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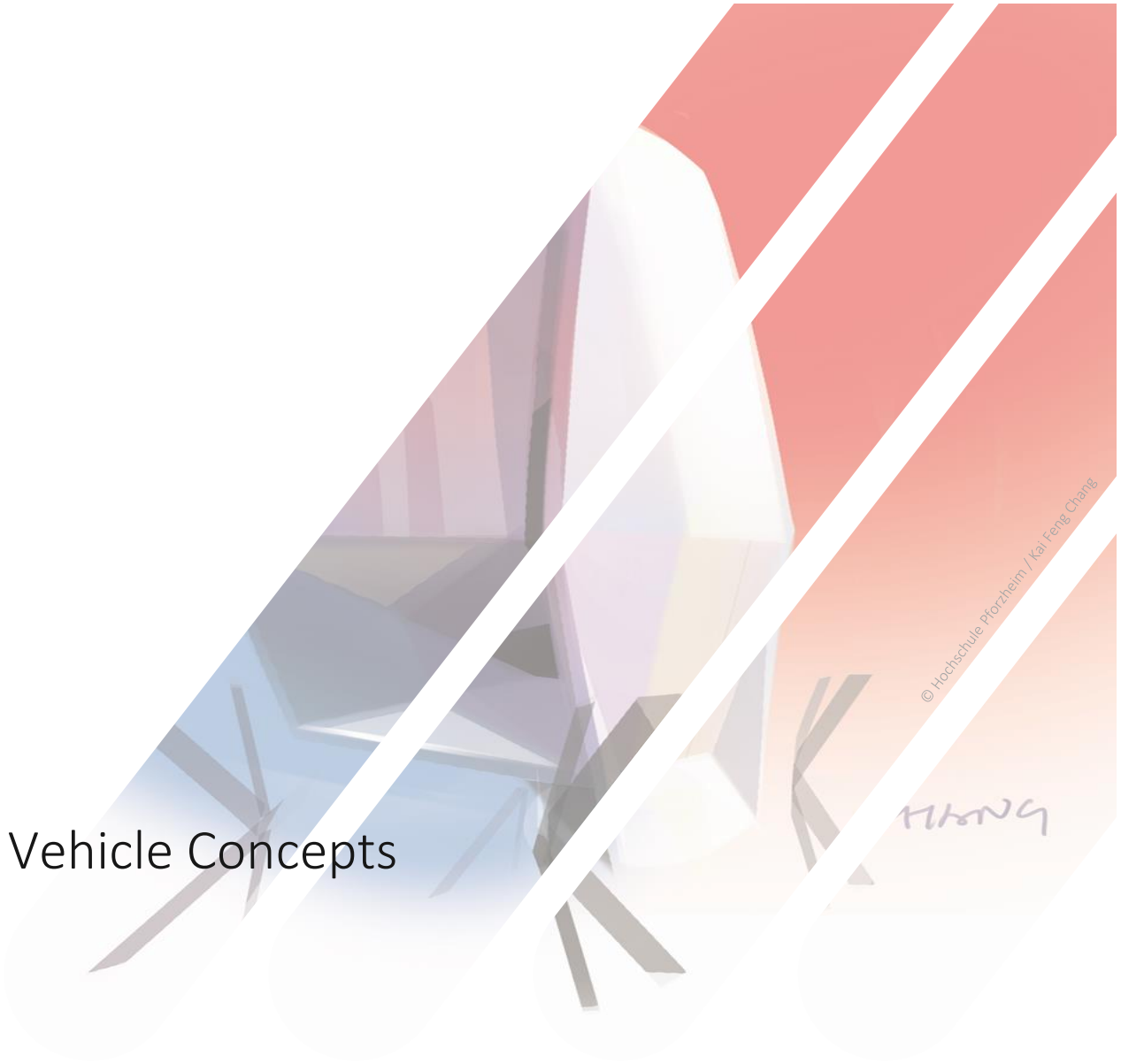


UNICAR*agil* – New Architectures for Disruptive Vehicle Concepts

Stuttgart, 20 March 2019

Dr.-Ing. Dan Keilhoff

University of Stuttgart

AGENDA

1. Project Overview
2. The Mechatronic Architecture
   - 2.1 The Sensor Modules and the Cerebrum
   - 2.2 The Brainstem and the Platform Sensors
   - 2.3 The Dynamic Modules and the Spinal Cord
3. The Brainstem Hardware
4. Automotive Service Orientated Architecture
5. Mechanic Architecture

1. Project Overview

OBJECTIVE

1. Modular structures for agile, automated vehicle concepts
2. Disruptive concepts in hardware and software architecture
3. Modular platform with dynamics modules
4. Fully automated and driverless vehicles
5. Four prototypes of different characteristics

