UNICAR*agil*

Disruptive Modular Architecture for Agile, Automated Vehicle Concepts

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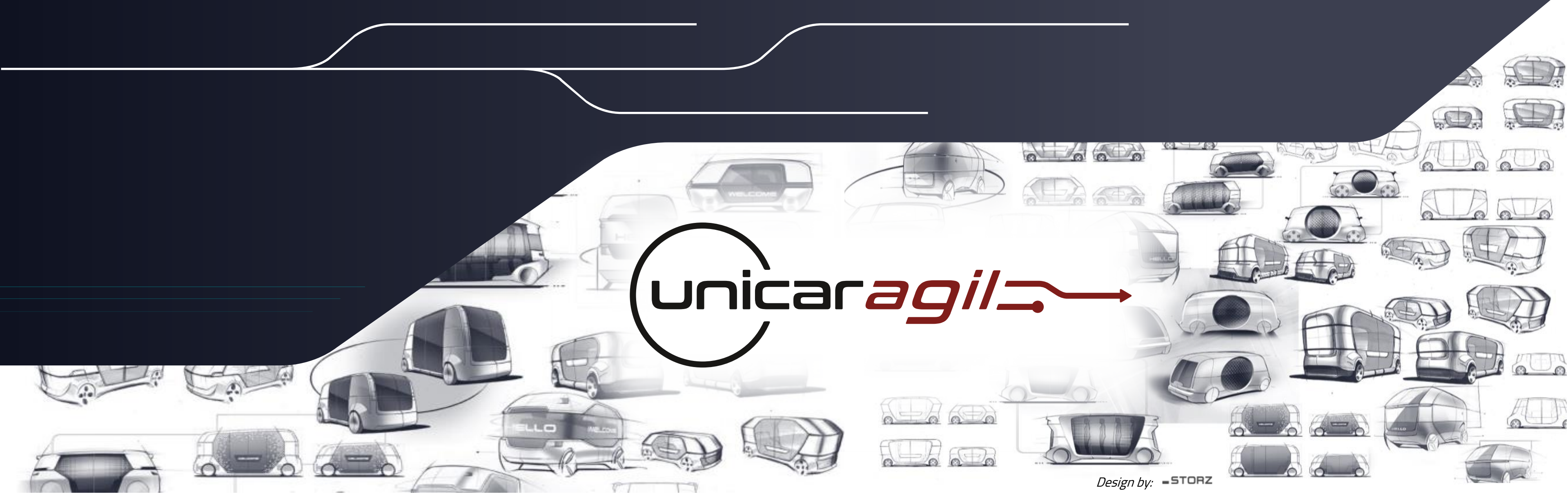

The UNICAR*agil* Project

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KEYFACTS

- ca. 32 Mio. € BMBF funding
- 01.02.2018 – 31.05.2023 (64 months)
- 15 university chairs / institutes
  8 industrial partners

OBJECTIVE

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

The Consortium

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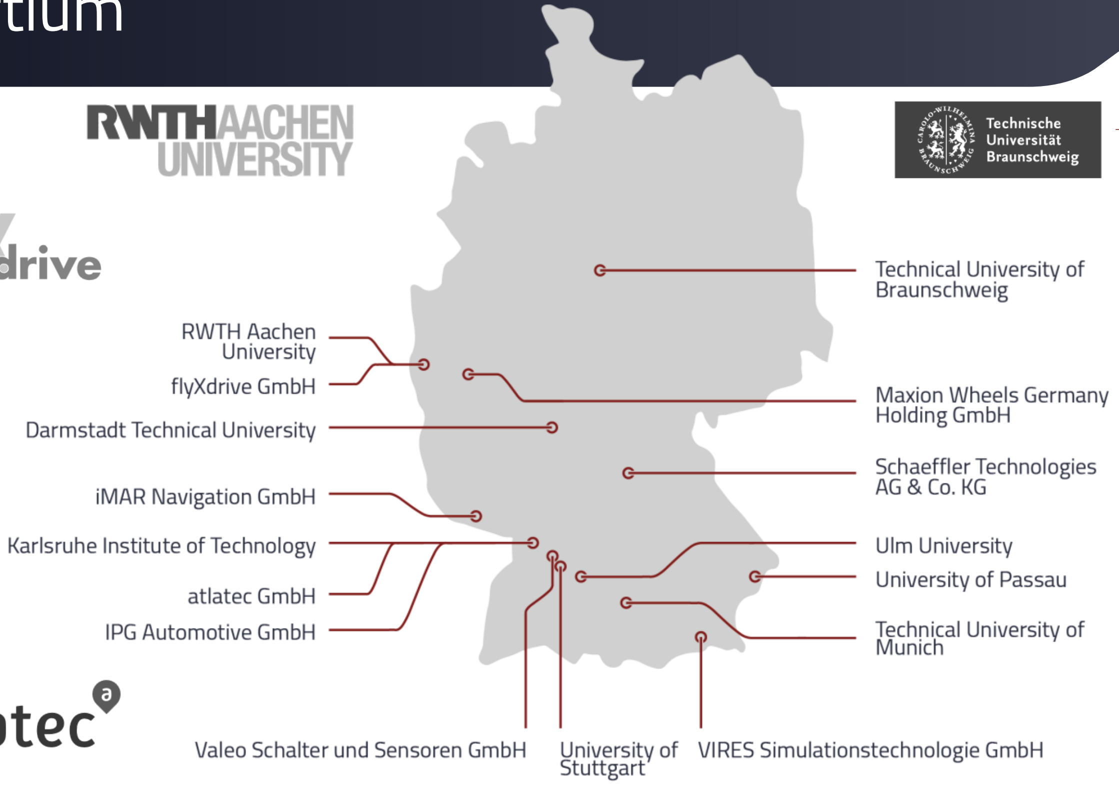

Core Innovations

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User-centered Design Approach

