CODE4EV: Collaborative Development Framework for Electric Software-defined vehicles

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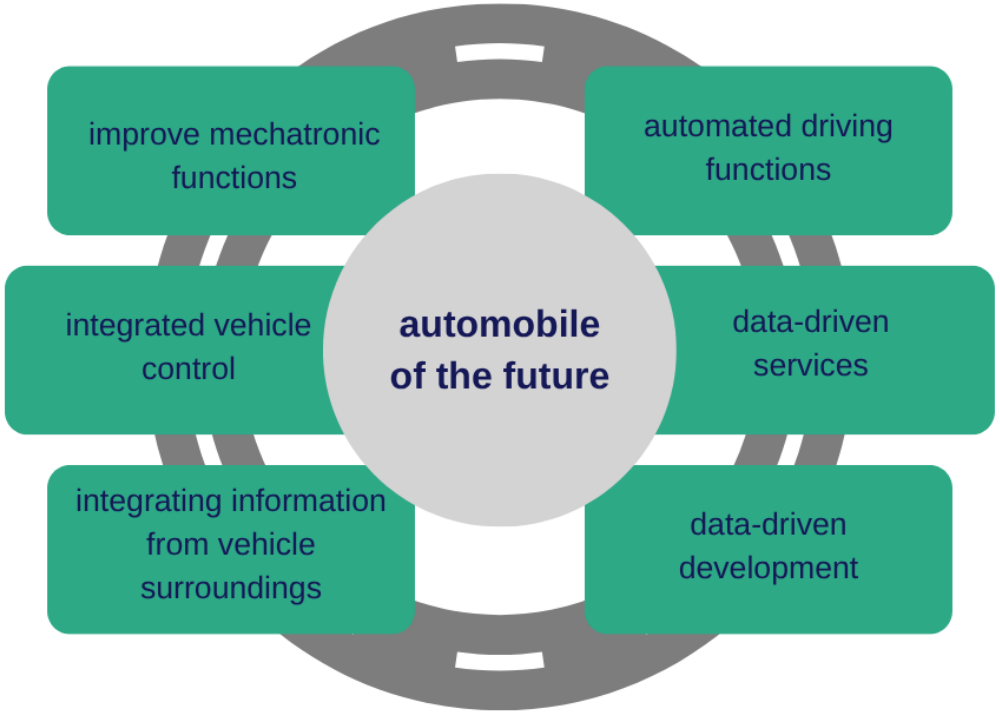
Funded by
the European Union

Evolution of the automotive industry

societal needs

- reduce greenhouse gas emissions
- reduce road fatalities
- support mobility for all
- increase European competitiveness

key enabling technologies



Sources: [1] CINEA, 2022; [2] UNFCCC, 2015; [3] EC, 2019; [4] EU, 2025; [5] EC, 2021; [6] EC, 2020; [7] EC, 2016 / © *Armengaud Innovate*

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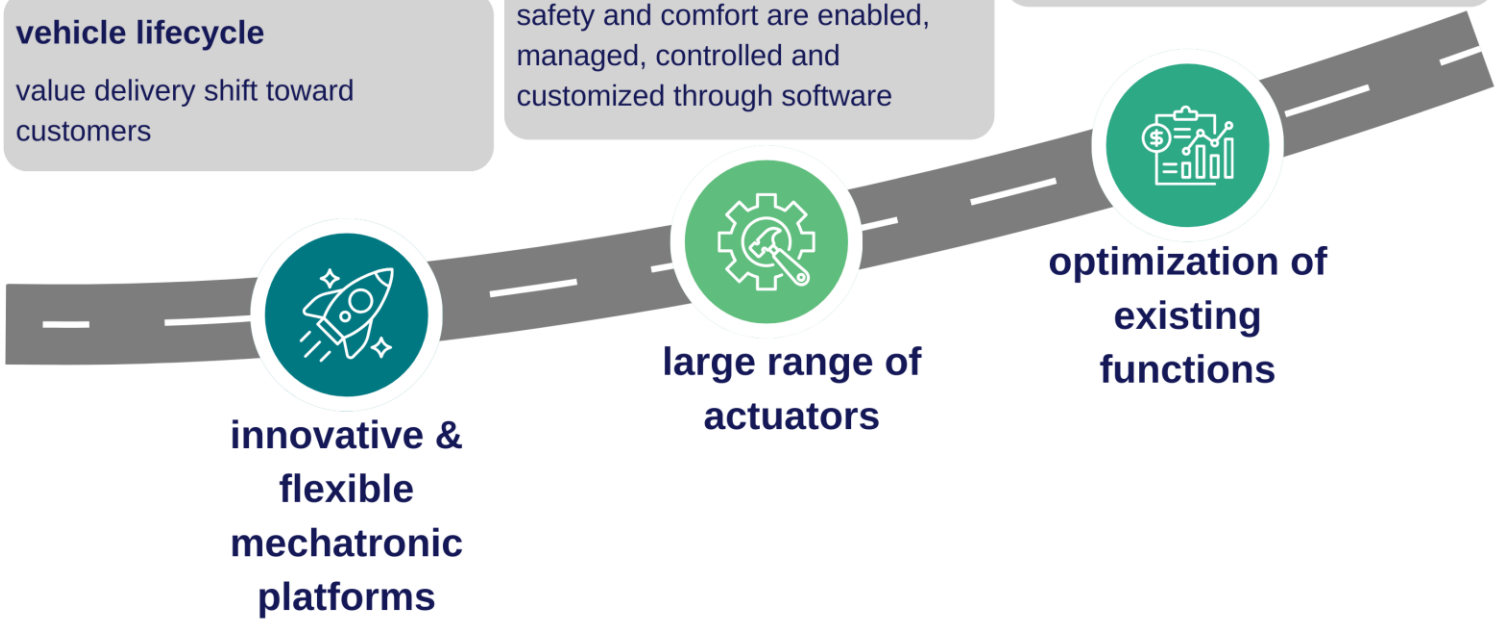
Software defined vehicle

