Katharina Nagel, Autobahn GmbH des Bundes

12 MAY 22

FINAL EVENT

Results and Core Statements

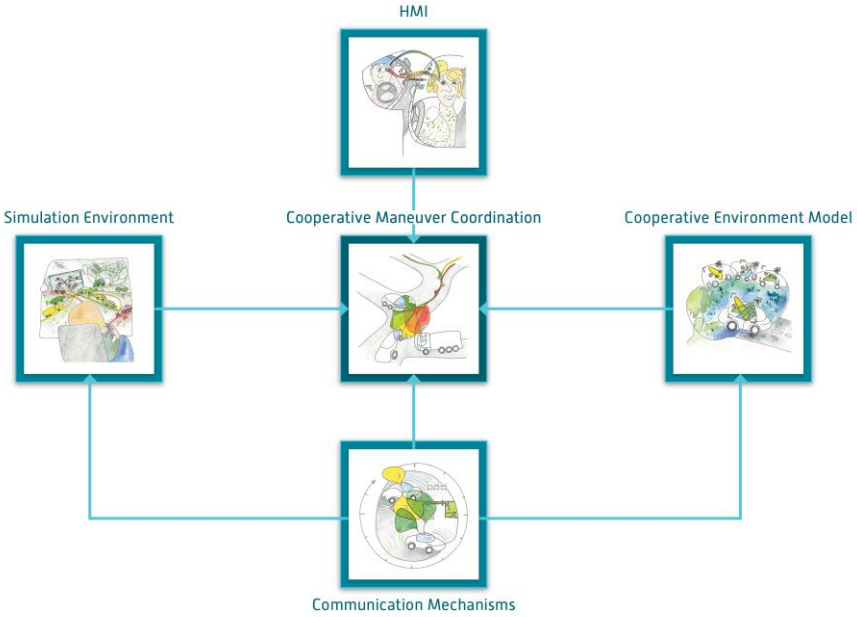
IMAGinE

AGENDA

Cooperative Maneuver Coordination
Communication
Cooperative Environment Model
Cooperative HMI
Simulation Environment
Overall System

Cooperative Maneuver Coordination

- Coordinated decision-making
- Various concepts for cooperative maneuver coordination were realized, both in simulations and in real vehicles on rural roads and highways

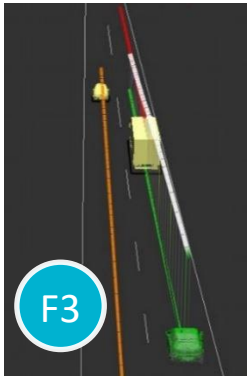


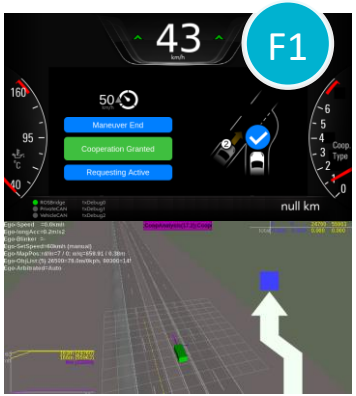
Cooperative Maneuver Coordination

Core Statement

The various aspects of cooperative maneuver coordination were examined in several, more specific implementations of the basic concepts, and potentials were demonstrated.

Maneuver coordination is dependent on levels of cooperation, relative distances, and means of communication, among other factors.