Consequent Modularization

Innovative Electronics System Hardware Architecture

Automotive Service-oriented Software Architecture

Collective Cloud Functions

Safety by Design

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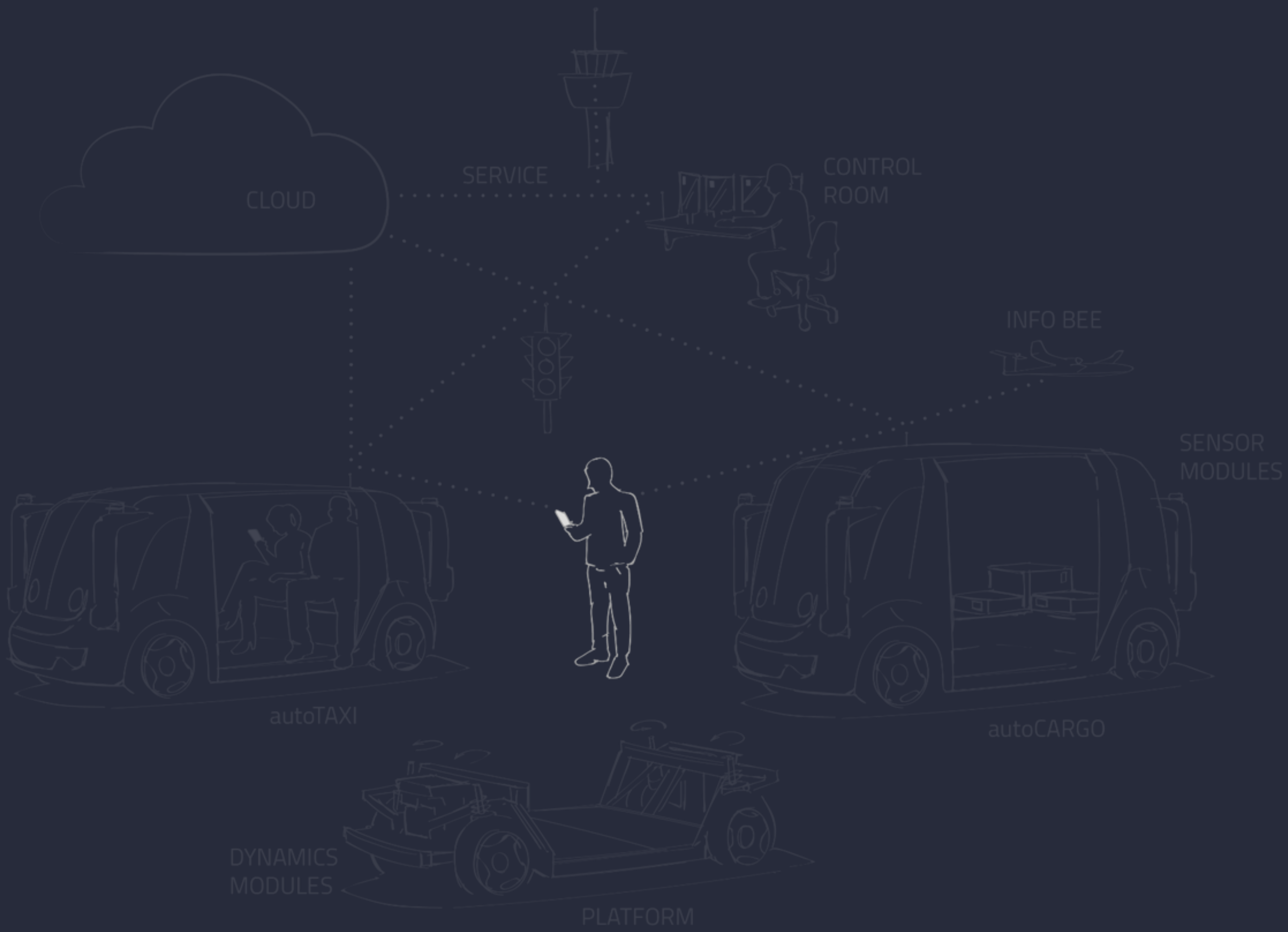
Our user-centered design approach focusses on the human being as the center for future mobility system development.


CLOUD
SERVICE
CONTROL
ROOM
INFO BEE
SENSOR
MODULES
autoTAXI
autoCARGO
DYNAMICS
MODULES
PLATFORM

Modular Driving Platform with Dynamics Modules

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use cases derived from human needs

four Vehicles built up

fully self driving

connected and driverless

autoSHUTTLE

- Supplementing the public transport system
- 6 – 8 persons

autoTAXI

- Order, open, interact with CE device
- Cooperative and agile

autoELF

- Private „Butler / Nanny“
- Private, individual, accessible & trustworthy

autoCARGO

- Pick up and delivery service
- Automated handover

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Consequent modularization creates flexibility in the usage of automated vehicles.

