"Von der Mensch-Maschine-Interaktion zur Mensch-Maschine-Kooperation: Neue Herausforderungen für Automobile Intelligente Benutzerschnittstellen"

Antrittsvortrag im Rahmen der Ernennungsfeier des Vortragenden,
Dr.-Ing. Christian Müller, zum DFKI Research Fellow

Gliederung des Vortrags

Kapitel 1:

wesentliche Ergebnisse
unserer Arbeit in der
Automotive-Gruppe

Kapitel 2:

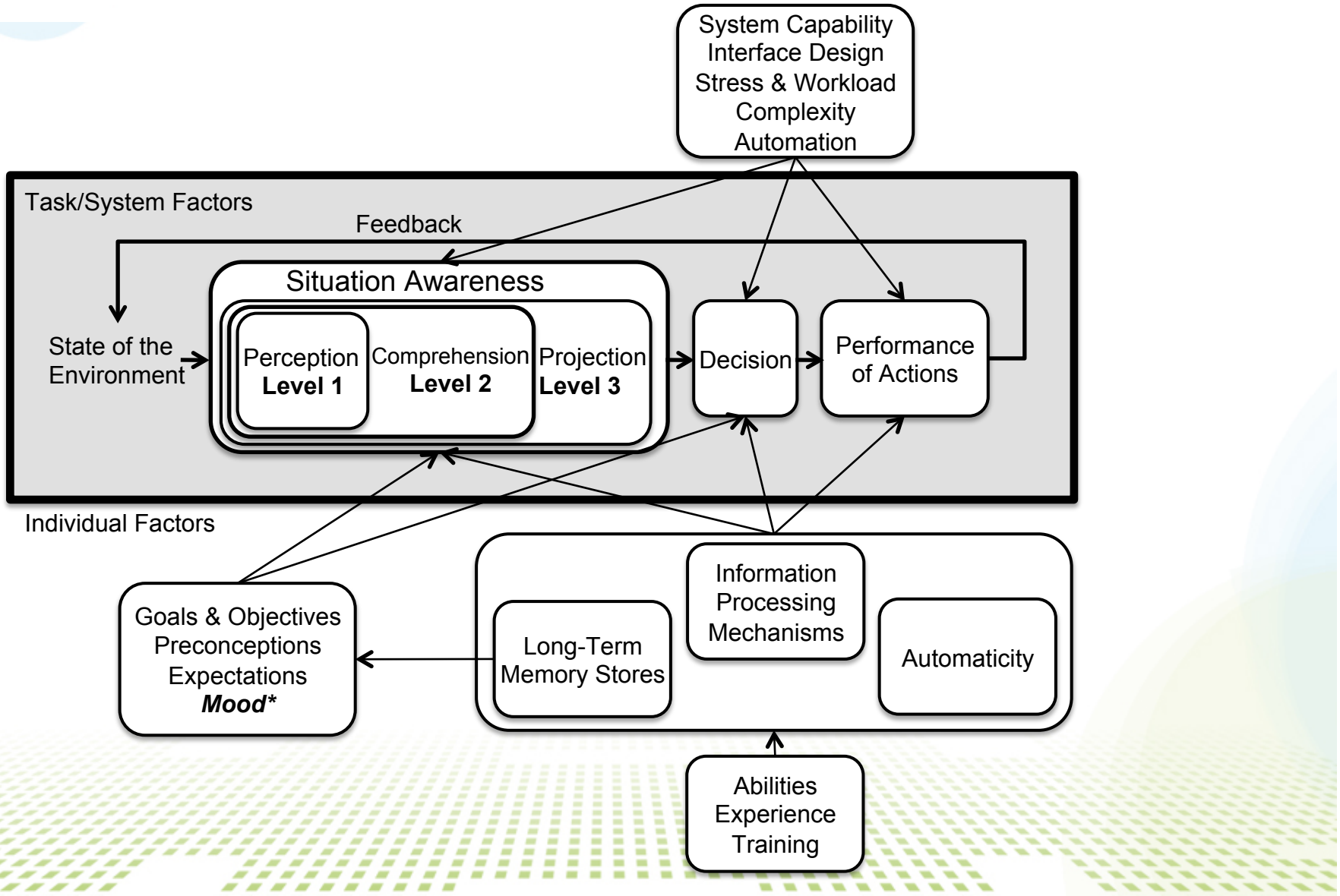
methodische und inhaltliche
Weiterentwicklung

Vorwort

Situation Awareness

„The perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future”
M.R. Endsley

Endsleys Model der Situation Awareness



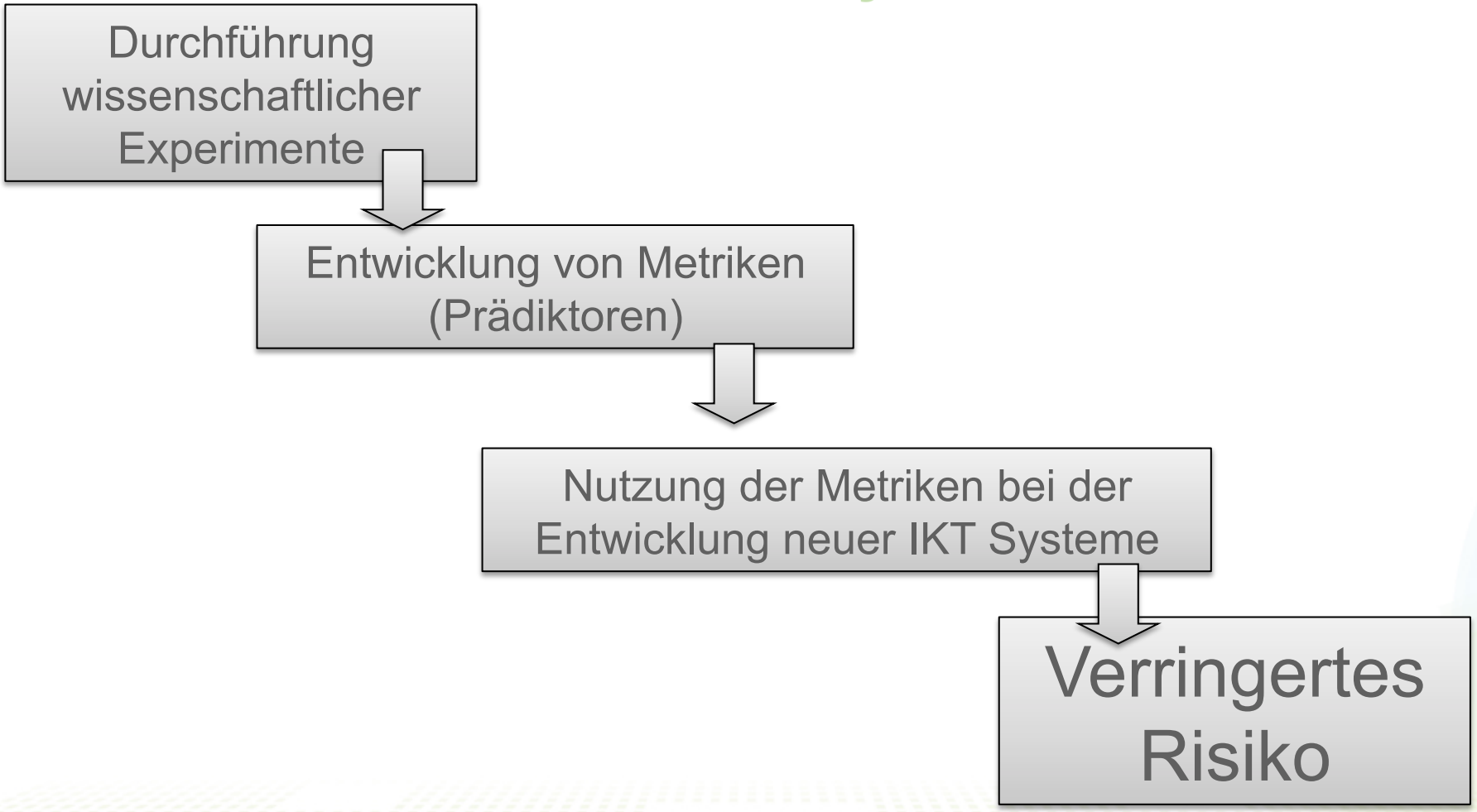
Hierarchisches Model der Fahraufgabe

Primäre Aufgabe: Steuern der Fahrzeuges

Sekundäraufgabe: Aufrechterhaltung der Sicherheit

Tertiäraufgabe: Infotainment, Navigation und Kommunikation

Metriken zur Ermittlung von Kognitiver Belastung des Fahrers durch IKT Systeme




A
B
PULL
driver:
"When does the construction zone end?"
DFKI CARMINA
Car2X "Pull" Applikationen
Carmina Antrag 2008

Mensch-Maschine Schnittstelle (HMI) für Car2X Applikationen

The sim[TD] HMI for weather hazard warning.

