A Methodology for Interactive Spatial Visualization of Automotive Function Architectures for Development and Maintenance

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Outline

1. Motivation
2. Function-oriented Data Integration
3. Our Methodology
4. Conclusions

An Increase in Complexity

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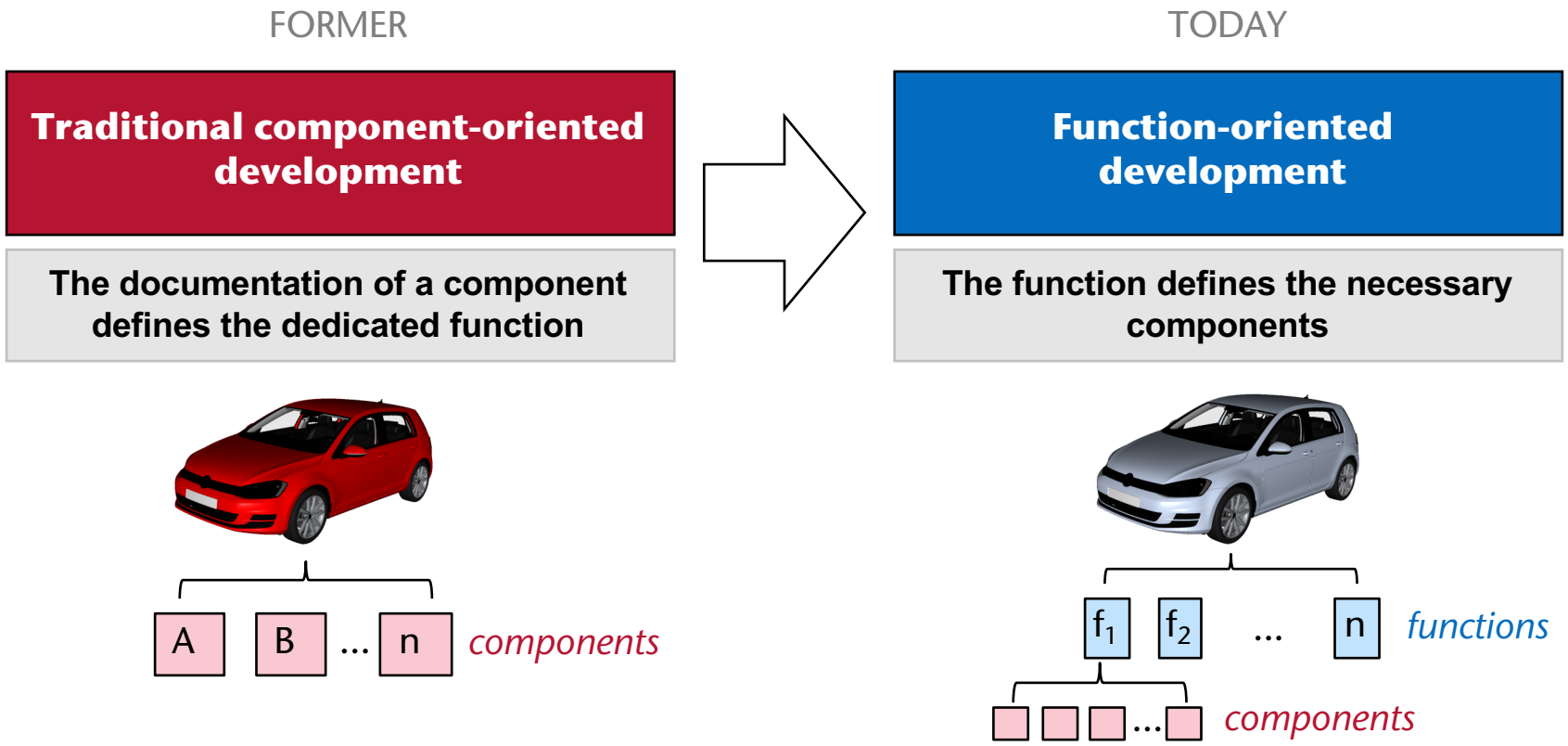
TODAY

A major challenge in current automotive development is the high degree of complexity.

- Ever increasing amount of vehicle functions, electrics/electronics, and networking
- Increasing diversity of variants and configurations

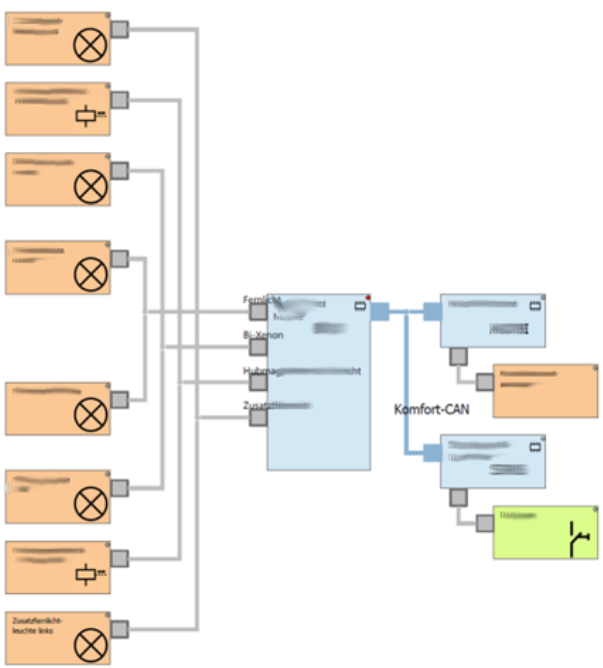
Function-oriented Development



- Function-orientation enhances a component-driven view by shifting the focus to complete vehicle functions
- Vehicle functions = mechatronic systems (comprising x and y and z)