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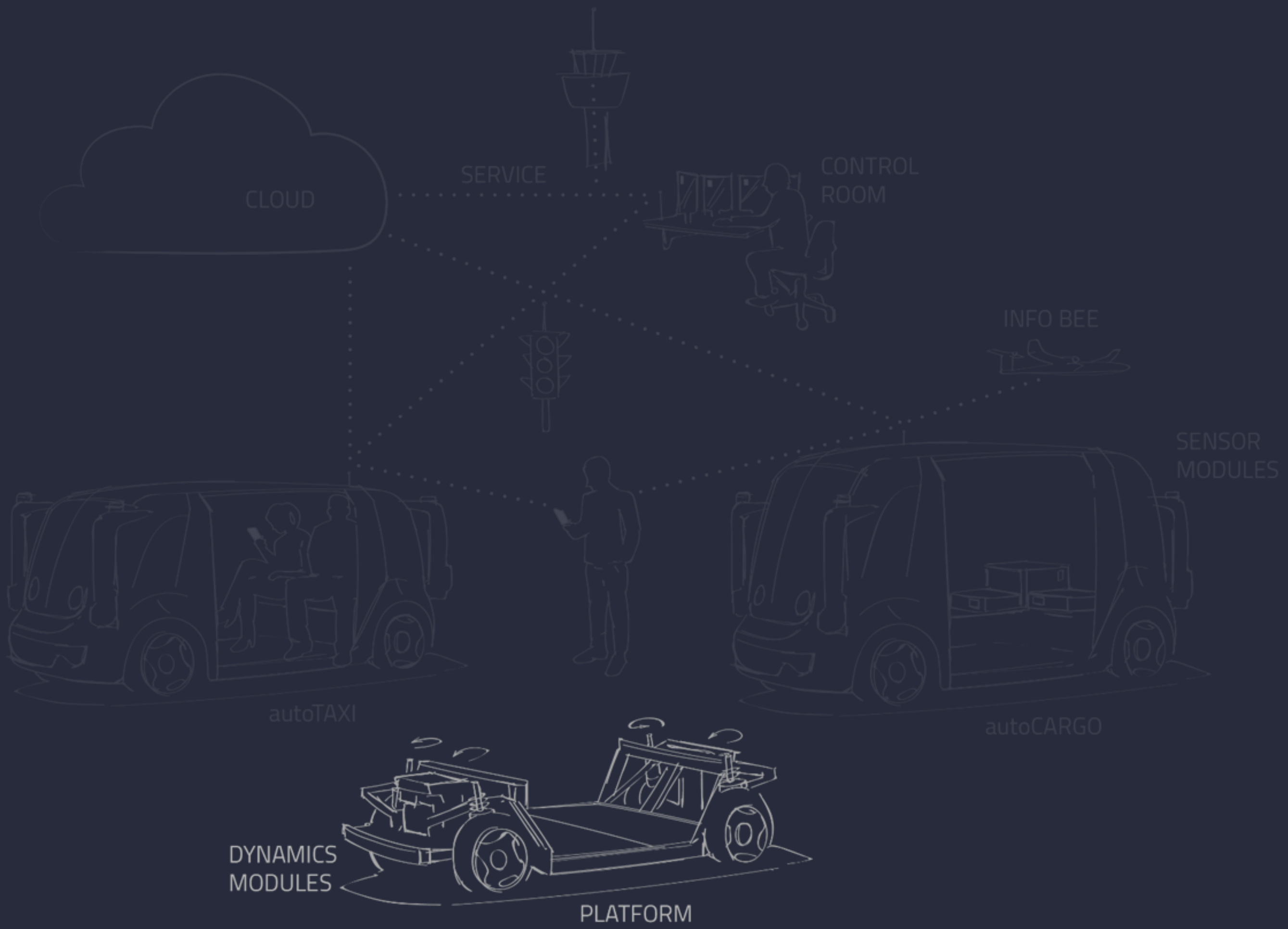
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Modular Driving Platform with Dynamics Modules

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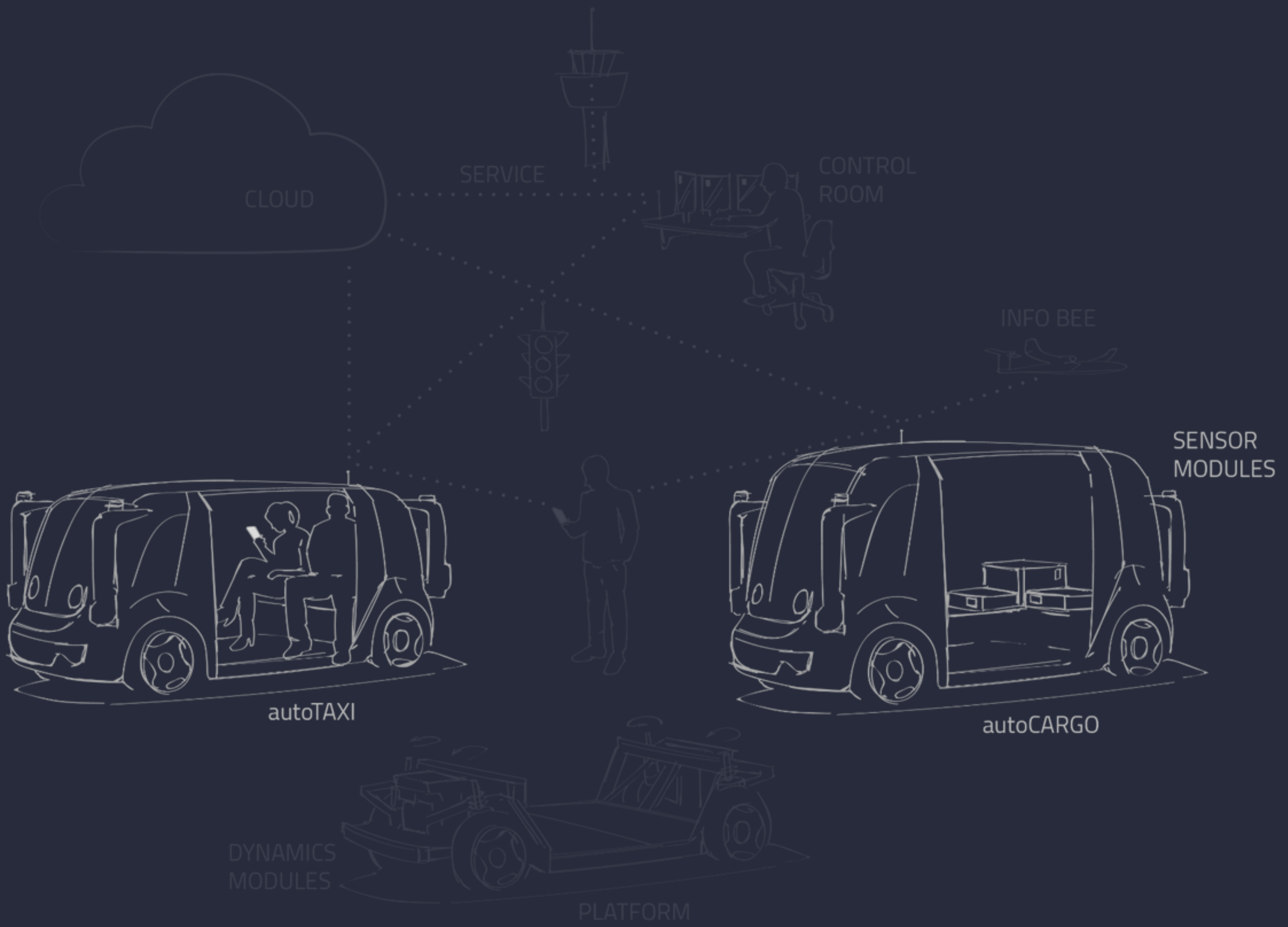
scalable in length