KEY ASPECTS	DEFINITION	QUOTE
vehicle development integration of software development methodologies	**an automobile that relies on digital technology** all functionalities incl. driving, entertainment, communication, safety and comfort are enabled, managed, controlled and customized through software	“It isn’t about the bits and bytes or the number of sensors and cameras - it’s about the customer experiences we build.”[1]
vehicle lifecycle value delivery shift toward customers		



Sources: [8] O'Reilly Media, Inc., 2023; [9] Strategy & PwC, 2024 / © *Armengaud Innovate*

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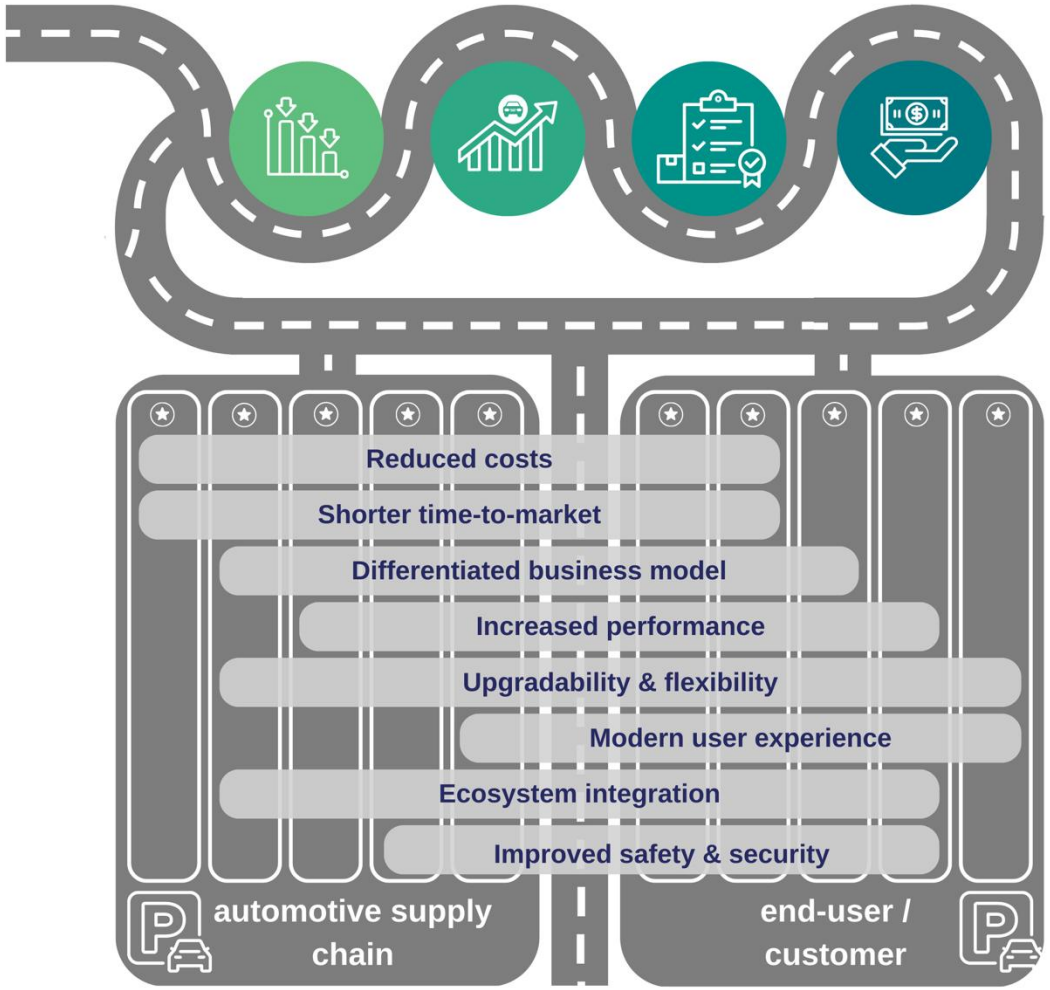
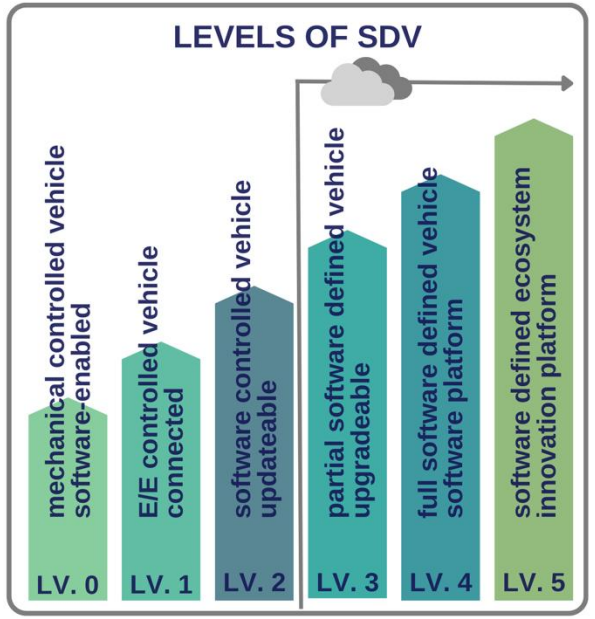
Benefits of SDV



