



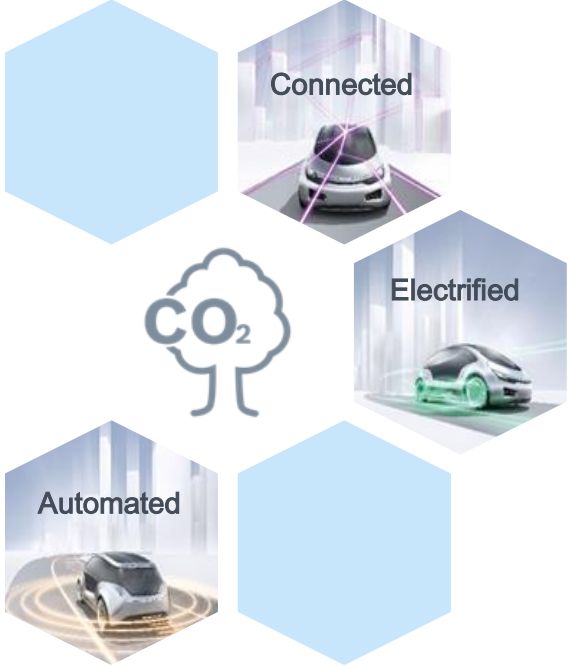
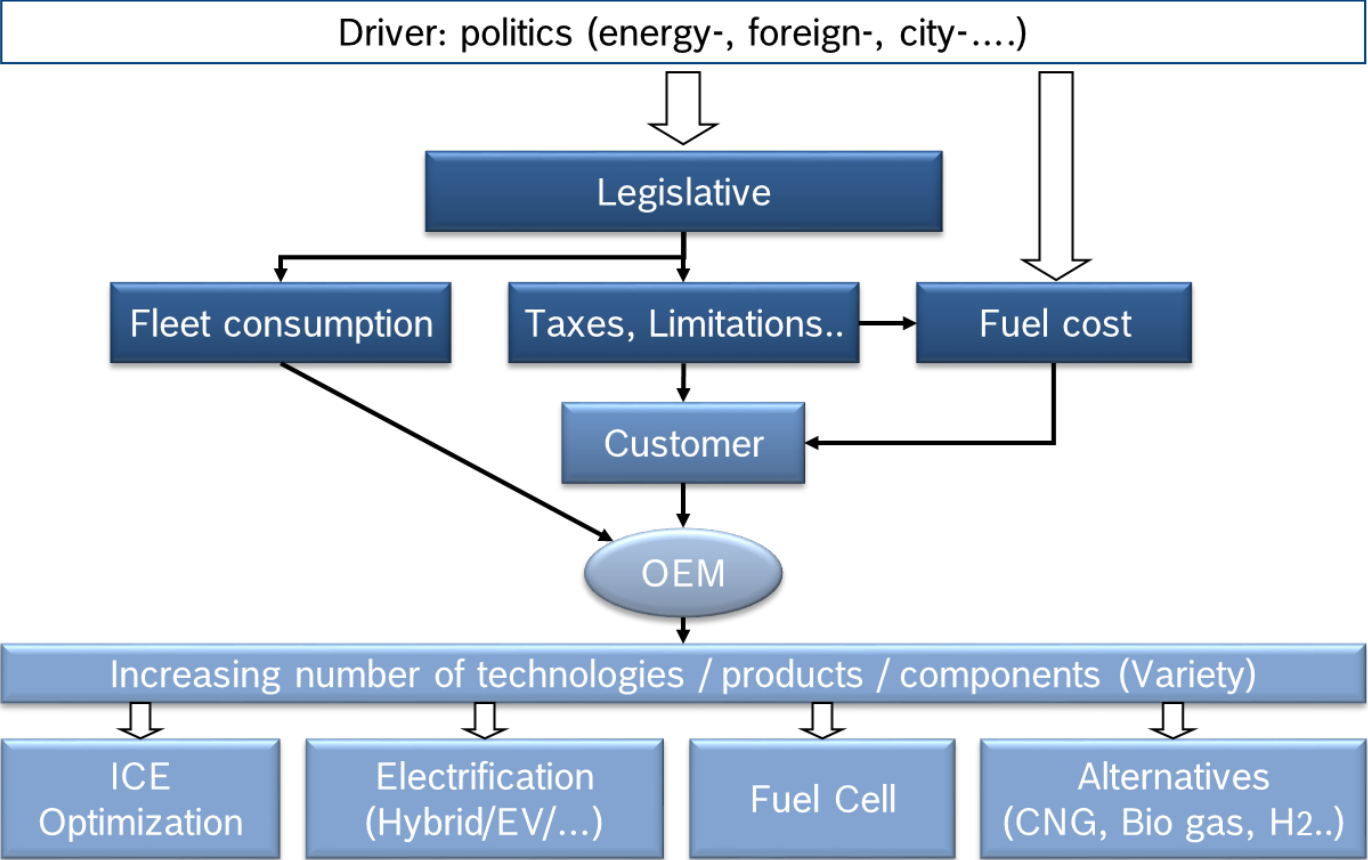
# Future Opportunities & Challenges in Powertrain Development with Model Based Design

