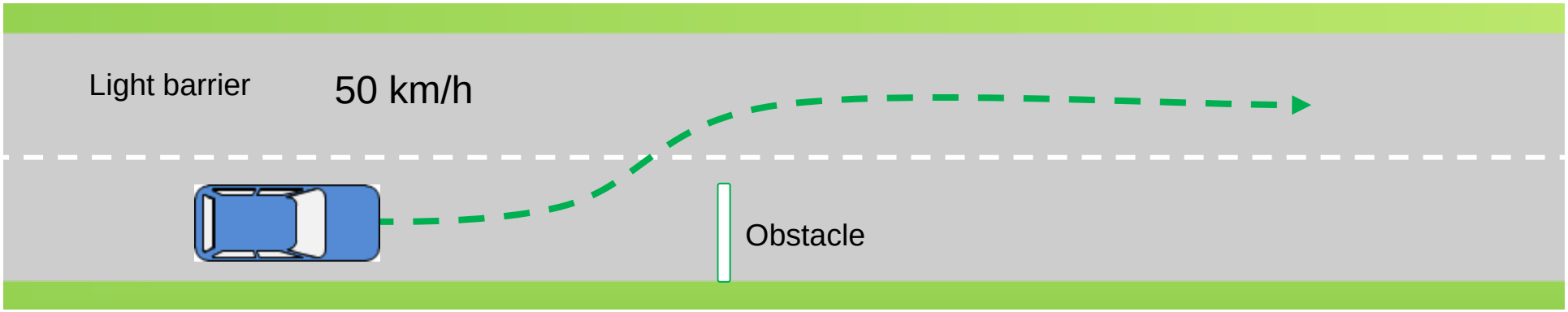
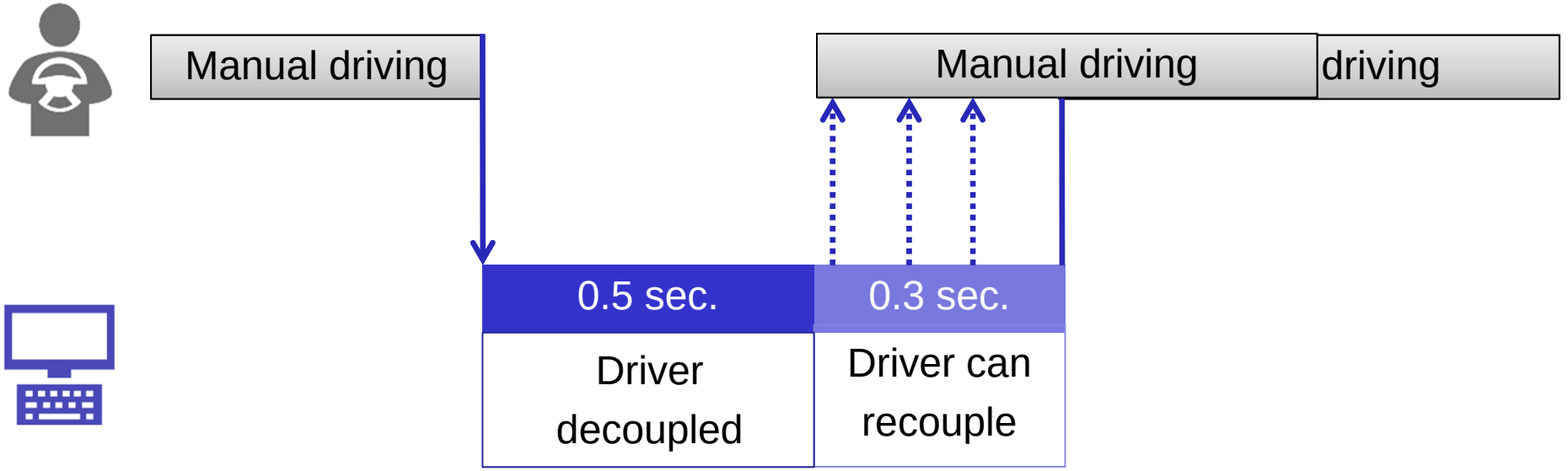
Controllability: Steering intervention (decoupled condition)