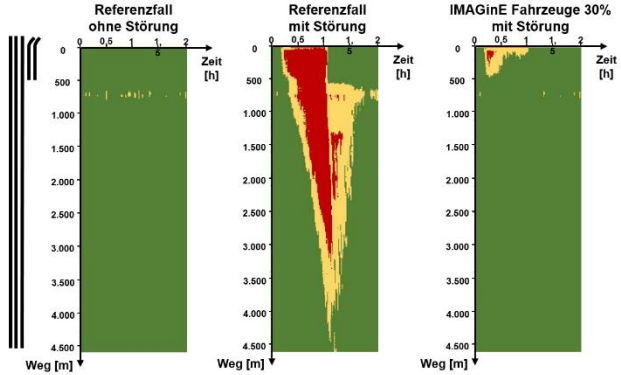


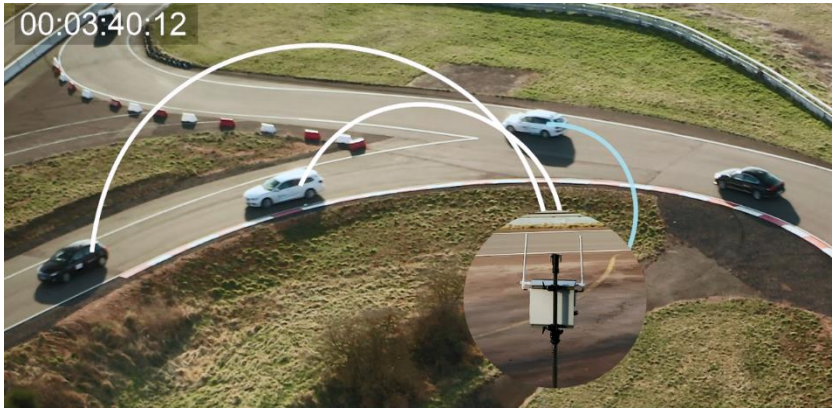


Cooperative Maneuver Coordination

Core Statement

Cooperative maneuver coordination between vehicles can be supported by strategic traffic information from a central traffic management system.

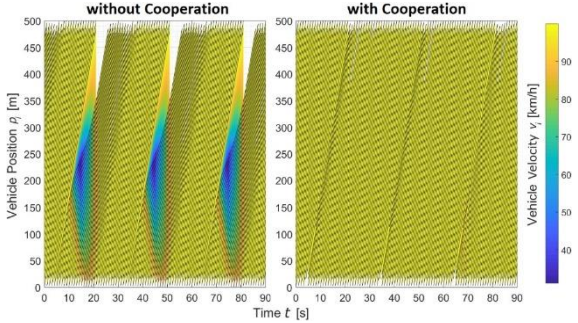


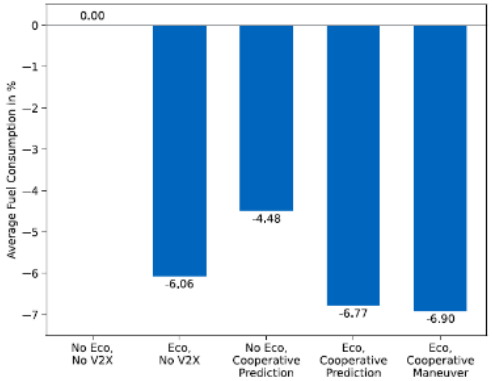


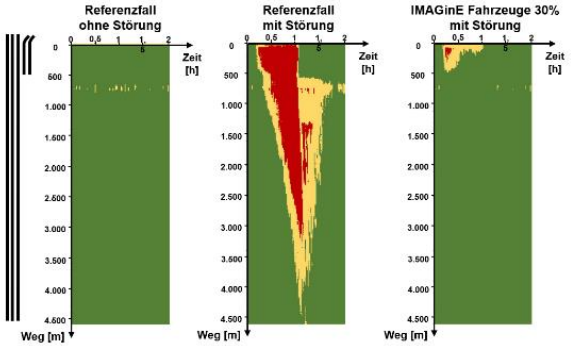
Cooperative Maneuver Coordination

Results

- With the realized cooperative maneuver approaches:
  - Improvement of traffic efficiency and safety
  - Average vehicle speed increased
  - Fuel consumption reduced