Examples of Function Architectures

headlamp flasher

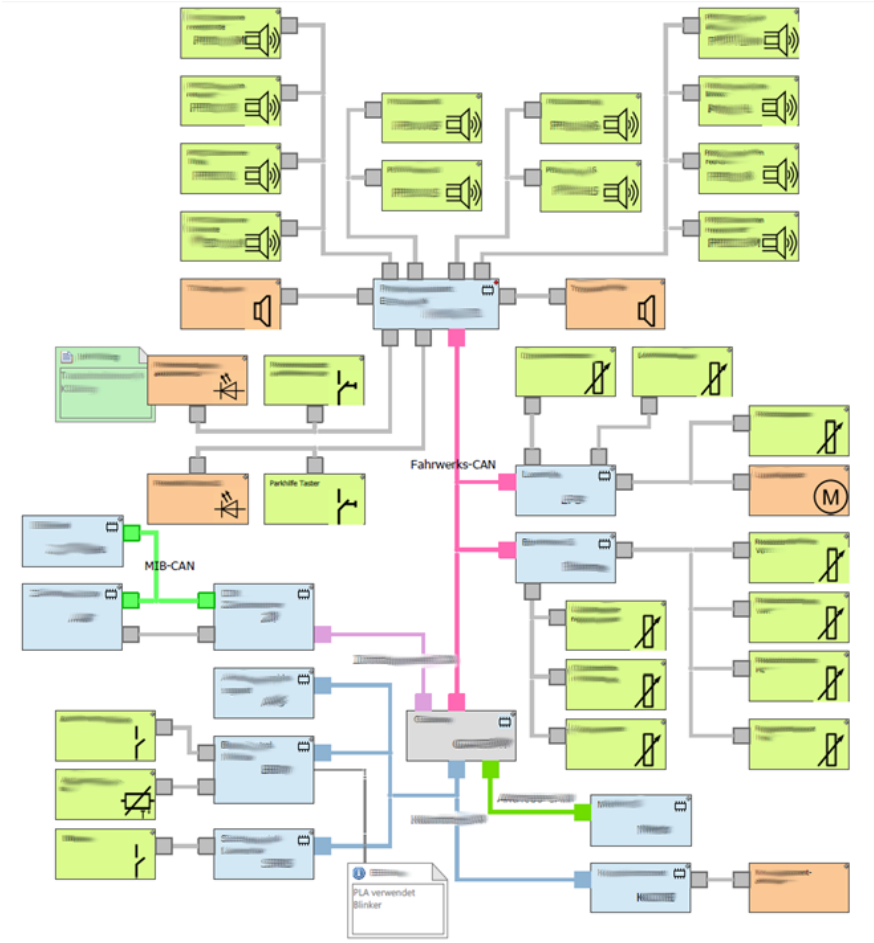


Controllers

Actuators

Sensors

park assist

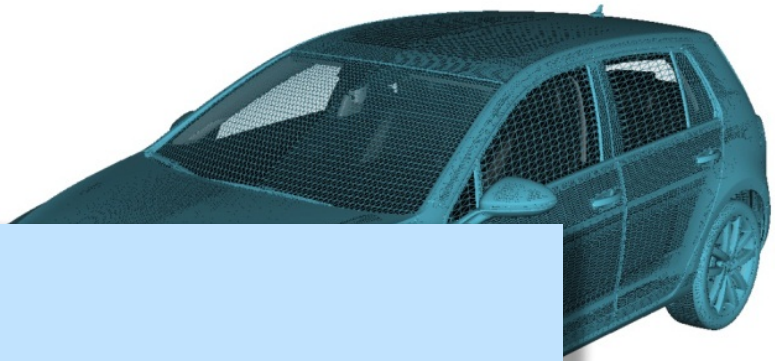


Current Challenges and Issues

- Complexity of mechatronic systems
- High amount of functions, variants and configurations
  (Volkswagen system description includes **300 functions** on **911 pages**)
- Significant challenges for developing engineers and service technicians
- Architecture diagrams do not provide information about the spatial distribution of functions in actual vehicle configurations