KEYFACTS

ca. 26 Mio. € BMBF funding

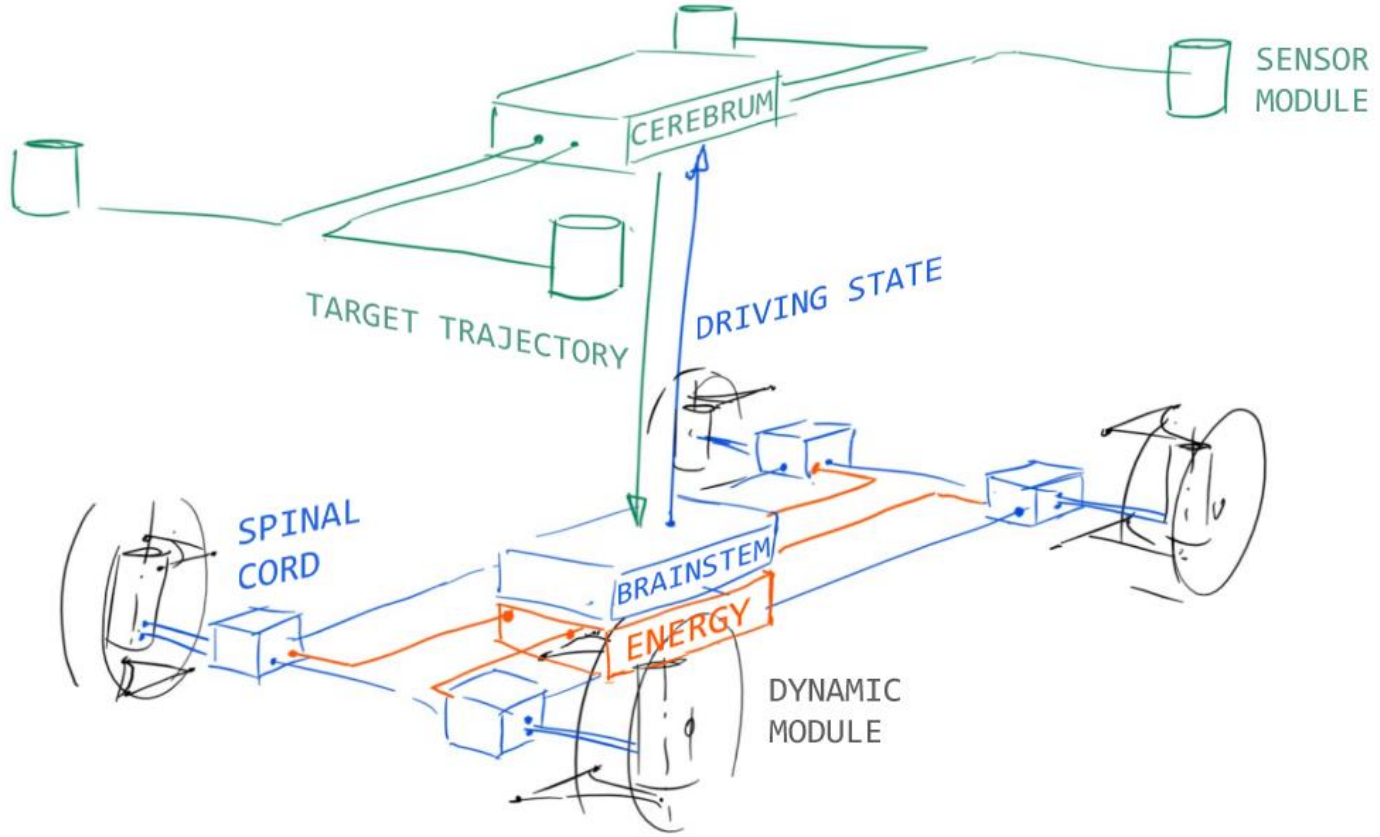
01.02.2018 – 31.01.2022 (48 months)

15 university chairs / institutes

6 industrial partners

Project team of over 100 researchers

2. The Mechatronic Architecture



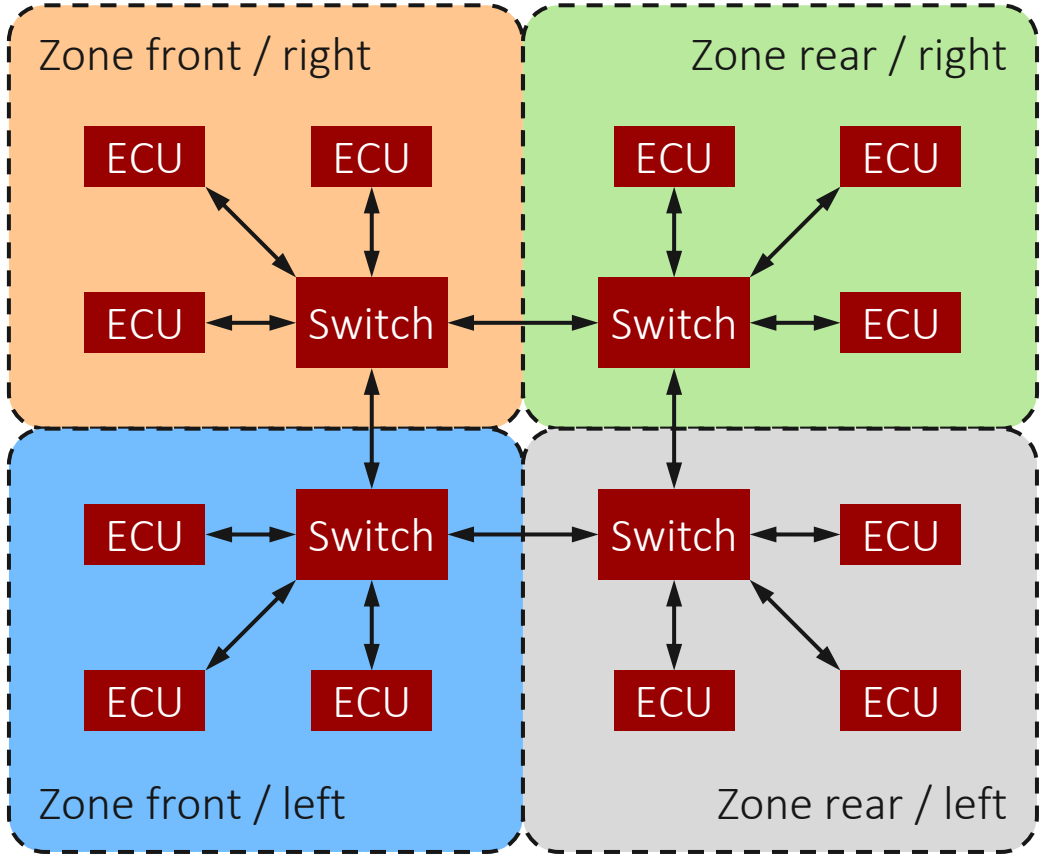
2. The Mechatronic Architecture

Zone Architecture

- Main communication via Ethernet
- Enables service orientated software structure
- Zone architecture also used for sensor and dynamic modules