- reduce the number of variants for the subsystems
- increase the degree of customization of the vehicle
- increase quality & enable continuous improvement
- accelerate verification & validation activities



Sources: [10] O'Reilly Media, Inc., 2023; [11] Strategy & PwC, 2024 / © *Armengaud Innovate*

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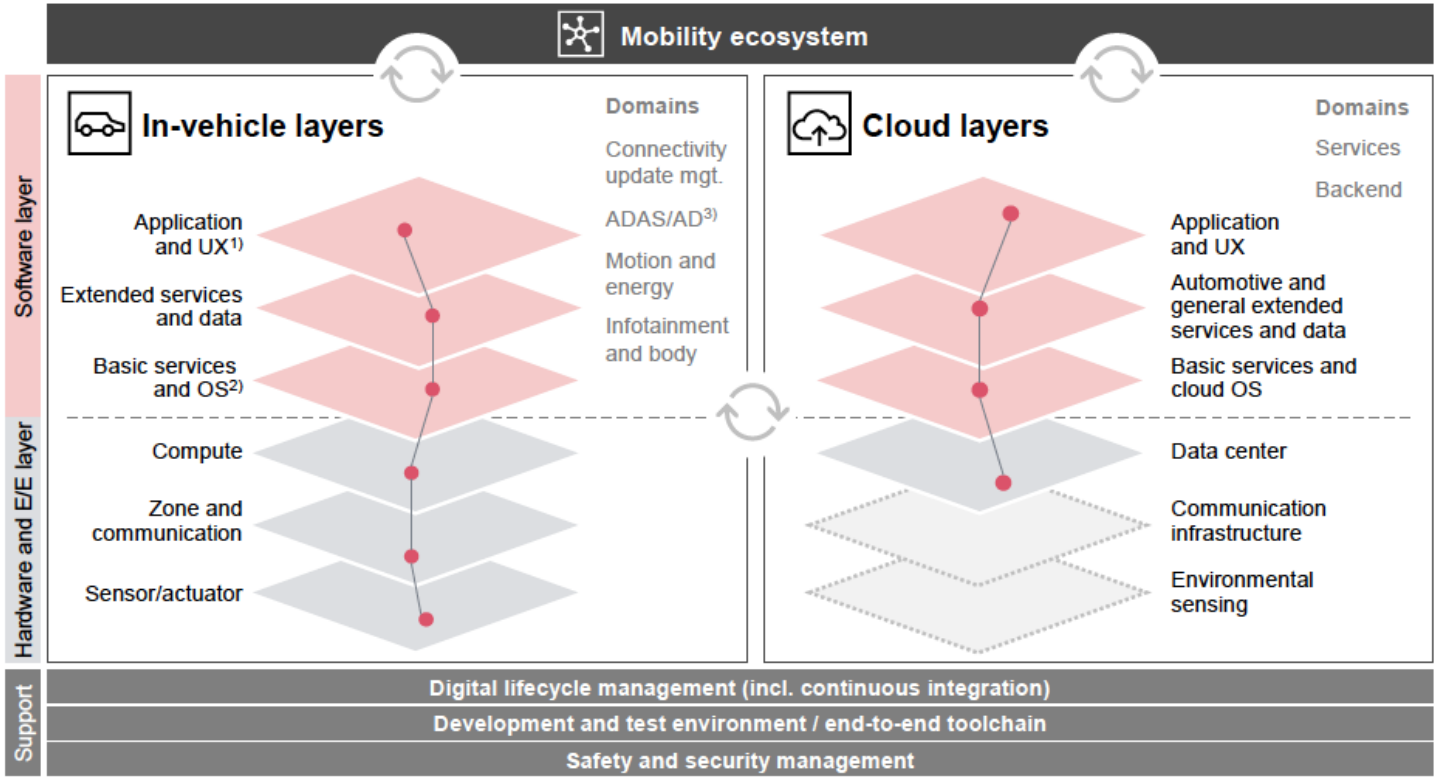
Vehicle architecture