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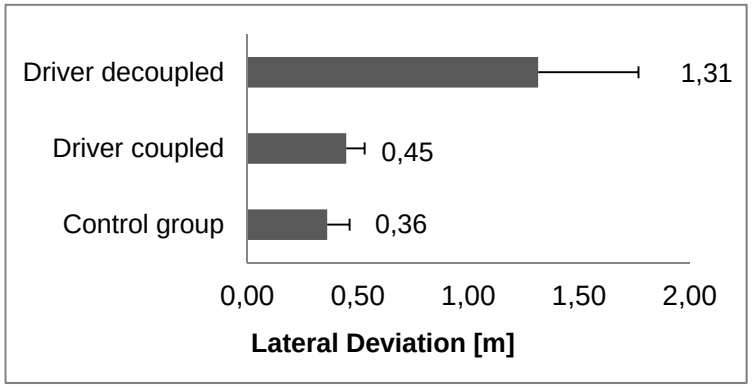
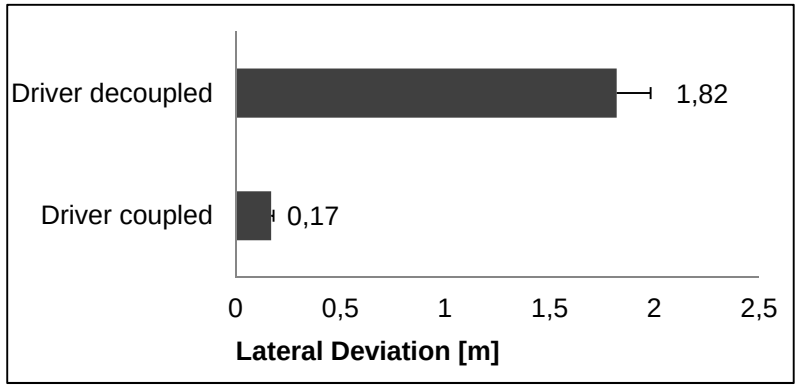
Controllability: Driver Decoupling Concept

‘true’ decoupling



- Lateral deviation (50 km/h) in ‘true’ decoupling was significantly higher than in other conditions → GOOD
- ‘True’ decoupling seemed to be well controllable for the driver

‘false’ decoupling



- Lateral deviation (30 km/h) in ‘false’ decoupling was significantly higher than in other conditions → BAD
- ‘False’ decoupling seemed to be badly controllable for the driver