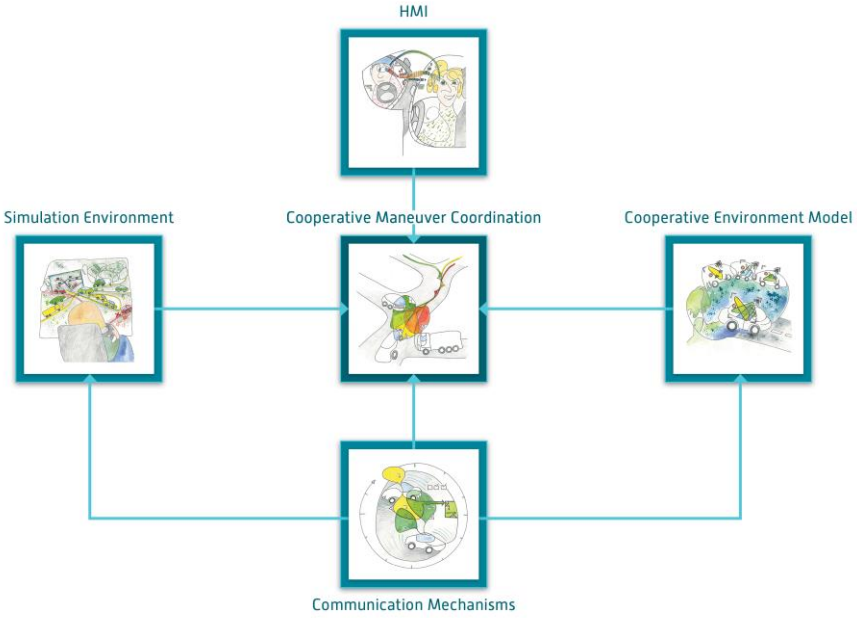






Communication

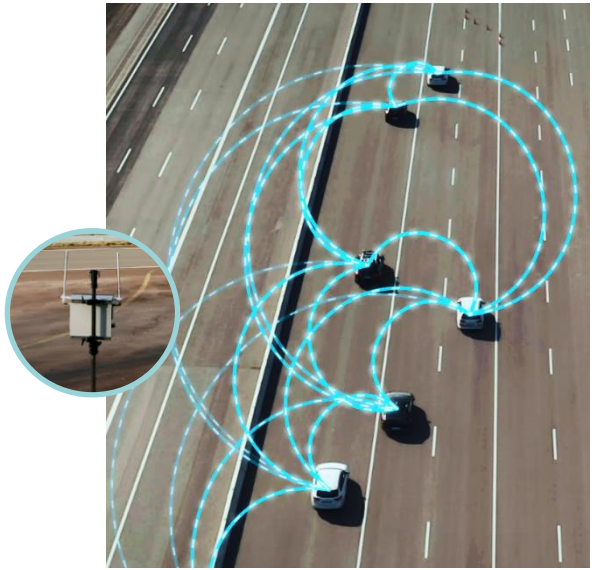
- Exchange of V2X Messages
- Communication mechanisms have been set in place and message types have been defined for cooperation between vehicles and infrastructure

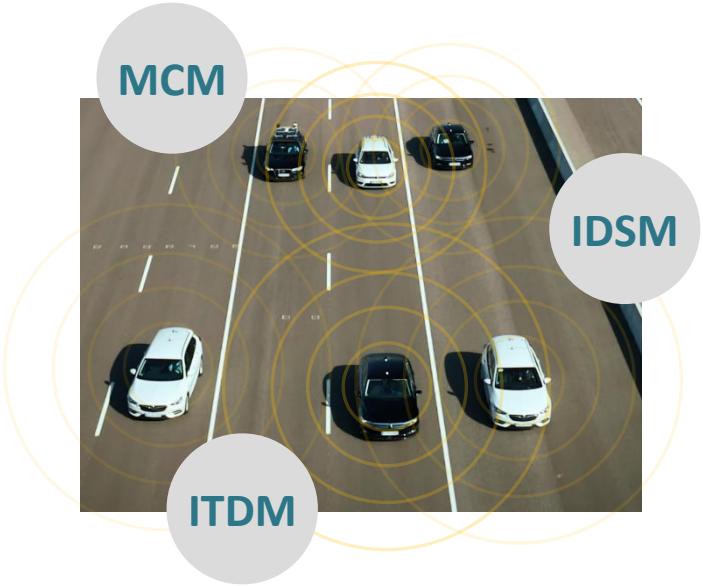


Communication

Core Statement

In IMAGinE, new message formats were defined and examined with regard to standardizability.