4 Individual Dynamics Modules

48 V energy supply

redundant platform sensors



CLOUD
SERVICE
CONTROL ROOM
INFO BEE
SENSOR MODULES
autoTAXI
autoCARGO
DYNAMICS MODULES
PLATFORM

Add-On and Sensor Modules

add-on modules scalable in height

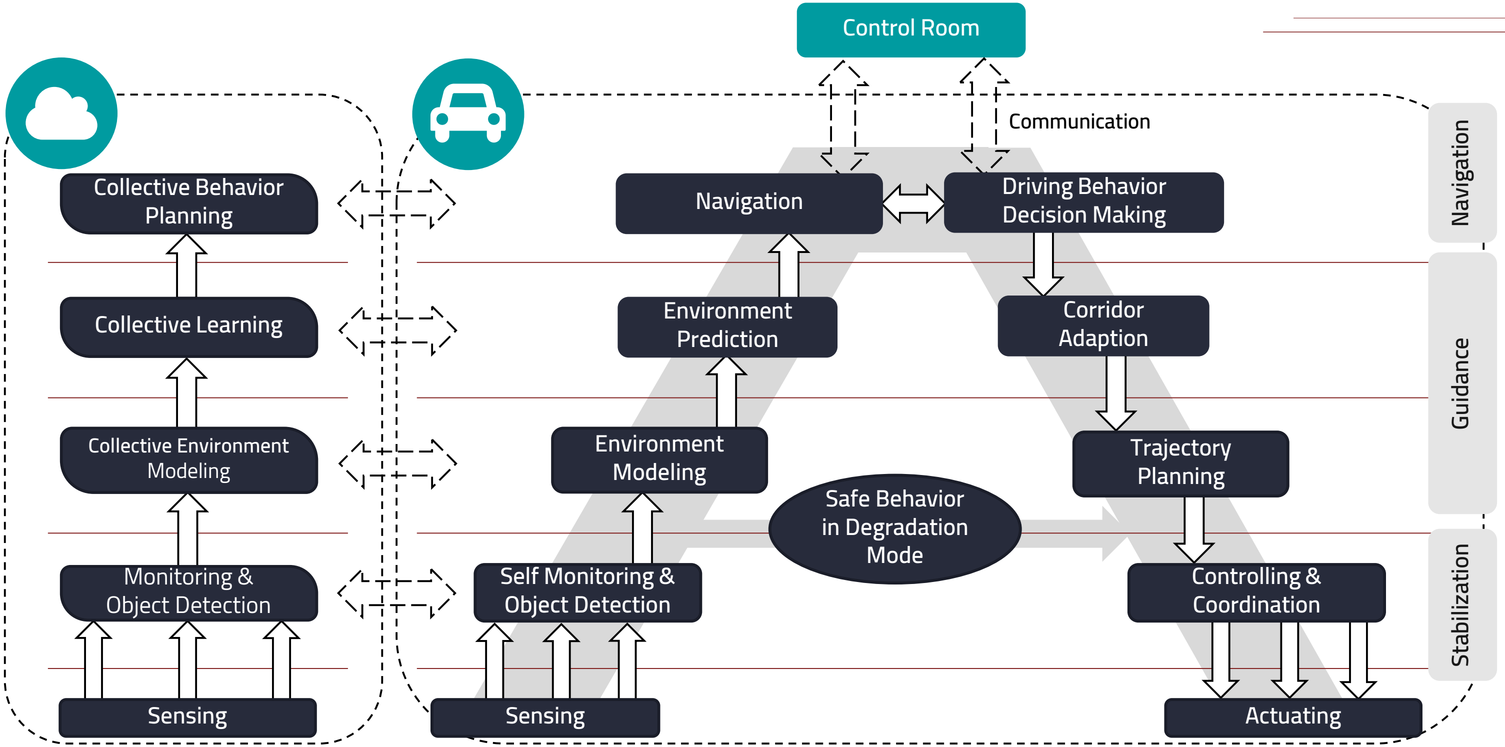
different use-cases possible

sensor modules as carry over part

sensor modules combine three different sensor principles

sensor modules fail-operational environment perception

Functional Architecture



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Our innovative electronics system hardware architecture enables the implementation of efficient and safe ECUs.

Mechatronic Architecture

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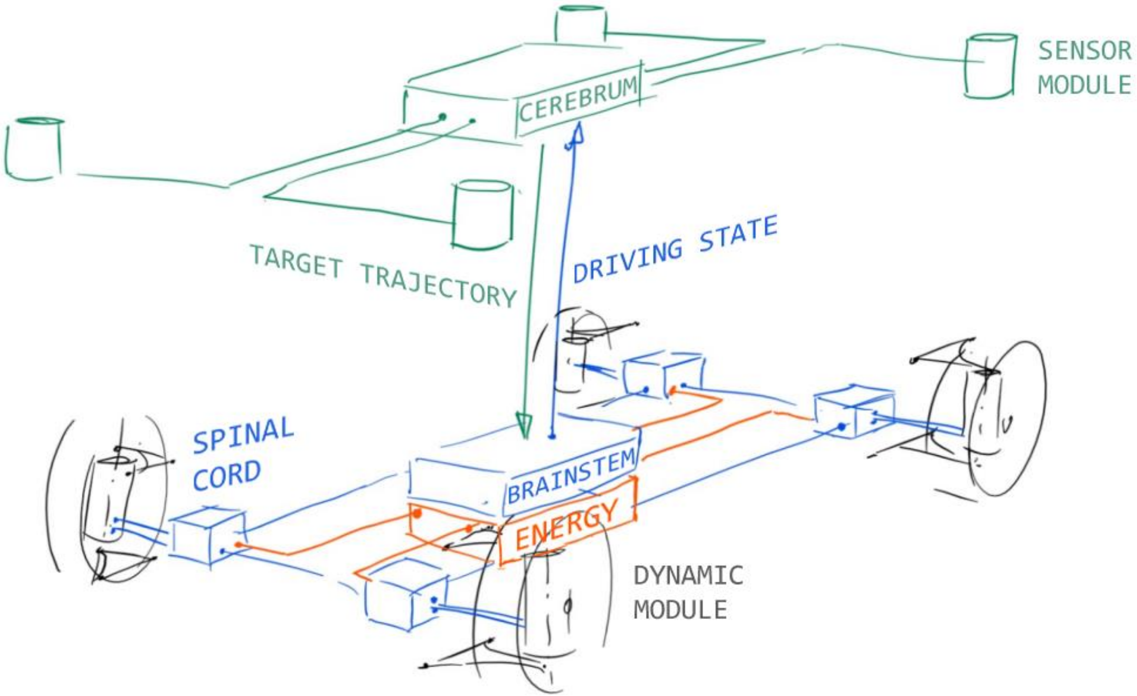

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The automotive service-oriented software architecture (ASOA) is the basis for upgradeable and updatable software for automated mobility.