SDV architecture highlights

- Includes **in-vehicle** and **cloud components**
- **Separation** of **hardware** and **software** for **rapid updates** and **hardware-independent software operations**
- Separation is achieved through a **layered architecture** akin to those used by hyperscalers
- Enables **modular development** of **software**, together with **other players**
- **Applications** and **functionalities** are created by **combining** underlying **services across layers**
- **Services** are used across and within layers via **standardized APIs**[4)]

Software-defined vehicles – revolutionizing the automotive industry
Strategy&

Access via standardized interfaces 1) UX = User experience 2) OS = Operating system 3) ADAS/AD = Advanced driver-assistance system 4) API = Application programming interface

November 2024
6

PwC, 2024, What is an SDV (Software Defined Vehicle)? Defining SDVs beyond just vehicles, Shinichiro Watanabe and Shuhei Itoda, available at https://www.pwc.com/jp/en/knowledge/column/definition-of-sdv.html

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CODE4EV: key facts

software-defined vehicles (SDVs) play a crucial role in the automotive landscape of the future

Development of digital design tools and a reliable methodology for electric SDVs in 3 use cases:

- Collaborative Development Framework
- Tailored Electric SDV architecture
- Optimal Powertrain Design & Control
- EV Health Monitoring & Predictive Maintenance
- Smart motion control

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CODE4EV: key facts

Started in January 2025
Project duration 36 months
Coordinated by TU Ilmenau, Germany
Costs of the project amount € 4.995.981,25

14 partners from eight European countries

Project consortium
Technical University of Ilmenau
AGH University of Krakow
Armengaud Innovate
Aptiv Services
Austrian Standards International
BET Motors
Elektrobit Automotive
Elaphe Propulsion Technologies
FAE Technology
Heron Sports
Instituto Tecnológico de Aragón
Siemens
TTTech Auto
Université de Lille