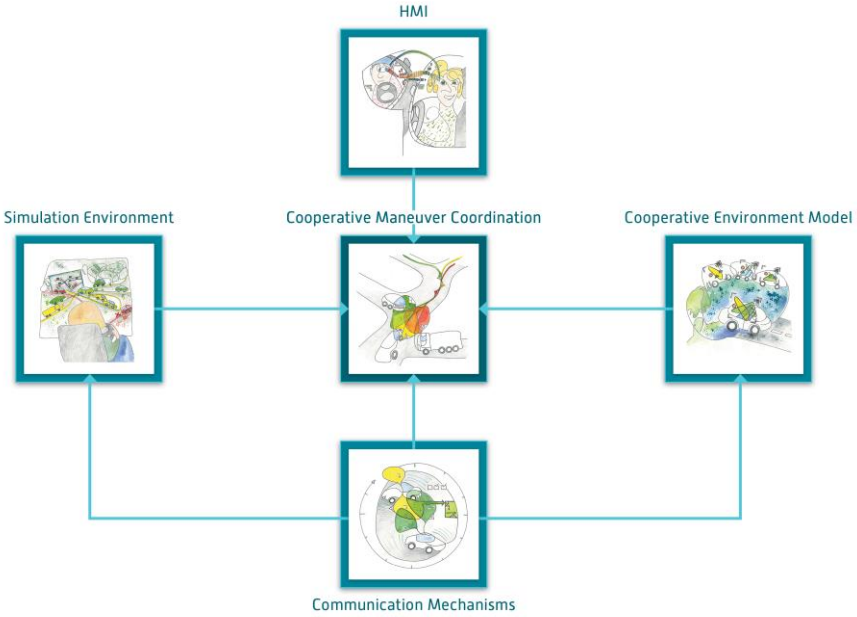


Communication
Results

- In IMAGinE
  - Message formats have been defined for cooperation between vehicles and infrastructure
    - MCM – Maneuver Coordination Message
    - IDSM – IMAGinE Driving State Message
      - Used by MAN for state machines
    - ITDM – IMAGinE Traffic Distribution Message
      - Used by Autobahn GmbH for strategic traffic distribution
  - Maneuver coordination messages can operate together with V2X standard messages in one channel
  - Sending and receiving messages with CAM, CPM, MCM and IDSM is feasible up to an equipment rate of 20% without having to regulate the channel load.

Cooperative Environment Model

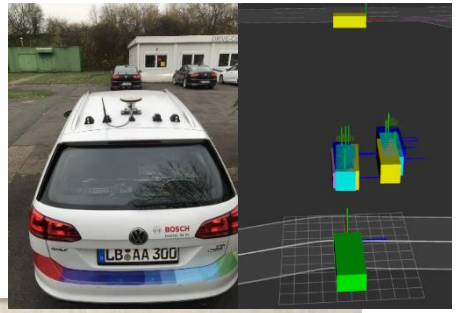
- Fusion of sensed and received objects
- Cooperative environment models have been implemented for the realization of driving functions

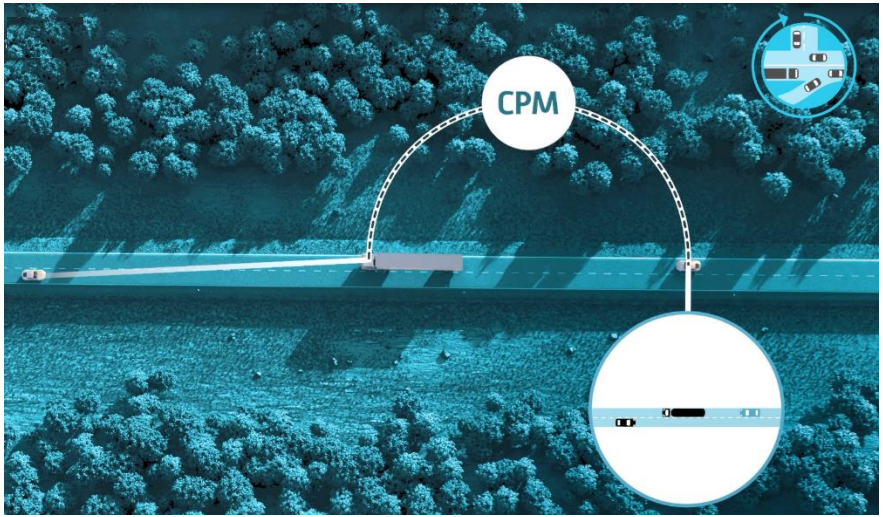


Cooperative Environment Model

Core Statement

With collective perception, the individual's perception is enhanced by the knowledge of others, thereby improving the individual's own model of the vehicle environment.





