

VDI-Initiative:
**Zukunft
Deutschland
2050**



**Shaping
our
future**

VDI

Humanoid Chauffeur & the Potential of Embodied AI

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Competent, neutral, productive

VDI – a predestined player ...



1856

Founded



125,000

Members



46

District chapters



600

Committees



10,000

Volunteers



+750

VDI employees



12

Specialist societies



15

State associations



5

Subsidiaries

Germany's Capacity for Innovation

Deutschland fliegt aus Top 10 der innovativsten Länder

Ergebnisse des Global Innovation Index 2025 auf Basis von 80 Indikatoren





China rückt auf Platz zehn vor

Innovationsindex: Deutschland rutscht aus Top Ten

16.09.2025 | 14:00

[←](#) | [☆](#)

Global Innovation Index 2025		
GIIrank		I
↓	Economy	Score
1	Switzerland	66.0
2	Sweden	62.6
3	United States	61.7
4	Republic of Korea	60.0
5	Singapore	59.9
6	United Kingdom	59.1
7	Finland	57.7
8	Netherlands (Kingdom of the)	57.0
9	Denmark	56.9
10	China	56.6
11	Germany	55.5

[Global Innovation Index 2025](#)

VDI-Initiative:
**Zukunft
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**Key question:
What makes Germany attractive
for individuals and companies
over the next 25 years?**

06.10.2026

Univ.-Prof. Dr. Lutz Eckstein – Humanoid Chauffeur & Embodied AI

Agenda

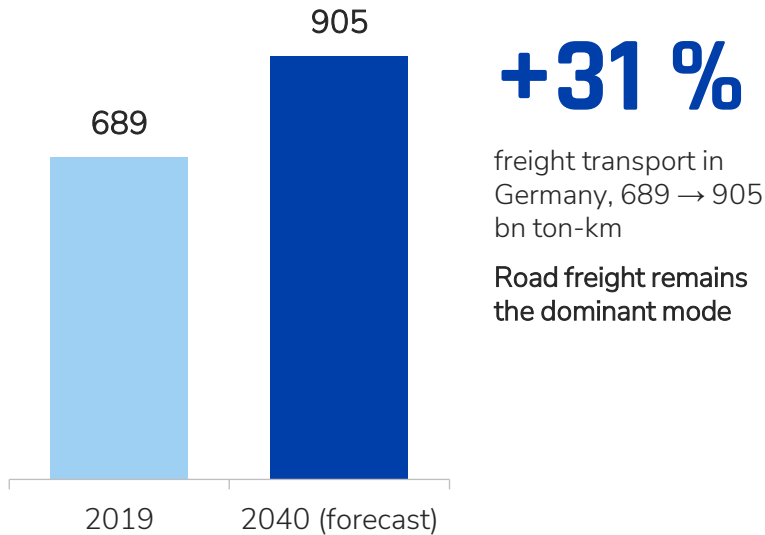


1. **Selected Challenges**
2. Humanoid Chauffeur
3. Potential of Embodied AI

1. Road Transport Challenges

Increasing Transport Demand

Germany – freight transport performance



European Union

+43 %

EU freight transport growth 1995–2023 (3,433 bn tonne-km in 2023)

52.6 %

of EU freight carried by road in 2023 – up 5.7 pp since 1995

+30–40 %

projected growth of freight activity 2015–2030

Demand keeps growing and road transport carries most of it.

Sources: BMDV, Gleitende Langfrist-Verkehrsprognose 2040 (2024); EEA, Sustainability of Europe's mobility systems (2025)

1. Road Transport Challenges

Decreasing Number of Drivers

Germany



120,000+

professional truck drivers missing today

Every year:

Drivers retiring



New drivers



→ a structural gap of about 15,000 drivers per year

Europe

502,000

unfilled truck driver positions
(13 % of demand)

660,500

drivers retiring by 2030 – about
one in five

Share ranking concern #1 of European operators [%]



The shortage is structural and mainly driven by demographics, not only by economic cycles.

Sources: BGL via eurotransport (01/2026); IRU, Global Driver Shortage Report (06/2026)

1. Road Transport Challenges

Existing Fleet is hard to Automate

14 years

average age of the 6.2 million medium and heavy trucks in the EU

1.8 million

agricultural and forestry tractors in Germany

207,000

Refuse, municipal, construction and special vehicles in Germany

6,500

new conventional military trucks ordered for the Bundeswehr through 2031



Mining & construction

Heavy machinery, mixed fleets, decades in service



Agriculture & forestry

Tractors and harvesters, seasonal and remote use



Municipal services

Waste collection and street cleaning



Military logistics

Supply trucks for convoys and resilience

Hardly any of these vehicles has steer-by-wire or brake-by-wire.