Functional Safety

- Failure of an entire zone can be handled: still enough capabilities available

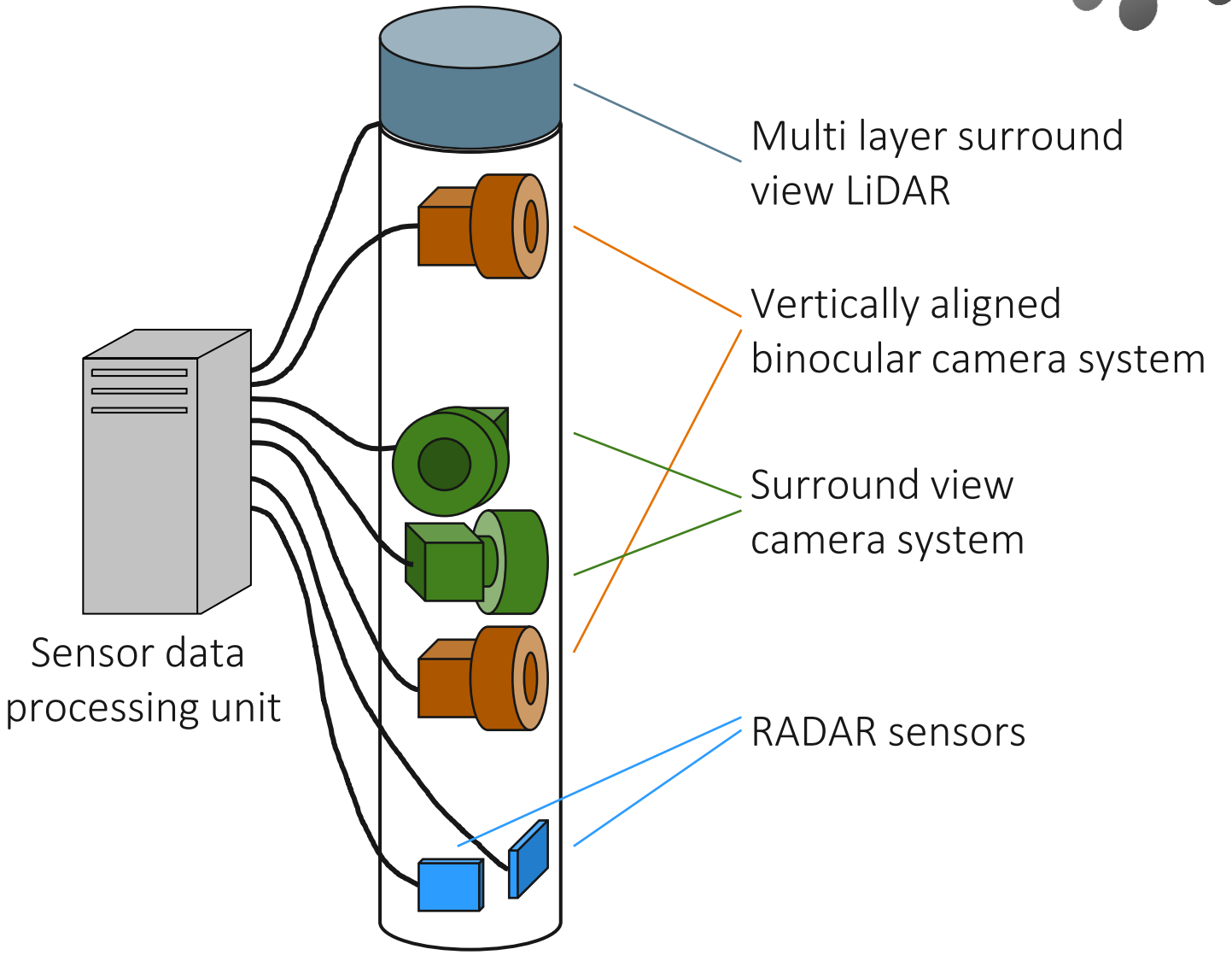


2.1 The Sensor Modules and the Cerebrum

Sensor Modules

- Vision, LiDAR, & RADAR in solid housing
- Surround view sensors
- Binocular vision in preferential direction of movement
- Sensor data processing unit

- Diverse sensor setup allow reliable sensing of the environment
- Local sensor evaluation reduces complexity
- Processing unit calculates one environment model per module
- Several sensor modules can be integrated in one vehicle