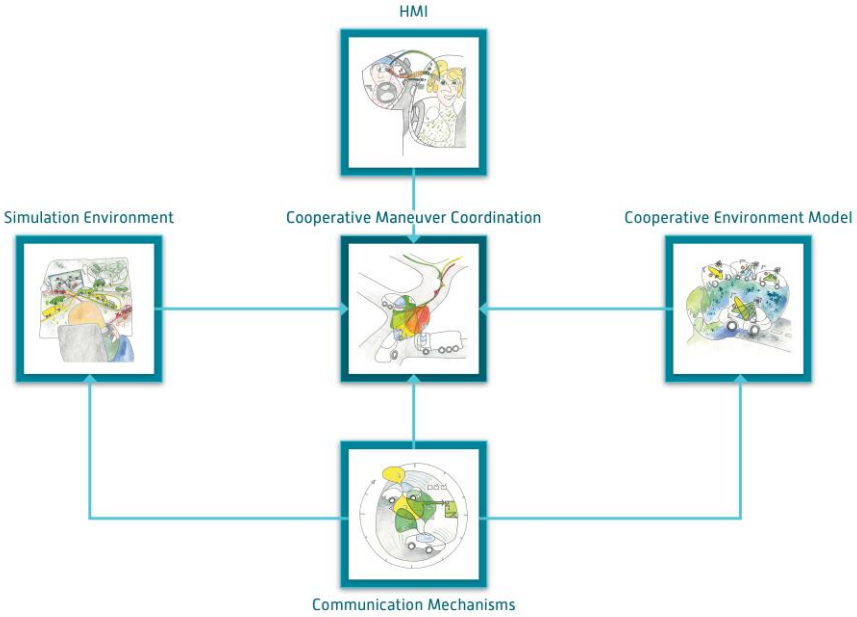
Cooperative Environment Model

Results

- With the implemented cooperative environment model, perception was enhanced
  - “See/Detect” objects beyond the own sensing capabilities
  - View on larger environment
  - Share the environment with others achieving common view on a (traffic) situation

Cooperative HMI

- Interact with and motivate drivers to cooperate



Cooperative HMI

Core Statement

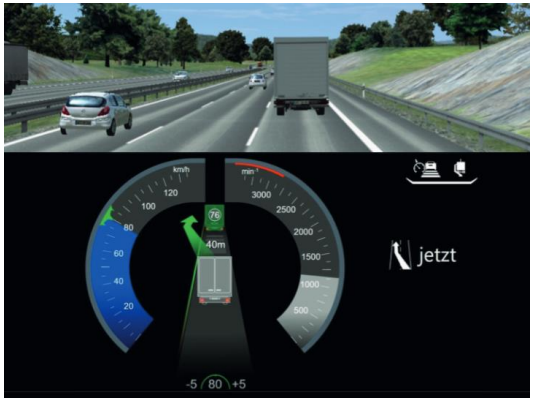
IMAGinE has investigated cooperative driving based on subject studies in a driving simulator and proposes solutions for intuitive HMI concepts.

System Usability Scale – Acceptability Ranges

Cooperative HMI

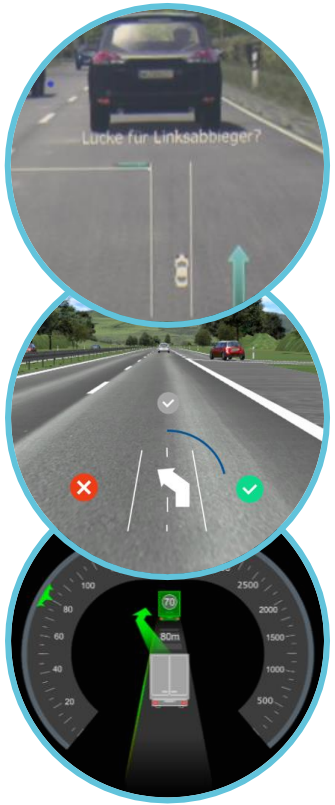
Core Statement

The cooperative HMI integrates humans into the cooperative maneuver coordination and is thus a prerequisite for driver understanding, acceptance, and trust.