Virtual Technologies for CAD and DMU

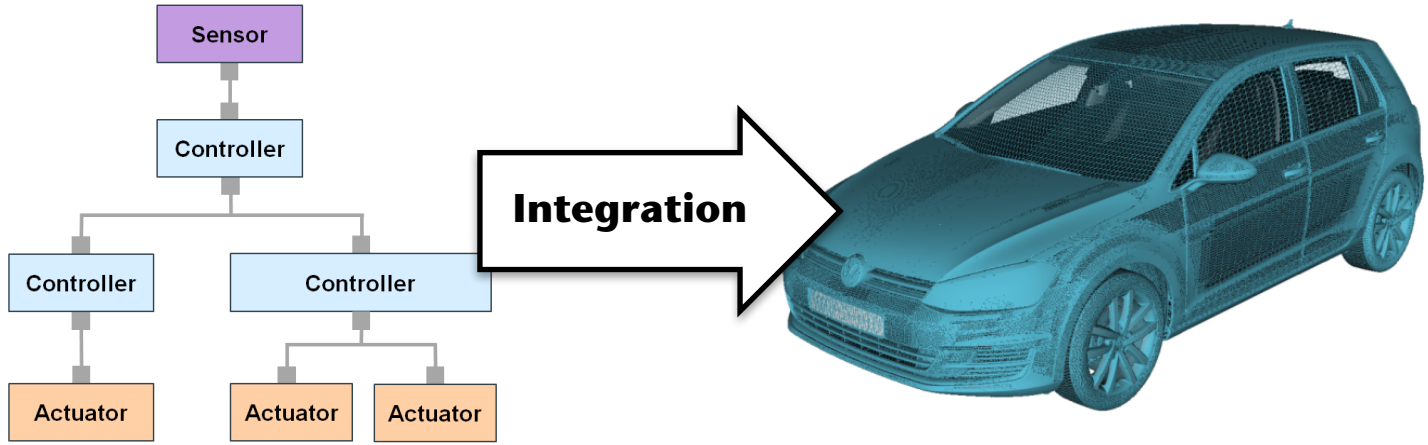
- We understand virtual technologies as applied virtual und augmented reality in the field of virtual prototyping
- Established technologies have many areas of application, like CAD and DMU (Design reviews, assembly analyses, etc.)
- Such technologies improve product quality, time-to-market, competitiveness and cost-efficiency



Research Question:

How to exploit the potentials of virtual technologies to help manage the growing complexities with function-oriented development?

Our Data Integration Approach



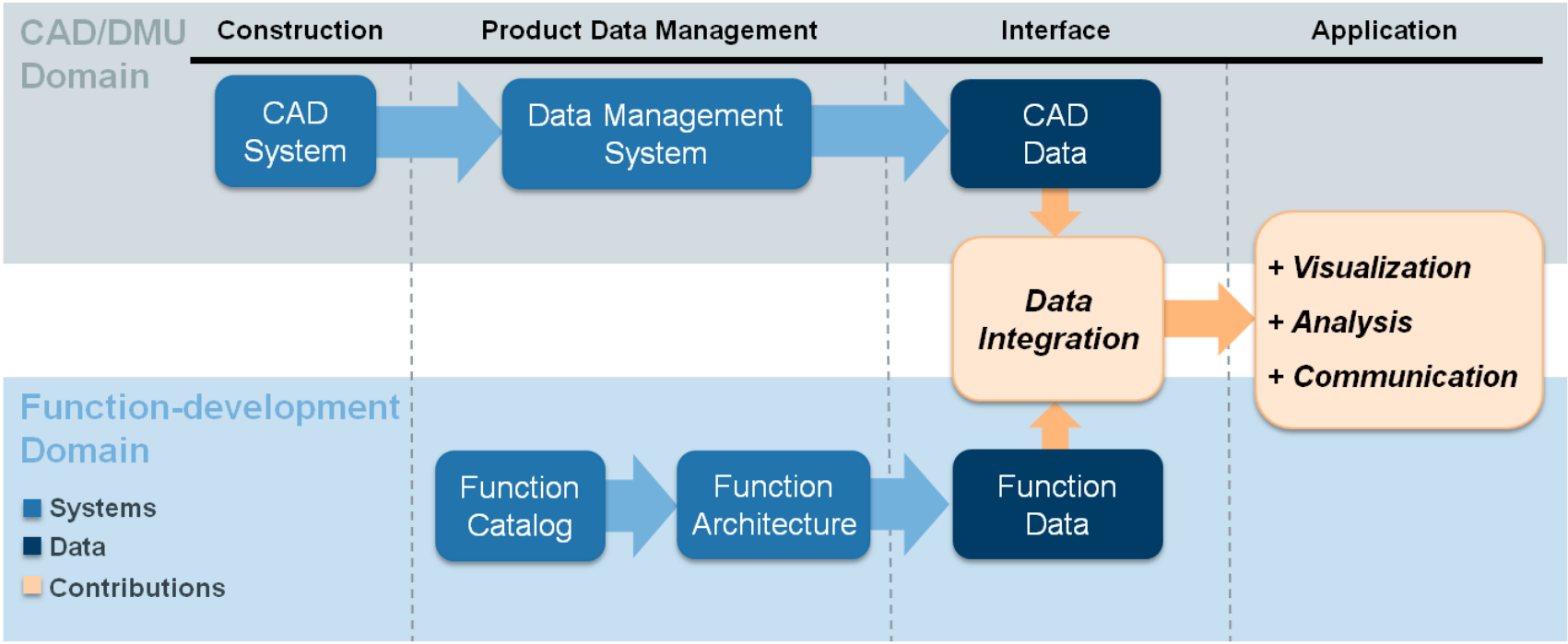
Function architectures

CAD models

- Our approach integrates function architectures with CAD models
- We derived requirements for a consistent data-mapping
- We developed an XML schema for system-independent description and utilization of function architectures
- Prototypical implementation within an established visualization system