Cross Traffic Assistant.

Location dependent services.

- We are a leading research group in the area of design, development, and test of HMI solutions for cooperative vehicles.
- For example, we developed the HMI solution for the large-scale field test sim^{TD} (www.simtd.de) and will continue this development in the project Converge.
- The HMI visually and acoustically indicates information and warnings to the driver. It also receives input from the driver to trigger functions. The HMI is a central sim^{TD} system component, whose functionality has been tested and verified extensively prior to of the field test during multi-stage tests in the laboratory.
- The HMI was designed to incorporate non-technical user-friendliness criteria. These criteria were tested during an iterative process.

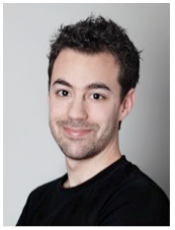
HMI Design, Entwicklung und Test

PhD topic: *Beyond the „Push“-Paradigm: Enhanced forms of Information Access and Novel Application Areas for Vehicle-2X Communication Networks*

dfki iui automotive

2011

software campus

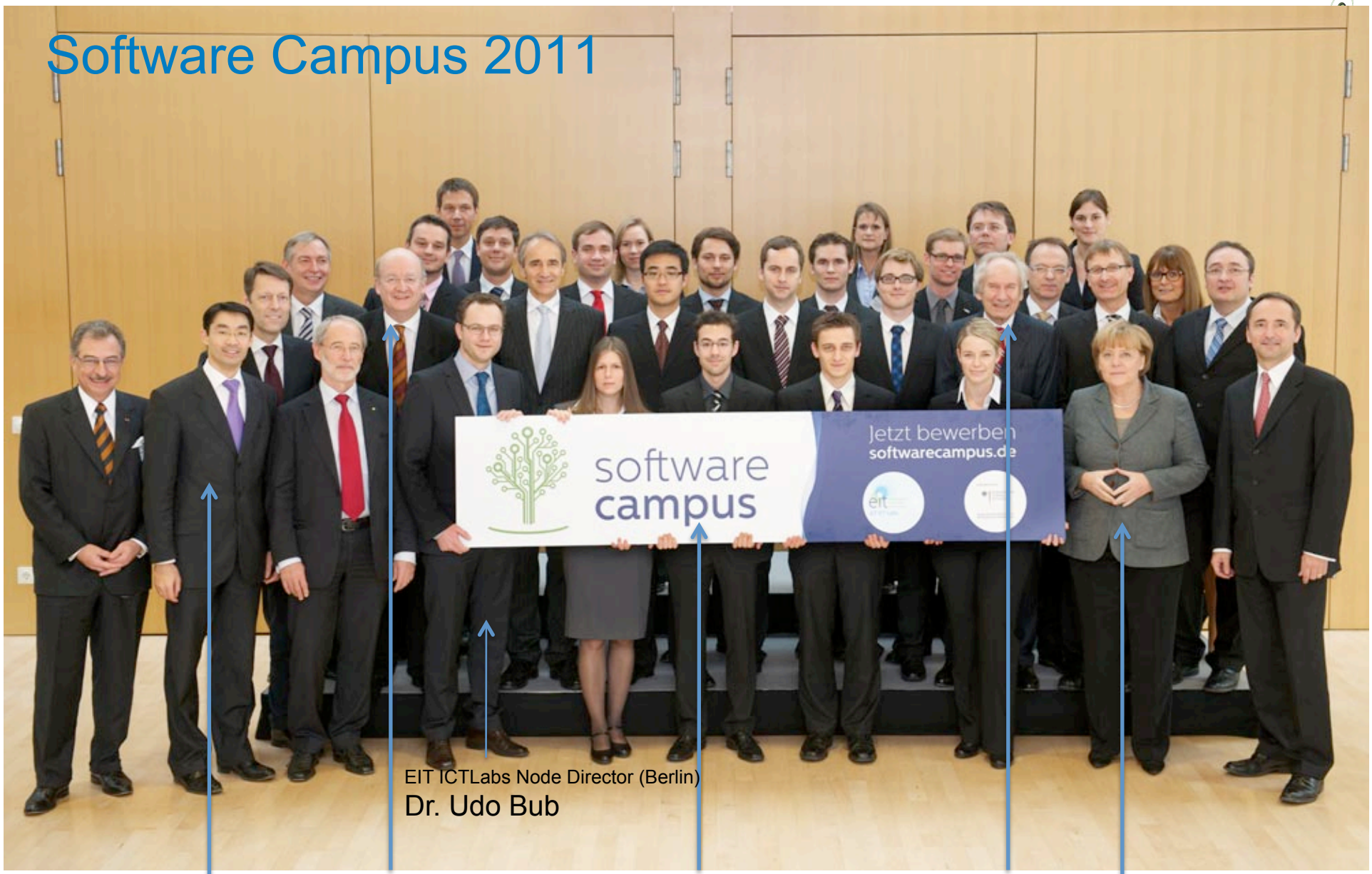


Sandro Castronovo

Driver

Presentation / Interaction	•The usage of which modalities is suitable in a specific driving context? •What is the effect on driver distraction considering the current cognitive load? •How can different modalities be integrated into the framework? •What novel modalities are feasible (eye gaze, gestures, etc.)?
Novel Applications	•What pull applications are possible considering the specific limitations of V2X? •Which of them comprise an additional benefit and are accepted by the driver? •What is the applications‘ effect on safety?
Framework	•How can pull applications and novel modalities be integrated in a well defined framework? •What requirements exist to this framework in the driving context? •How can existent ADAS and IVIS be integrated?
Simulation	•Are existent simulation tools applicable to integrate and evaluate pull applications? •How can they be applied to proposed pull paradigm?
Network	•Are today‘s protocols applicable to proposed pull paradigm? •Where is enhancement of these protocols necessary

