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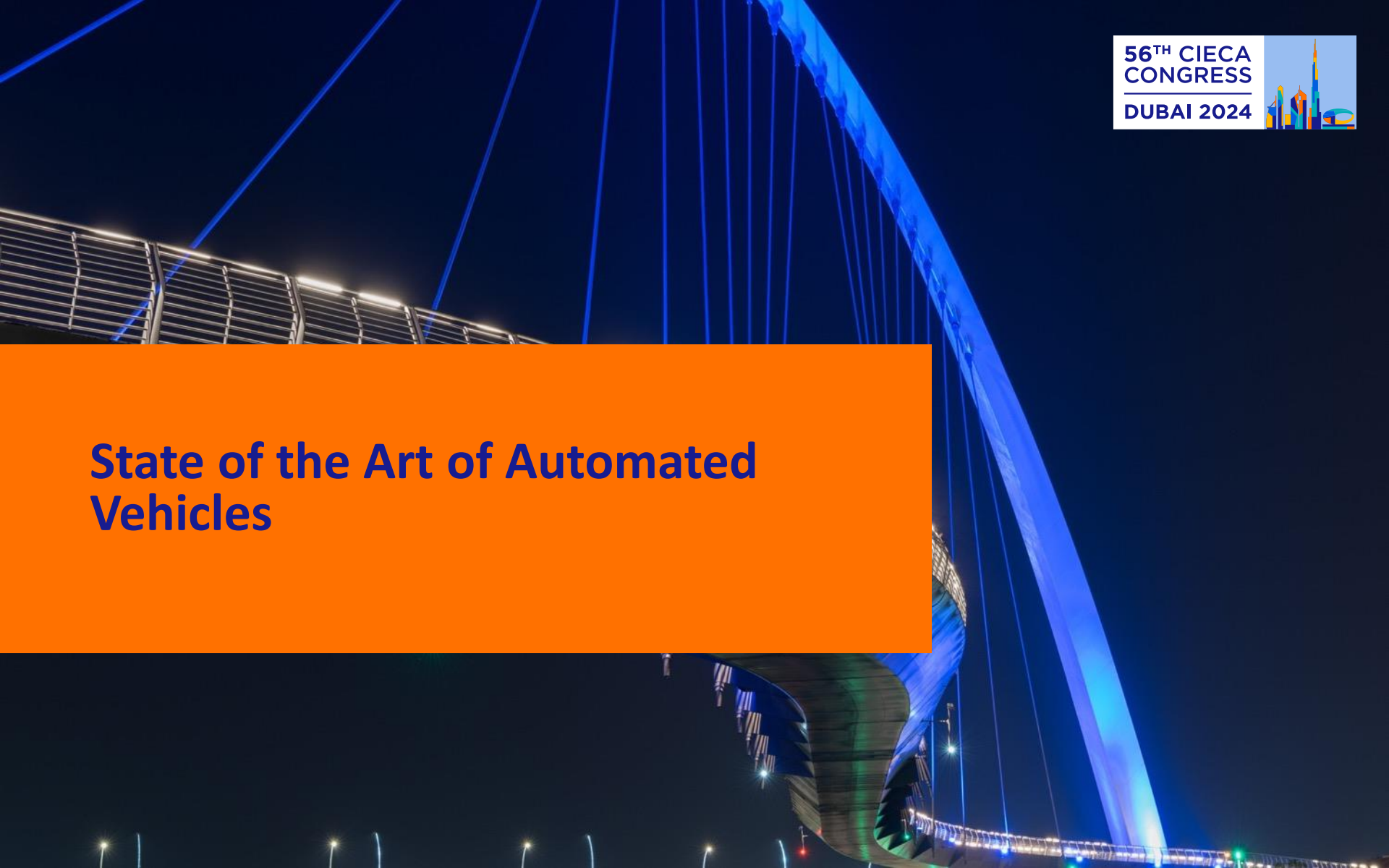
RTA

Enhancing Safety in the Era of Automated Vehicles

Karlsruhe Institute of Technology

Christoph Stiller



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State of the Art of Automated Vehicles

Selected Challenges & Public Demonstrations

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Long Distance Automated Driving