Industrial Advisory Board
AUDI
HONDA
ZF-TRW
FEDERATE
Sarolea Motorcycles

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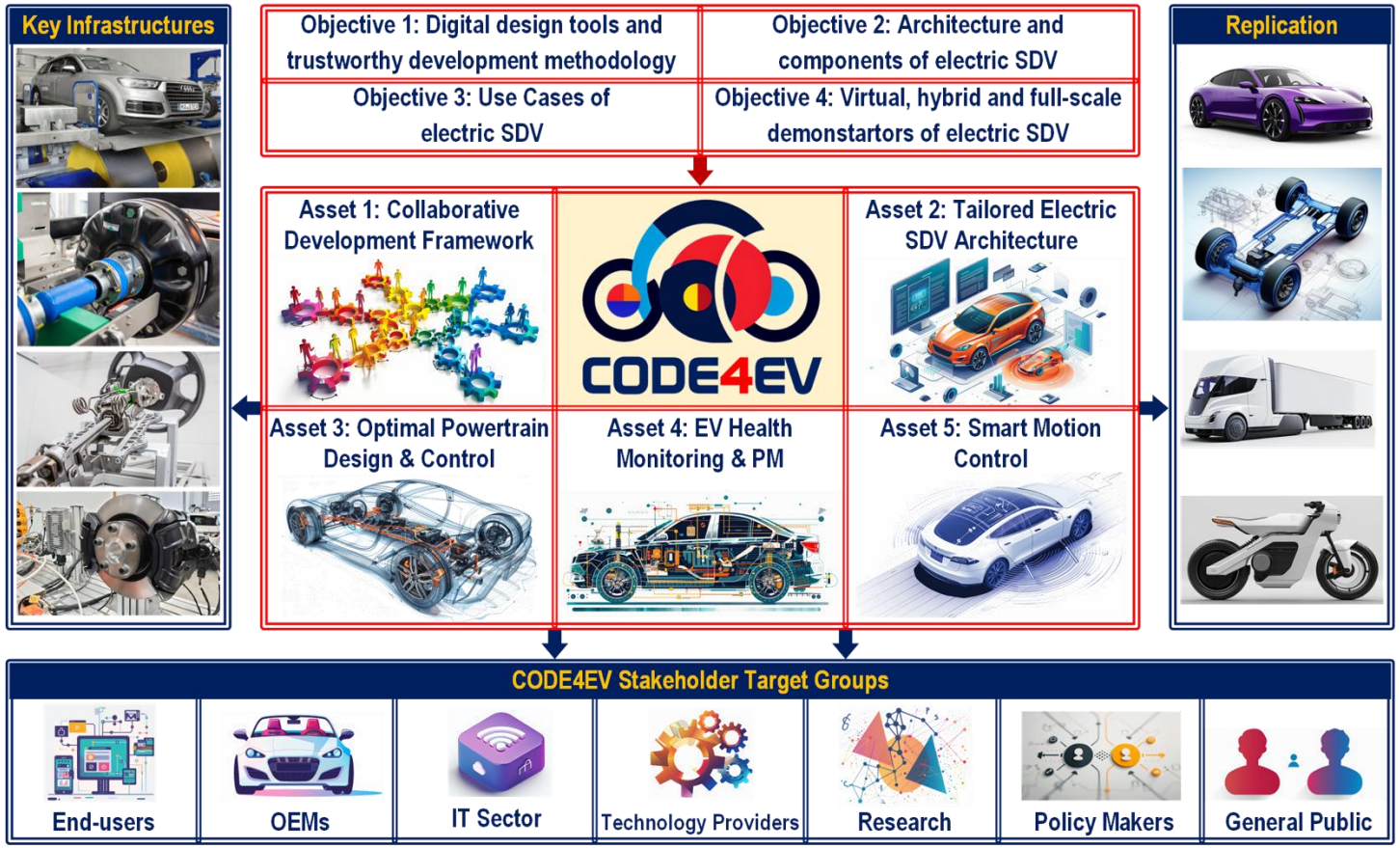
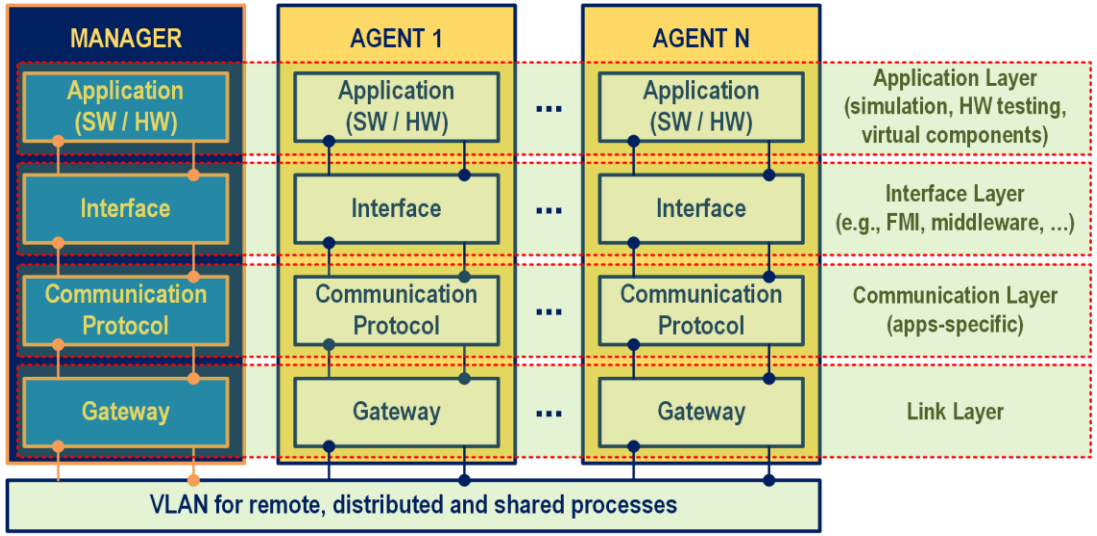
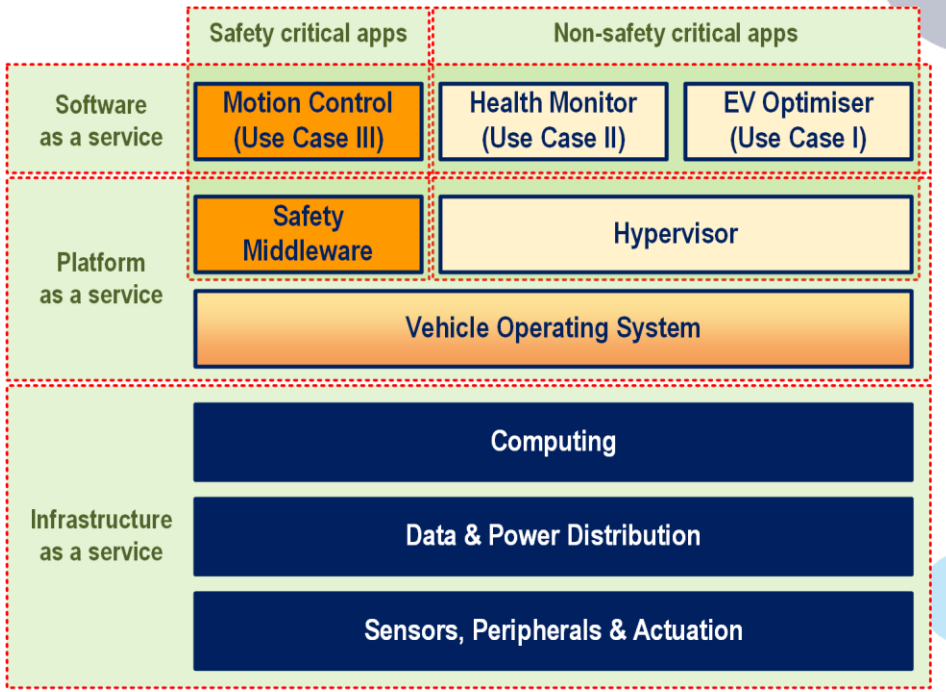
CODE4EV: objectives