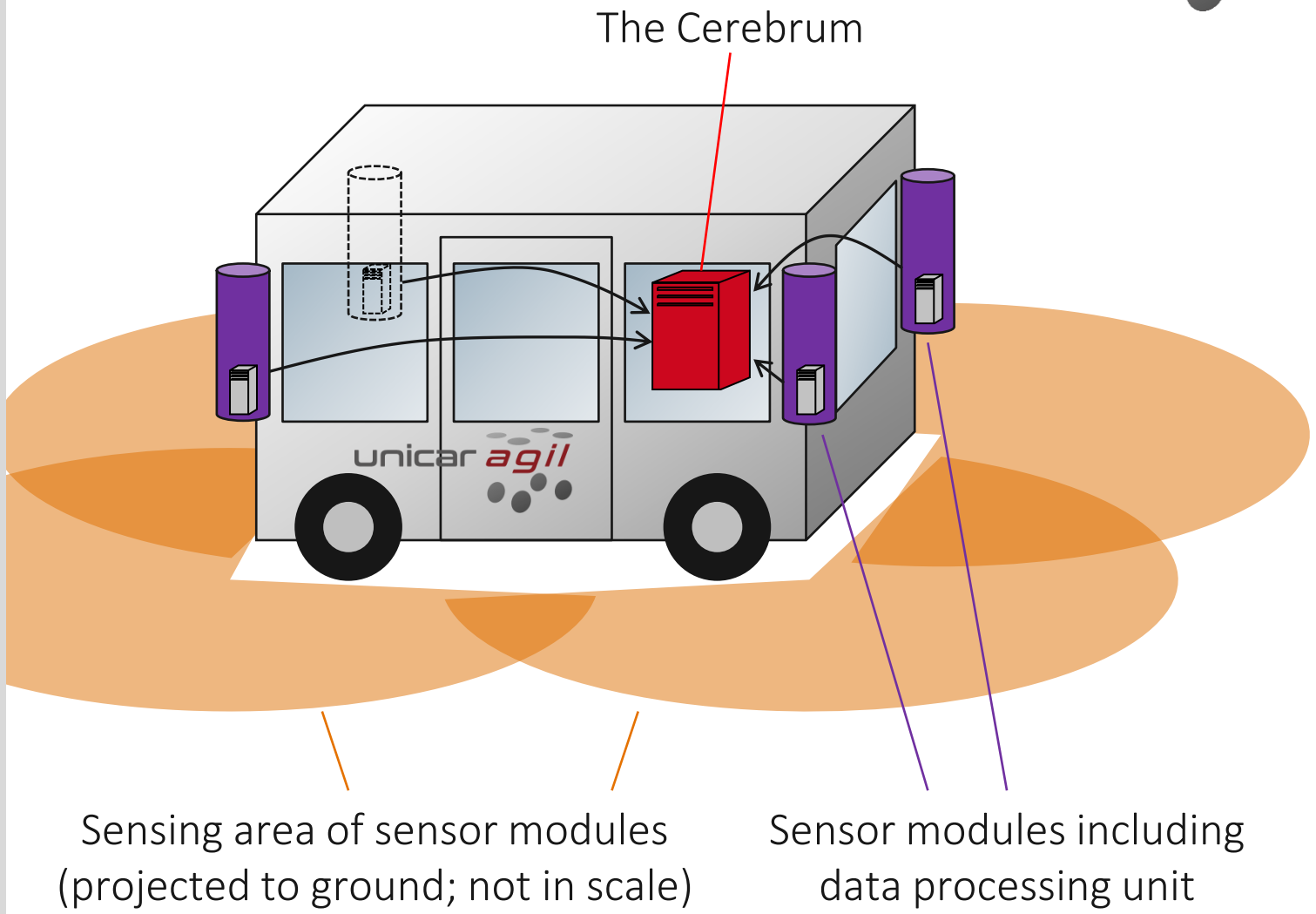


2.1 The Sensor Modules and the Cerebrum

The Cerebrum

- Collects sensor environment models from all 4 sensor modules
- Fuses sensor environment models to full vehicle environment model
- Cross-checks between sensor environment models

- Predicts behavior of other traffic participants
- Determines adequate behavior and safe future trajectory for ego vehicle
- Transmits trajectory to the brainstem for further processing



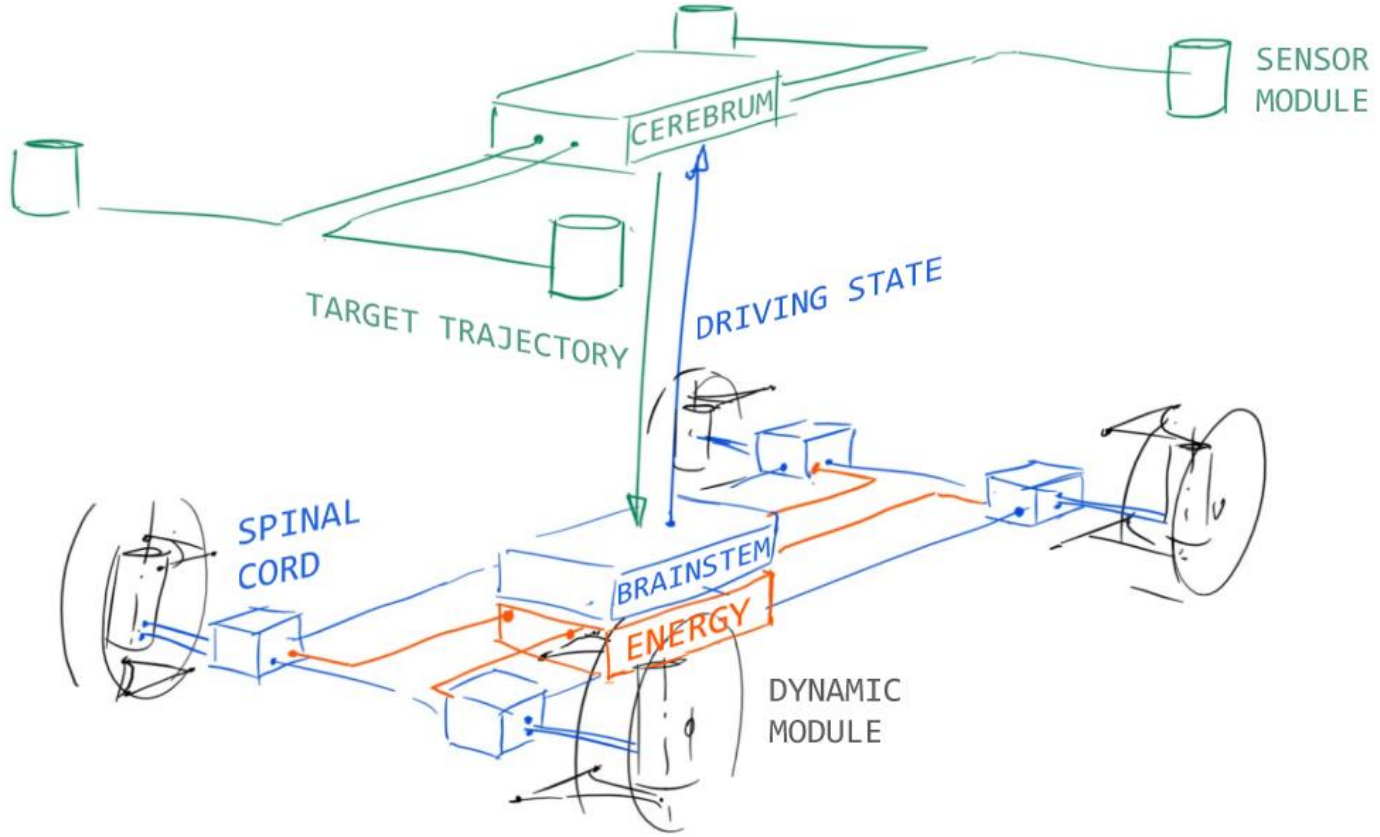
2.2 The Brainstem and the Platform Sensors