Bertha Benz Memorial Route

Karlsruhe Institute of Technology

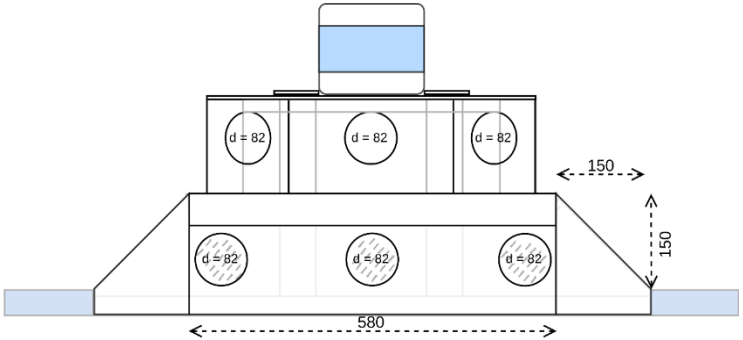
FZI

DAIMLER

- 100+ km on historic route
- 3 large cities
- 23 smaller towns

Sensor Box for Automated Driving

- VLS-128 Alpha Prime Lidar
- 2x Hesai XT-32 Lidars for near range
- 6 x 90° low-distortion cameras
- Stereo HDR cameras
- HD-map, Trigger box, IMU, GNSS
- Radars adopted from series



Sensor box: Cameras in Ring

Front



Back



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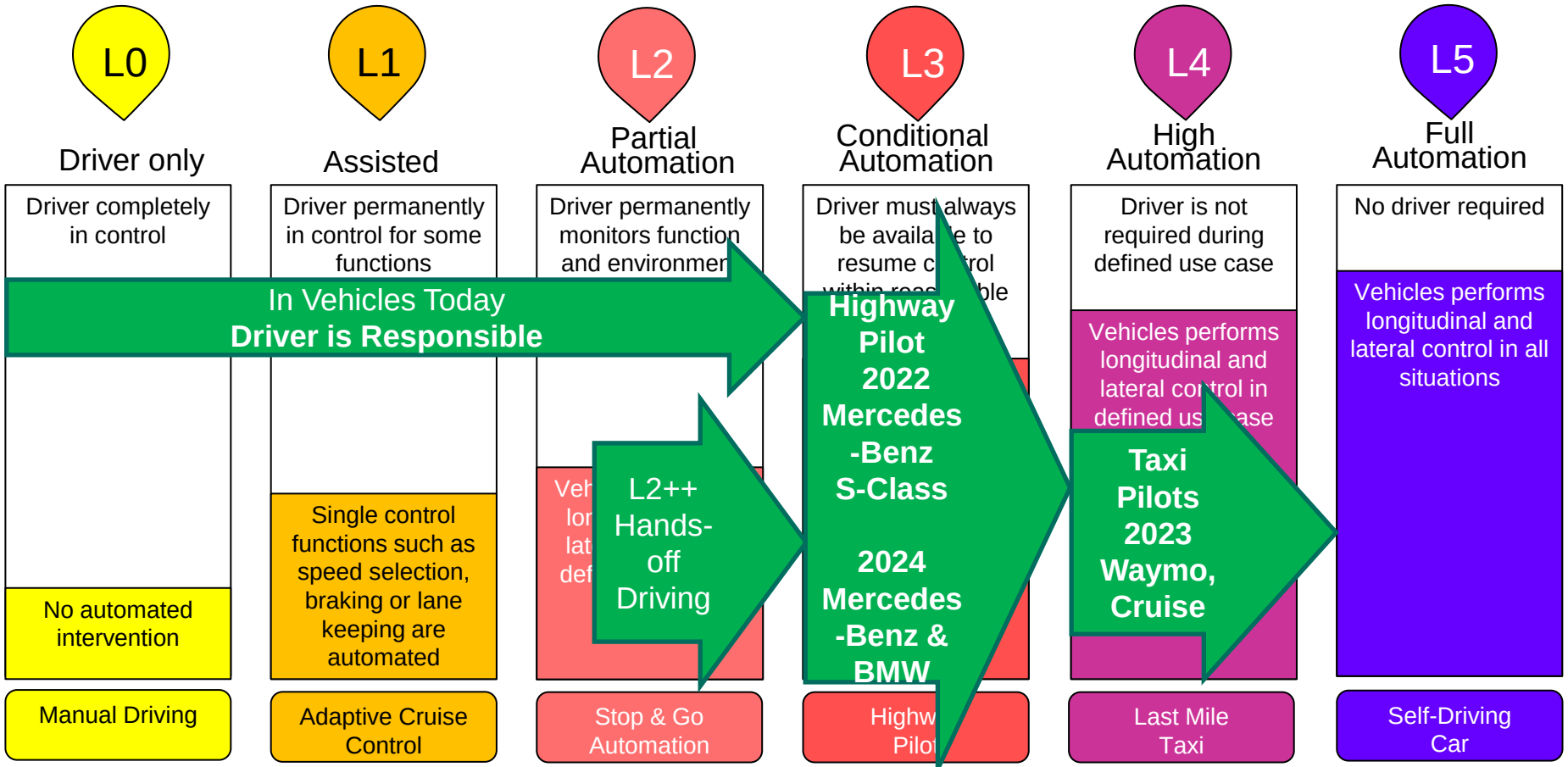
Are We There Yet?

