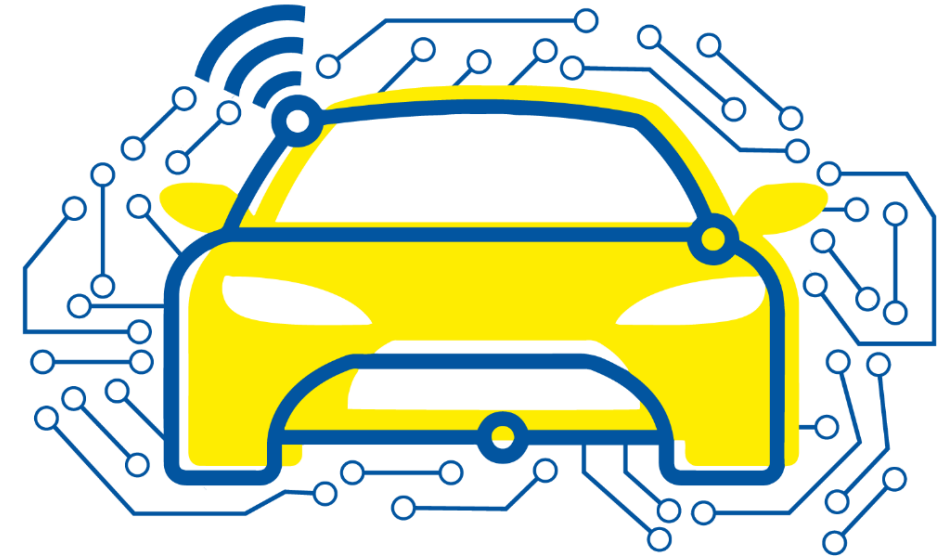**Automated and Connected Driving Challenges**
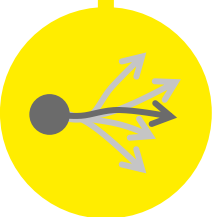
Section 4 – Vehicle Guidance

Vehicle Guidance on Stabilization Level

Introduction

Bastian Lampe

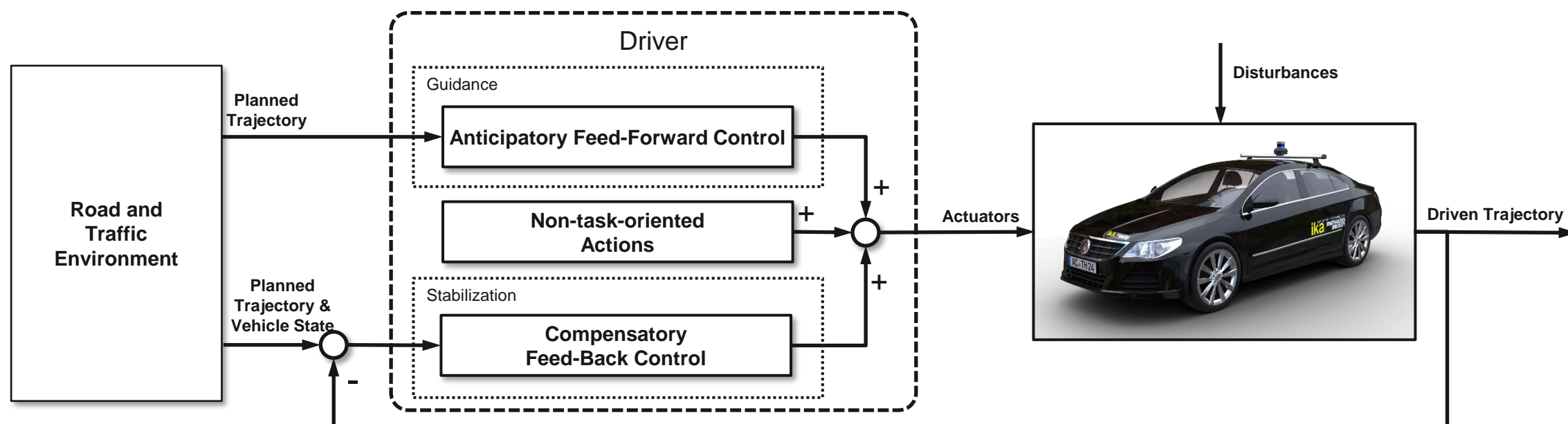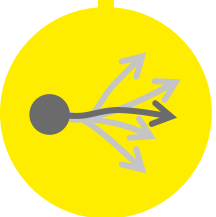Institute for Automotive Engineering