interactive

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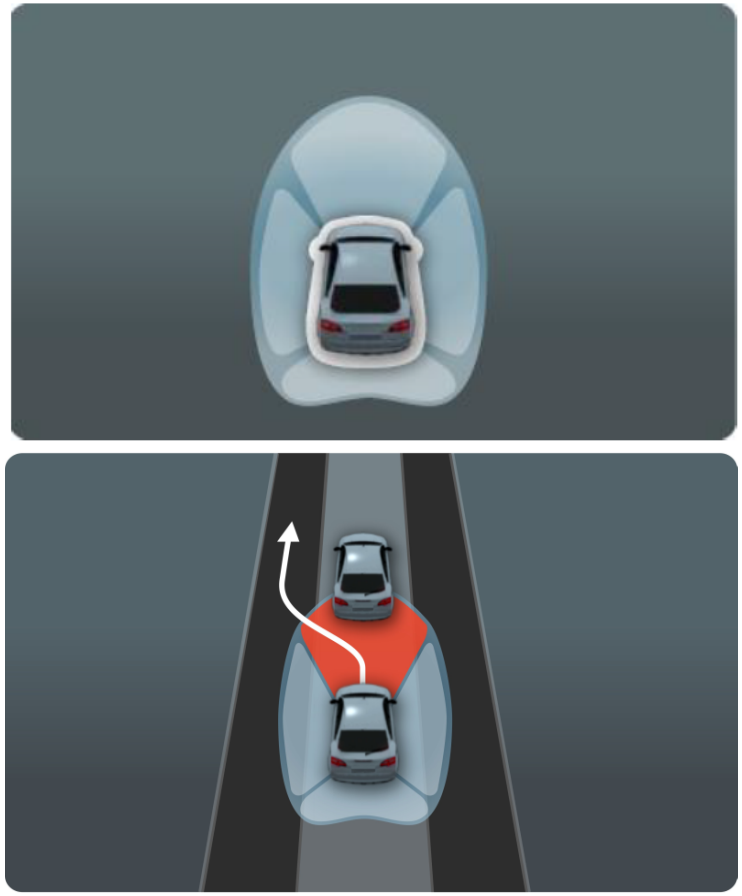
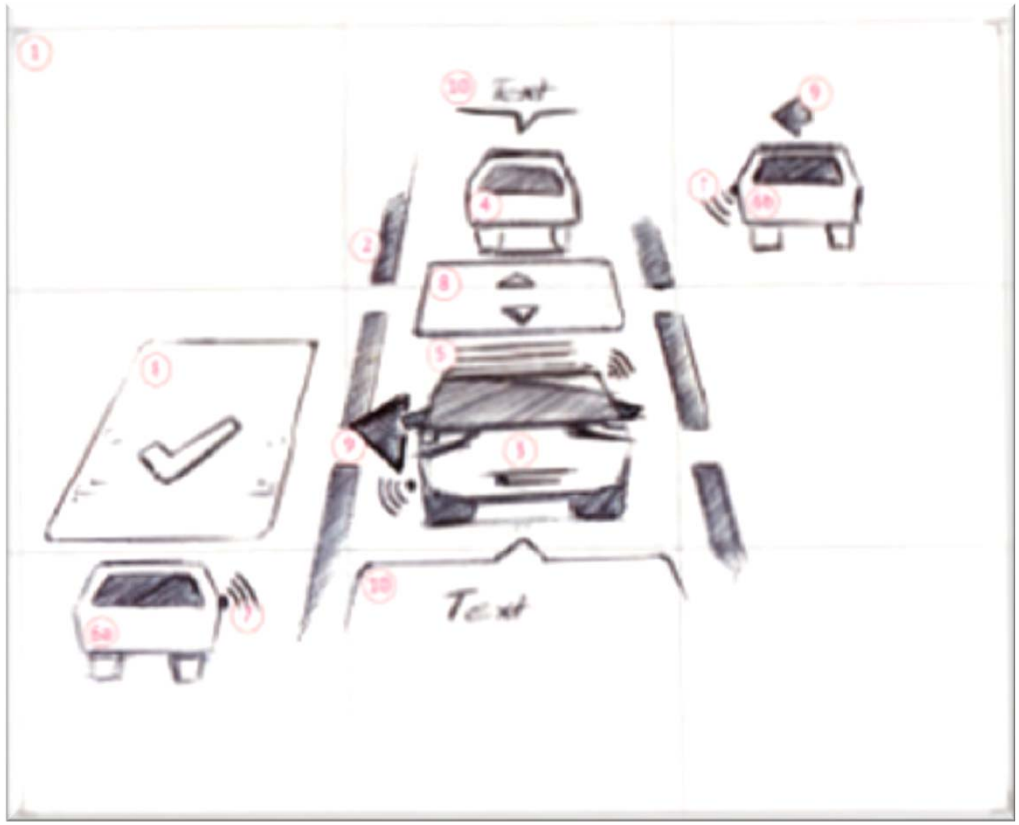
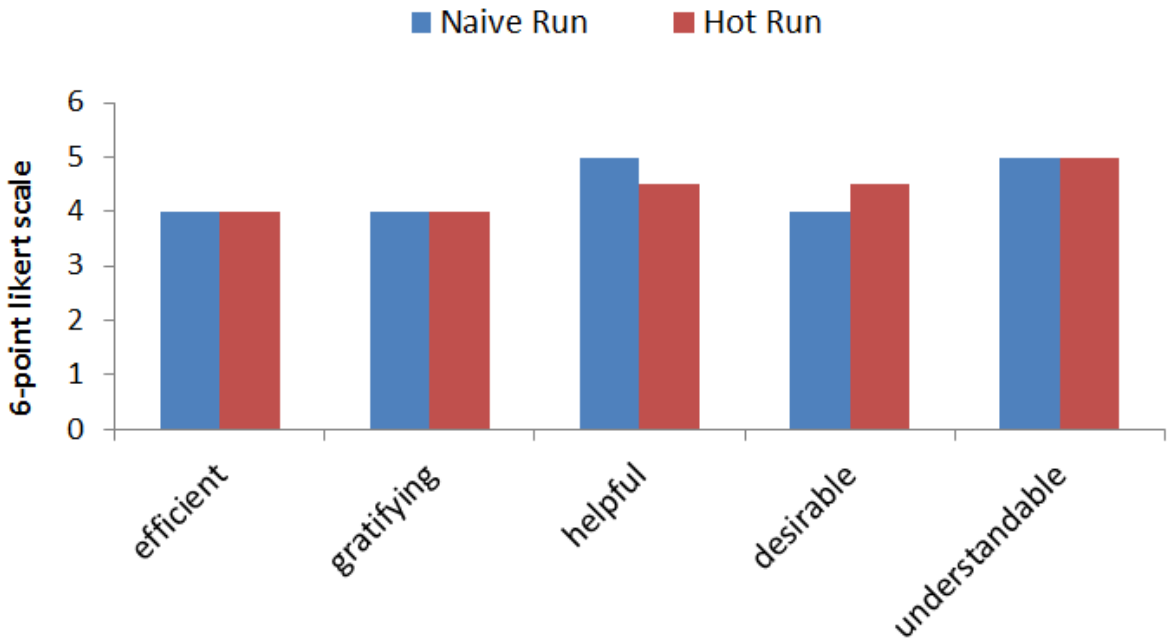
Joint System Observability: HMI Concepts