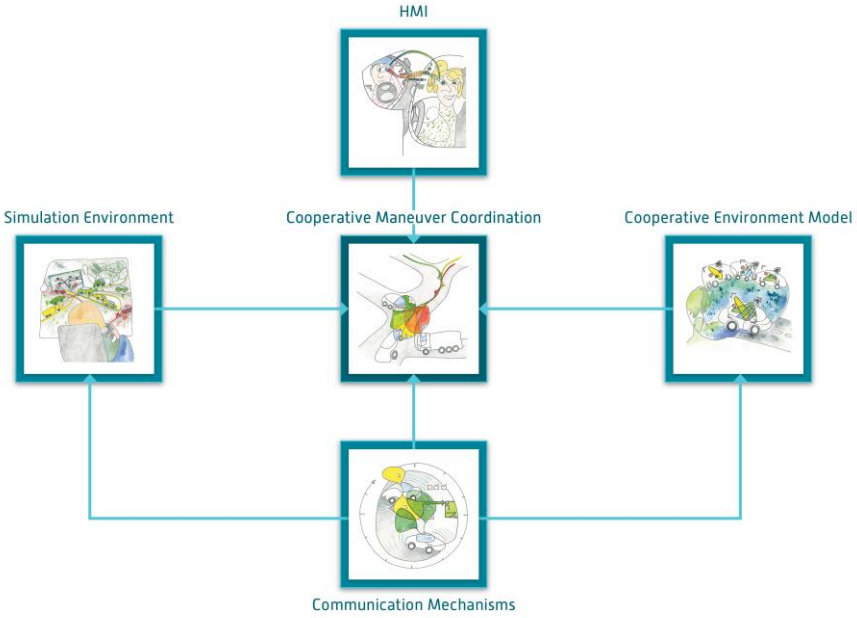
Cooperative HMI
Results

- The realized HMI approach in IMAGinE enhances:
  - Willingness and motivation to cooperate
  - The acceptance for cooperative driving by the drivers
  - Traffic safety



Simulation Environment

- Development and test of basic components up to the cooperative overall system
- Evaluation of technical components and traffic impact
- Supporting the system integration into the real vehicles

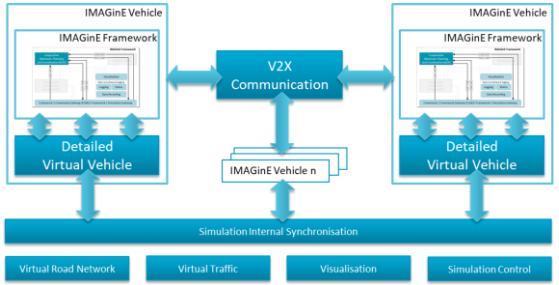


Simulation Environment

Core Statements

The complexity of cooperative systems increases with the number of participating vehicles and can therefore only be tested systematically and reproducibly with simulation.

For a safe and efficient development of cooperative systems, a flexible, modular simulation architecture is necessary.



Simulation Environment
Results

- In particular, the simulation environment enabled
  - Considerably fewer kilometers must be driven in order to realize cooperative maneuver coordination
  - Significantly reduce the time required to develop and implement the chosen cooperative maneuver coordination approach
  - Reproducible and safe testing even in critical situations.
  - Cross-functional, cross-system and cross-vehicle testing possible
  - Application: early concept and development phase up to integration into real vehicles

Overall System

The functionality of the IMAGinE concepts has been successfully demonstrated in simulations and vehicles.

➔

*It is possible for the vehicles of **all partners** to cooperate with each other in **any interchangeable way***

➔

*A **single software** for **all functions** and **roles** integrated in the vehicles*

IMAGinE

THANK YOU

Katharina Nagel

Die Autobahn GmbH des Bundes

www.imagine-online.de

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on the basis of a decision
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Images: IMAGinE, Unsplash