Software Campus 2011



EIT ICTLabs Node Director (Berlin)
Dr. Udo Bub

Prof. Wahlster

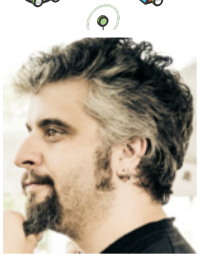
Sandro Castronovo

Prof. Scheer

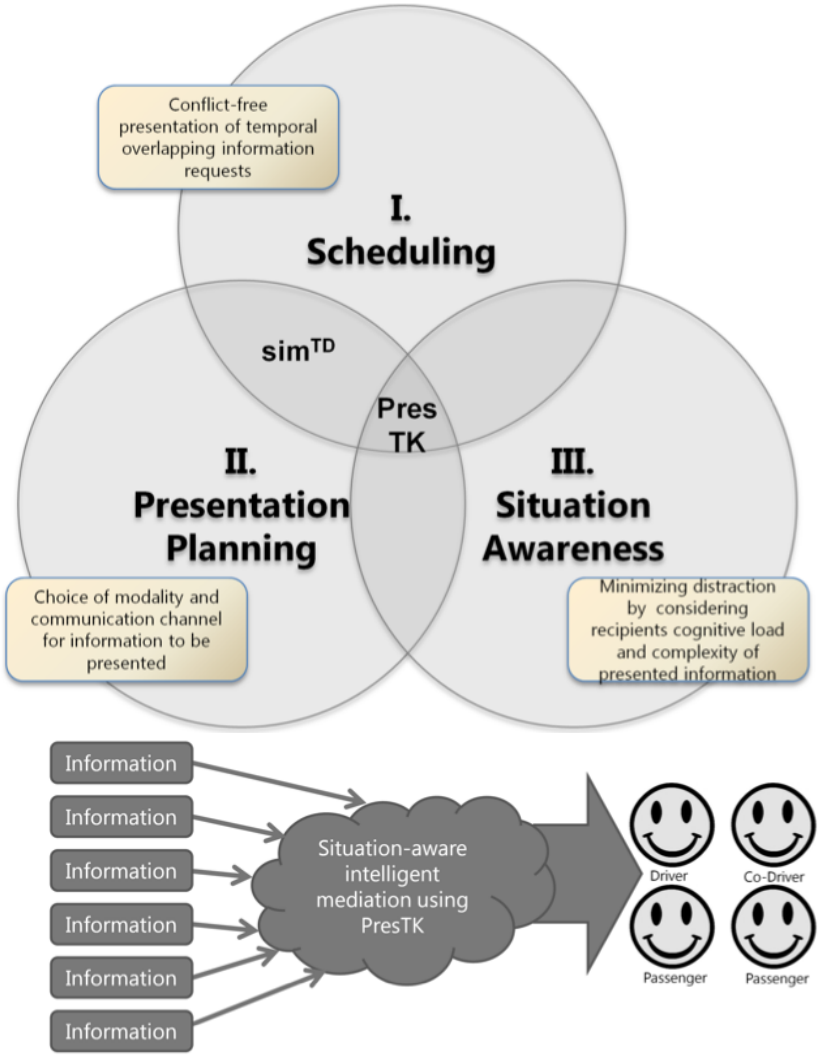
Wirtschaftsminister Philipp Rösler

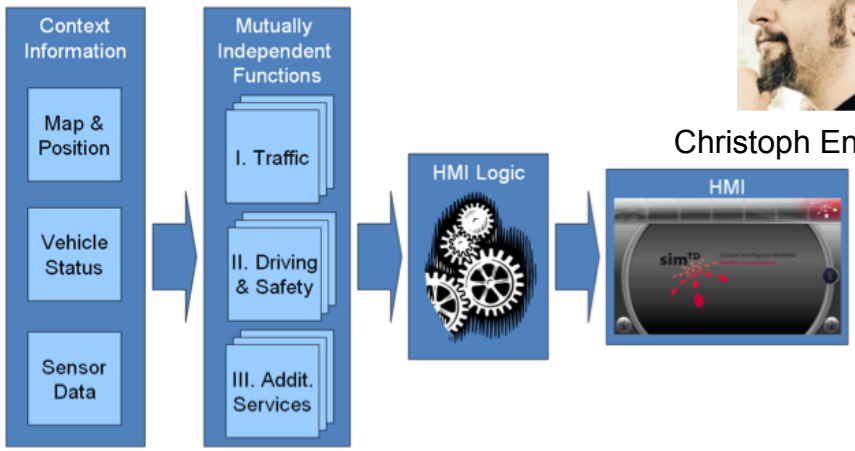
Bundeskanzlerin Angela Merkel

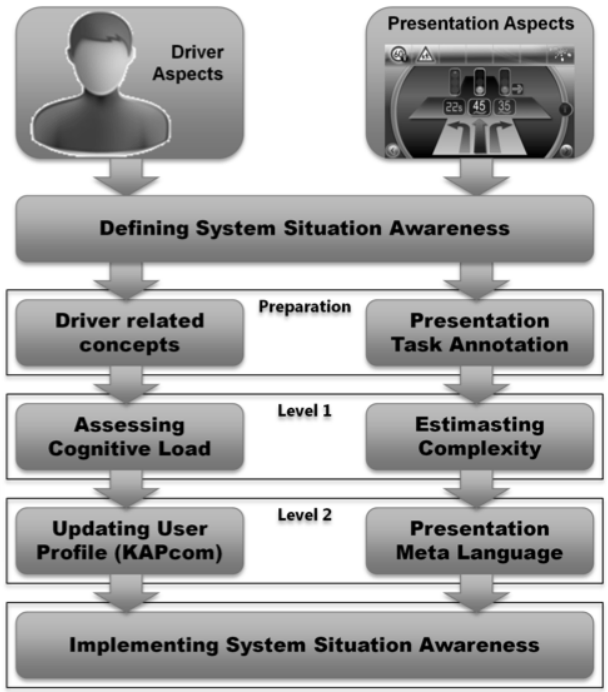
PRESTK: Situation-Aware Presentation of Messages and Infotainment Content for Drivers



Christoph Endres







Kontextbezug, äußere Umgebung
Carmina Antrag 2008

Winning DFKI researchers: Internet access from the car enabled by a glance!

Wednesday, 22. August 2012

Three employees of the DFKI were awarded on the major international conference on "Intelligent Environments 2012", Mexico (27th-28.06. 2012), with the "Best Video / Demo Award". The winning paper describes a novel way of personalized interaction between occupants and the environment, and the infotainment system of the vehicle.

The publication "Personalized In-Vehicle Information Systems: Building an Application Infrastructure for Smart Cars in Smart Spaces" of DFKI researchers Mohammad Mehdi Moniri, Dr. Christian Müller and Dr. Michael Field (technical realization of the video: Renato Orsini) describes the interaction passengers in a vehicle perform with its external environment. The occupants of the car for example have the opportunity to get information on buildings and other visible objects around them while driving. For this interaction, it is sufficient to look through the window at the target object and formulate a question like "What is this building?", or "Give