A novel interdisciplinary Approach

Our work bridges two domains of automotive development:

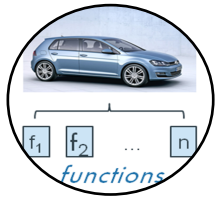


Contribution:

A novel methodology to process function-oriented data

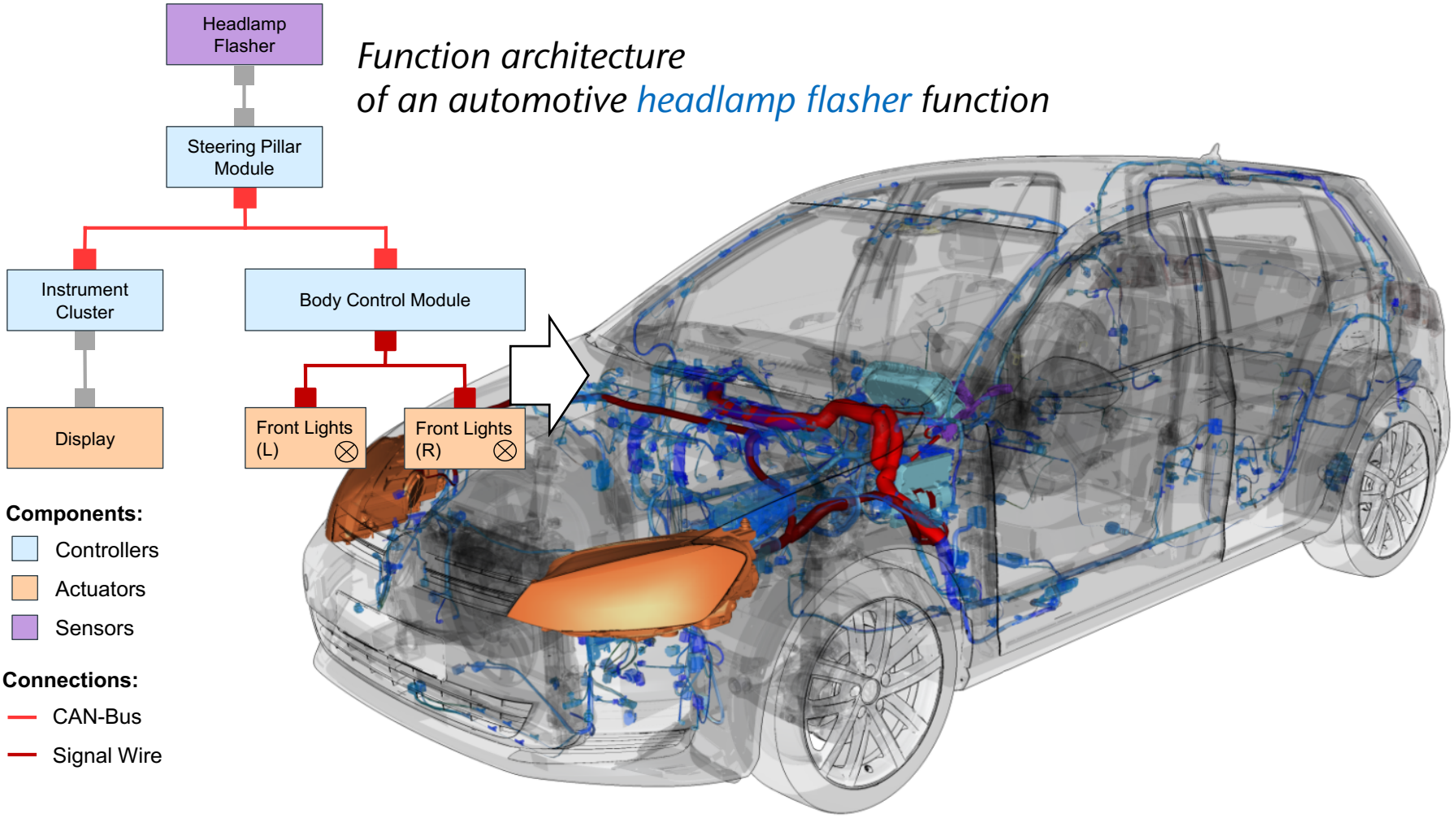
Our Contribution

- We propose a novel methodology for
  Virtual Vehicle Function Visualization and Analysis
- Goals:
  - Assisting a function-oriented development:
    - Improving quality of function architecture designs
    - Enabling early detection of assembly-related issues
    - Mastering complexity and Increasing transparency and communication along PLM



  - Assisting service and maintenance
    - Increasing tracking time for components and wiring harness
    - Fast acquisition of function-related information
    - Mastering the diversity of variants and configurations