Vehicle Guidance on Stabilization Level

Principle of Vehicle Stabilization

- Vehicle guidance implements principle of the **driver model** proposed by Donges
- **Anticipatory** feed-forward control based on planned trajectory
- **Compensatory** feed-back control based on observation of vehicle state and deviations from trajectory
- **Disturbances** by unintended or non-task-oriented control actions or external influences on vehicle dynamics
- For experienced drivers, the anticipatory part represents the main portion of the control actions, inexperienced drivers apply more compensatory control actions

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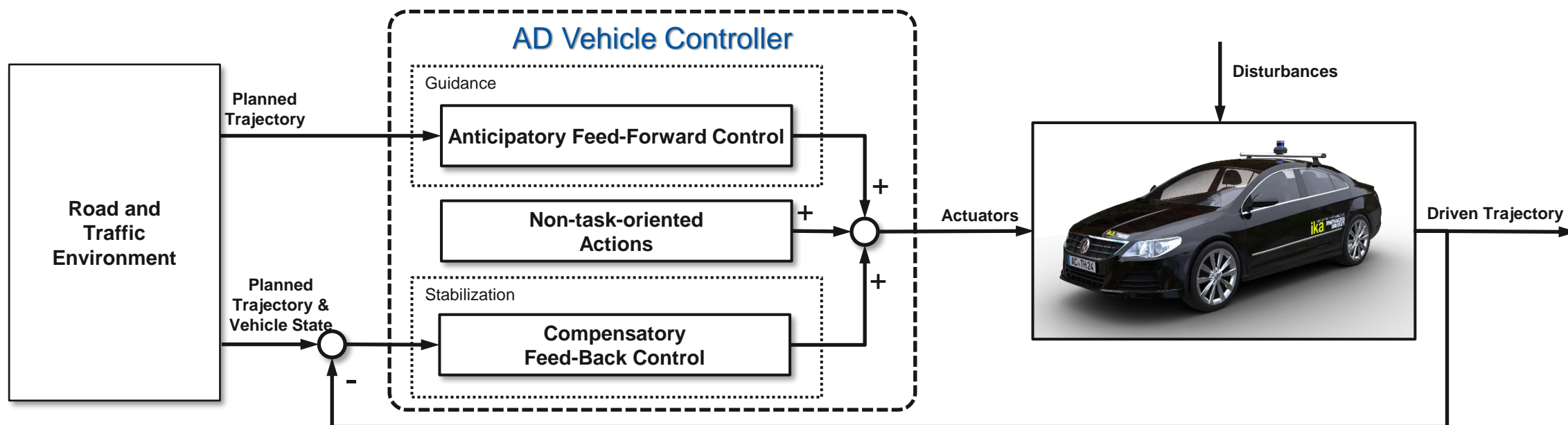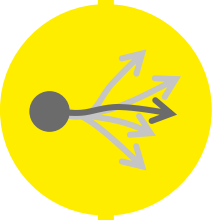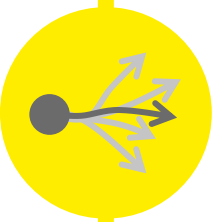
Vehicle Guidance on Stabilization Level

Levels for Vehicle Control

High-Level

- Typical "high-level" interfaces in production vehicles are e.g.
  - Longitudinal: Wheel torque, acceleration, deceleration, brake pressure, accelerator pedal value, gear selection
  - Lateral: Steering (wheel) torque, steering (wheel) angle, steering angle rate, vehicle torque
- Typically, certain control variable restrictions are applied and checked by the interfaces
- These interfaces are typically provided also to suppliers in order to integrate their assistance systems