Automating them today means a vehicle-specific retrofit kit for every model and variant.

→ expensive, slow, and hard to scale across fleets with long service lives.

Long service lives keep conventional vehicles on the road for decades.

Sources: ACEA, Vehicles on European Roads (2026); KBA vehicle stock 01/2025 via trans.info; Rheinmetall (07/2024)

Agenda



1. Selected Challenges
2. **Humanoid Chauffeur**
3. Potential of Embodied AI

2. Humanoid Chauffeur

Role of the Humanoid



Actuation of the vehicle

Steering wheel, accelerator, brake and indicators operated like a human driver, without a by-wire interface.



Communication with other traffic participants

Hand signals and gestures towards other traffic participants and marshals, where an empty driver's seat would leave others guessing.



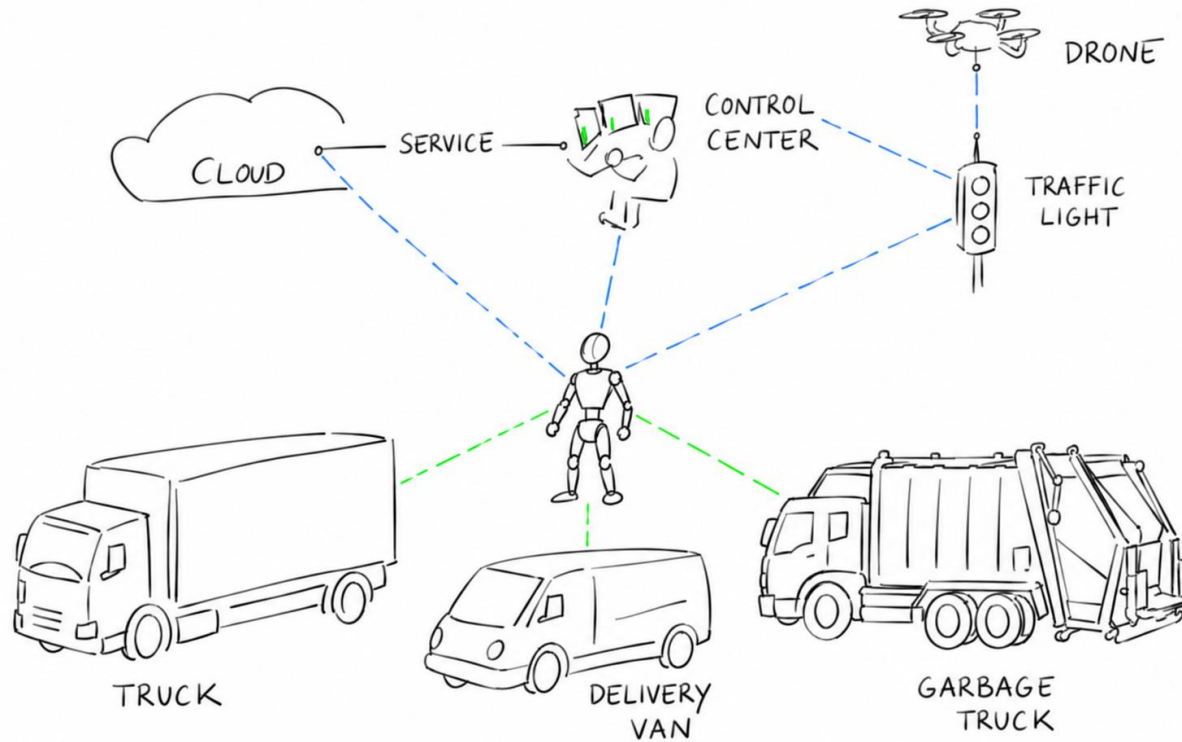
Continuous operation

No driving and rest time limits as for human drivers: the vehicle can run in extended shifts, limited only by charging and maintenance.

One robot, any vehicle: Automation without touching the vehicle's actuators.