**Werner Quirant**

Diesel Gasoline Systems – Electronic Controls

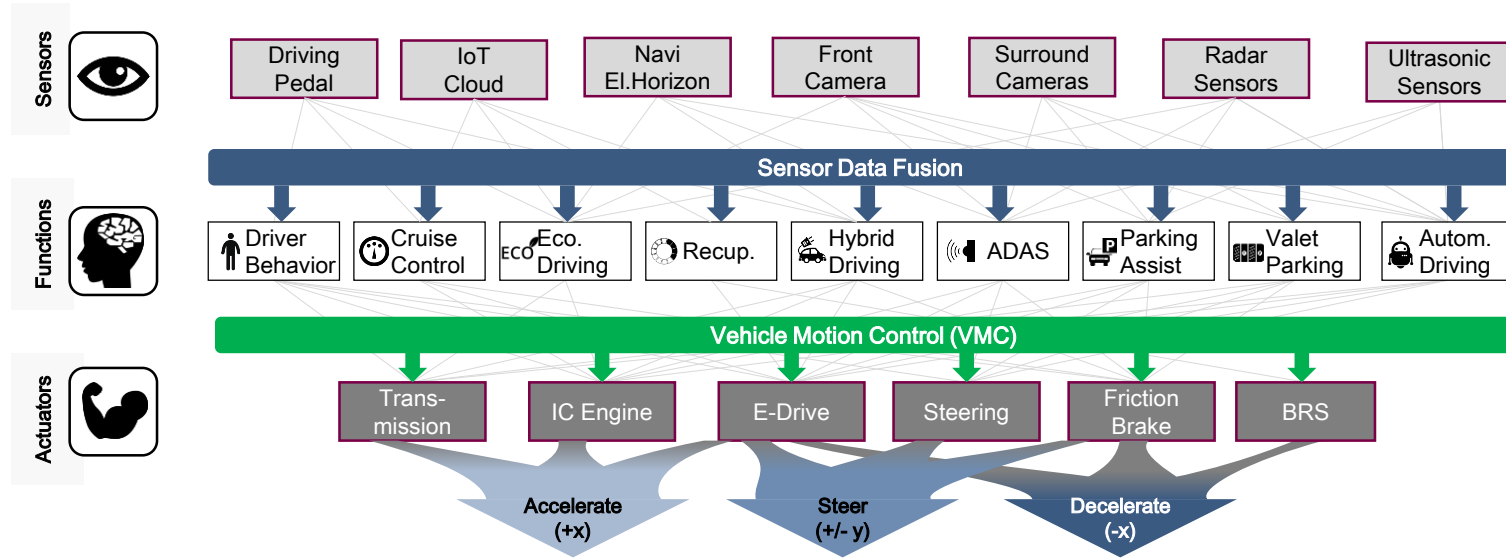
# Powertrain Development: Opportunities & Challenges

