From Wiring Harnesses to Digital Nervous System

How Data-Driven Development, Virtualization, AI, and China Speed are Transforming Automotive Electrical System Engineering

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Bordnetze Digital 2026

Dr. Siegmar Haasis

HaasisDEC
Digital Engineering Consulting

Trends in Automotive Industry

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Sustainability Electric Drive	Software Defined Vehicle	Market Regulations	Geopolitical Challenges
Electrification & Hybridization	Car Software, Connectivity	CO2, WLTP, SUMS, …	US Tarifs & Trade Protection
Emissions Reduction	As Service & Data Security	Local Market Requirements	US-China Strategic Rivalery
Lightweight Development	Autonomous Drive	Compliance	China’s Automotive Rise

Digital Transformation & AI

Value Driven Digital Transformation

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Vision: 90:10 (Digital / Physical)

Target: 30% Reduction of Resources for Prototype HW

COST

Vision: PEP < 2-3 Years

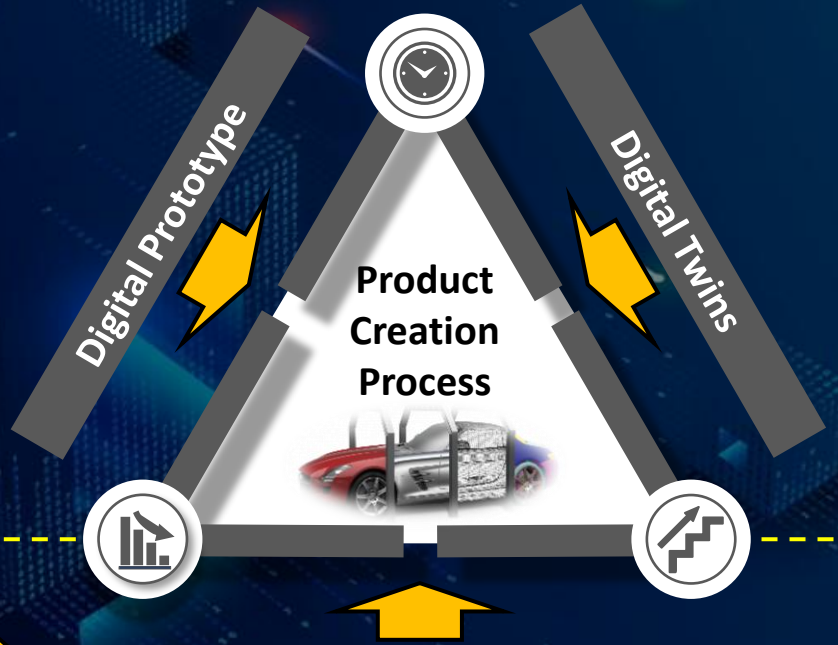
Target: Reduction by 12 months for the Lead Vehicle

