Future Opportunities & Challenges in Powertrain Development with Model Based Design
Werner Quirant
Diesel Gasoline Systems – Electronic Controls
Powertrain Development: Opportunities & Challenges

Global Drivers

Driver: politics (energy-, foreign-, city-....)

Legislative

Fleet consumption

Taxes, Limitations...

Fuel cost

Customer

OEM

Increasing number of technologies / products / components (Variety)

ICE Optimization

Electrification (Hybrid/EV/...)

Fuel Cell

Alternatives (CNG, Bio gas, H2..)
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

Definition of a physical E/E system

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

- Powertrain Electrification
- Automated driving
- Energy-management
- Connectivity
- SW Updates FOTA
- High-speed-Communication
- Safety & Security

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

Technical drivers
- Emission reduction, Powertrain Electrification, Automated driving and Connectivity
- Introduction of complex cross domain or cloud-based functions
- Variant management
Powertrain Development: Opportunities & Challenges
Future E/E-Architecture

**FUTURE**

Vehicle centralized E/E architecture

Vehicle Cloud Computing

Vehicle Computer & Zone ECUs

Zone Oriented Architecture and Vehicle Computer

**TOMORROW**

(Cross) Domain centralized E/E architecture

Domain Fusion

Central Cross Domain ECUs

Central Domain ECUs

**TODAY**

Distributed E/E architecture

Integration

Functional Integration

Each function has his ECU

Modular

increasing No of SW
Powertrain Development: Opportunities & Challenges
Model-Based Cross-Domain Feature Development

**Availability**

**Real Prototype**

**Virtual Prototype**

**Time to Market**

**Cost**
Simulation scenario:
- No traffic ahead
- Vary driver & optimizer
- CO₂ saving: ~10%
  (depends on route)

Simulation scenario:
- Varying traffic
- Different road types
- CO₂ saving: 2% - 5%
  (depends on traffic)
Powertrain Development: Opportunities & Challenges

Current Solution for mapbased EcoACC Development

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

Today: Expert Solution
Future Solution for Cross-Domain Development

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