The Brainstem

- Tracking of the desired trajectory
- Fallback Level for the cerebral layer

The Platform Sensors

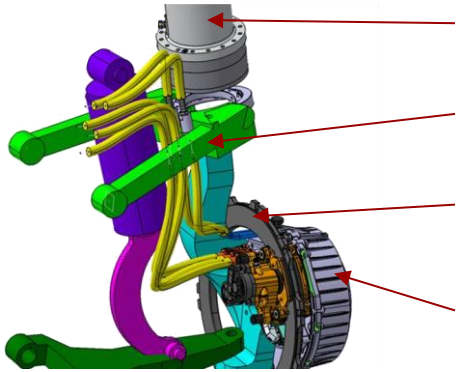
- Independent from the sensors at the cerebral layer
- Used for the “Safe Halt”, a risk-minimal vehicle transition activated in the event of a failure of an essential vehicle component



2.3 The Dynamic Modules and the Spinal Cord

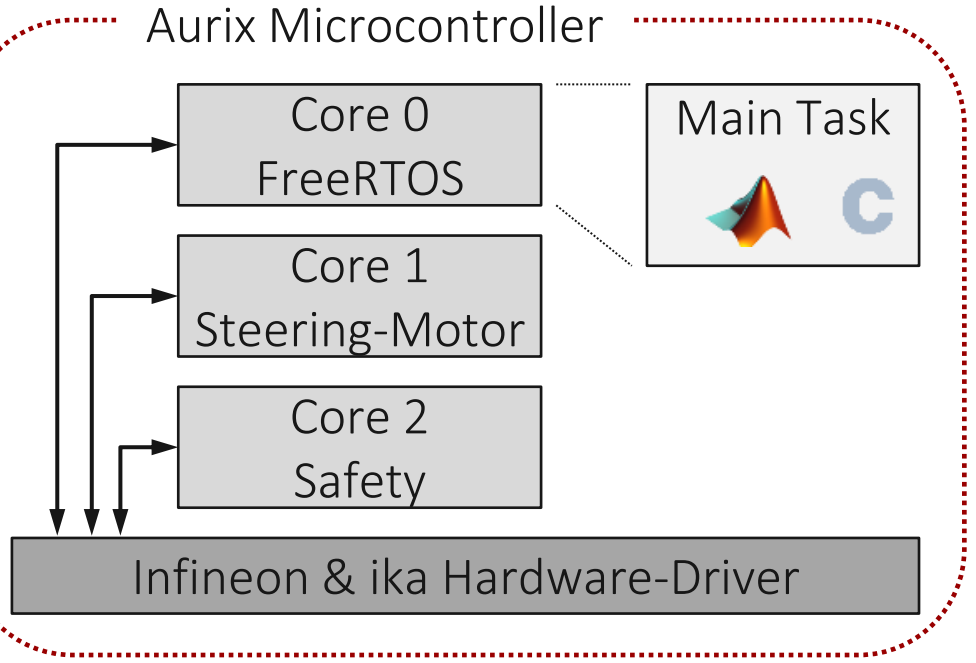
Mechatronic Module

- Highly Integrated IWD + Steering Actuator
- Steering Angles up to 90 °
- Power Electronics mounted in the Vehicle Platform



The Spinal Cord

- Hardware & Software developed at ika
- Services „Driving“, „Braking“, „Steering“
- Standard Op.: Inputs from Brainstem
- Brainstem Failure: Own Movement-Strategy, Inputs from Cerebrum
- Manual: Inputs from control devices