## Global Drivers



# Powertrain Development: Opportunities & Challenges

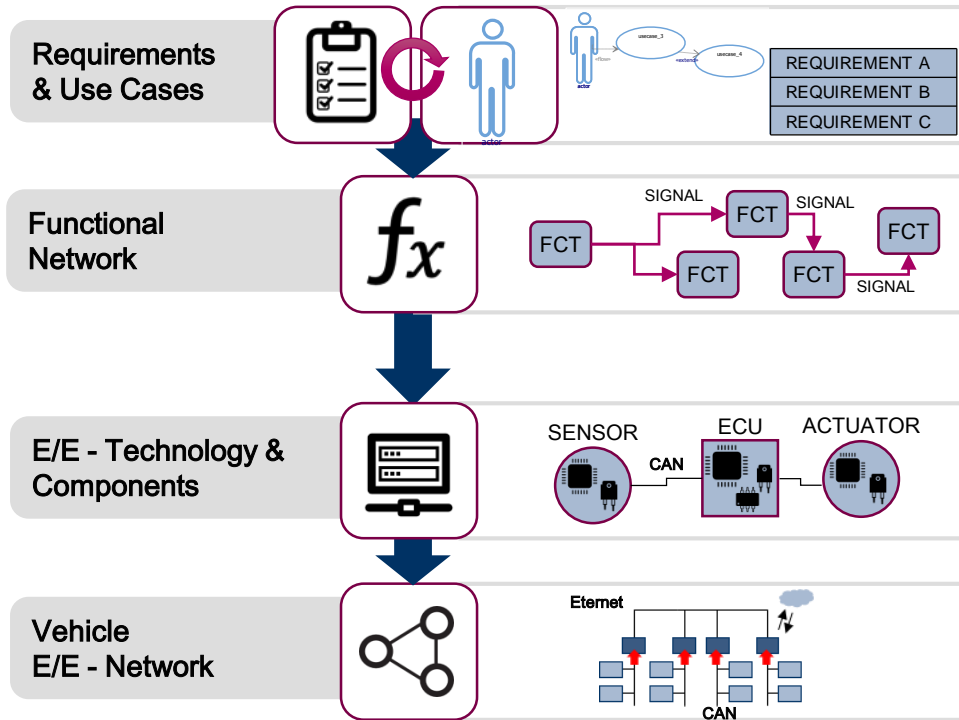
## Master Variance & Complexity of Cross Domain Functions



- ▶ Increase of cross-domain functions which influence the **Vehicle Motion (lateral and longitudinal acceleration)** are caused by comfort, safety, autonomous and eco driving functions.
- ▶ Complexity will be mastered by **functional coordination of Vehicle Motion Control** (arbitration/coordination of Vehicle Motion Aggregates like braking, ICE, E-Machine & steering)

# Powertrain Development: Opportunities & Challenges

## Model Based E/E-Architecture Design



Definition of relevant use-cases and of the functional requirements for the electric and electronic systems