Best Video/Demo Award

2012

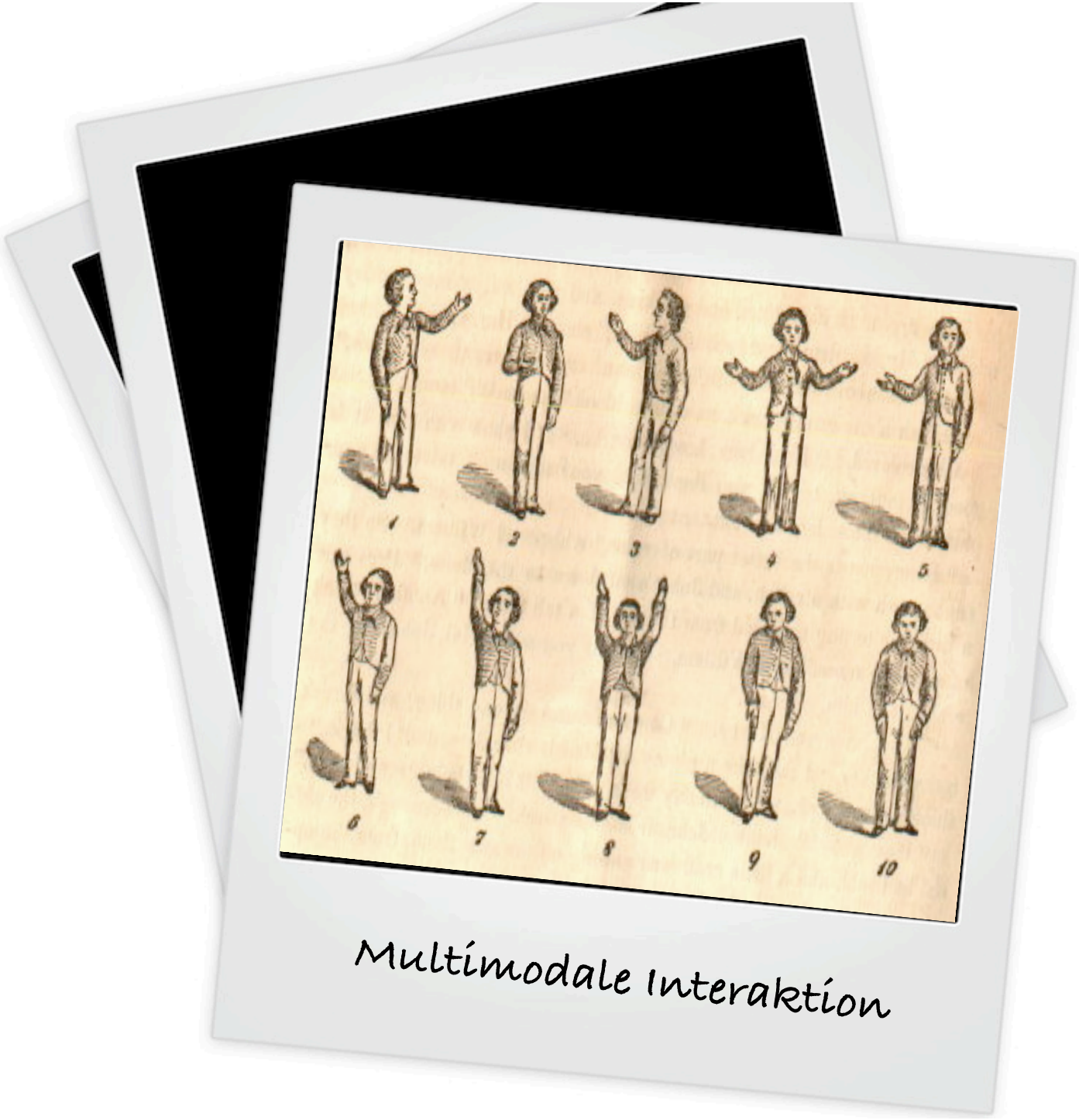
software campus

Mehdi Moniri

Moniri, Müller (2012): Multimodal Reference Resolution for Mobile Spatial Interaction in Urban Environments. In *Proceedings of the 4th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*. (to appear).

Mohammad-Mehdi Moniri, Michael Feld, Christian Müller (2012): Personalized In-Vehicle Information Systems: Building an Application Infrastructure for Smart Cars in Smart Spaces. In *Proceedings of the 8th International Conference on Intelligent Environments IE'12*.

Eyebox: Multimodale Referenzauflösung für raumbezogene Interaktion im städtischen Umfeld


Multimodale Interaktion

Kombination von Texteingabe per Sprache und Multimodaler Korrektur

	1) Searching / Composing text	2) Error correction	3) Modes	4) Driver distraction	5) Task-oriented quality measures
Description	initial input error (blue bars) and interaction steps needed (red bars) depending on search / input method.	reduction of the error (blue bars) and additional interaction steps (red bars) via different correction strategies.	driver distraction caused by different interaction modalities (colors) as a function of the number of interaction steps (x-axis).	acceptable level of driver distraction depending on the driving situation (traffic, difficulty of track, speed, time of the day, …) and the initial cognitive workload.	acceptable error rate depending on the communicative goal and message context.
Empirical Paradigm	corpus studies using available speech / text corpora or purpose-built corpora on the target domain.	data driven evaluation using separate development and evaluation sets	driving experiments investigating the relationship between modalities (or combinations of modalities) and driver distraction	available standards and driving experiments investigating the relationship between driver distraction and driving performance.	corpus studies using available text corpora or purpose-built corpora on the target domain.
Challenges	possible lack of realistic constraints with respect to context (driving) , variability (voice, emotions, time of the day), and nuisance attributes (background noise, cross-talk, light conditions, vibrations,…)	sufficient generalization may not be possible because correction mechanisms are likely to be domain-specific	regarding the driver distraction as of function of interaction steps is a simplifying assumption and can at only be used as an approximation.	empirically, driver distraction is in alia investigated on the basis of driving performance (simulated driving task). Estimation of severity / consequences of failures with respect to real driving is complex.	word error rate (WER) may not be a suitable error measure or is at least not ideal. Rather than that, a differentiated error measure should be developed.

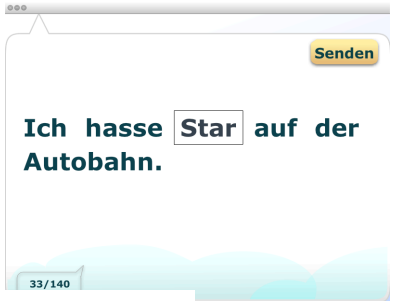
Connected Driving: Multimodal Texting Dialogs

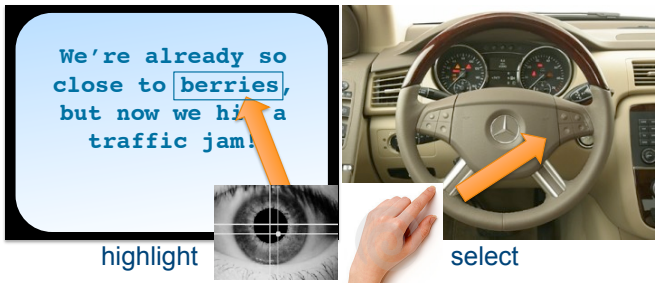
dfki iui automotive

We furthermore investigated multiple modalities and respective dialog concepts for post ASR error correction:
-central rotary device (turn-and-push dial)
-speech
-touch-screen
-eye tracking
We were one of the first research groups to investigate explicit gaze-based interaction in the car.

(ASR = Automatic Speech Recognition):

tobii WORLD LEADER IN EYE TRACKING & EYE CONTROL





Dagmar Kern, Angela Mahr, Sandro Castronovo, Christoph Stahl and Christian Müller: **Twitte** Correct Spoken Free-Text Input (i ; not published yet)

get safe

post-ASR error correction, gaze-based interaction, multimodal interaction

GetHomeSafe: Extended Multimodal Search and Communication Systems for Safe In-Car Application

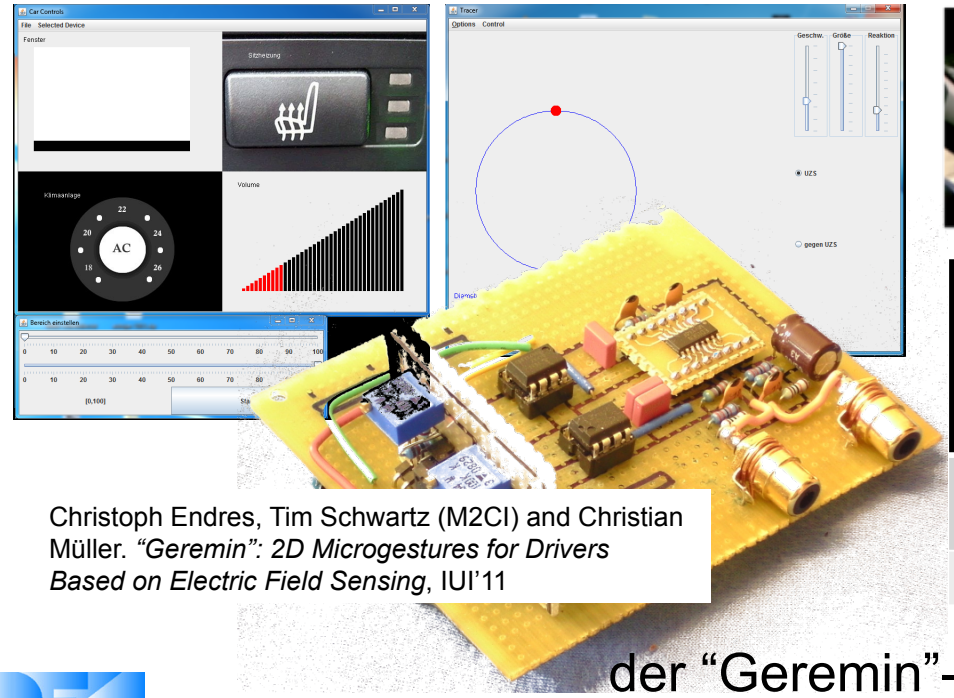
DFKI Koordinator (C, Müller)
Partner: Nuance, IBM, Daimler, KTH