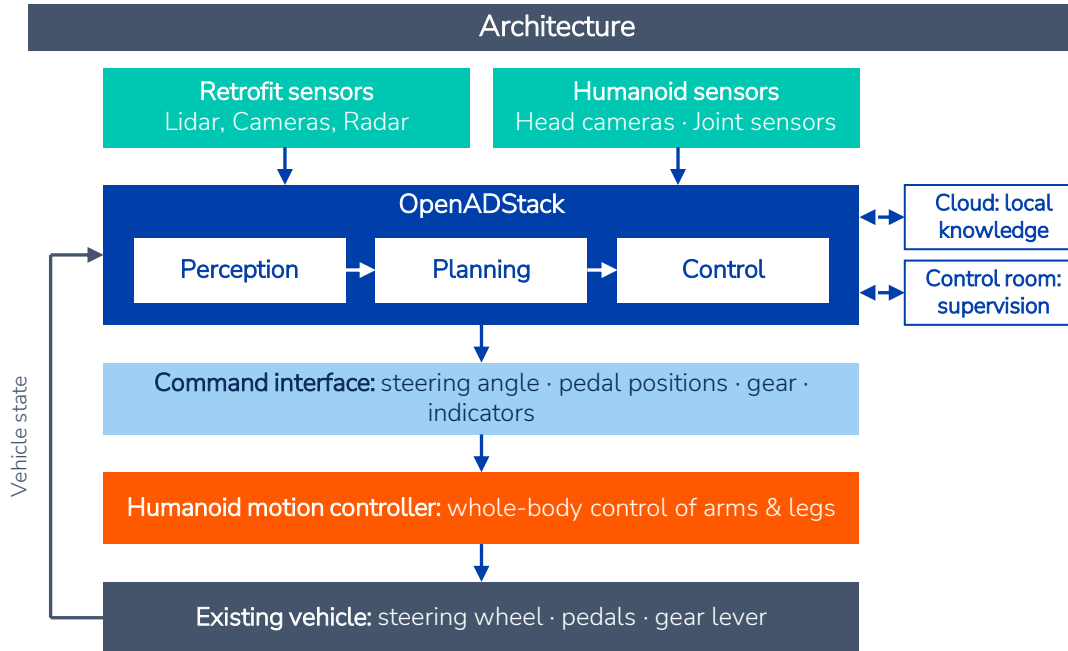
2. Humanoid Chauffeur

Idea = Humanoid + Sensors + AD-Stack + Cloud



2. Humanoid Chauffeur

Idea = Humanoid + additional Sensors + AD-Stack



No by-wire interface needed: the humanoid is the actuator, the vehicle remains unmodified apart from easy to mount retrofit-sensors.



2. Humanoid Chauffeur

AD-Stack based on OpenADS



Open Automated Driving
Stack | Sim | Suite | Safety



Diverse platforms ...



Humanoid Chauffeur HAINZ

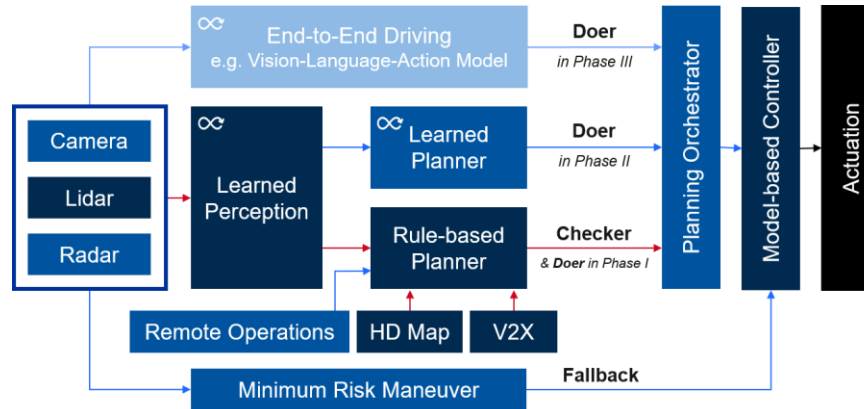


Ika's L4-Vehicle karl.



UNICARagil autoSHUTTLE.

... run the same modular Level 4 ADS software stack ...



IEEE Xplore

Multiple contributions a year to
top-tier scientific conferences

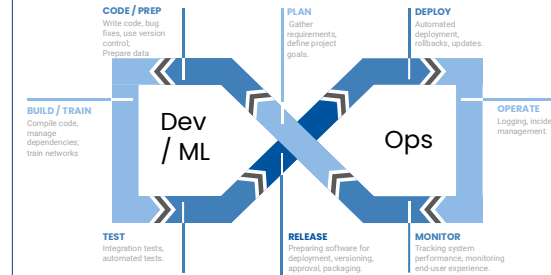


★ > 3.000

OpenADS
github.com/ika-rwth-aachen

Open-Source AD Ecosystem and many
open-sourced repositories, both actively
maintained and related to scientific
publications

... in a continuous DevOps cycle.



Containerized

Microservices

are Orchestrated

in a Service-Oriented
Architecture

2. Humanoid Chauffeur

Training HAINZ in the Driving Simulator



Video: HAINZ in action

Why start in the simulator?