TIME

Vision: 100% Target Achievement Start of Sales

Target: Provision of saleable Vehicles to Customers on PRO 1

QUALITY



Target: Revenue / EBIT Growth
Customer Driven Innovation

Innovation

Business Challenges & Digital Engineering Strategy Automotive

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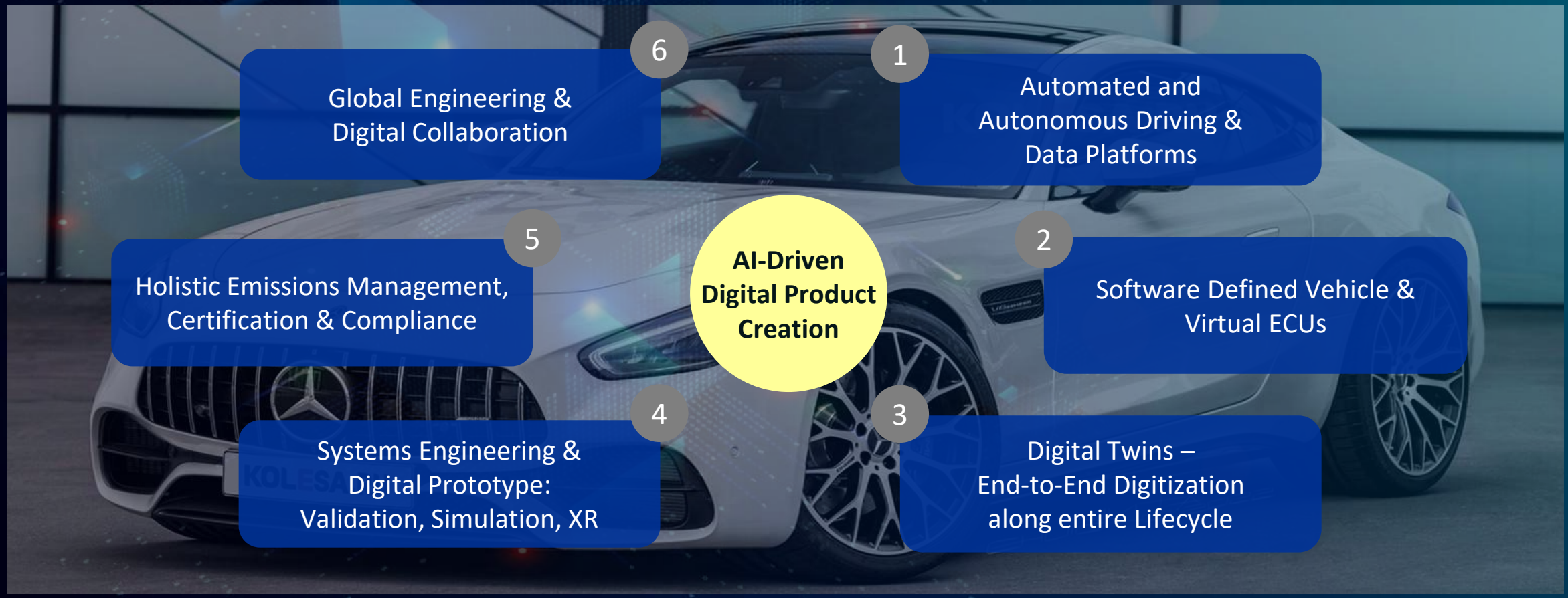
- Reduction of Hardware Prototypes & Costs
- Shortening of Product Creation Process
- Optimization of Product Maturity
- Safeguarding Market Entry Dates
- Avoidance of Penalties (CO2, SUMS, Compl.)



Onboard Network is envolving into a Digital Nervous System

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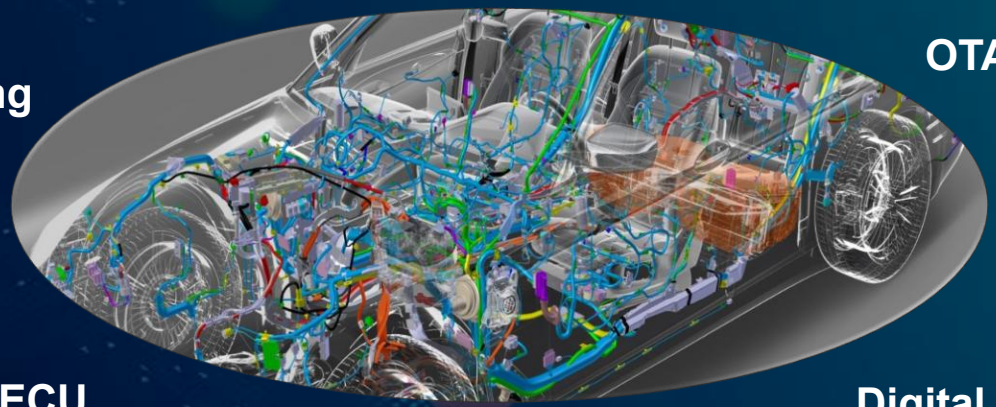
Software Defined Vehicle

Zonal Architecture

Systems Engineering (MBSE)



OTA Updates

Virtual ECU

Digital Twin

AI

In the future, the Onboard Network will connect not only ECUs, but also Data, Software, and Functions