Multimodale Kontrolle von Komfortfunktionen

Sandro Castronovo, Angela Mahr, Margarita Pentcheva, Christian Müller: *Multimodal Dialog in the Car: Combining Speech and Turn-And-Push Dial to Control Comfort Functions.* Proceedings of Interspeech '10, 510-513

Multimodale Eingabe für die Kontrolle von Komfortfunktionen

→ Unterstützt Tertiäraufgabe



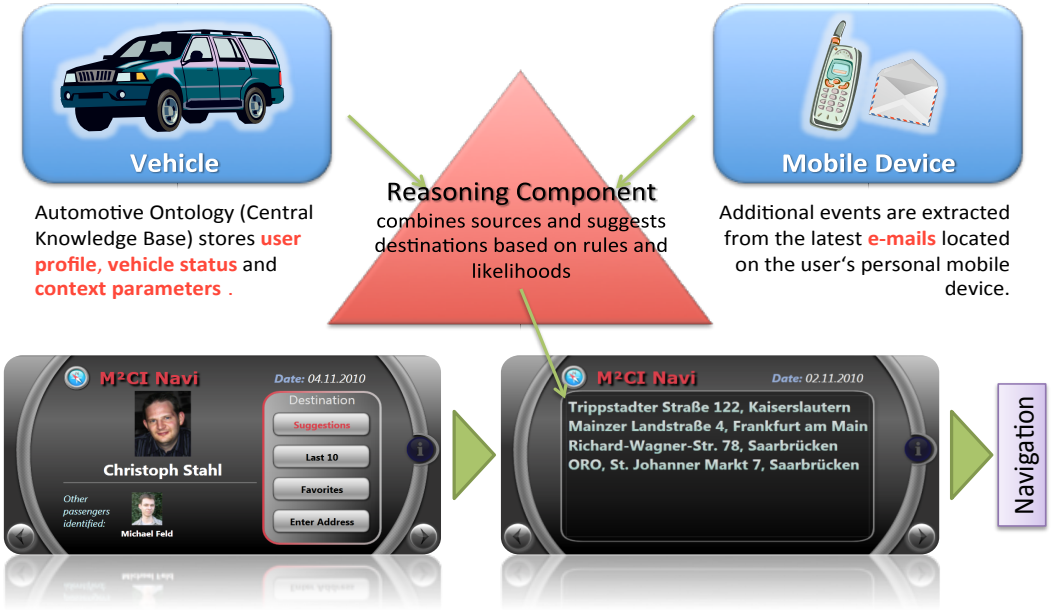
Christoph Endres, Tim Schwartz (M2CI) and Christian Müller. *"Geremin": 2D Microgestures for Drivers Based on Electric Field Sensing*, IUI'11

	windows	air condition	volume	seat heating
plus (+)	close	warmer	louder	warmer
minus(-)	open	cooler	less loud	cooler

der "Geremin"-Ansatz für 2D Mikrogesten

Multimodale Interaktion

in collaboration with



Michael Feld et al: *Generating Personalized Destination Suggestions for Automotive Navigation Systems under Uncertainty* ***UMAP11***

Nicht-Obstrusive und personalisierte Eingabe von Fahrzielen

→ Unterstützt Tertiäraufgabe

Automotive Domain Application

KAPcom

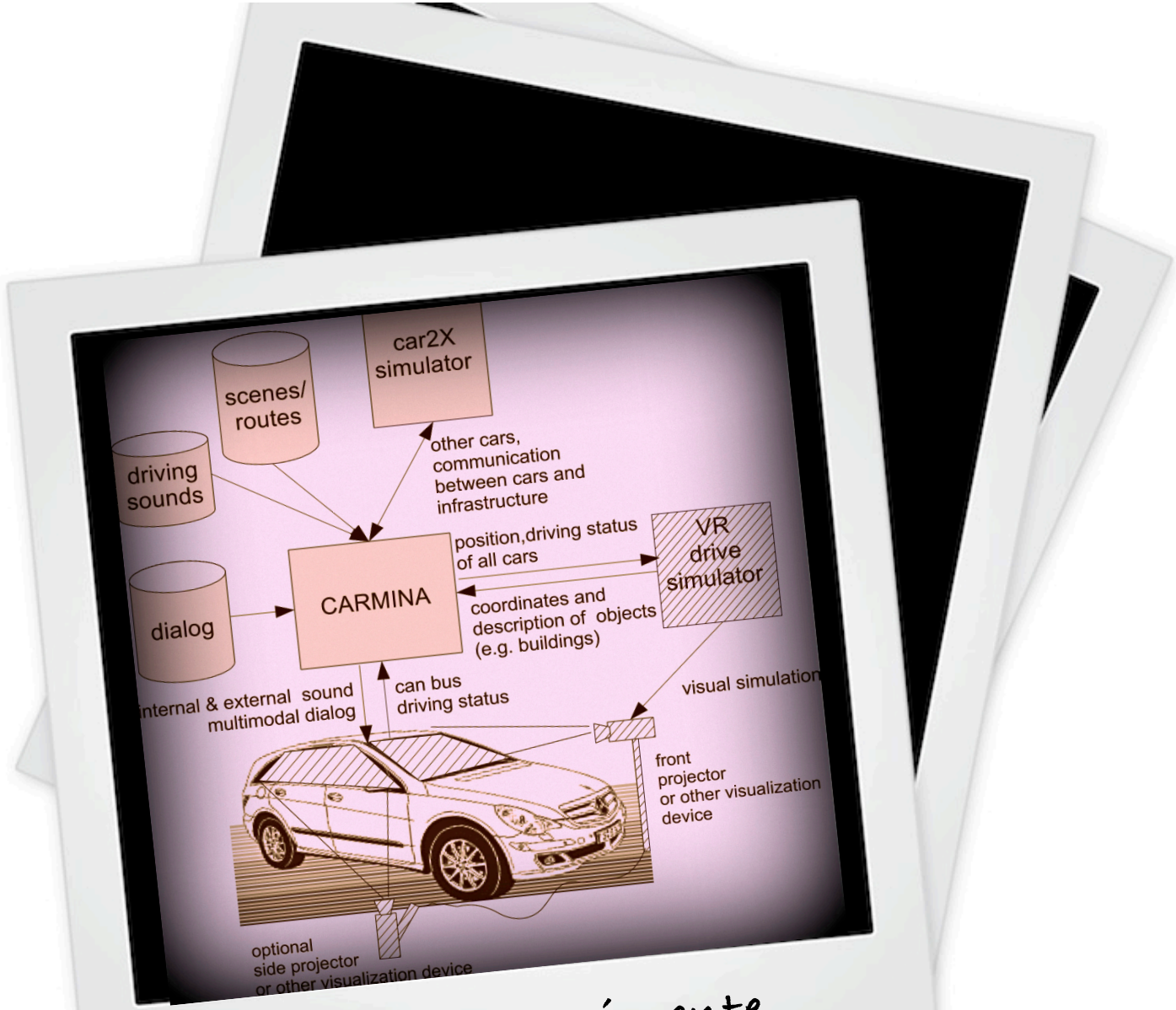
Knowledge Management, Adaptation and Personalization Component

How can knowledge about the user be maintained and used to adapt in-car services?