ASOA - Automotive Service Oriented Software Architecture

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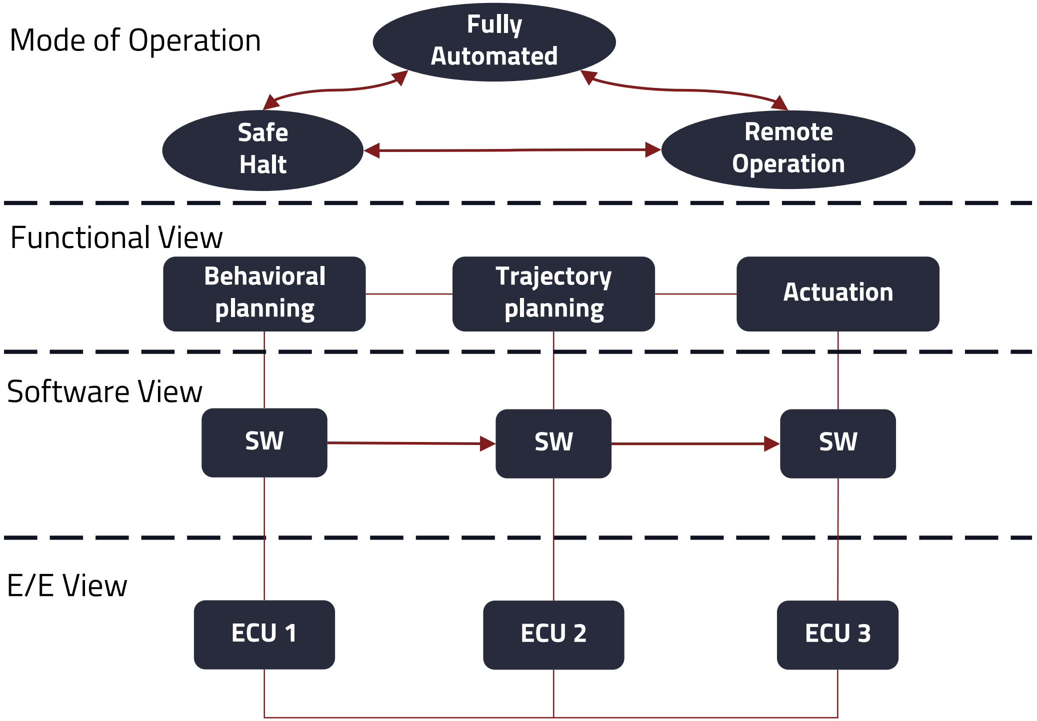
Classic Approach
- SW integrated at design-time
- Hard to update, repurpose, replace

ASOA
- SW integrated at run-time
- Machine interpretable service specification
- Easy to repurpose, update, replace
- Transparent implementation across various computer platforms



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ASOA - Automotive Service Oriented Software Architecture

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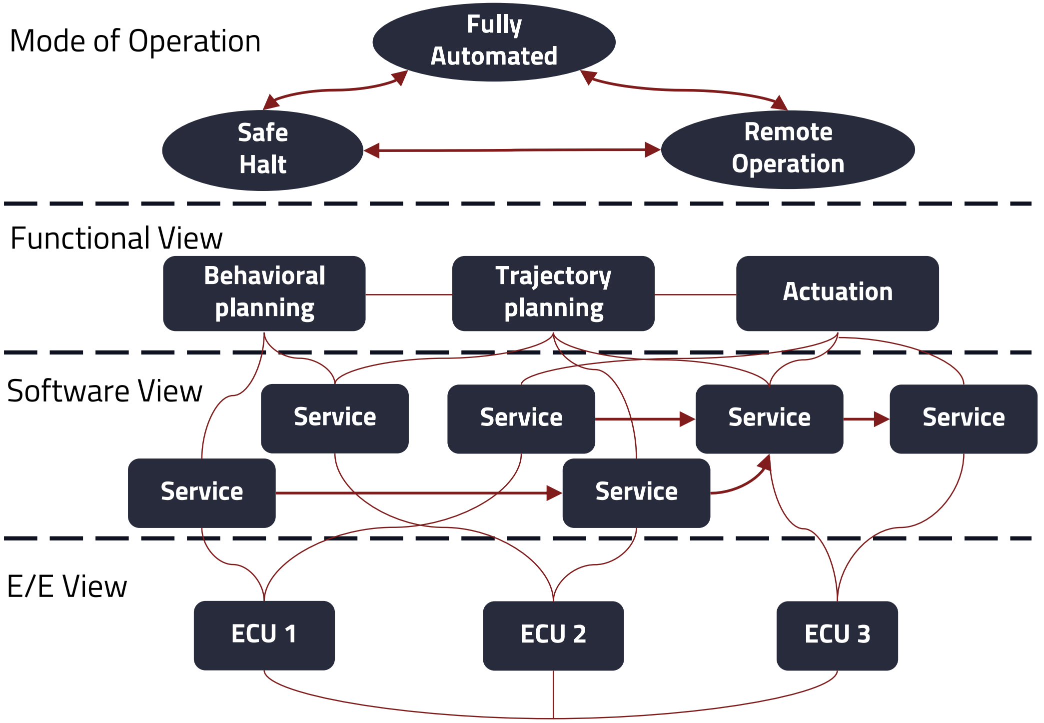