Low-Level

- Low-level controller take care of the correct implementation of the control quantities based on particular sensor feed-back
  - Longitudinal: Management of engine and brake control, gearbox management, direct interface with engine controller and ESP interfaces
  - Lateral: Typically control of motor currents (EPS steering systems) based on precise angle sensors
- Low-level regulators need to have a quick response with no or low offsets and time delays, ideally with linear or known settlement behavior, in order to simplify the higher-level controller tuning process
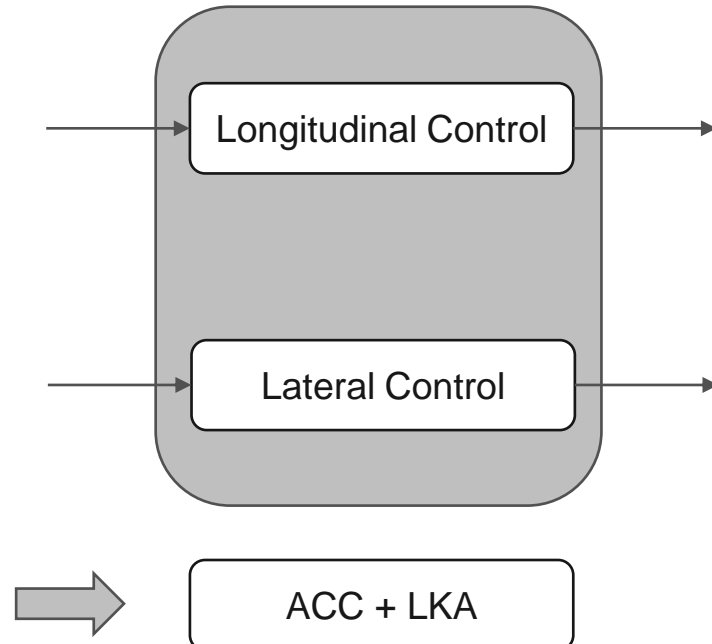
Vehicle Guidance on Stabilization Level
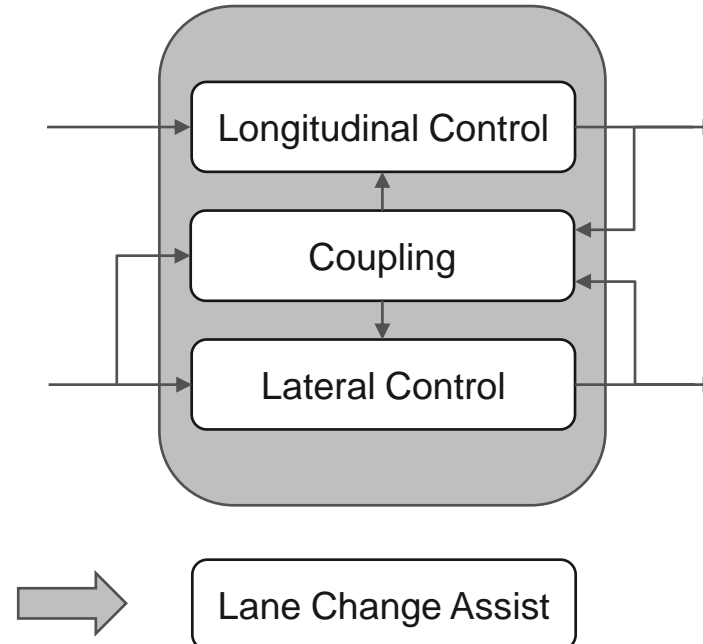
Combined Lateral and Longitudinal Control

- **Parallel approach**
  - Two driving assistance systems discretely designed
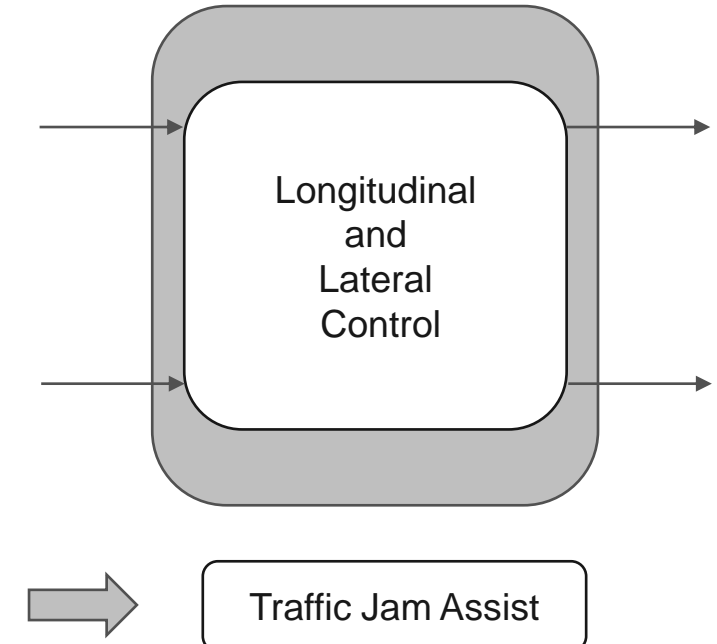 - No interaction intended
  - Single variable control systems
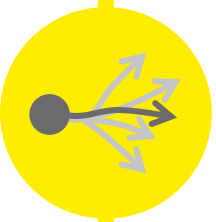
- **Combined approach**
  - Two driving assistance systems discretely designed
  - Linking between both explicitly considered
  - Single variable control systems