Systems Engineering for Wiring Harness Development

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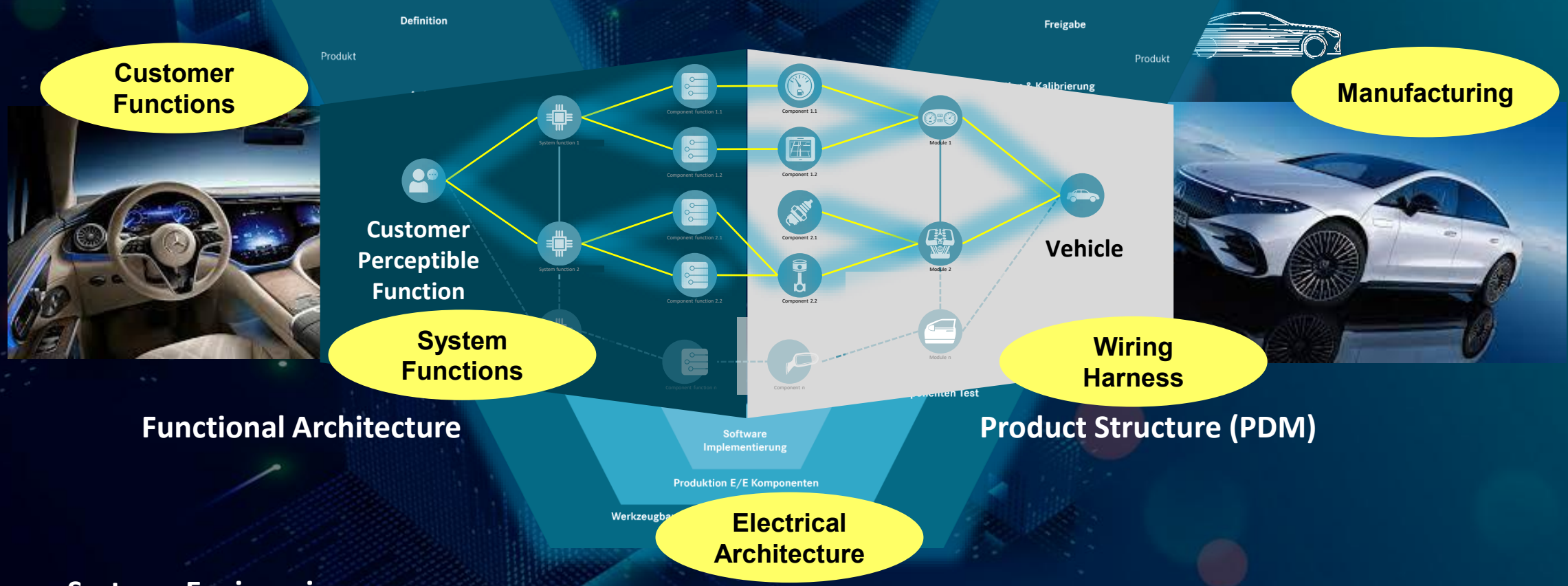
Specification of Systems

Validation of Realized Functions



Systems Engineering –
Change of Culture and Mindset, Roles & Organization, Processes, Methods & Systems

Source: According to Mercedes-Benz, Engineering IT

Digital Twins

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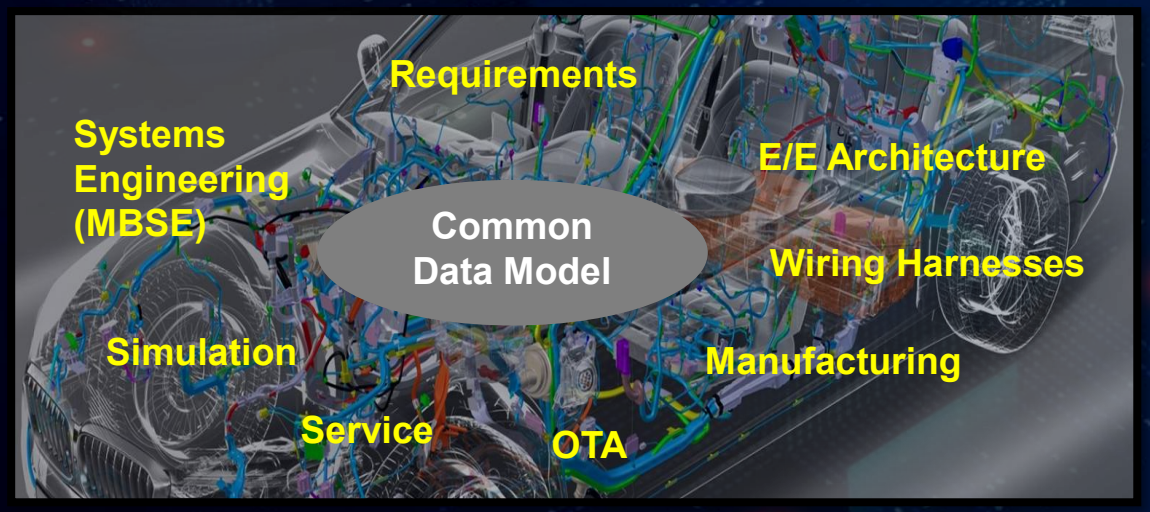
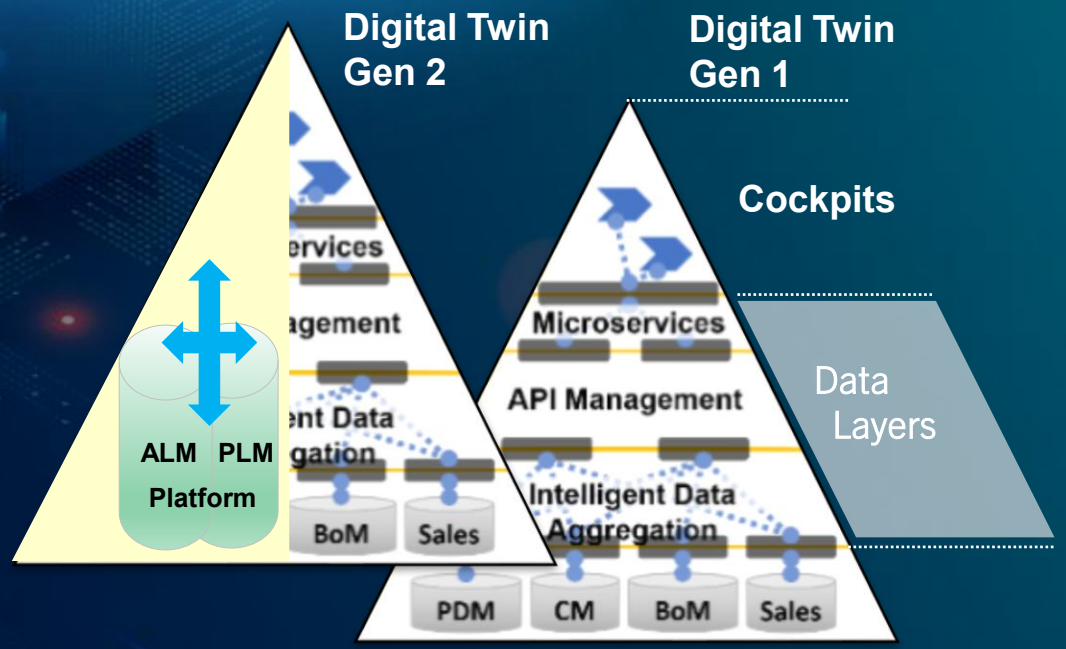
Definition