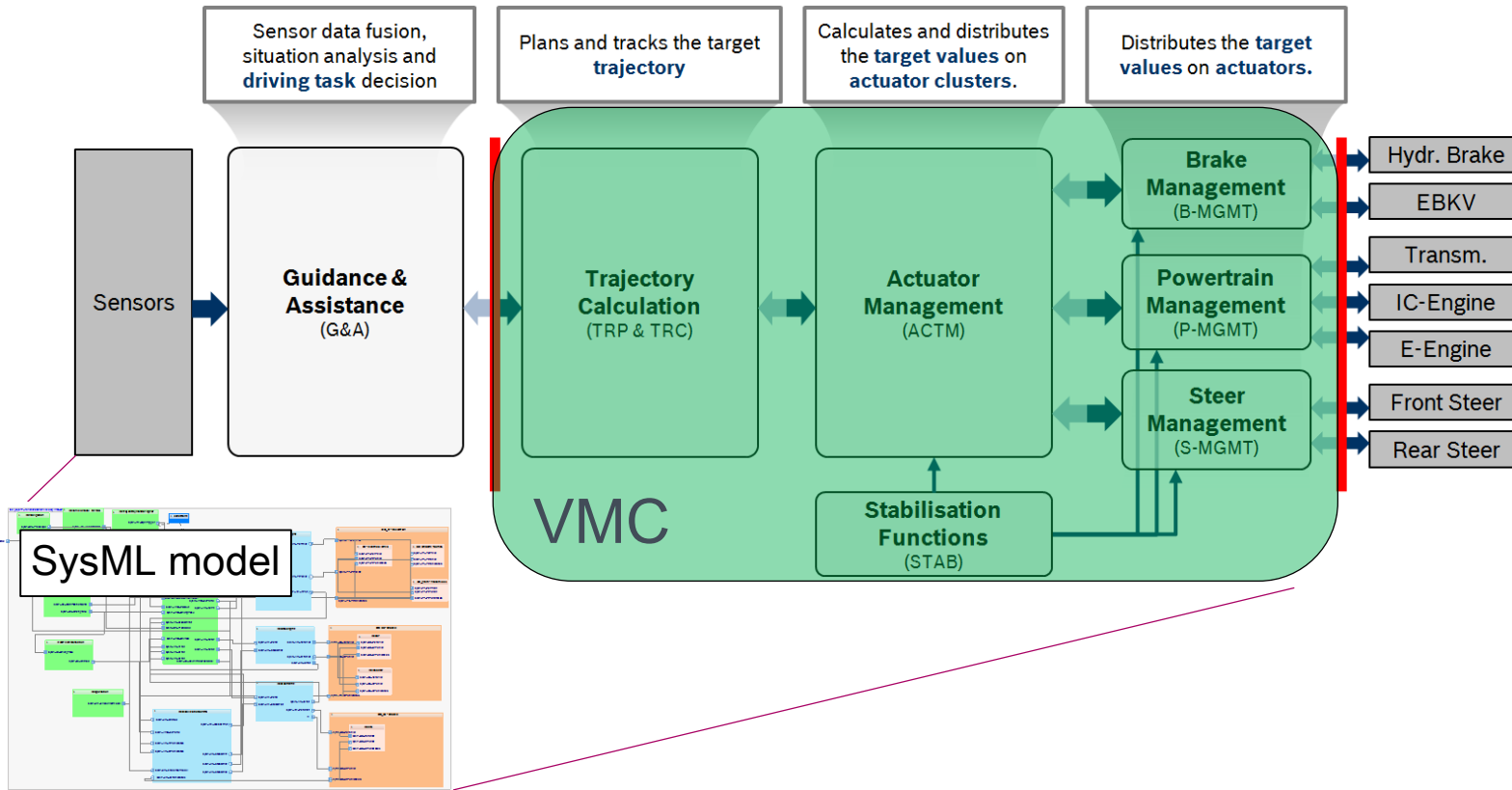
Derive main functional cause-effect relationships and define functional networking with optimized functional cluster



Transfer functional clusters on physical E/E components and domains. Consider technological and strategic criteria, such as weight, cost, flexibility, innovation cycle, safety and security requirements, ..

# Powertrain Development: Opportunities & Challenges

## Functional Network: Example Vehicle Motion Control



- Visualization of interactions/interfaces between the different functionalities of the vehicle system
- Supports distributed development, impact analysis, conservation of system competency
- Base for deriving physical E/E architecture

Bosch Approach: Modelling of vehicle wide (Cross-Domain) Functional Network in SysML