- **Integrated approach**
  - Coupling implicitly included
  - Multivariable control system

| Longitudinal Control |
| Lateral Control |

ACC + LKA

| Longitudinal Control |
| Coupling |
| Lateral Control |

Lane Change Assist

Longitudinal and Lateral Control

Traffic Jam Assist

Vehicle Guidance on Stabilization Level

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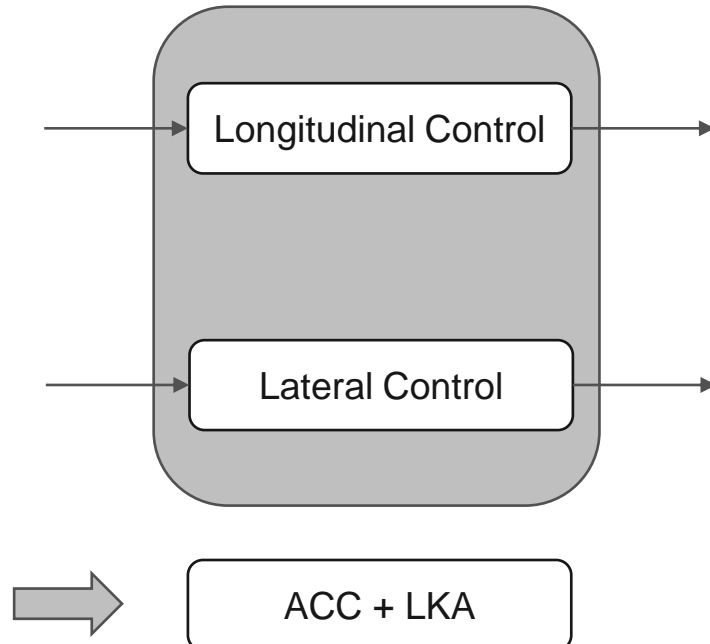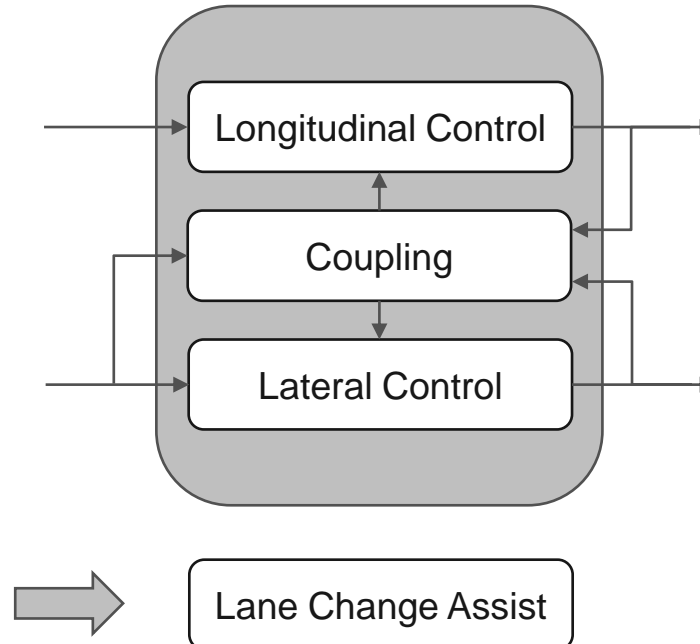 - Multivariable control system

ACC + LKA	Lane Change Assist	Traffic Jam Assist