Digital Twins represent **geometry/shape, function** and **behavior** of a product **along** the **entire product lifecycle** (development, production, sales, aftersales, customer use)





Value

- **Acceleration** of **product creation process** up to 50%
- Significant **cost reduction** through minimization of prototype hardware and avoiding repair costs
- **Quality improvement** and stability due to first time right

Integrated Virtual Prototype – Complete Digital Validation

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Digital Prototype
Overal Vehicle Engineering (OVE)

Digital Prototype
Electric / Electronic / Software

Cross-Domain
Chains of Effects

Data Orches-tration

Digital Prototype
Powertrain & eDrive

CAE, Simulation, AI

Digital Prototype
Production & Aftersales

VR/AR/XR & Metaverse - Reduction of Hardware Prototypes

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Realistic
Color Visualization

High End Visualization
Overall Vehicle Design

Crash and Sensor
Placement

Tablet based Augmented
Reality based on PDM

Mixed
Reality

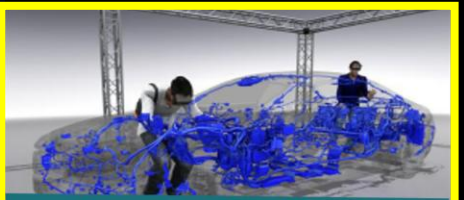
Tolerance
Certification

VR / AR based
Training

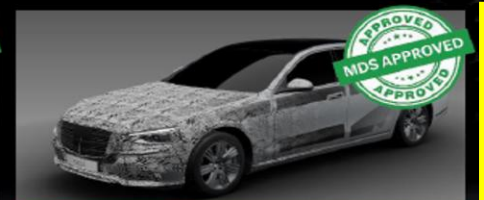
Virtual Certification
(Technical Inspection Agency)