SAE Automation Levels – Automotive Industry



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Safety

Safety Goal

- Naive Thinking: The safety goal for SDA should be „Zero Accidents“

- Safety goal should be „safe x% lifes“, i.e. achieve SIF level

$$\text{Safety Improvement Factor} = \frac{\text{Risk of Traffic with Conventional Driving}}{\text{Risk of Traffic with Self Driving Automobiles}}$$

- Which SIF level is societal acceptable?

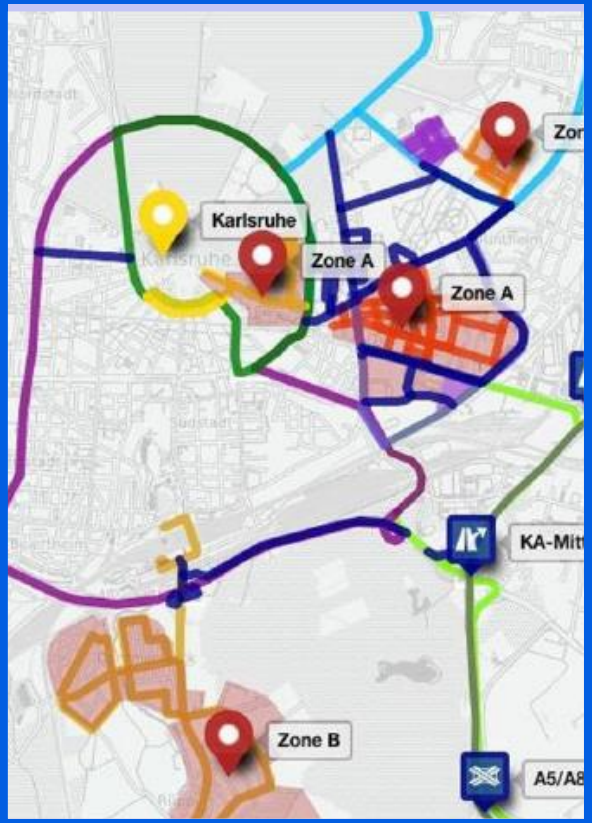
Required Safety Level

- Risk of traffic in Germany: 1 fatality per 230 Mkm
- Best AI perception performance is some % error rate
- AI Networks are by far not safe enough
  – just as model-based Bayesian Perception
- Improvements:
  - Restrict ODD
  - Information fusion with diverse sensors (camera, lidar, radar), maps
  - Diversity in prediction & planning
  - Uncertainty aware AI
  - Scenario-based training and validation
  - Collective safety