Our Visualization Methodology

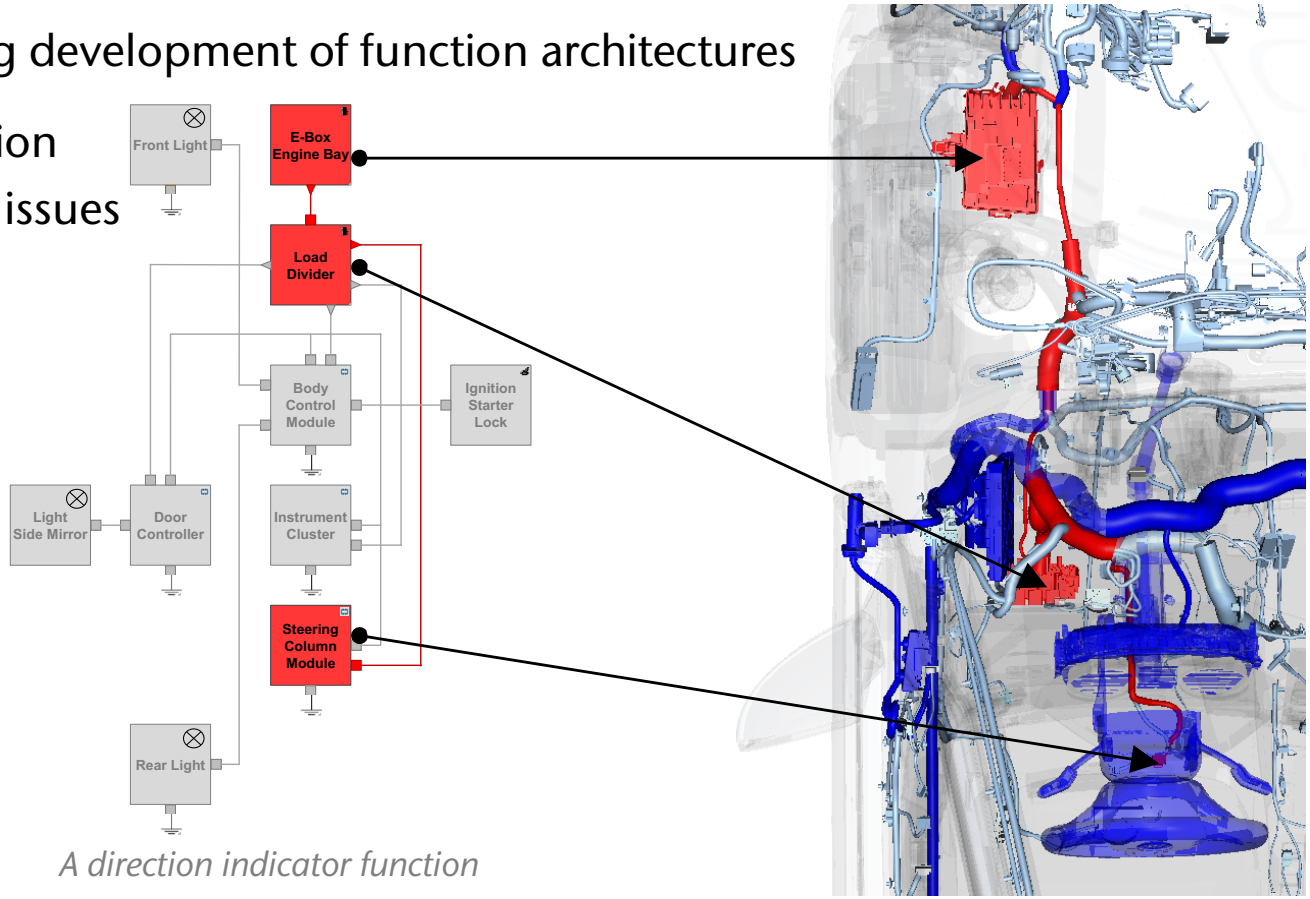


Function architecture of an automotive headlamp flasher function

- Our function visualization makes it possible to trace the spatial distribution and location of function components and connections in actual vehicle configurations