XR
Driving Simulator

AR
Remote Service

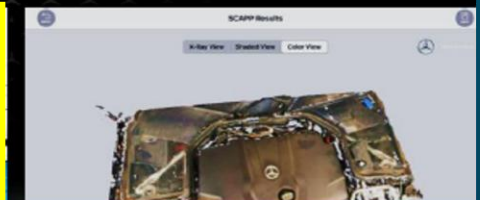

Overall Vehicle Design
Wiring/Component Review

Ergonomics
Assessment/Evaluation

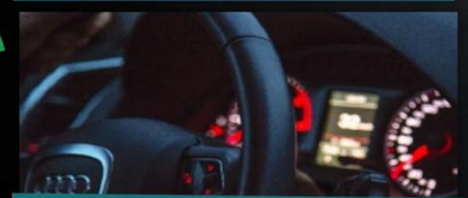


Prototype Camouflage
Planning & Evaluation

Buildability Review
Mounting/Disassemly, physics


3D Shape Generation
e.g. Crash/Accident Research

Digital Car Clinic
Marketing/Styling


Visualization / Comparison
of Competition Vehicles

Reflections
in the Interior

VR/AR Based
Collaboration

XR
Kiosk

Software Defined Vehicle

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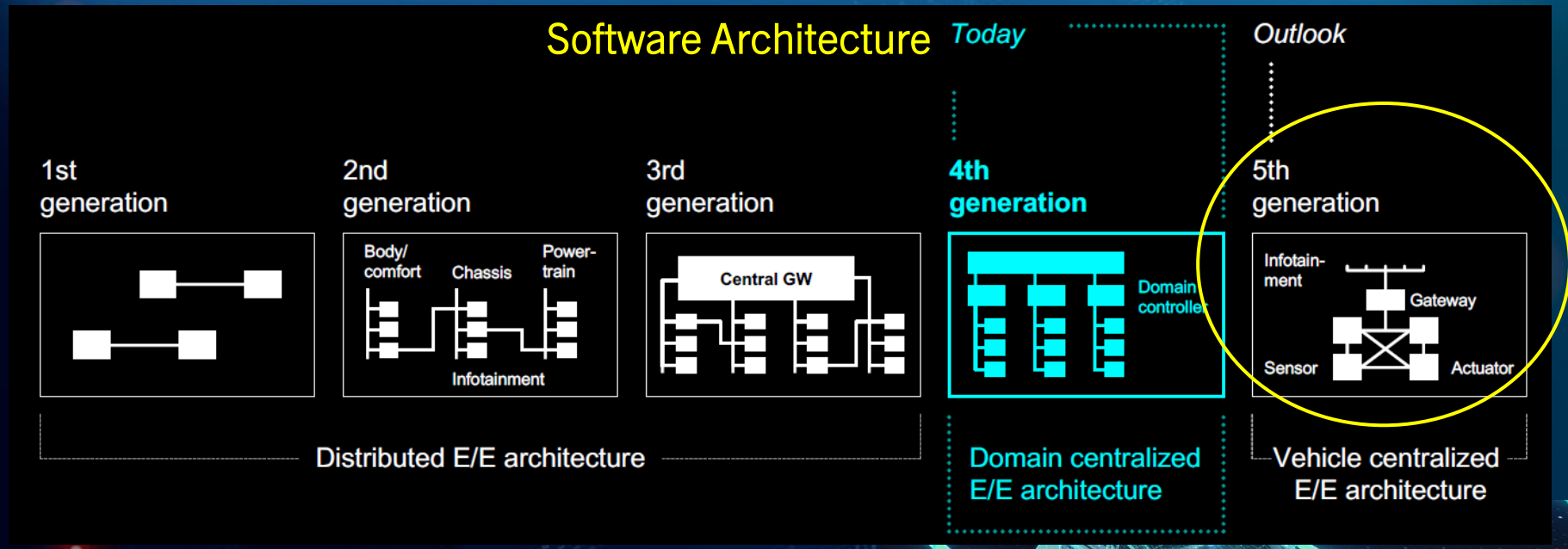
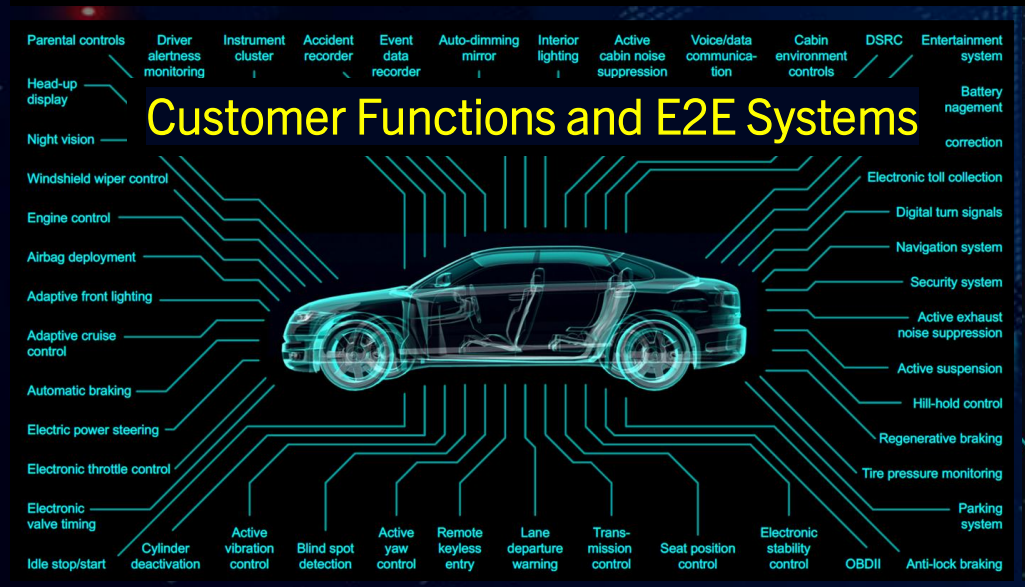
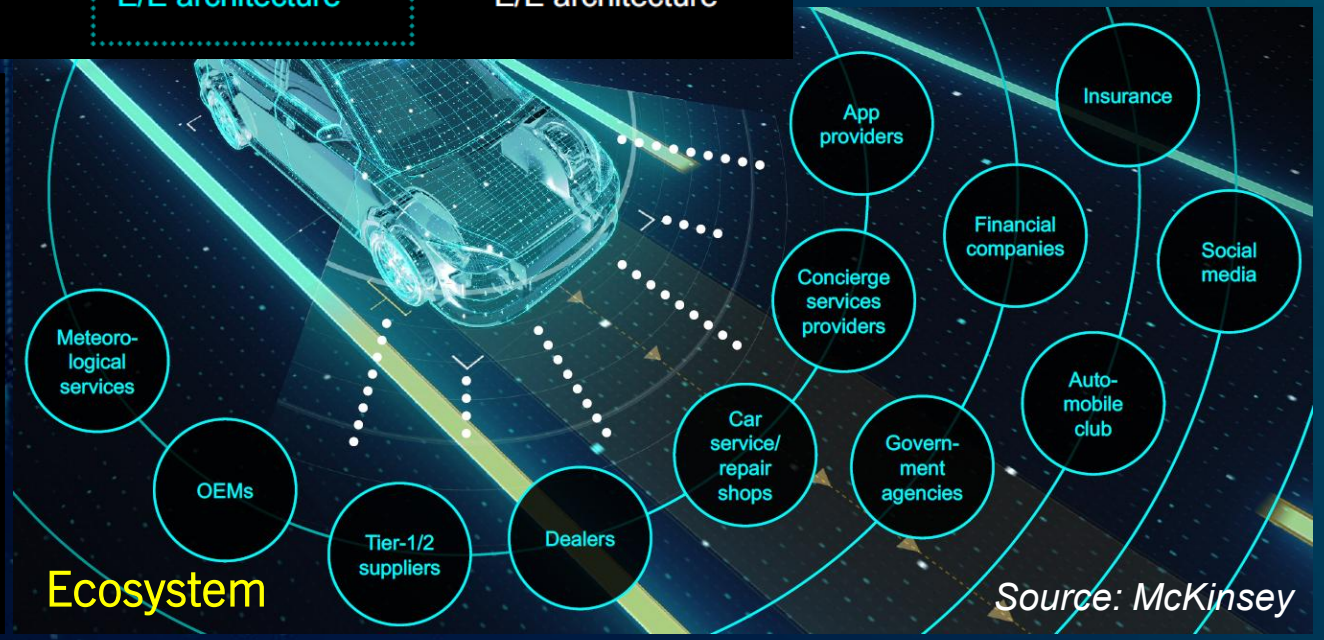