- Automotive Ontology
- Domain Examples
- Adaptation Strategies

Wissenrepräsentation, Sensorfusion, Reasoning

→ Basiskomponente für intelligente Anwendungen (sekundär, tertiär), prinzipiell auf für Primäraufgabe (wurde aber noch nicht eingesetzt)



Aufbau für Experimente
Carmina Preproposal 2008

OpenDS: Open-Source Fahrsimulationssoftware

- Wichtiger Bestandteil unseres Portfolios (Werkzeug + Produkt)
- Open-Source Entwicklung in EU-Projekt GetHomeSafe (FP7) + zusätzliche Förderung über „Open-Source Booster“ der EIT ICT Labs
- Erstes OS-Release Ende 2012
- Bisherige Kunden: Audi, Daimler, Nuance, Universitäten

- Gemeinsame Einrichtung von DFKI und UdS
- DFKI-Anteil finanziert von EU-Projekt GetHomeSafe
- Teil der EIT ICT Labs Test-Site auf dem Campus der UdS
- Eröffnet am Tag der Offenen Tür 2012

Das Projekt Carmina als Sprungbrett für den Aufbau der Automotive-Gruppe

dfki iui automotive

Projektvolumen
➢10 ME

DAIMLER

Incar-Rob, Automotive HMI Innovationen

NUANCE

VoiceCar HMI

getHomeSafe

GetHomeSafe: Extended Multimodal Search and Communication Systems for Safe In-Car Application

DFKI Koordinator (C, Müller)
Partner: Nuance, IBM, Daimler, KTH

carmina

Car-Oriented Multimodal Interface Architectures

simTD Sichere Intelligente Mobilität Testfeld Deutschland

Sichere und intelligente Mobilität von morgen durch Erforschung und Validierung von Car2X Kommunikation und ihrer Anwendungen

BMBF, BMWI, BMVBS

SiAM

SiAM: Situations-Adaptive Multimodale Interaktion für Innovative Mobilitätskonzepte der Zukunft

BMBF

TÜV SÜD bast

TÜV Süd und Bast. Projekt zur Prüfung von Fahrkompetenz

Das Projekt Carmina als Sprungbrett für den Aufbau der Automotive-Gruppe

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Universität Stuttgart

Wissenschaftsbeirat Eco-Fahrassistenz

große Anzahl von Programm- und Organisationskomitees
Bsp, IUI, Automotive UI, CHI

eit Knowledge & Innovation Community
EIT ICT Labs

EIT Knowledge and Innovation Community
DFKI leitet Action Line Intelligent Mobility and Transportation Systems

carmina

Car-Oriented Multimodal Interface Architectures

Eingeladene Vorträge
VDE congress Automotive Meets Electronics
IUI WS keynote

UNIVERSITÄT DES SAARLANDES

5 Vorlesungen / Seminars

UNIVERSITÄT DUISBURG ESSEN

Kollaboration
Gastwissenschaftler: Dagmar Kern

University of Twente
Enschede - The Netherlands

Gastwissenschaftler
Phd Committee

Die Rolle des Vortragenden als “Action Line Leader Intelligent Mobility and Transportation Systems”

- Partners …

CRF CENTRO RICERCHE FIAT

SIEMENS

ERICSSON

German Research Center for Artificial Intelligence GmbH

Fraunhofer

TU/e Technische Universiteit Eindhoven University of Technology

KTH VETENSKAP OCH KONST
ROYAL INSTITUTE OF TECHNOLOGY

TNO innovation for life

TU berlin

novay
NETWORKED INNOVATION

UNIVERSITÄT DES SAARLANDES

UNIVERSITY OF TRENTO - Italy

CREATE-NET

UNIVERSITY OF TWENTE.

Ziele

Intelligent Mobility & Transportation Systems

1. Set-up test sites and create concrete new services and product offerings for large companies and SMEs.

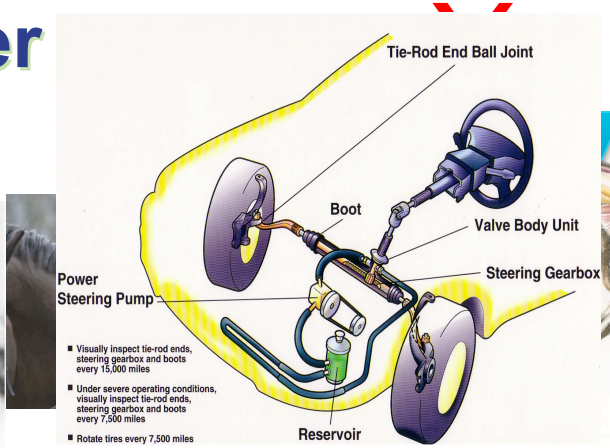
2. Leverage and coordinate innovation in the field in order to have maximum impact on societal challenges.

3. Issue regular and open challenges (organized by the KIC) in order to foster innovation that is well-directed according to 1 and 2

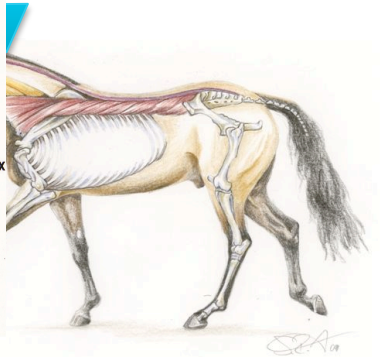
Gesellschaftliche Herausforderungen

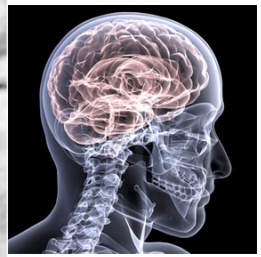
Safe Mobility	• Mainly Car2X related products and services as well as tools for development and research • Challenge: “Protection of vulnerable road users”
Sustainable Mobility	• Products and services related to the market launch of electric vehicles, car-sharing concepts as well as intermodal mobility • Challenge: “ICT innovation with the highest individual impact on CO2 reduction”
Autonomous Mobility	• Technology implementing concrete steps on the transition from completely human-operated cars to fully autonomous cars\ • Challenge: “Systems that are able to perform manoeuver X” (X= overtaking, filtering into another lane, entering or exiting motorway, etc.)
Socially Enriched Mobility	• Products and services related to create compelling new features for products of the automotive industry • Challenge: “ICT innovation leading to more empathy on the roads”
Accessible Mobility	• Mainly platforms and services for efficient intermodal mobility • Challenge: “Find the system that creates the most efficient journey in one of the large KIC-cities.”