Example: Power Supply Failure

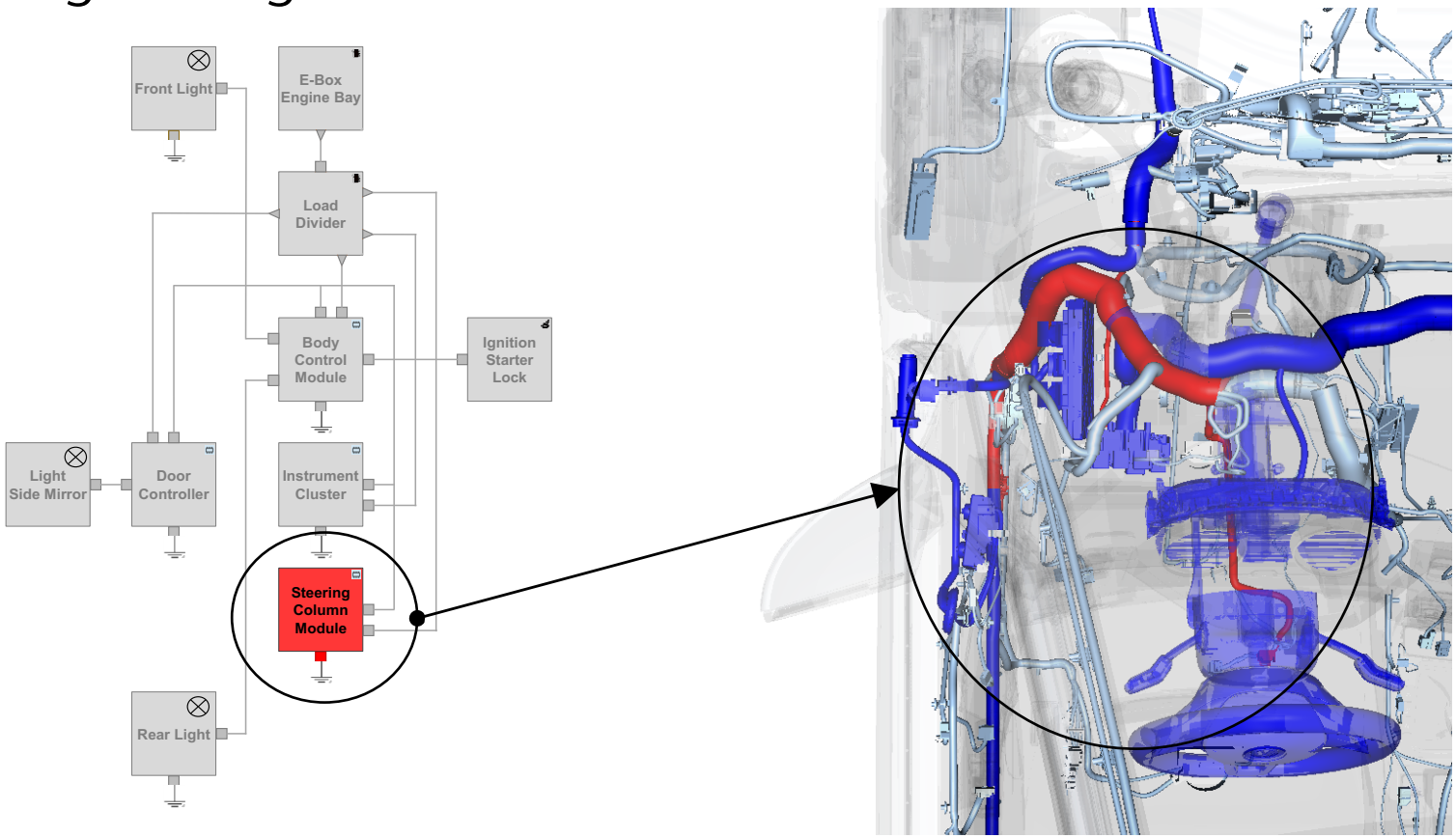
- Our visualization enables tracing of the actual power supply routing in a specifc vehicle configuration:
  - Saving time in service tasks and functional validation
  - Streamlining development of function architectures
  - Early detection of potential issues



A direction indicator function

Example: Grounding Connection

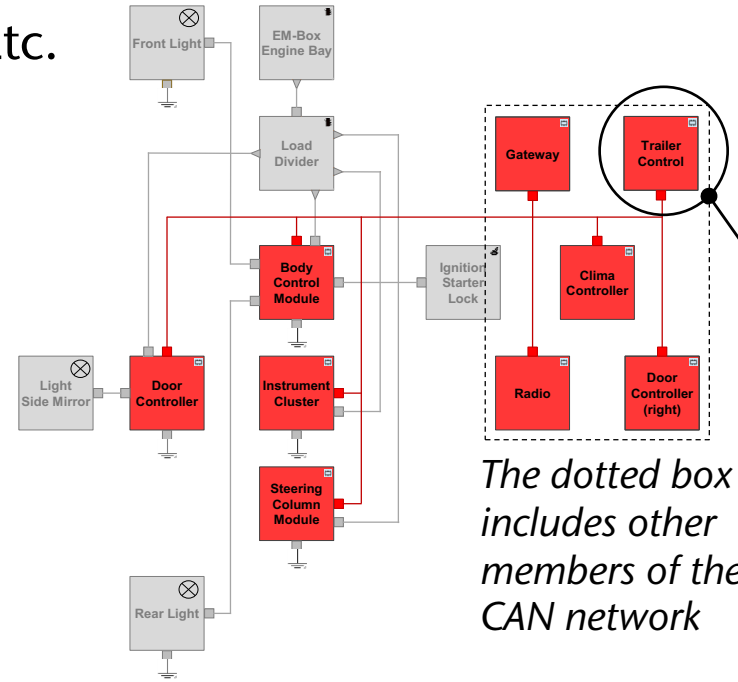
- The diagram on its own does not provide any information on the routing of the ground connection