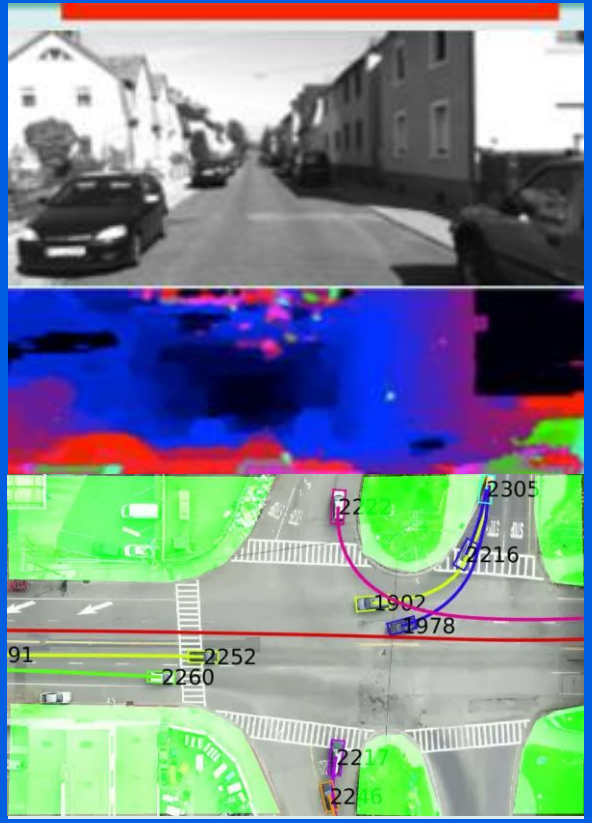
Diversity in hardware, data, processing & verification is key to safety

How to test 10^{10} km?