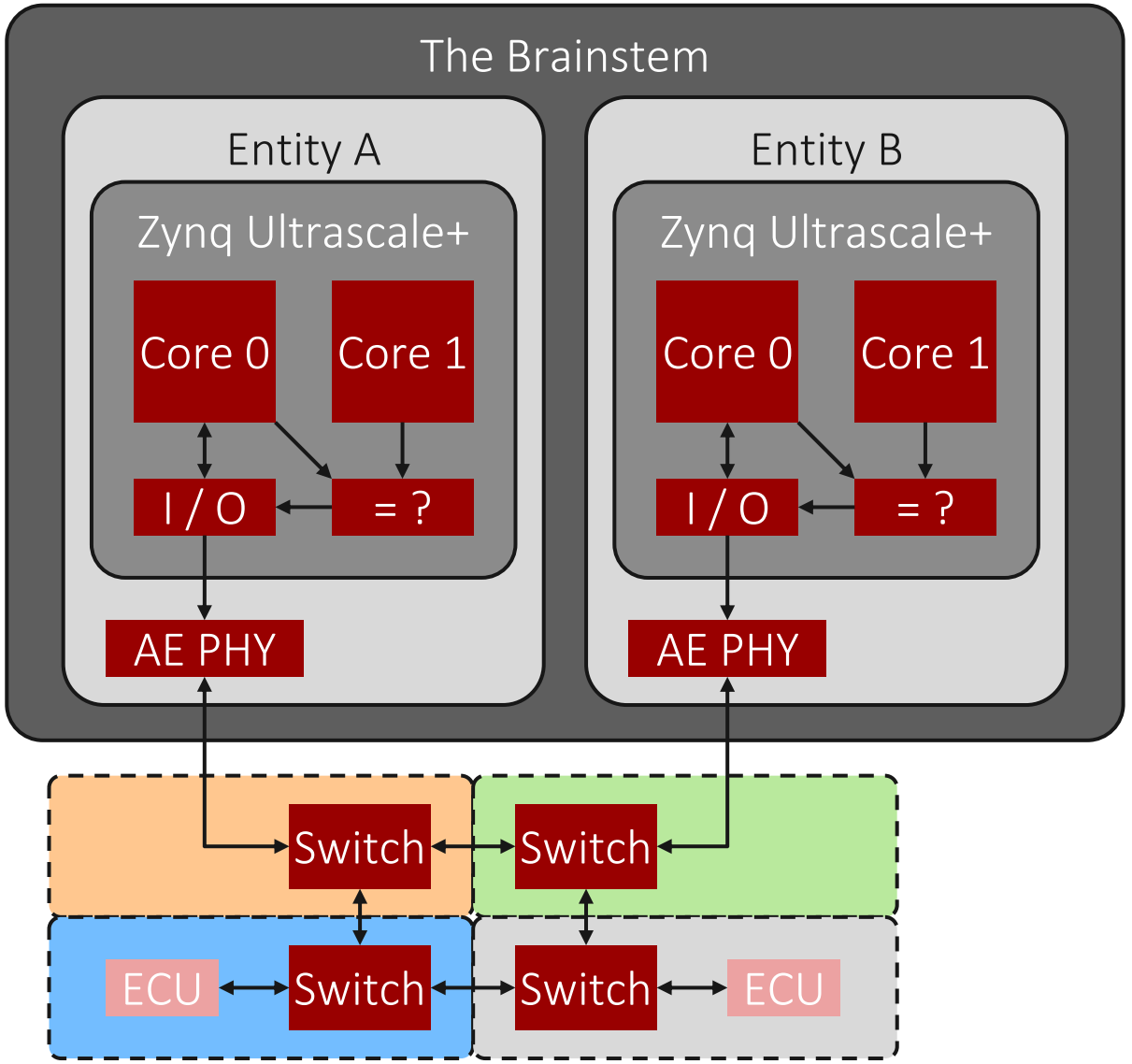
3. The Brainstem Hardware

Architecture

- Duo-Duplex Architecture:
  2 redundant entities with 2 cores each
- Lockstep Mode
- Comparison of the results, Deactivation of a Lockstep-pair if not equal