ASOA - Automotive Service Oriented Software Architecture

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Example: Motion Control

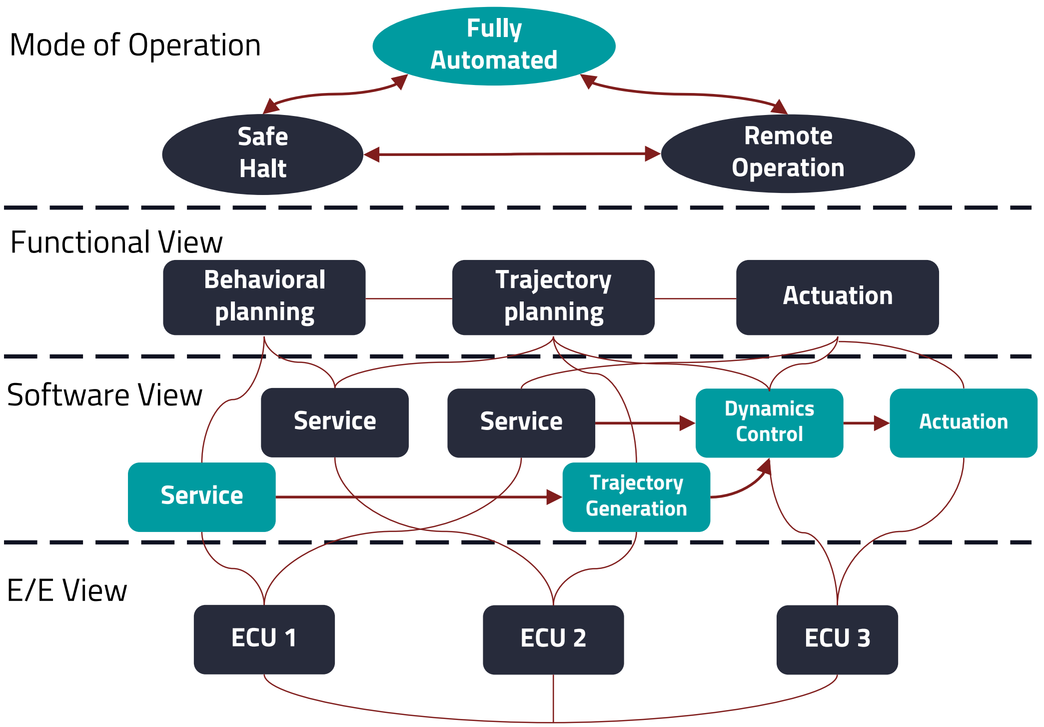
Vehicle Dynamics State Estimation

- High demands on availability and accuracy
- Two dissimilar multi-sensor data fusion setups

Vehicle Dynamics Control

- 3-DoF motion control: x,y,ψ
- High over-actuation

→ New possibilities in vehicle's driving dynamics design



ASOA - Automotive Service Oriented Software Architecture

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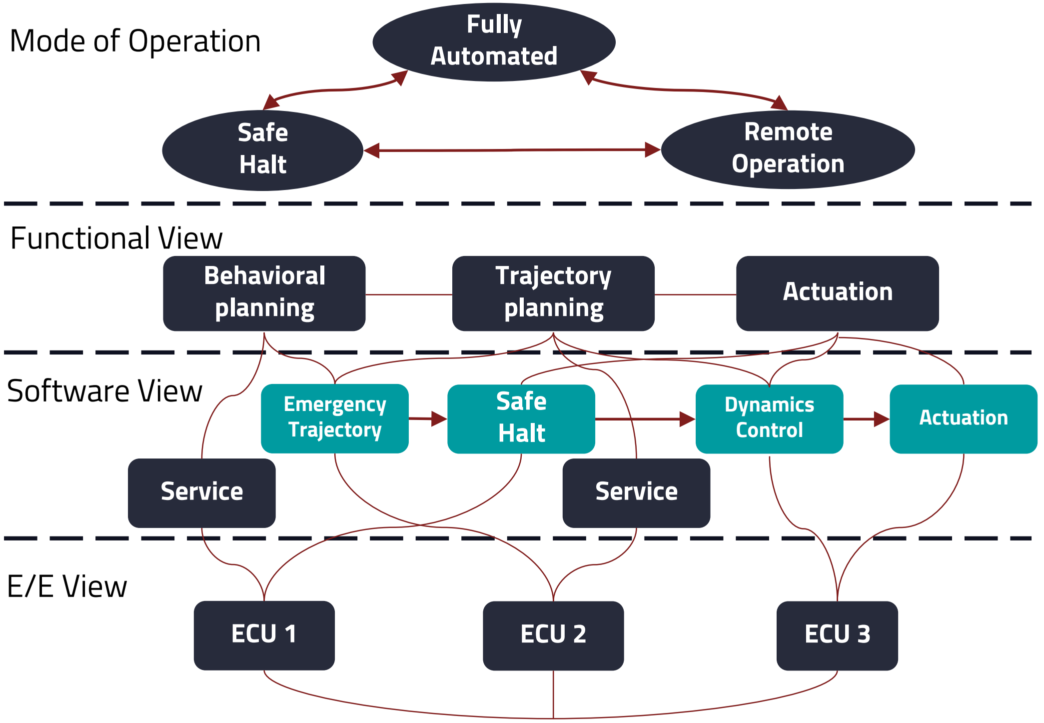
Example: Safe Halt

- Capable to transfer the vehicle into a risk-minimal state
- Additional sensors to check the free space
- Separate emergency trajectory



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Cooperative and collective cloud functions and an accompanying control room support the vehicle automation.

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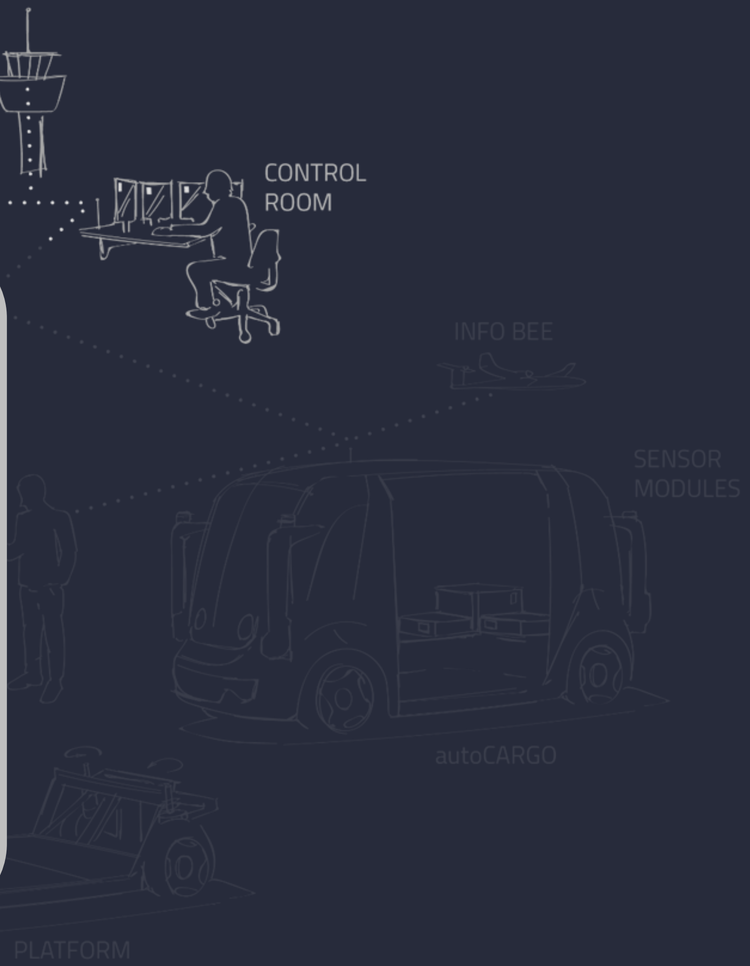
Remote or trajectory approval vehicle operation