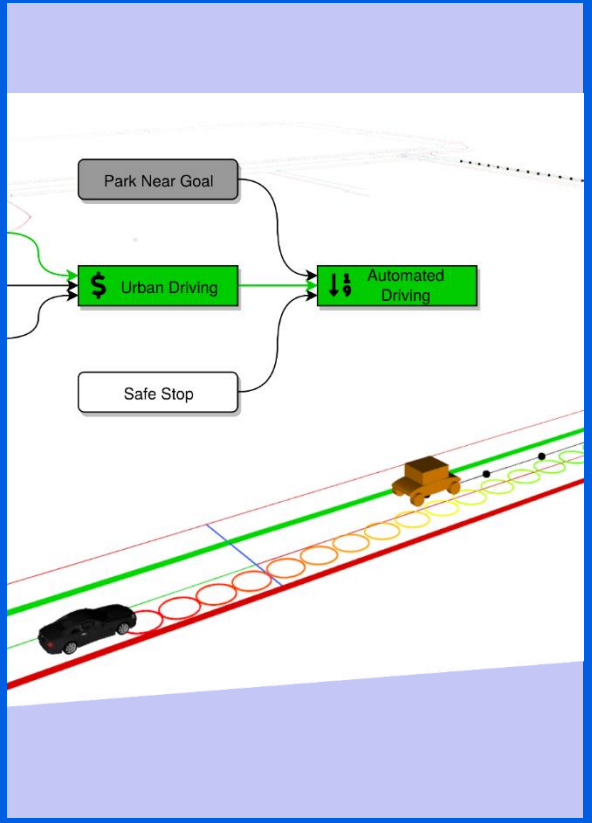
Real World Driving



Real World Data



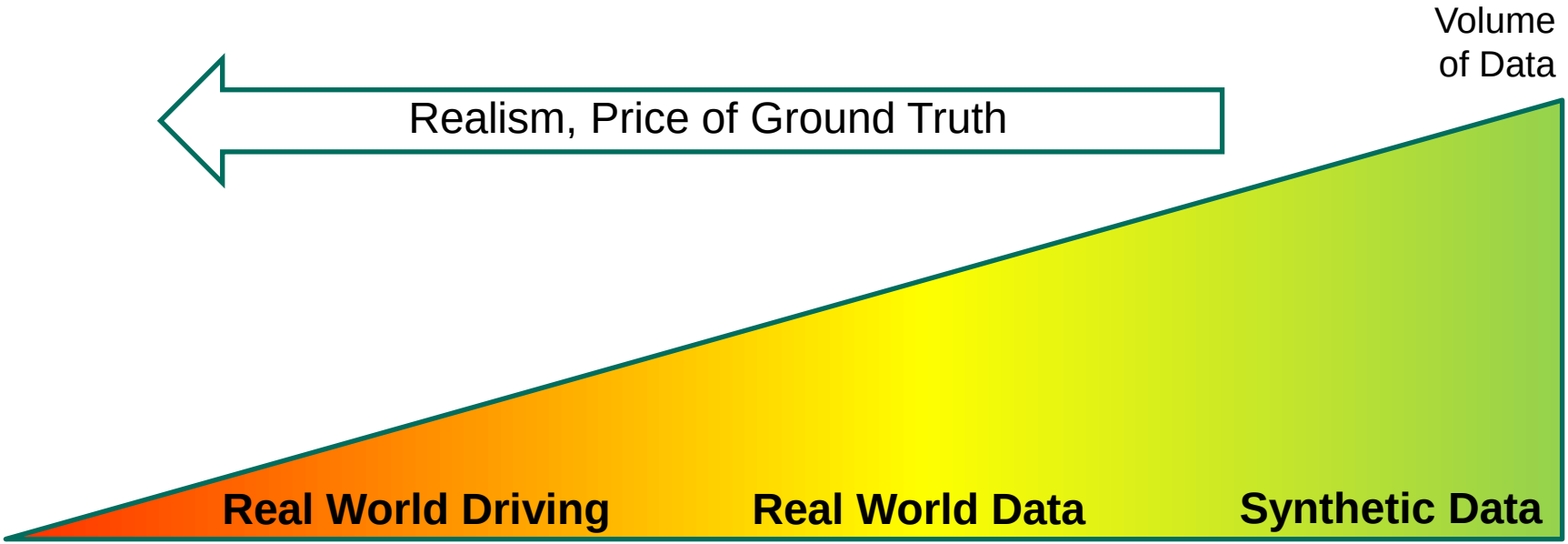