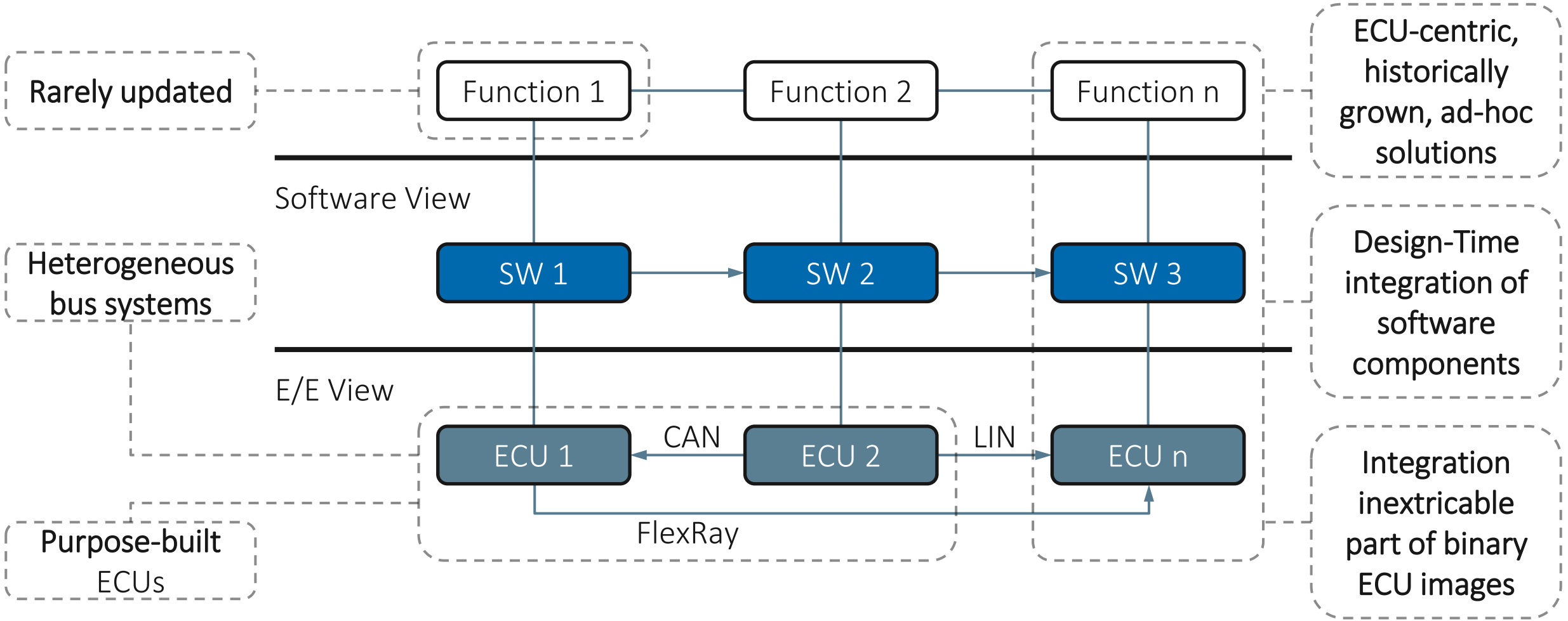
Functional Safety

- Integrity by using Lockstep
- Reliability by using 2 entities



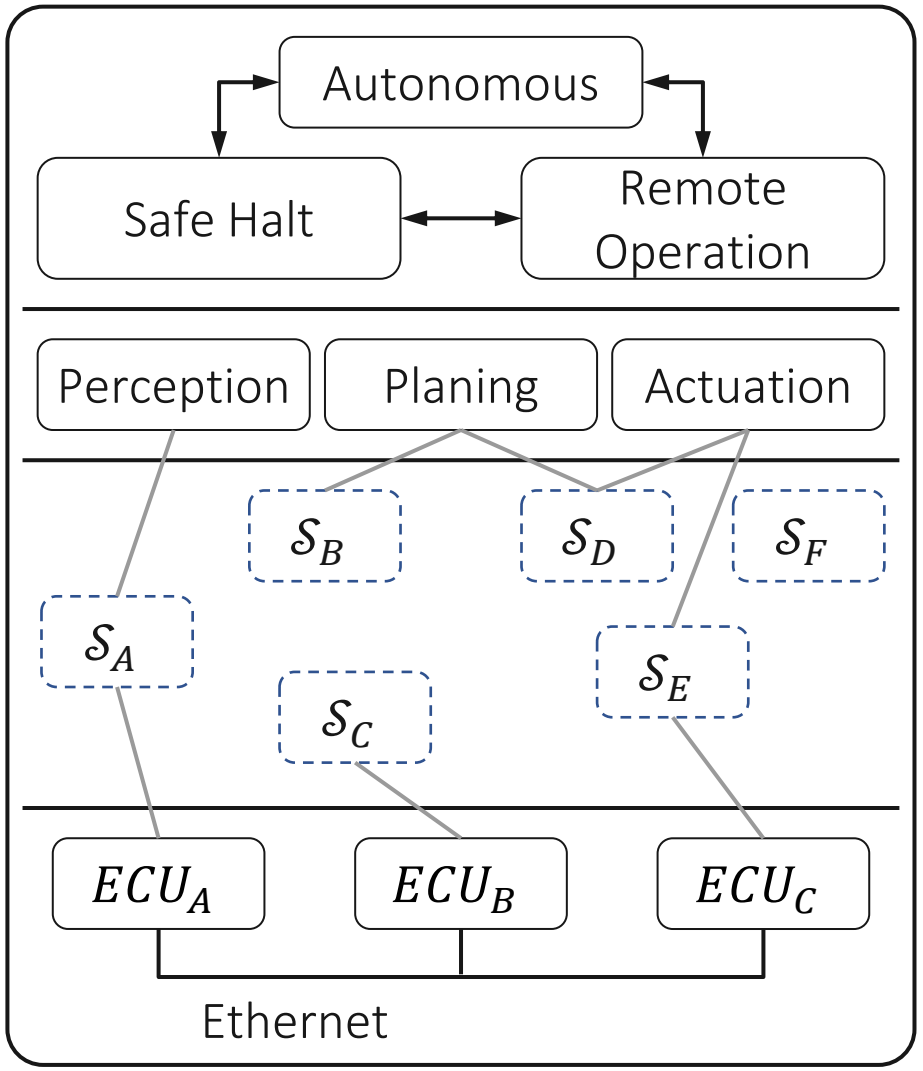
4. Automotive Service Orientated Architecture (ASOA)