Not New SDV but Design Process



CODE4EV: CoDe-Framework - Concept





- (Real-time) connection of labs, testing facilities, and developers in **different geographical locations**
- **Manager** - cloud-based hub with global vehicle model and emulated on-board software (VehicleOS, middleware, apps et al.)
- **Agents** – local hosts that can (i) replace a system in the global vehicle model with real hardware on the test setup, or (ii) replace components of emulated SW with own blocks / apps

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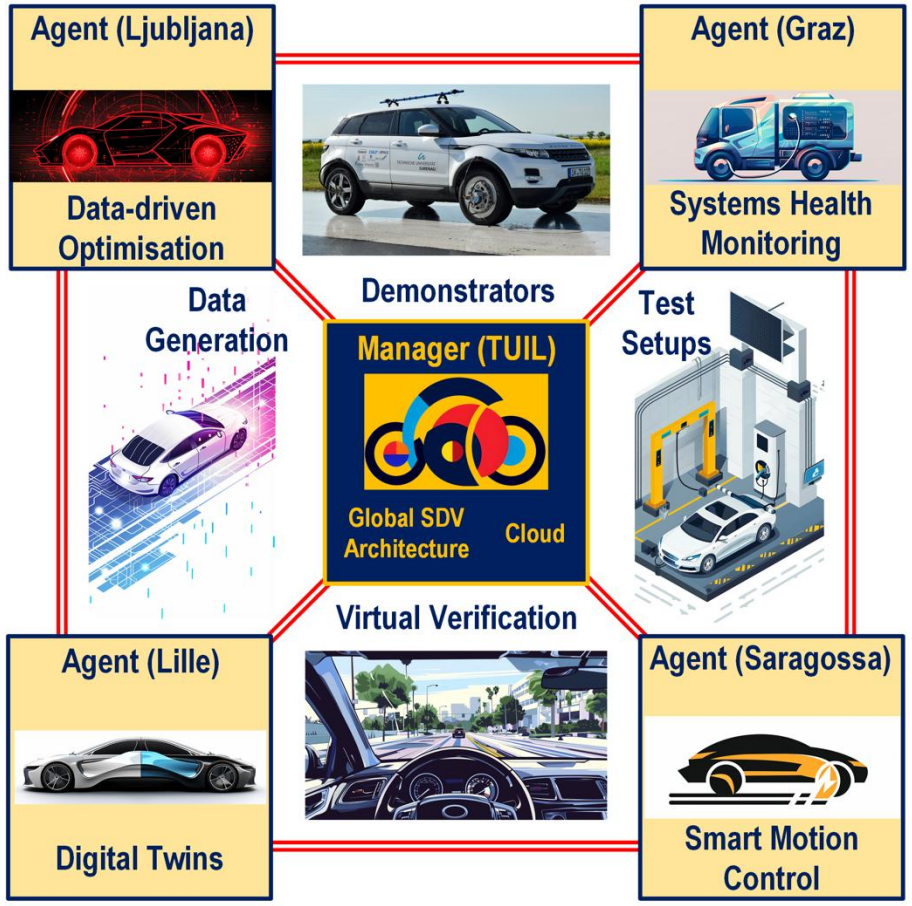
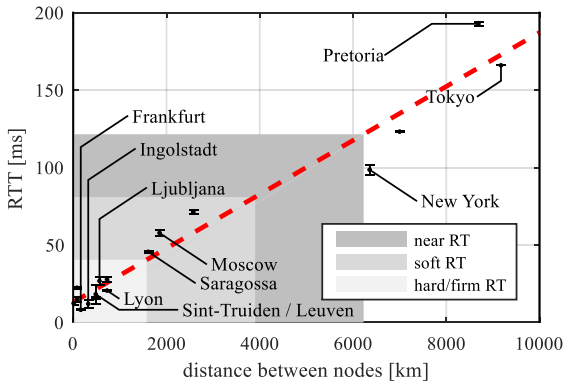
CODE4EV: CoDe-Framework - Realisation