- Computer on Wheels
- Centralized Computing
- Cross-Functional Connection
- Collaboration of ECUs
- Zonal Computing Platform





Virtualization & Virtual ECU

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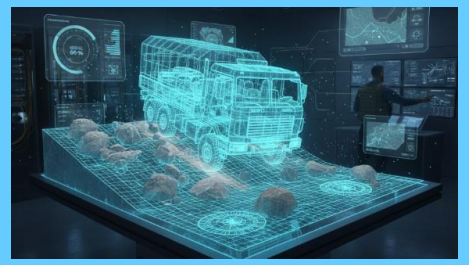
Virtual Testing

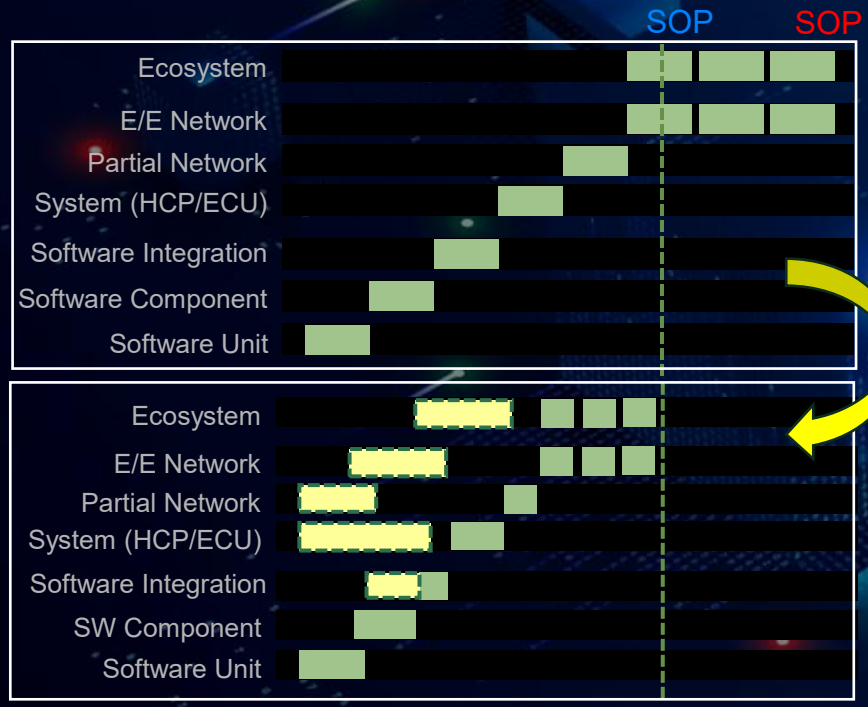


ECU Testing

Vehicle on Testbed with Simulation

Vehicle Testing Proving Ground

Shift Left

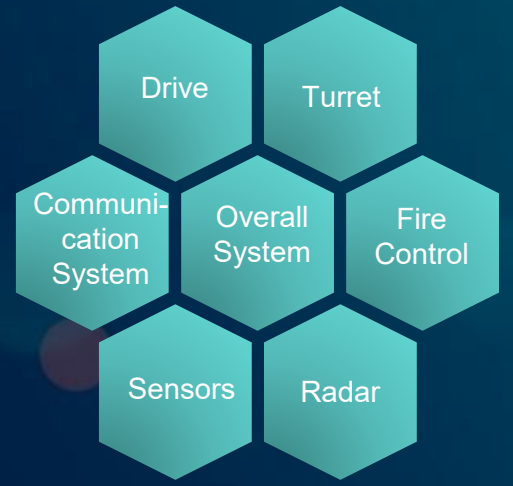


TODAYS SOP RISKS

- "Big bang" integration
- Sequential, late integration in composite instances
- Poor launch quality

VIRTUALIZATION & FRONT LOADING

- Pre-validation in the system context Automated testing
- Early error detection and resolution
- High maturity level



Data Centricity – First Data Homework then AI

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- **Data Quality**:
  Poor data quality can lead to inaccurate AI outcomes, undermining the entire initiative.
  Organizations must prioritize data integrity and cleanliness.

- **Infrastructure Modernization**:
  Legacy systems can be a major roadblock. Upgrading IT infrastructure -
  like migrating to the cloud and establishing reliable data pipelines - is essential.

- **Data Liquidity**:
  Seamless access to quality data is a game changer.
  Ensuring data is readily available and in the right format enables AI to deliver meaningful insights.

Before jumping into AI, make sure your foundation is solid.
Invest in data quality and infrastructure today to unlock AI's full potential tomorrow.

AI in Engineering - Use Cases & AI Setup

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1: Market Analysis

2: Requirements & Test Mgmt.

3: Systems Modelling

4: Quality Analysis

5: Assistant C… Model Gen.

6: Assistant C… Design

7: Assistant Software Developme…

8. Change Re… quest Anal…

9. Production Planning

AI in Wiring Harness Engineering

- AI-assisted Wiring Design
- Automatic Routing
- Variant Optimization
- Manufacturing Planning
- AI Quality Inspection
- Agentic Engineering
- Engineering Copilots

Implementation Strategy

- **Orientation**: AI-Potential & Readiness
- **Piloting**: Value Cases, Domain Agents, MVP->Production
- **Scaling**: Multi Agent, Governance, IT
- **Transformation**: New Process & Business Model

10: Lifecycle Management

11: Field Analysis

12: Homologation

13: Analysis Support

14: Test Case Generation

15: Test Data Generation

: Automated Compliance Checking

: User & Repair Manual Gen.