- Safe and reproducible training and testing of the Humanoid Chauffeur HAINZ
- Truck model with retrofit lidar & camera feeding OpenADS
- Challenging scenarios on demand – without risking other peoples lifes or vehicle damage
- [Live demo here at the colloquium](#)

1 Driving simulator

Truck with retrofit lidar & camera;
HAINZ learns to steer, brake and accelerate

2 Test track

Real vehicle on a closed proving ground

3 Closed operational site

Special-purpose vehicle in a depot, mine or logistics yard

2. Humanoid Chauffeur

Beyond Driving: Potential Additional Tasks



Inspection

Check tyres, lights and load as well as inspect for damage



Open gates

Open and close gates at depots, yards and construction sites.



Load & unload

Move bins, parcels and materials between vehicle and ground.



Couple & connect

Charge or refuel the truck, couple the trailer, connect supply lines

A driverless vehicle can drive to the destination, but it cannot perform tasks there.

Agenda



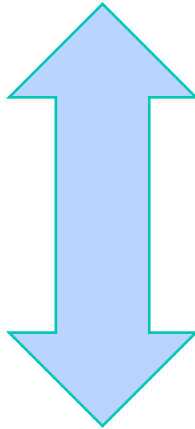
1. Selected Challenges
2. Humanoid Chauffeur
3. **Potential of Embodied AI**

3. Potential of Embodied AI

Societal Potential



- **Ageing society** puts increasing strain on social systems.
- Shortage of skilled workers calls for more automation in existing environments.
- **Security & sovereignty** require **Physical AI** “made in Germany & Europe”

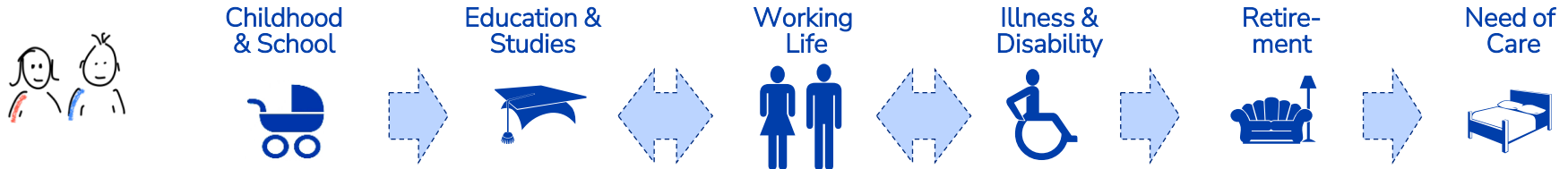


1. What potential does **Embodied AI** have to help solve these societal challenges?
2. How could the **potential of Embodied AI** be unlocked systematically?

- **Physical AI** Umbrella term for the **combination of physical systems** and **AI-based intelligence**
- **Embodied AI** Physical AI **in the form of humans or animals** that interact with their environment

3. Potential of Embodied AI

Potential beyond Industry – New Consumer Goods



Humanoid
Quadruped

▪ Homework support ▪ Companionship	▪ Training object ▪ Companionship	▪ Help at work ▪ Household support	▪ Care support	▪ Companionship	▪ Care support
▪ Play ▪ Ride ▪ Supervision	▪ Delivery service ▪ Training object	▪ Delivery service ▪ Household support	▪ Delivery service	▪ Companionship ▪ “Pack mule”	▪ Companion ▪ “Little helper”



Essential prerequisite:
Absolute trustworthiness of the technology

3. Potential of Embodied AI

Key Requirements



Software & data design:

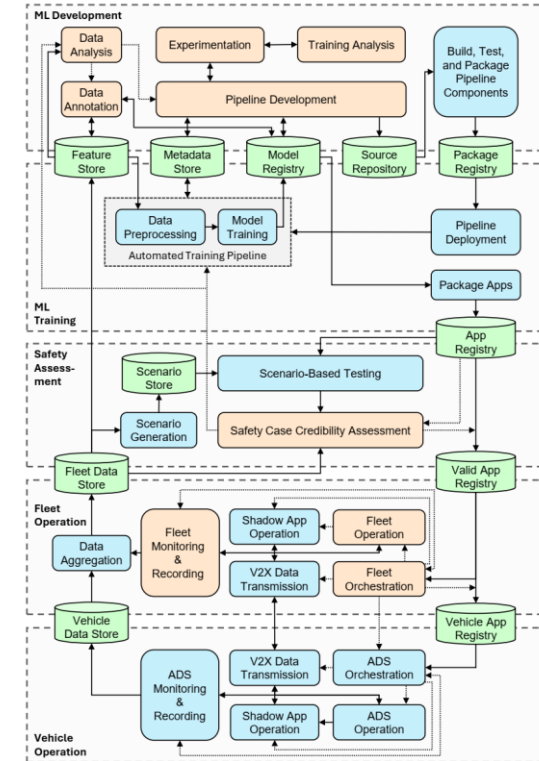
- Transparency & traceability through OSS
- Updates & upgrades without “backdoors”
- MLOps & AI flywheel in Germany/EU