# Powertrain Development: Opportunities & Challenges

## Future E/E-Architecture

### Drivers 'Next Generation' (E/E and SW) Architecture design



#### Technical drivers

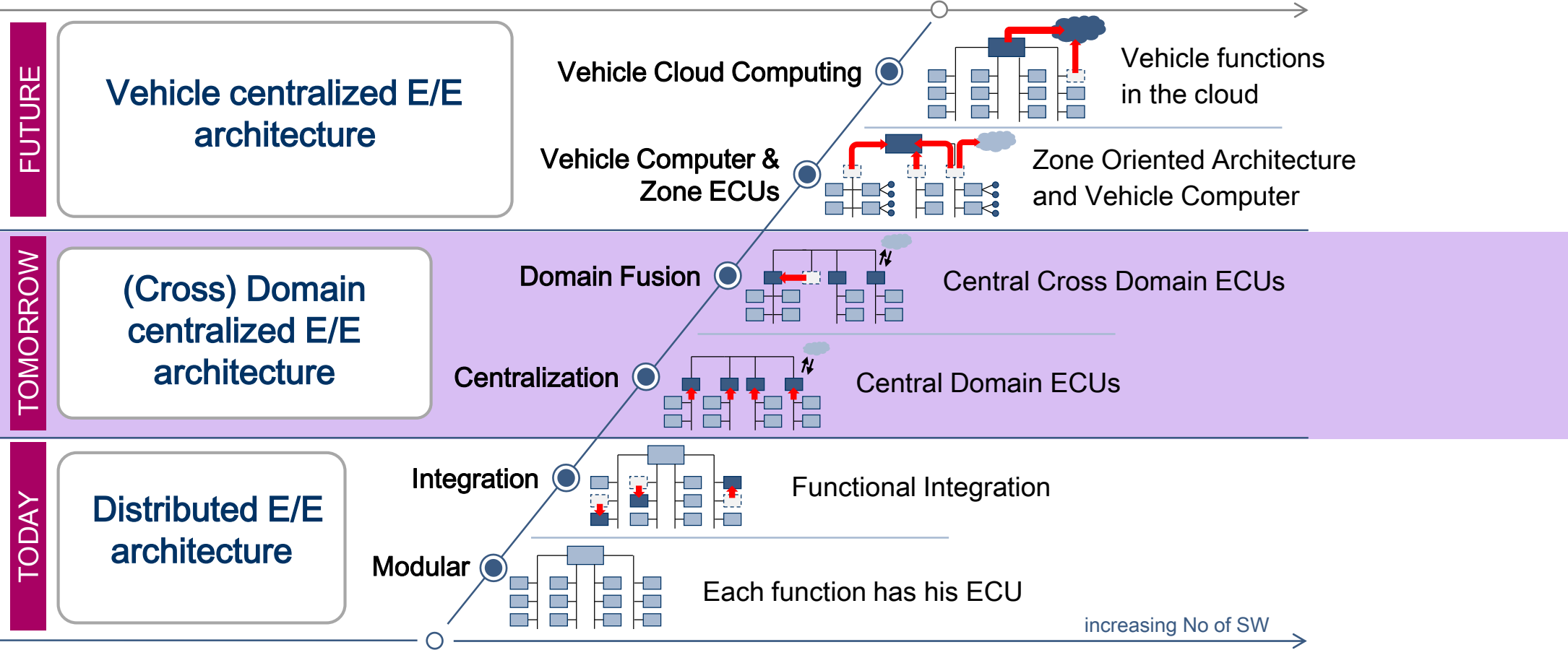
- Emission reduction, Powertrain Electrification, Automated driving and Connectivity
- Introduction of complex cross domain or cloud-based functions
- Variant management

#### Strategic drivers

- Fast innovation cycles
- Integration of SW from different sources
- Scalable, modular platform concepts
- Web-based services