Joint System Observability: HMI Display Concept for Cooperative Lane Change Assist



Joint System Usability: Cooperative Lane Change Assist



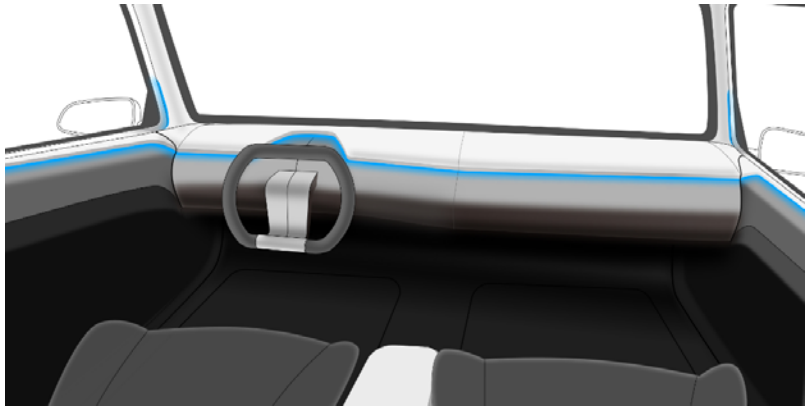
- Well accepted system design
- Easy to understand

Our research focus in…

Adapt:/Ve

Automated Driving Applications and Technologies for Intelligent Vehicles

- Designing a Joint System
- Ambient display
  - visual, haptic & acoustic stimuli
- **Idea:**
  - Transporting information by using peripheral signals
  - Supporting / inhibiting drivers' actions by using affective design
- **Aim:** Improving performance in:
  - primary driving tasks
  - automation mode transitions
  - in normal & emergency situations