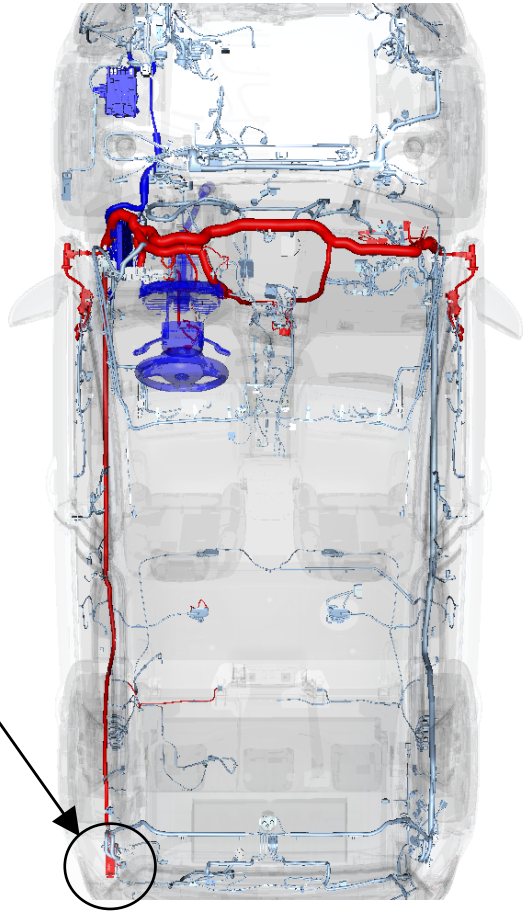
- We overcome this limitation by providing these information

Example: CAN Bus Network

- Our methods allows to answer many queries and helps to investiage different aspects during development
  - Potential defects in relation to crash-zones
  - Summed network lengths
  - Etc.



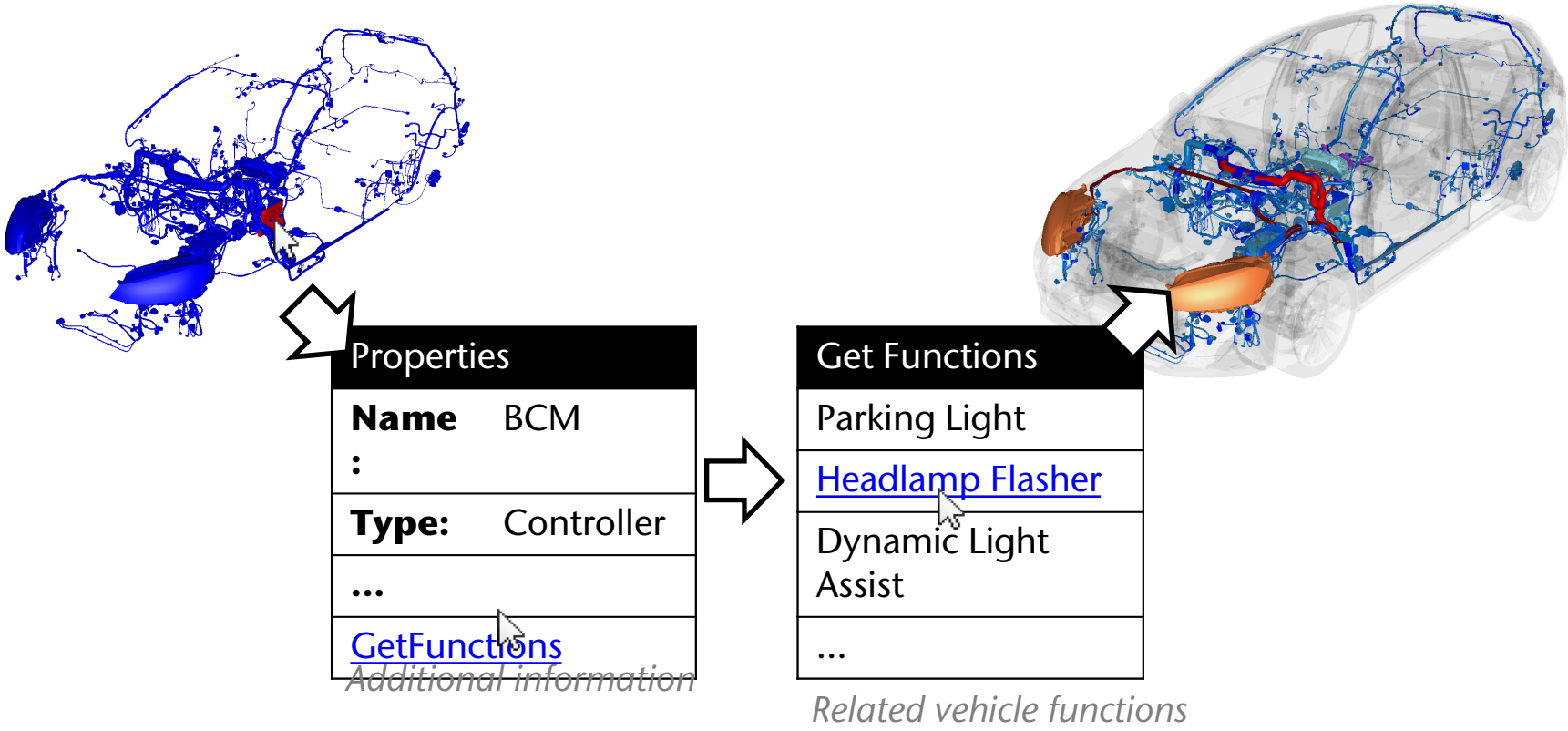
The dotted box includes other members of the CAN network