# Powertrain Development: Opportunities & Challenges

## Future E/E-Architecture



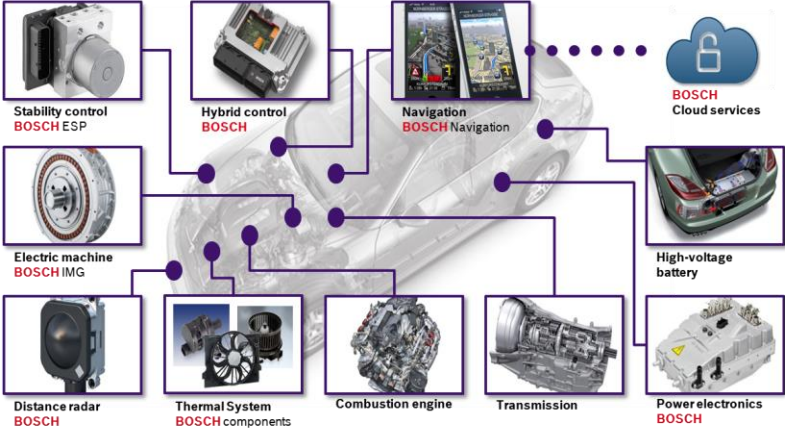
# Powertrain Development: Opportunities & Challenges

## Model-Based Cross-Domain Feature Development

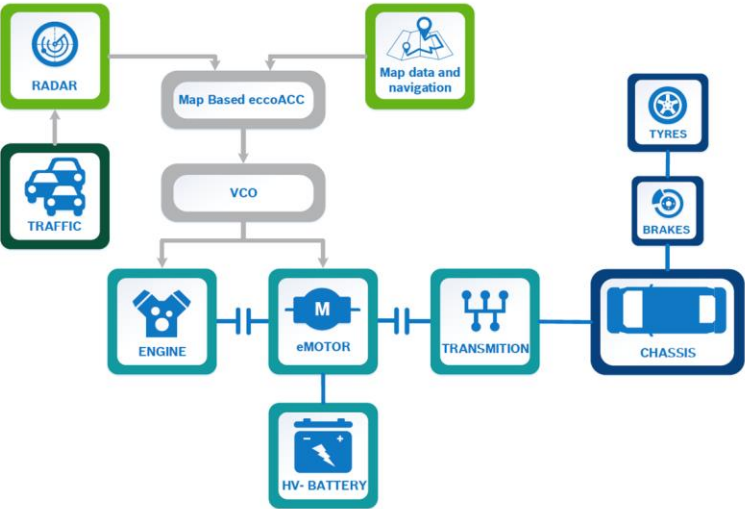
### Availability

Real Prototype

Virtual Prototype



Substitute



Time to Market

Cost

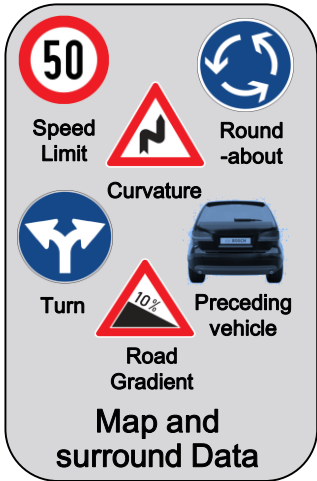


# Powertrain Development: Opportunities & Challenges

## Example mapbased *EcoACC*

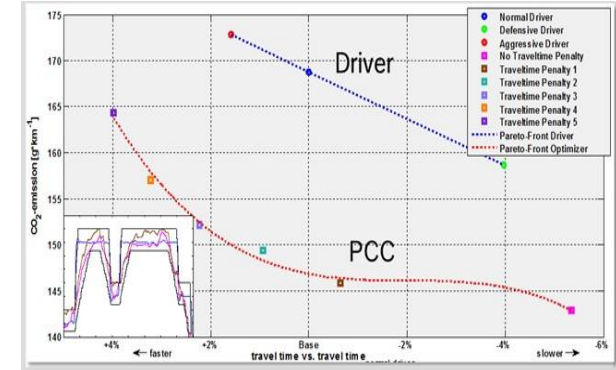


connected  
Optimized  
handover



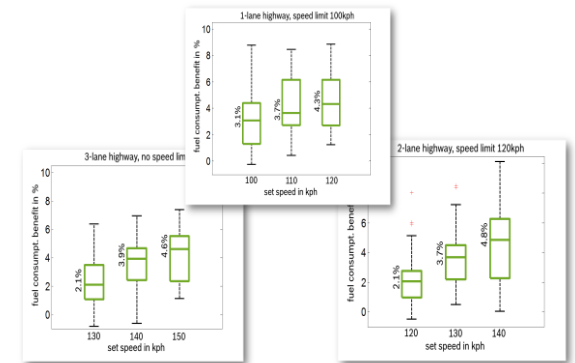
### Simulation scenario:

- No traffic ahead
- Vary driver & optimizer
- CO<sub>2</sub> saving: ~10% (depends on route)



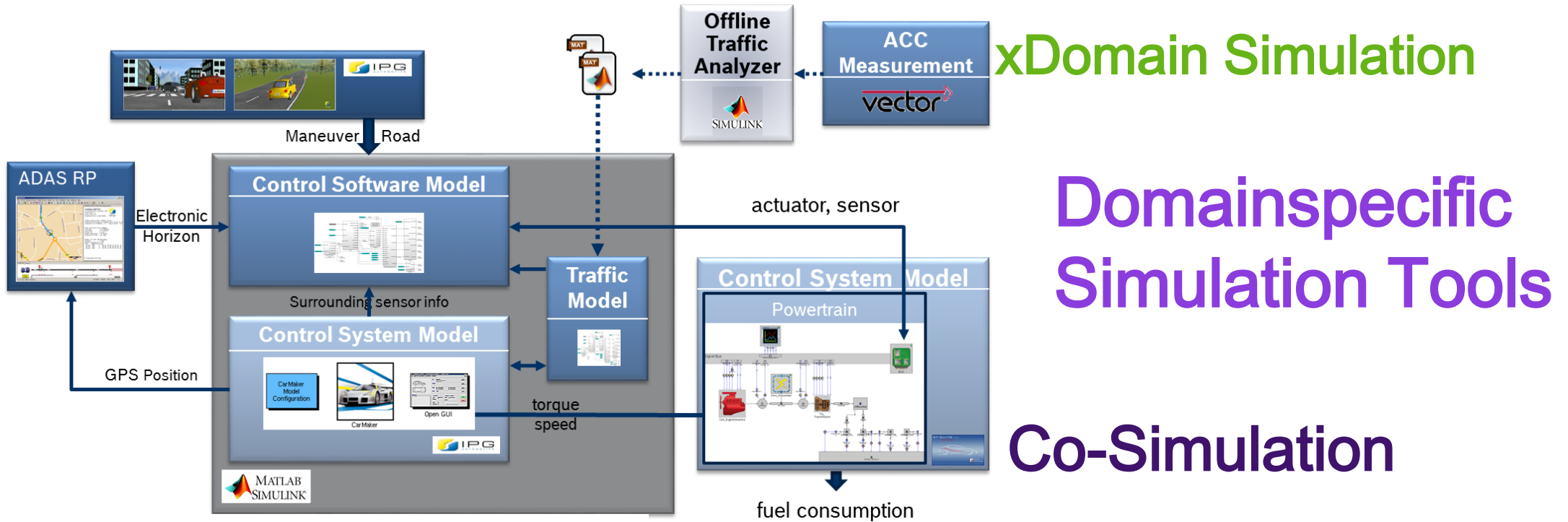
### Simulation scenario:

- Varying traffic
- Different road types
- CO<sub>2</sub> saving: 2% - 5% (depends on traffic)