Today's software architecture



4. Automotive Service Orientated Architecture (ASOA)

ASOA approach



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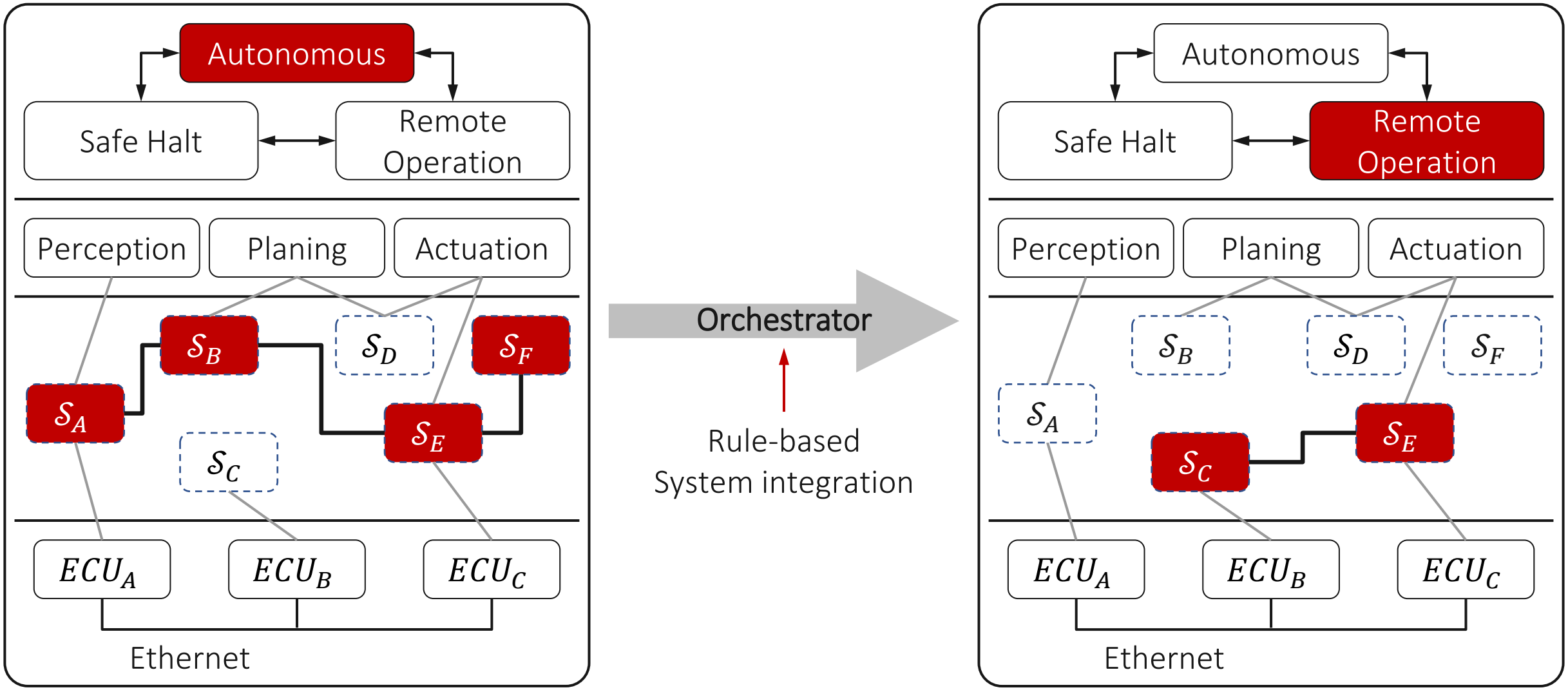
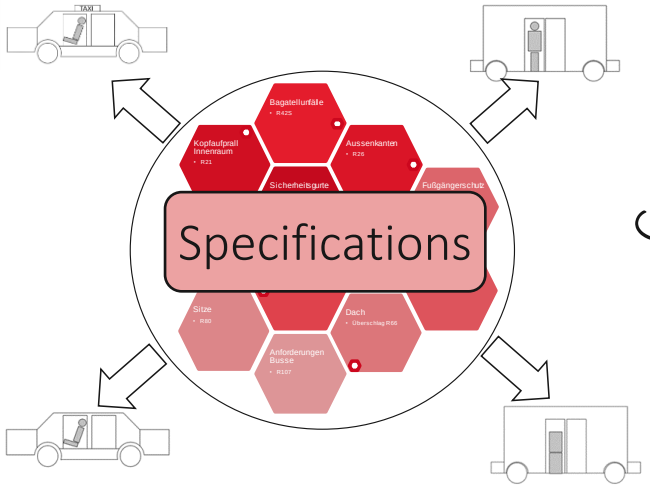
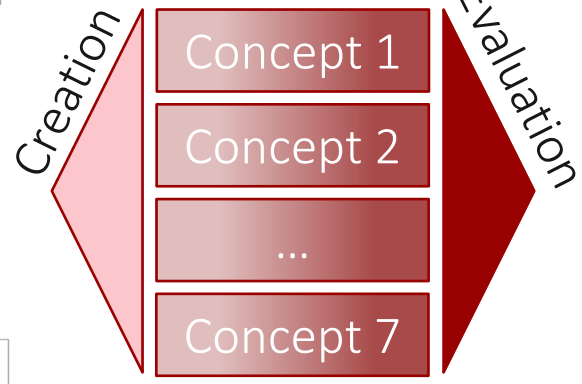
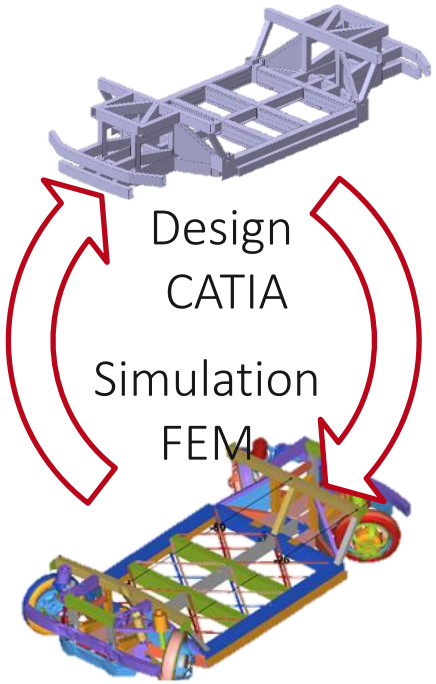
ASOA approach



5. Mechanic Architecture







Specification Phase

Sources:
- Stakeholder analysis
- Project description
- Safety requirements
- Prototype feasibility evaluation

Approach:
- Measurement concept
- Creative work
- Consideration of requirements
- Evaluation phase
- Concept selection

Design goals:
- Feasible structural model
- Assurance against requirements
- Lay-out of crash load paths
- Structural weight

Prototypical realization:
- Aluminum construction
- Profile-intensive
- Space-frame

Thank you very much for your attention.
Please feel free to ask your questions.

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The Brainstem Architecture

Functional Safety

- Main processor: Zynq Ultrascale+ by Xilinx
- 3 technologien on 1 chip:
  - 2x ARM Cortex-R (real time)
  - 4x ARM Cortex-A (calculation)
  - FPGA (low latent special tasks)
- Diverse Implementation possible