Service center for emergencies or sovereign interventions



Additional information for automated driving function

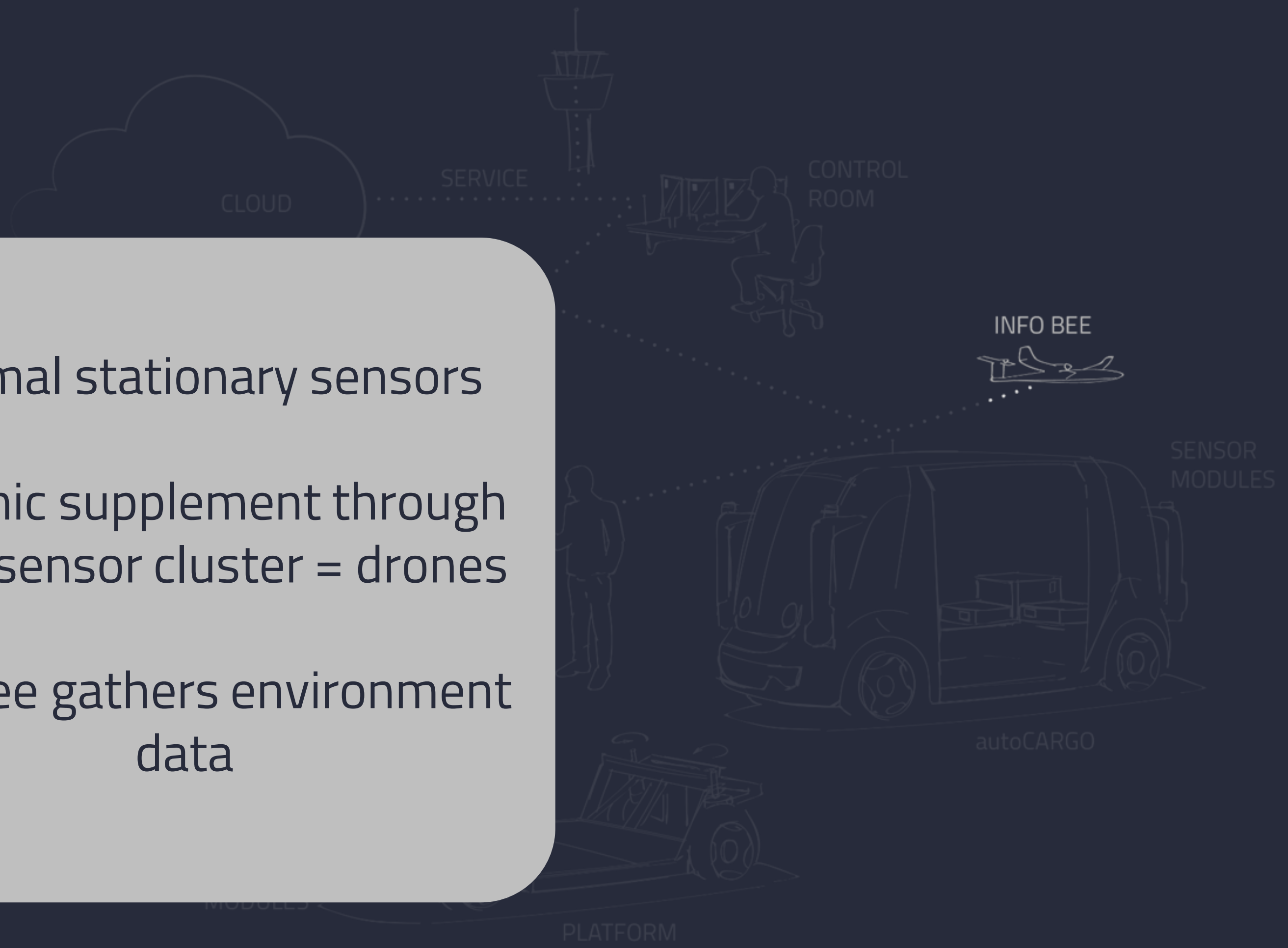
Collective **E**nvironment **M**odel

Collective Traffic **M**emory

minimal stationary sensors

dynamic supplement through flying sensor cluster = drones

Info Bee gathers environment data



Safety and Security by Design

Consistent safety orientation enables the development of safe autonomous vehicles from idea to approval.

SAFETY – Key Property of Automated Vehicles

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Self-Awareness

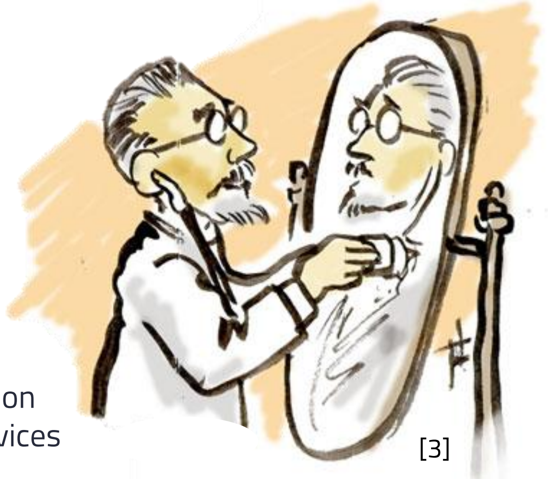
No Human Driver to Monitor Vehicle Health and Behavior

➔ Vehicle needs to become aware of its current capabilities

➔ Self-perception & self-representation as key safety feature

- Self-Perception
  - Software & hardware components provide information about their current quality of service, also including security aspects

- Self-Representation
  - Aggregation of all quality of service information into a holistic representation
  - Provides this information of the vehicle's current capabilities for other services
  - Vehicle behavior can be adapted to its current capabilities



[3]

[3] travelingboy.com

IT - Security

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Remote and local attacks on connected vehicles must be prevented.