# Powertrain Development: Opportunities & Challenges

## Current Solution for mapbased *EcoACC* Development

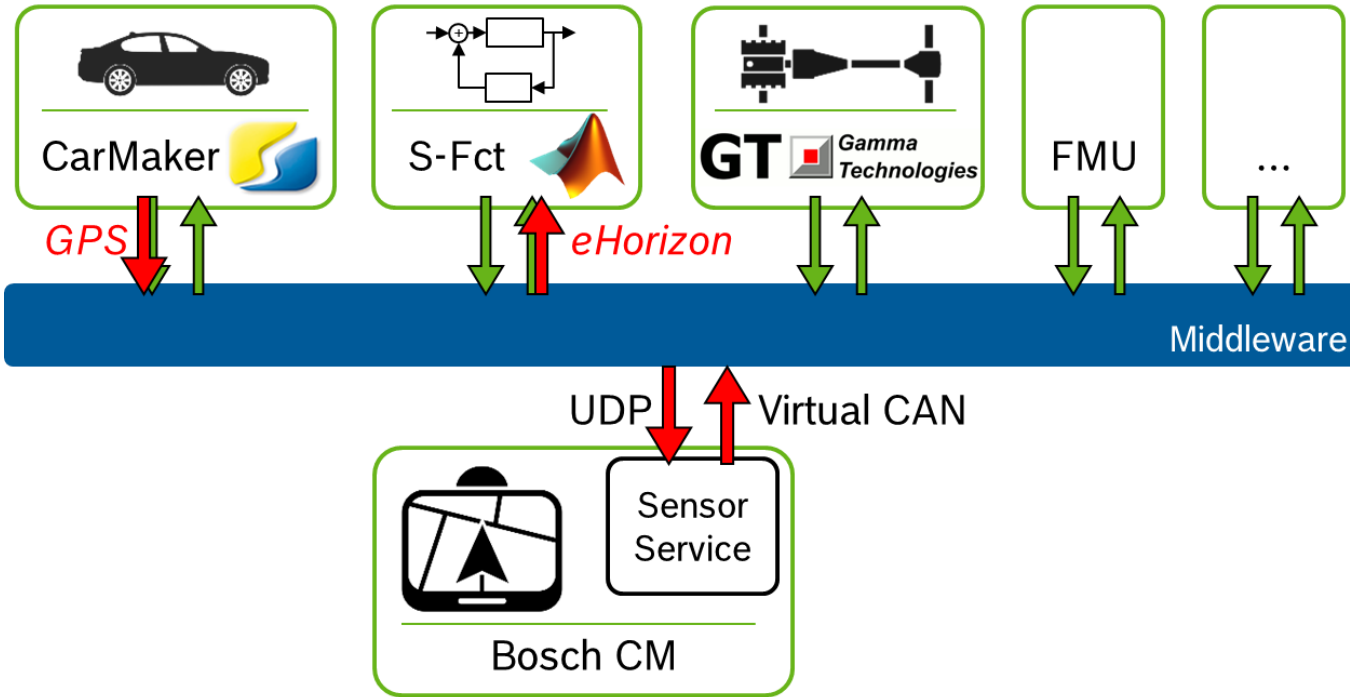


Today: Expert Solution

Key Enabler for successful Cross-Domain Simulation: Seamless Integration of different Simulation Tools

# Powertrain Development: Opportunities & Challenges

## Future Solution for Cross-Domain Development



Flexibility

Usability

Modularity

Reliability

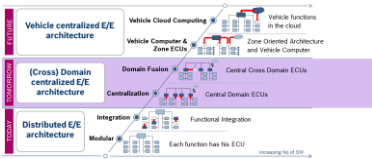
## Future: Standardized Cross-Domain Solution

# Powertrain Development: Opportunities & Challenges

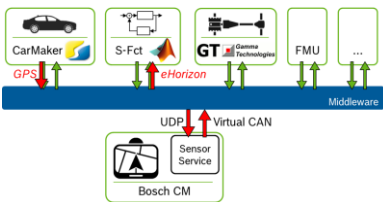
## Summary & Conclusion



Automotive Trends lead to more Cross-Domain Functions  
→ Increased Complexity, High Variance



Complexity, High Variance & Fast Innovation Cycles  
require enhanced E/E-Architecture Approaches



Complexity, Fast Innovation Cycles & Costs require  
the usage of Virtual Prototypes in Cross-Domain  
Function Development

Model Based Approach is key Enabler for E/E-Architecture & Cross Domain Function Development