: Cost Estimation

19: Supplier Selection

20: Configuration Management

21: Risk Management

22: Project Management

23: Product & Portfolio Mgmt.

24: Patent Management

25: Innovation Management

26: State-of-the-Art Monitoring

27: Variant Management

Best Practice for European Companies

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Radical Simplification

Reduce complexity and variants (Hardware, Software, Systems), from atoms to larger logical objects, streamline End-to-End processes and tool chain

Speed - Speed - Speed

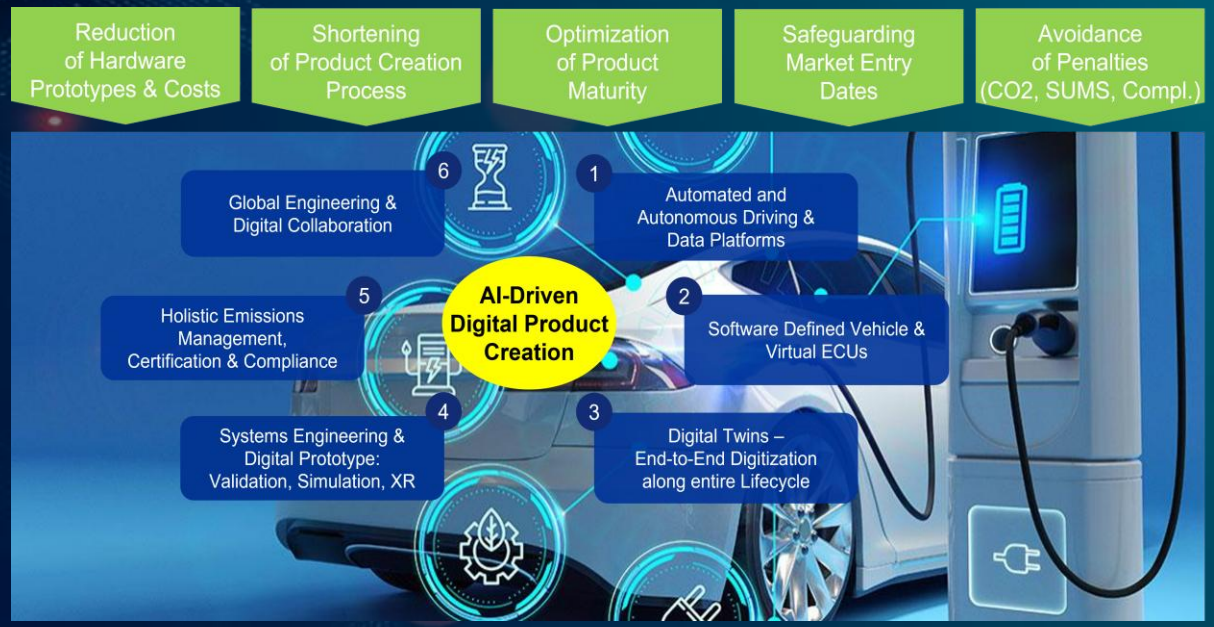
Rapid decision making, target is 2 years PEP, parallelization of development processes, risk taking, early integration of suppliers

Software First 2.0

Prioritize software development and integration as the core of vehicle, functionality and customer experience is key

Shift Left Next Gen

Digital First with no/very less hardware prototypes, early concept design and validation, end-to-end responsibility, AI & digital culture & mindset



Digital Courage

Summary - Executive Roadmap

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Strategy	▪ Digitization & Systems Engineering ▪ Make vs. Buy vs. FOSS ▪ Focus on Digital Twins	▪ **From Project to Product** ▪ **Data Centric Engineering** ▪ **SDV**
Processes & Methods	▪ Core of a modern Engineering IT ▪ Continuous virtual Evaluation ▪ Base for Homologation and	▪ **Standardized Data Models & APIs** ▪ **AI Assisted Engineering** ▪ **Digital Twins**
Tools & Technology	▪ Holistic Architecture ▪ Integration Legacy-Systems ▪ PLM = Base of Digital Twins	▪ **End-to-End Automation und AI** ▪ **From POC to Production** ▪ **IT Landscape Consolidation**
Organization, Culture, Mindset	▪ End-To-End Responsibility ▪ Single-Point-of-Truth Confidence ▪ Data-Driven Decisions	▪ **Digital Mindset & Courage** ▪ **Digital Leadership** ▪ **Digital First**

Thank you

Dr. Siegmar Haasis

E-Mail: Siegmar.Haasis@HaasisDEC.com
Tel.: (+49) 176 72164633
www.HaasisDEC.com

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Digital Engineering Consulting