- Preliminary **five** connected hosts
  - Ilmenau as “manager”
  - Ljubljana, Graz und Saragossa as Use Case owners (incl. hardware components)
  - Lille as digital twinning of Use Cases
- Performance of available **Internet-based communications** confirmed in previous studies, e.g. round-trip time for soft-RT applications (< 80 ms)



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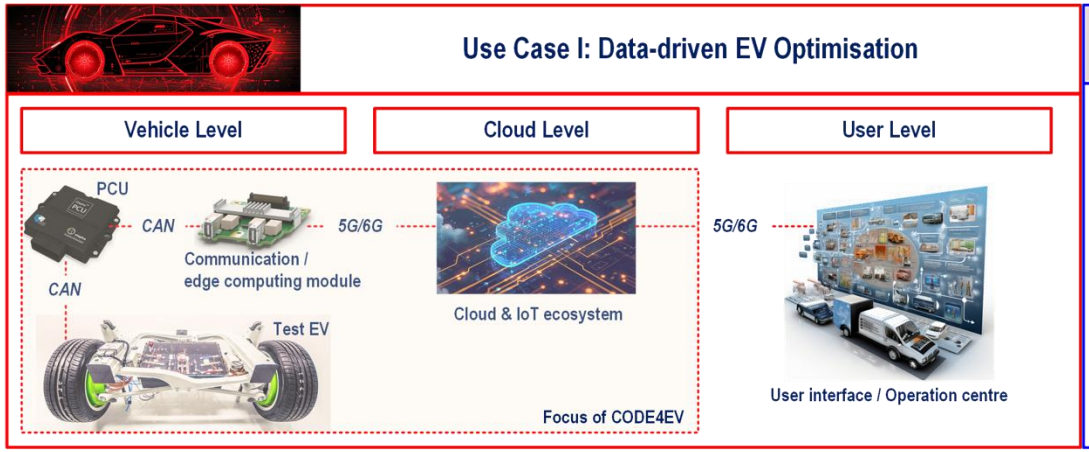
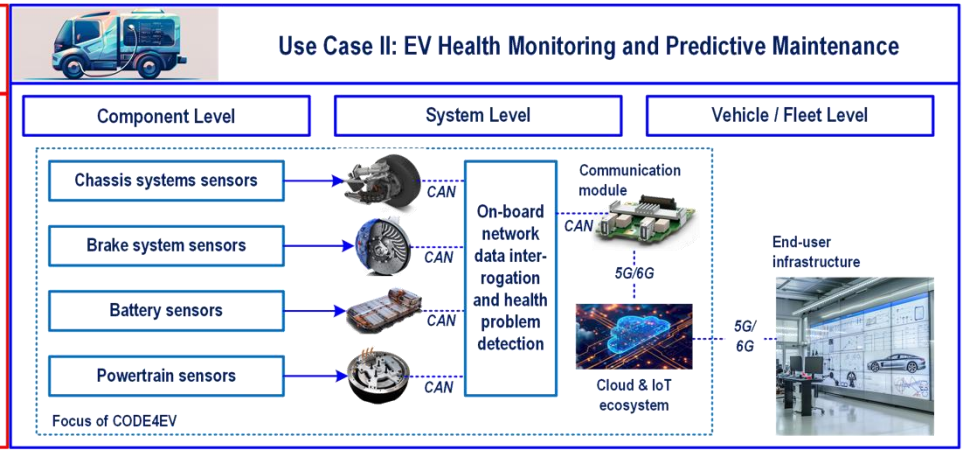
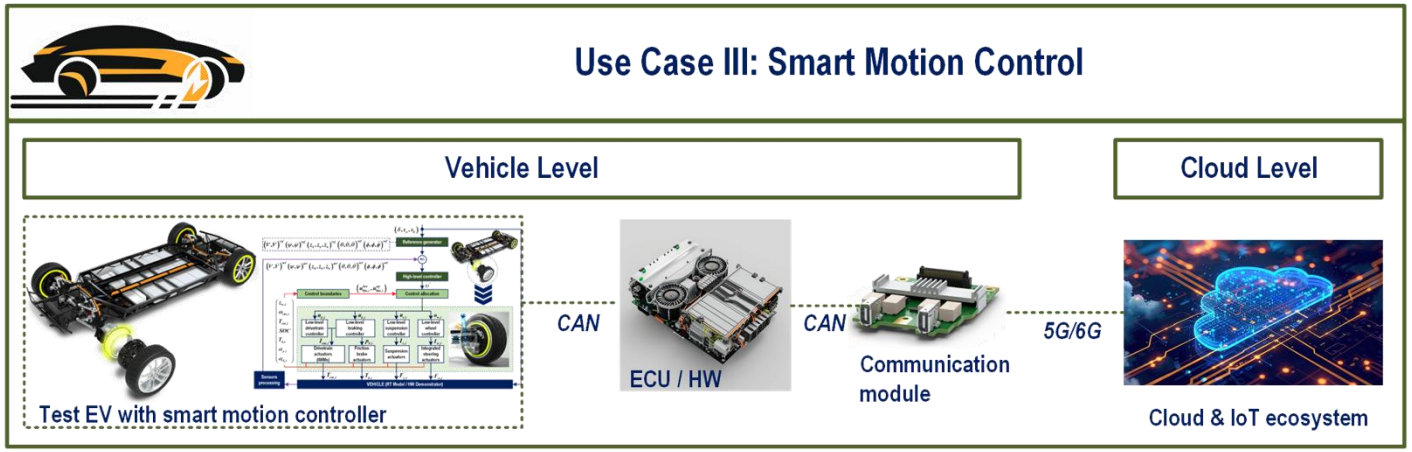
CODE4EV: Use Cases