Synthetic Data

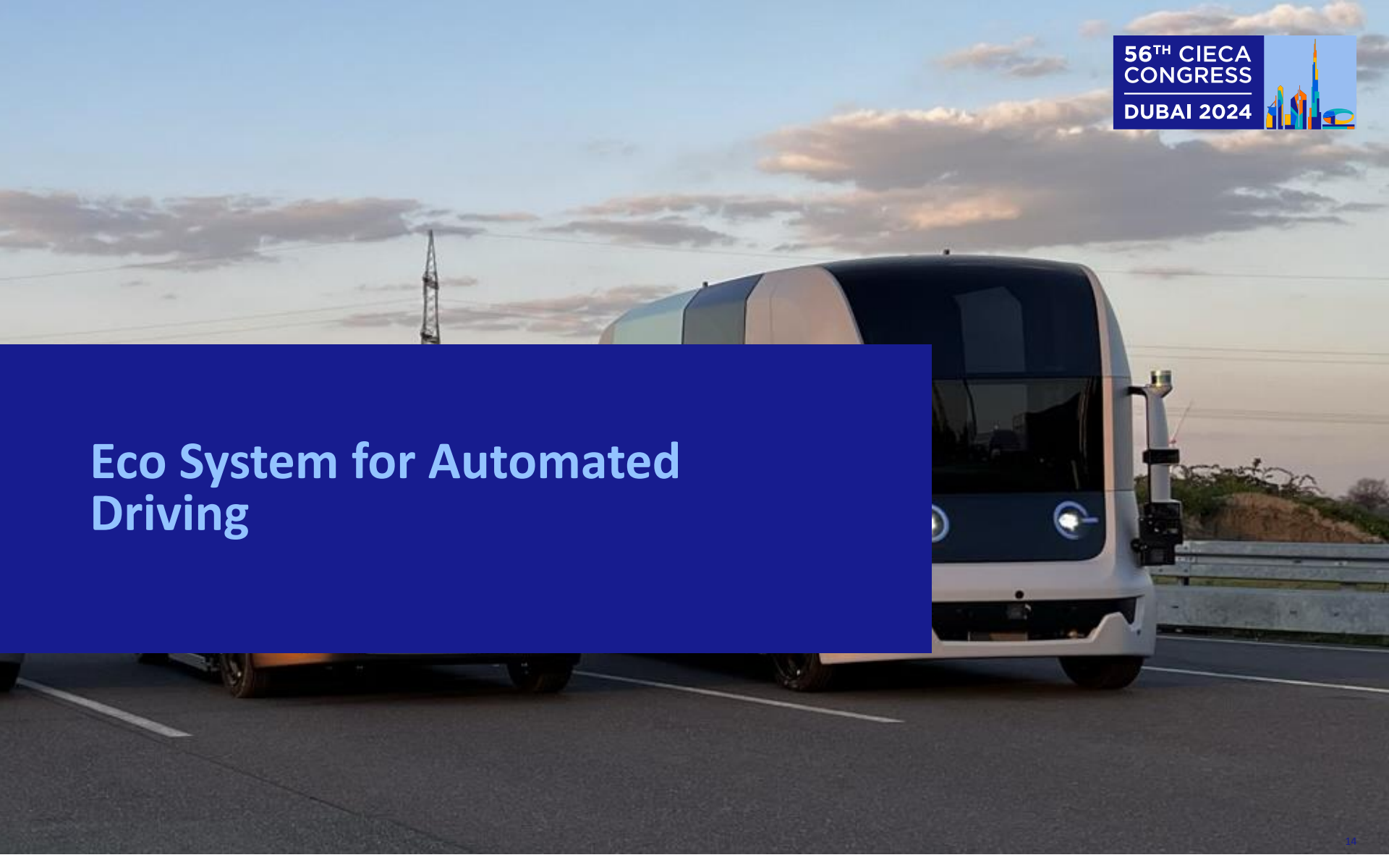


How to test 10^{10} km?