Mensch-Fahrzeug-Kooperation: Die Pferd-Methapher



direkte Kontrolle



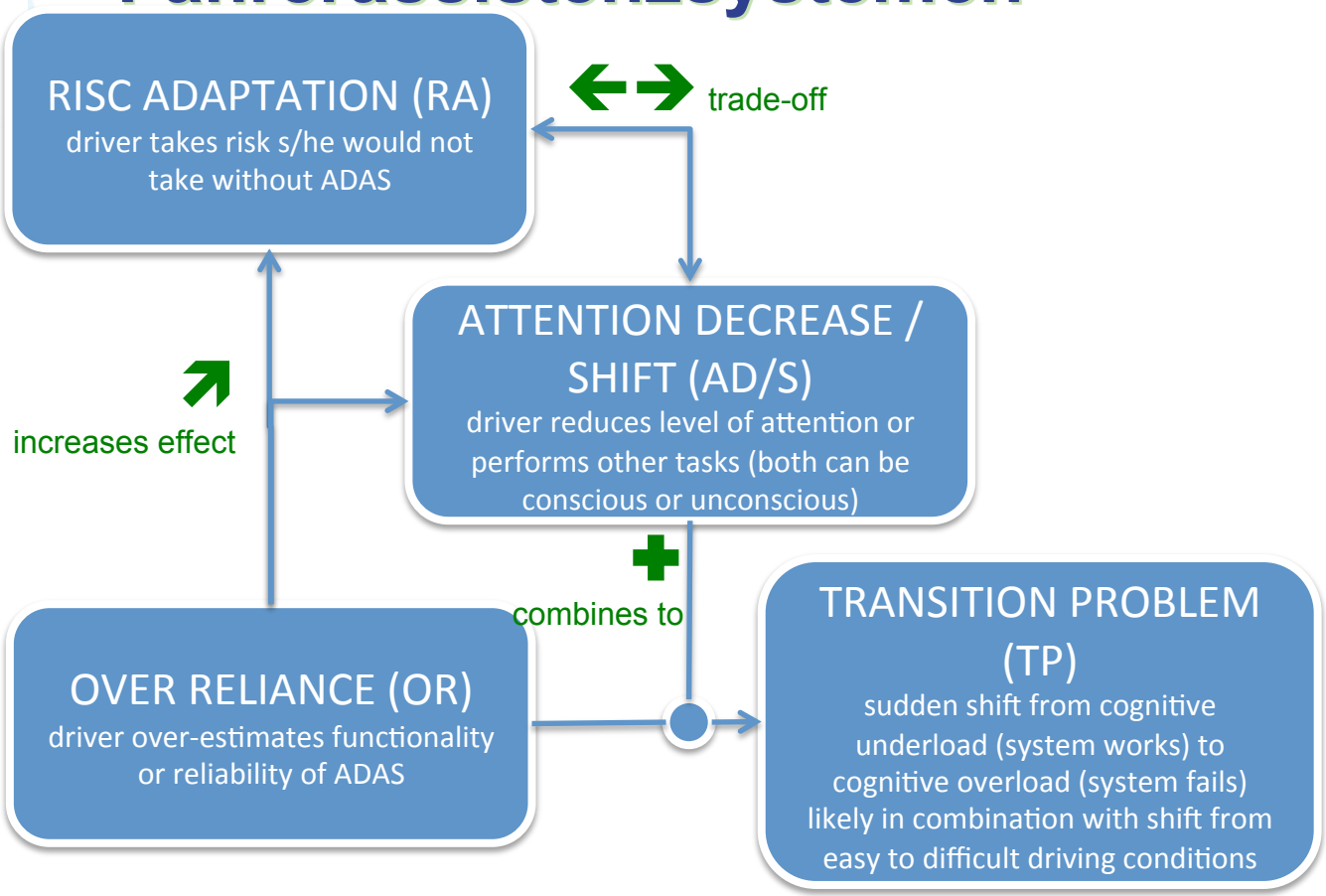


Komnunikation

- Zwei intelligente Systeme kollaborieren miteinander
- Vertrauen, Teilen von Verantwortung, das richtige Feedback

Wie die Pferd-Methapher unser Denken leitet

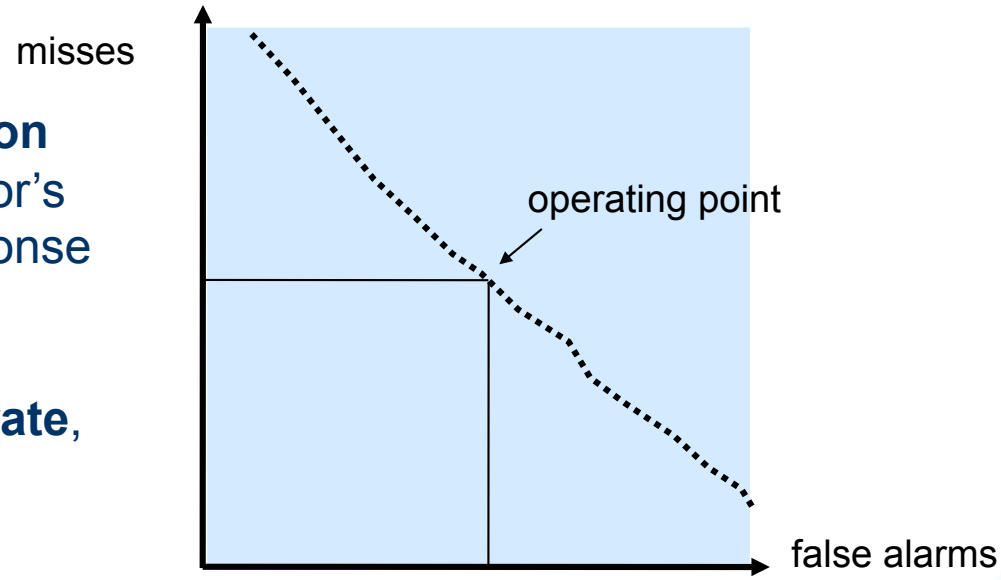
Verhaltenseffekte von Fahrerassistenzsystemen



- ADAS benefits are potentially very large because they may considerably contribute to decreasing human suffering, economical cost and pollution.

- However, as many researchers argue, in assessing the benefits of ADAS it has to be taken into account that any gains in terms of security may be again reduced by the fact they affect the drivers' behavior

Wickens: False Alarms / Misses



- Wickens: an increase in **automation false alarms** decreases the operator's *compliance* resulting in longer response time to / disregard of alerts

- An increasing automation's **miss rate**, on the other hand side, leads to a reduction of *reliance* and to closer examination of raw data in order to better avoid missing anything.

→ Conversely, if during a longer period of time only a marginal percentage of misses is occurring, the driver might excessively trust the warning system and be less conscientious when checking the raw data or even rely completely on the system.

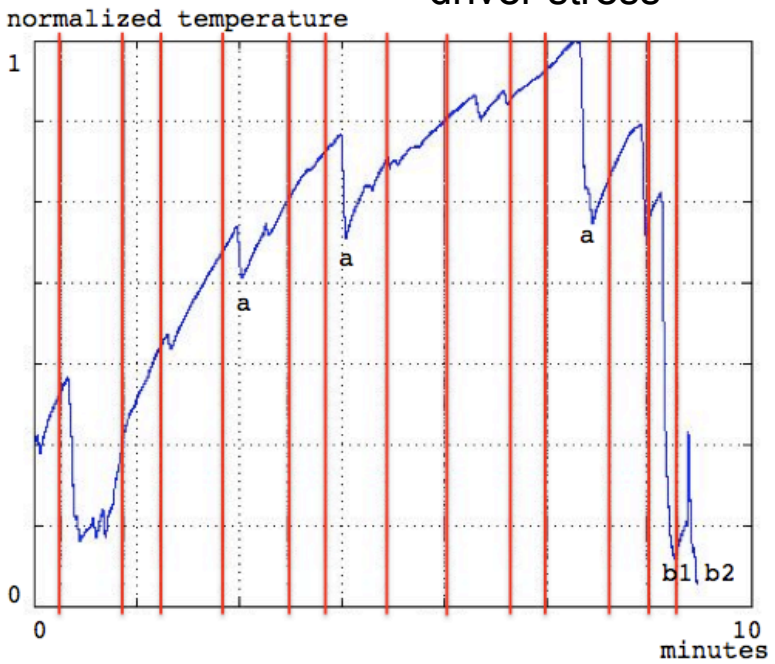
A Concrete Study

- Claim:
  - In assessing the benefits of Advanced Driver Assistance Systems (ADAS) it has to be taken into account that any gains in terms of safety may be again reduced by the fact they affect the drivers' behavior.
- Supporting Results
  - The drivers' ability to effectively react to suddenly appearing obstacles when a warning system fails is significantly lower than before they got used to it..
  - At the same time, the stress level is significantly higher.