Energy & operational design, e.g.:

- Energy efficiency & dynamics
- Availability & safety
- Fault tolerance & diagnostics

Physical design, e.g.:

- Lightweight design & strength
- Sustainability

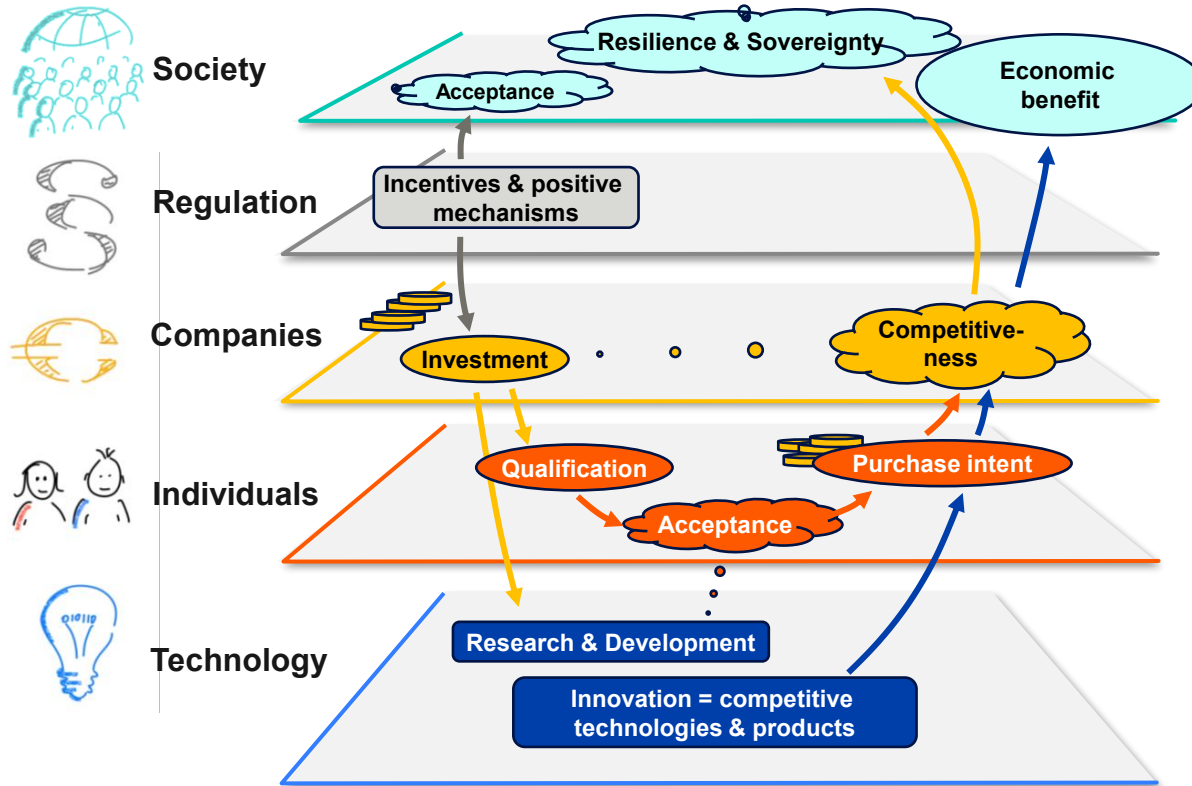


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Software Factory 4 Physical AI

3. Potential of Embodied AI

Challenges & Chances of Embodied AI



- **Embodied AI** offers the potential to build a new industry
- An attractive regulatory framework is a necessary prerequisite.
- High value-creation potential for B2B and B2C as well as defense
- For **acceptance** as a consumer good, **trustworthiness** is fundamental
- **Excellent starting conditions**
➔ *Embodied AI Designed in Europe*

A diverse group of seven people, including men and women of various ethnicities, are smiling and looking towards the camera. They are in an office environment with blurred background elements like shelves and windows. The image is partially overlaid with a blue banner at the bottom and blue geometric shapes in the top right and middle right.

Let's shape our future together
Goal = Driving Innovation for a Sovereign Europe

06.10.2026