Objectives

- Authentication of communication → Avoid manipulation of network traffic
- Mutual ECU attestation → Avoid manipulation of ECU software
- Secure storage of cryptographic keys → Avoid theft of cryptographic keys
- Runtime security measures → Detect attacks on runtime
- Secure over-the-air ECU updates → Enable software updates in a secure way
- Privacy protection → Avoid passenger tracking

Challenges

- Low impact on latencies and transparent integration
- Security-safety concept: map security issues on safety measures

Verification and Validation

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Safety approval by test drives for an autonomous vehicle requires billions of test kilometers[4], for each revision

„Approval Trap" [4]

High System Complexity

Real World Complexity

Modular Safety Approval

Categorization of the Road Network

[4] Wachenfeld and Winner, 2016. The Release of Autonomous Vehicles. In: Winner et al. Autonomous Driving.

Verification and Validation

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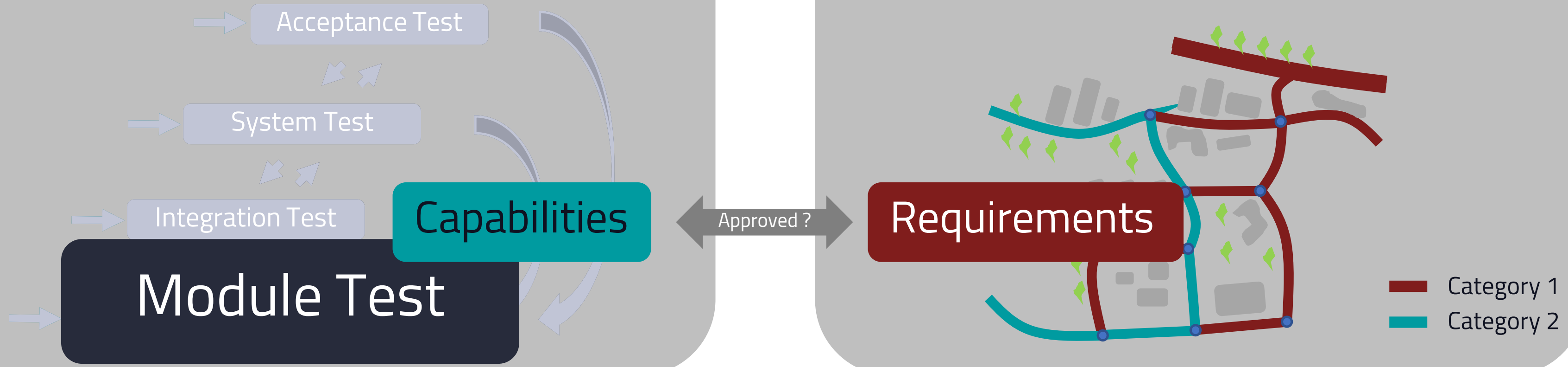
Modular Safety Approval

- More control of the parameter space
- Changes of one module shall not require verification of other modules

Categorization of the Road Network

- Segments of different requirements
- Safety approval for each category
- Verification of the required capabilities for segment categories



Outlook

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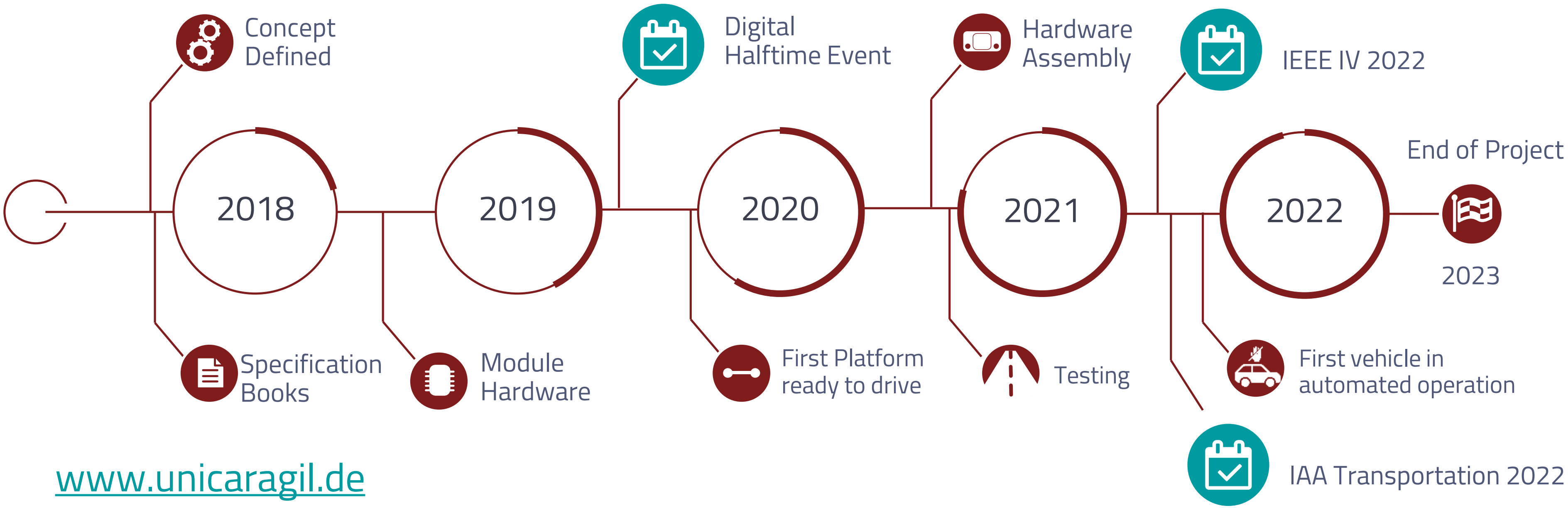

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