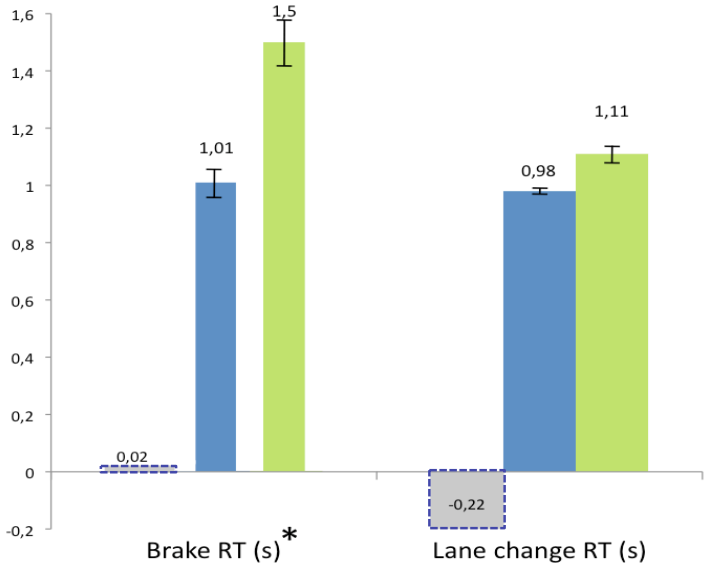
Angela Mahr, Yujia Cao, Mariet Theune, Veronika Dimitrova-Krause, Tim Schwartz, Christian Müller (2010): What if it Suddenly Fails? Behavioral Aspects of Advanced Driver Assistant Systems on the Example of Local Danger Alerts . In Proceedings of 19th European Conference on Artificial Intelligence (ECAI 2010).

Results

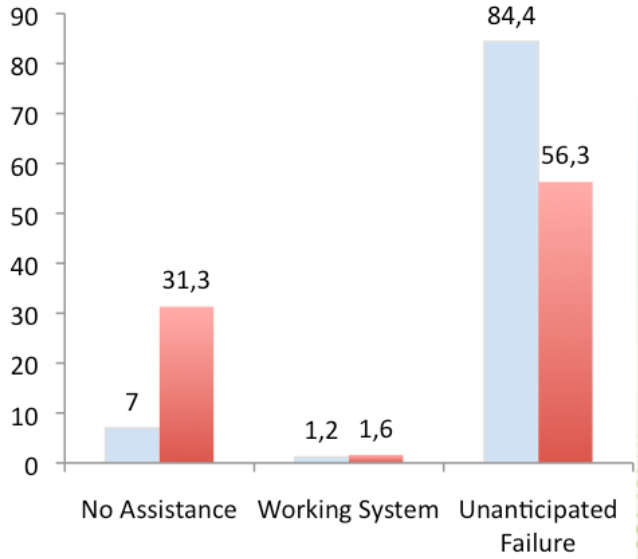
driver stress



driving performance



reaction times



- The findings reported here give rise questions on the roll-out strategy for fully autonomous cars, either into large-scale field test or into practice.

- The technology is susceptible for behavioral impacts such as attentional decrease/shift and transition problems in combination with over-reliance.

- According to our results, the behavioral effects have to be taken into account. Engineers should make sure that the drivers are always aware of the fact that the system may fail.

Auf dem Weg zum Autonomen Fahren: Wie sich das Aufgabenmodell ändert

Primäraufgabe: wird zur Kommunikationsaufgabe

Sekundäraufgabe: verschwindet weitestgehend

Tertiäraufgabe: Es kann und sollte mehr Angebote geben

Der Übergang zum Autonomen Fahren vorhergesehen

ACC

connected vehicles

+ drive by wire + road trains + ausgewählte Manöver + Schleusen

heute → 2030

Verbesserung der Sicherheit beim manuellen Fahren durch Assistenzsysteme
Auch: automatische Notbremse

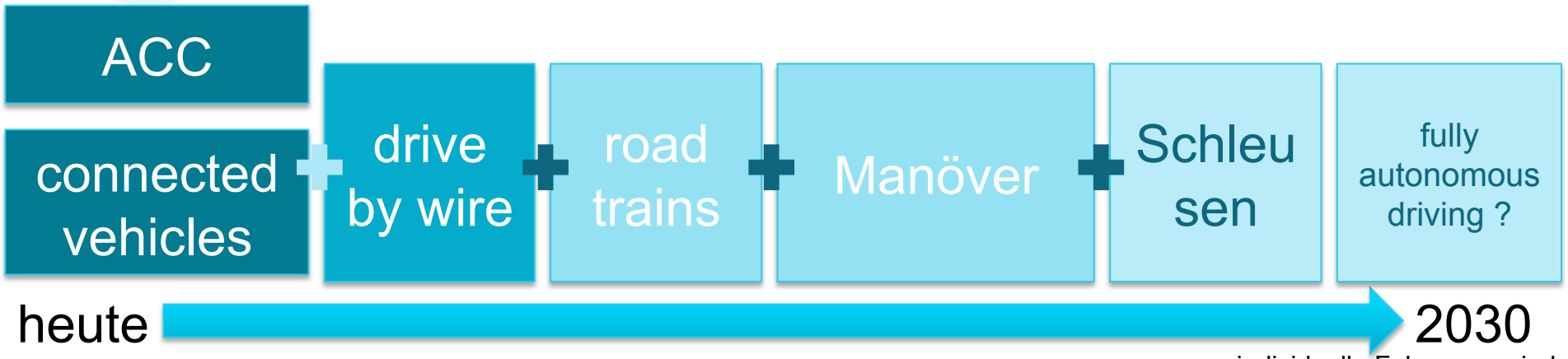
Ersetzen der mechanischen Verbindung zwischen Rädern und Lenkrad durch einen Kommunikations bus (IP?)

Verbindung von ACC und Car2X für semi-autonome Kollonnenfahrten auf der Autobahn

Parken (heute schon)
In die Garage fahren
Überholen
Auf- Abfahren von der Autobahn
…

Städte richten “Schleusen” ein für den Übergang von manuellem und autonomem Fahren

Der Übergang zum Autonomen Fahren vorhergesehen



individuelle Fahrzeuge sind in der Lage überall autonom zu fahren → ja

vollständiges autonomes Fahren (kein manuelles Fahren mehr) → eher nicht

Wie Wir Beitragen Können / Werden ?

Feedback-Schleife

Simulationsplattform

ACC

connected vehicles

+ drive by wire + road trains + Manöver + Schleusen + vollständiges autonomes Fahren

201x, x>12

welche Information wird wann und wie präsentiert?→ Endres

neue Anwendungsformen→ Castronovo

frühe Kombination mit anderen Technologien wie z.B. Ladesäule für E-Fahrzeuge
→ Hager, Mobile World Congress 2013 (EIT ICT Labs)

wie Benutzer steuern wollen und welches Feedback sie erhalten

wie steuern an- und abgeschaltet wird
→ SIAM

intuitive Ansätze für das Betreten und Verlassen eine Road-Trains

Angebote innerhalb eines Road-Trains

Vorbereitung der Benutzer wieder Verantwortung zu übernehmen

→ SIAM, EIT ICT Labs

Welche Manöver sind sinnvoll?
Wie wählen Benutzer Manöver aus ?

Simulationsstudien mit OpenDS

Software-Architekturen für das flexible Aufspielen neuer Manöver (App Store)

→ EIT ICT Labs activity „Apps for your Car“ , W3C, SW-Campus Projekt Barbu (Jameson)

realistische simulierte Städte erlauben die Erprobung neuer Verkehrsinfrastruktur

alles zusammen

Fazit

- Die Automotive-Domäne birgt eine Reihe von Herausforderung für IKT, im speziellen Intelligente Benutzerschnittstellen.

- Dies gilt nicht nur für den Themenbereich autonomes Fahren, sondern auch für nachhaltige Mobilität und effiziente Mobilität.

- Wir haben die Werkzeuge und das Know-How, um auch zukünftig wesentliche Beiträge zu leisten.

- Eine weitestgehende Verzahnung mit der EIT ICT Labs Action Line IMS ermöglicht eine größtmögliche Bedeutung/Wirkung für automotive@dfki.