The full CAN network is highlighted in red

Methodology: Interactive Data Exploration

- Our methodology enables an interactive exploration of geometric product data so that related function-oriented information can be acquired for given function elements



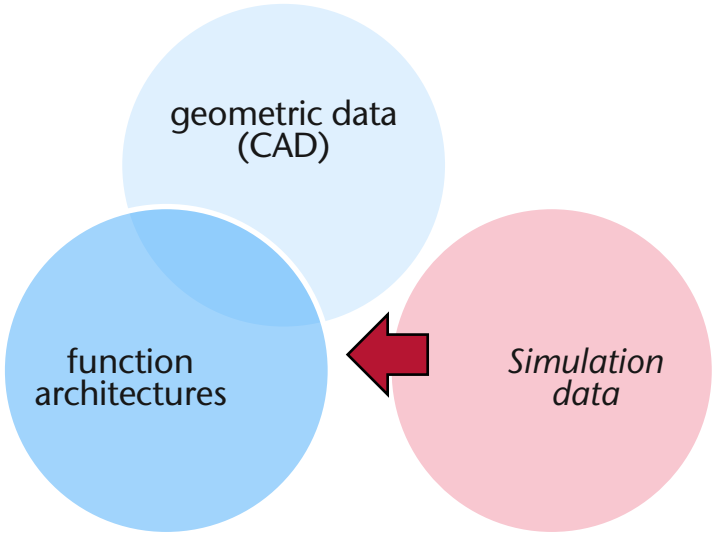
Conclusions

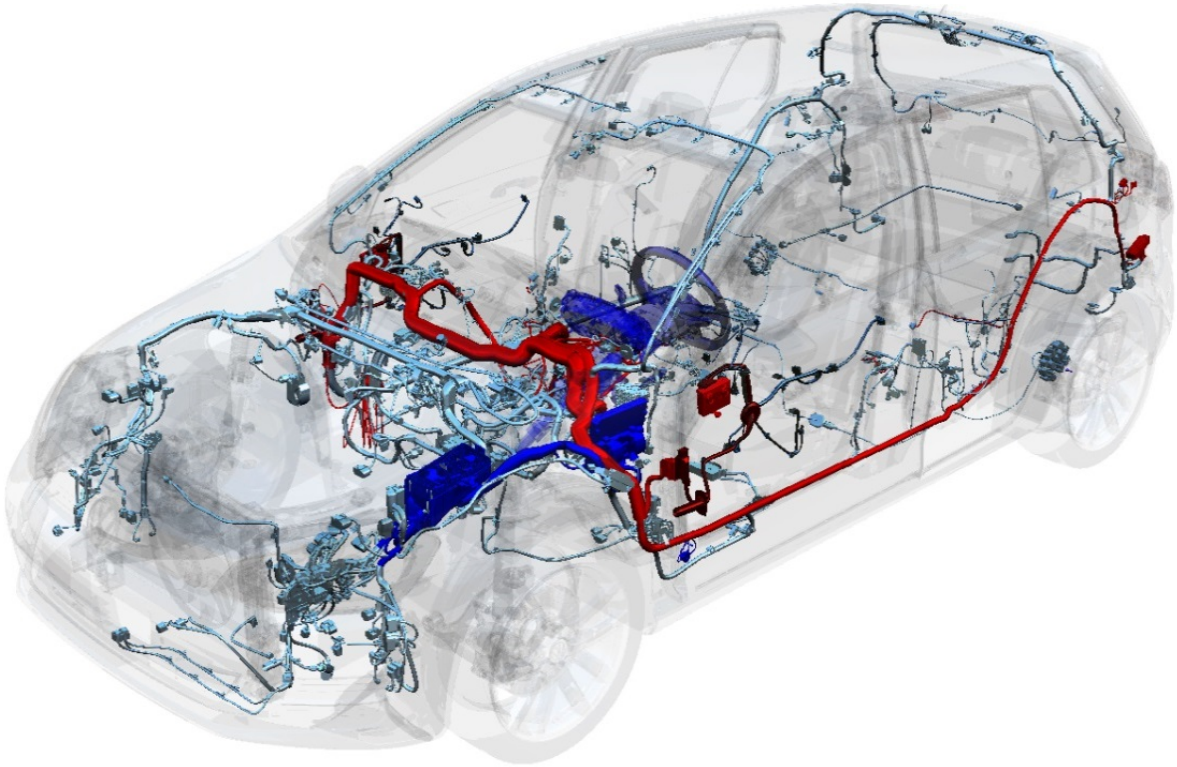
- Our methodology enables novel, beneficial options for:
  - Visualization of function architectures
  - Analysis of functional properties (incorporating geometric information)
  - Visual communication of function architectures

- There are beneficial applications in many fields, including:
  - Function-oriented development
  - System validation and verification
  - Service and Maintenance

Future Work

- Integration of the function-oriented methodology into established visualization systems to fully exploit the potentials of the proposed methods in daily work flows
- Further advancement of interdisciplinary approaches towards a more comprehensive virtual prototyping, for example by coupling our approach with simulation data (functional mock-up)





Thank you for your attention