#Scenarios, Critical Situations

Realism, Price of Ground Truth

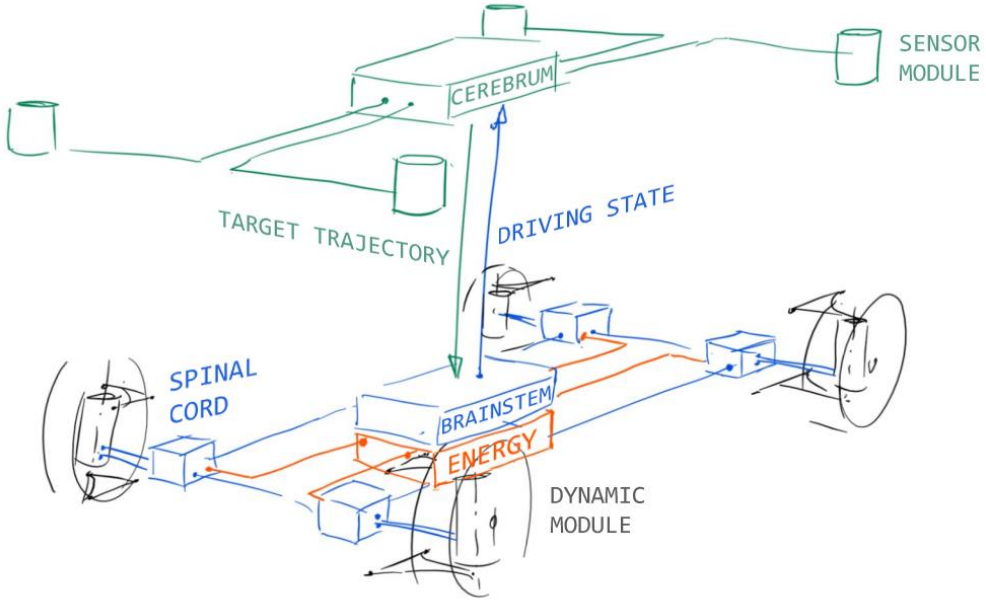




Eco System for Automated Driving

UNICARagil Vehicles

MECHATRONIC ARCHITECTURE UNICARagil



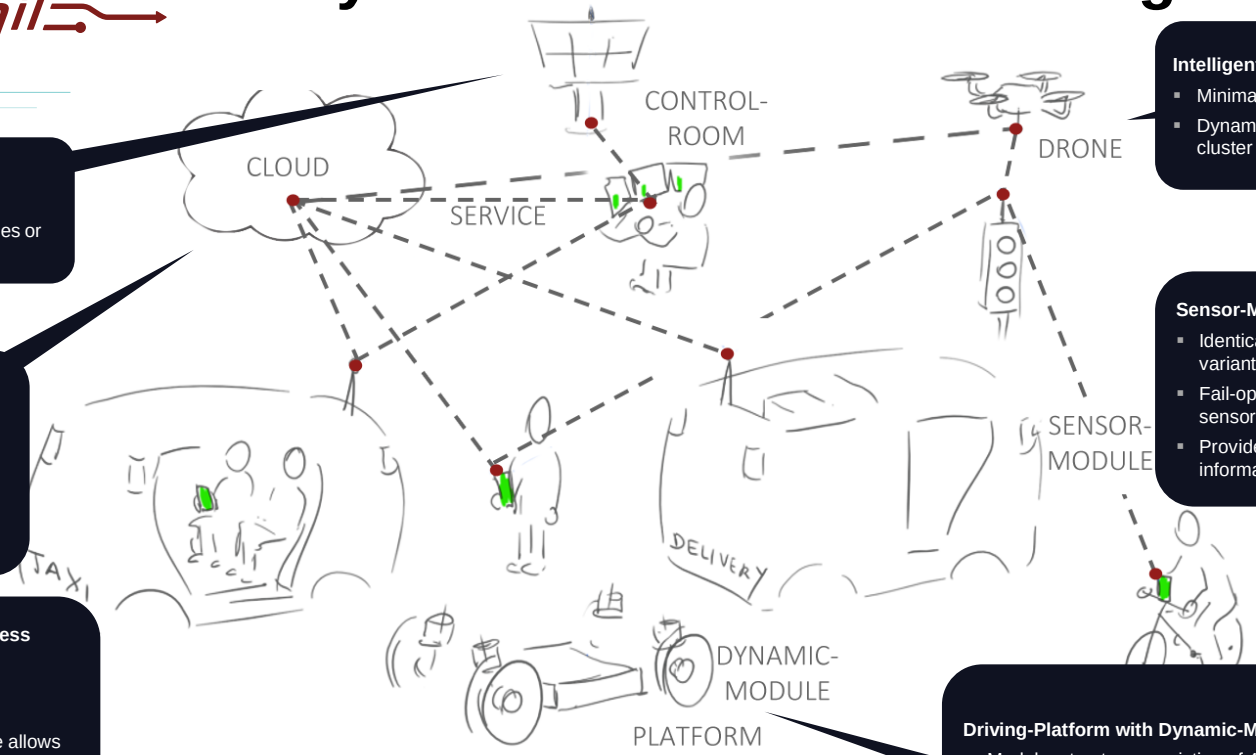
"Brain" Structure

"Cerebrum":
- Environment representation
- Behavior and trajectory planning

"Brainstem":
- Realization of desired trajectory
- Safety ECU
- Dedicated HW developed

"Spinal Cord":
- Steering angle and drive control
- Fallback in case of "Brainstem" failure

Eco-Sytem for Automated Driving



Control-Room
- Remote vehicle operation
- Service center, e.g. for emergencies or sovereign interventions

Cloud Functionality
- Additional information for automated driving function
- Collective environment model
- Collective traffic memory

Four Fully Automated and Driverless Vehicles

Enabled by Modular Information Processing
- Service-oriented SW architecture allows updates and additions to secure modules
- Vehicle fully functional without external Information

Intelligent Infrastructure
- Minimal stationary sensors
- Dynamic supplement through sensor cluster = drones

Sensor-Modules
- Identical integration for all vehicle variants
- Fail-operational due to 3 physical sensor principles
- Provides environment information as a service

Driving-Platform with Dynamic-Modules
- Modular structure consisting of 4 dynamic modules, energy module, brain stem + self-awareness
- Scalable, different vehicle sizes can be displayed
- Electric (48 Volt) and functionally safe

Field Monitoring of Automated Vehicles

Summary & Conclusions

- Automated Driving
  - is feasible in restricted ODD, or with safety driver
  - will cause a revolution in human mobility

- Safety
  - is key to market introduction
  - Societal consensus required on safety goal
- Verification and Validation
  - Testing 10^{10} km requires real world driving; real world data and synthetic data
  - Open issue: Design of a scenario set that is sufficient for market introduction
  - Crowd data collection must continue with series vehicles
- Eco System for Automated Driving
  - Vehicle, infrastructure, cloud, control center, etc.
  - Safety validation will continue in the development-life cycle of automated vehicles

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THANK YOU