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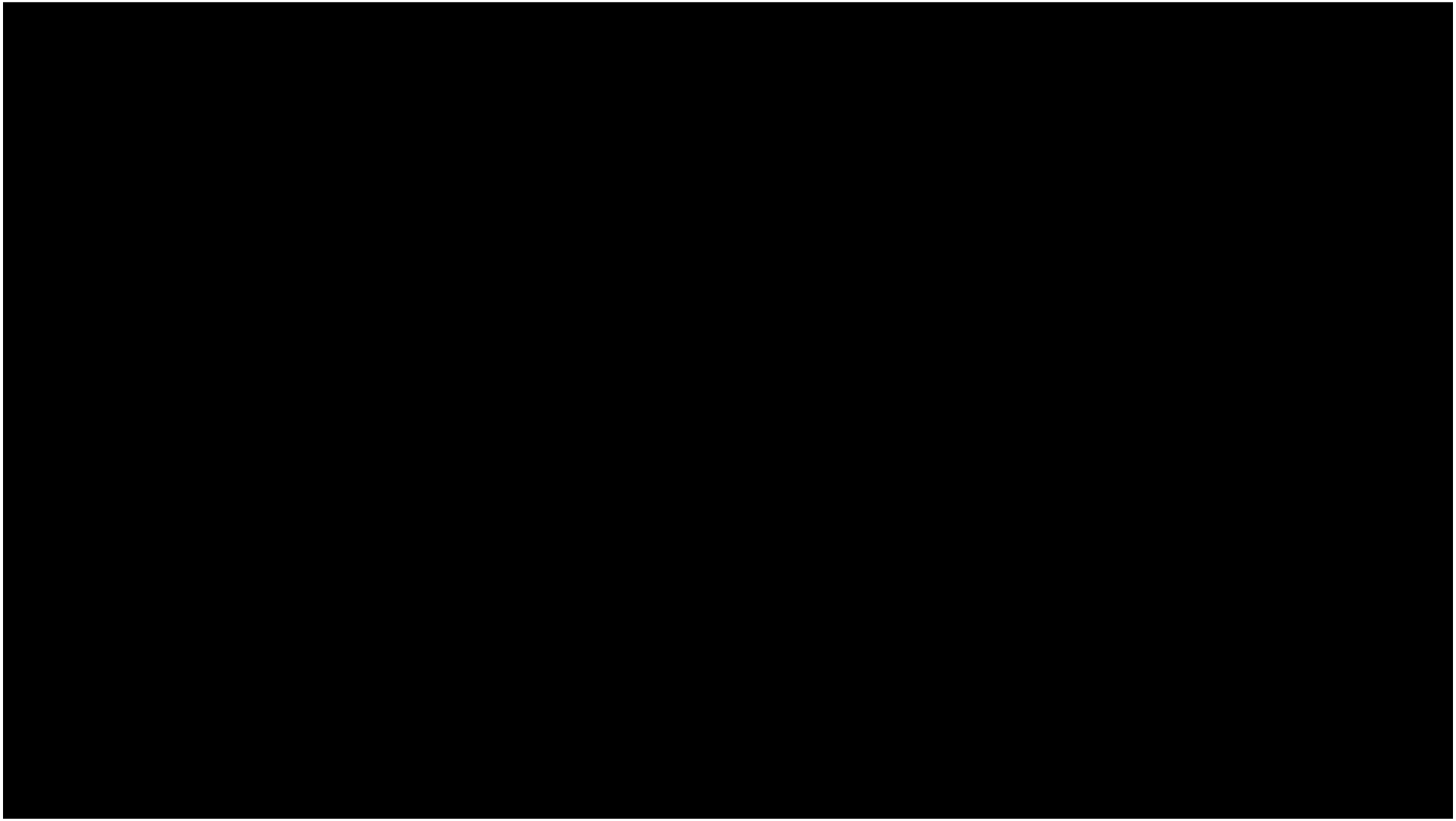

Conclusion

- Developing ADAS and vehicle automation, systems become complex

- Closely integrated Joint System Design is needed

- EU-Projects are addressing Joint System components, methods & tools

- Exemplary solutions show the possible developments in the future

- DLR develops Joint Systems enriched with affective HMI

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Thank You

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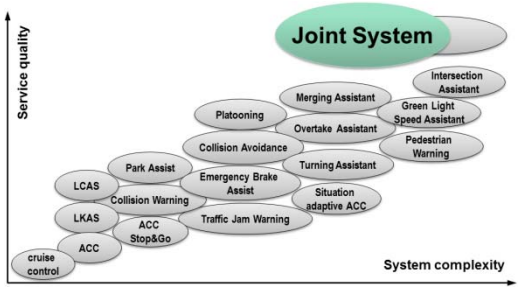

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iMobility Forum

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