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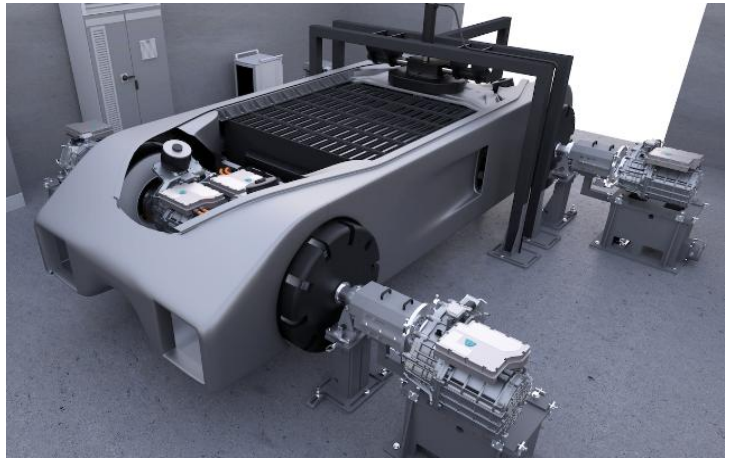
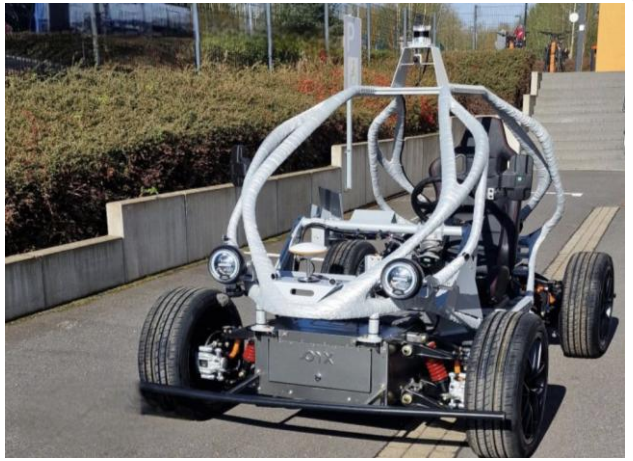
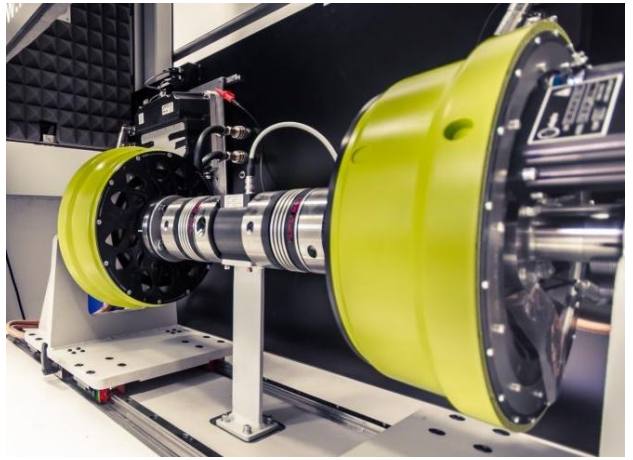
CODE4V: Hardware for Data Collection and Demonstration







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