Model-based software development for an electric endurance racecar

E&A 2023

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ELECTRONICS & APPLICATIONS '23

26 T/M 28 SEPTEMBER '23
JAARBEURS UTRECHT

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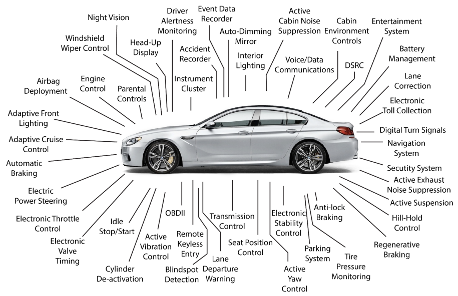
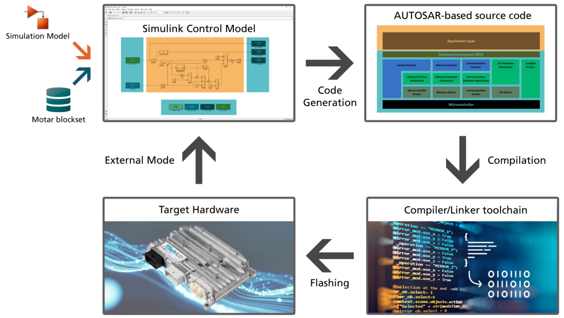


- Model-based development



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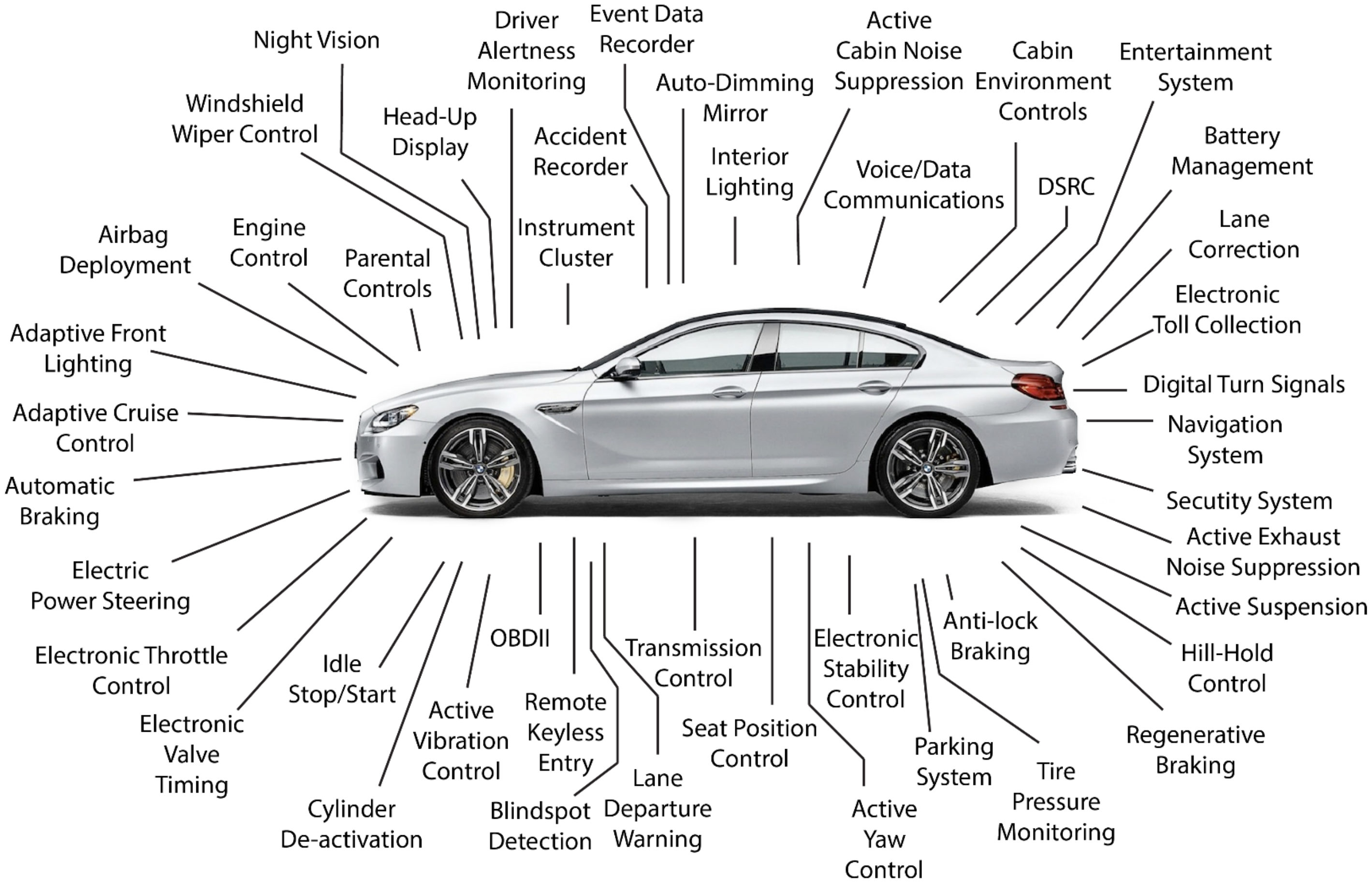
Trends in E-mobility



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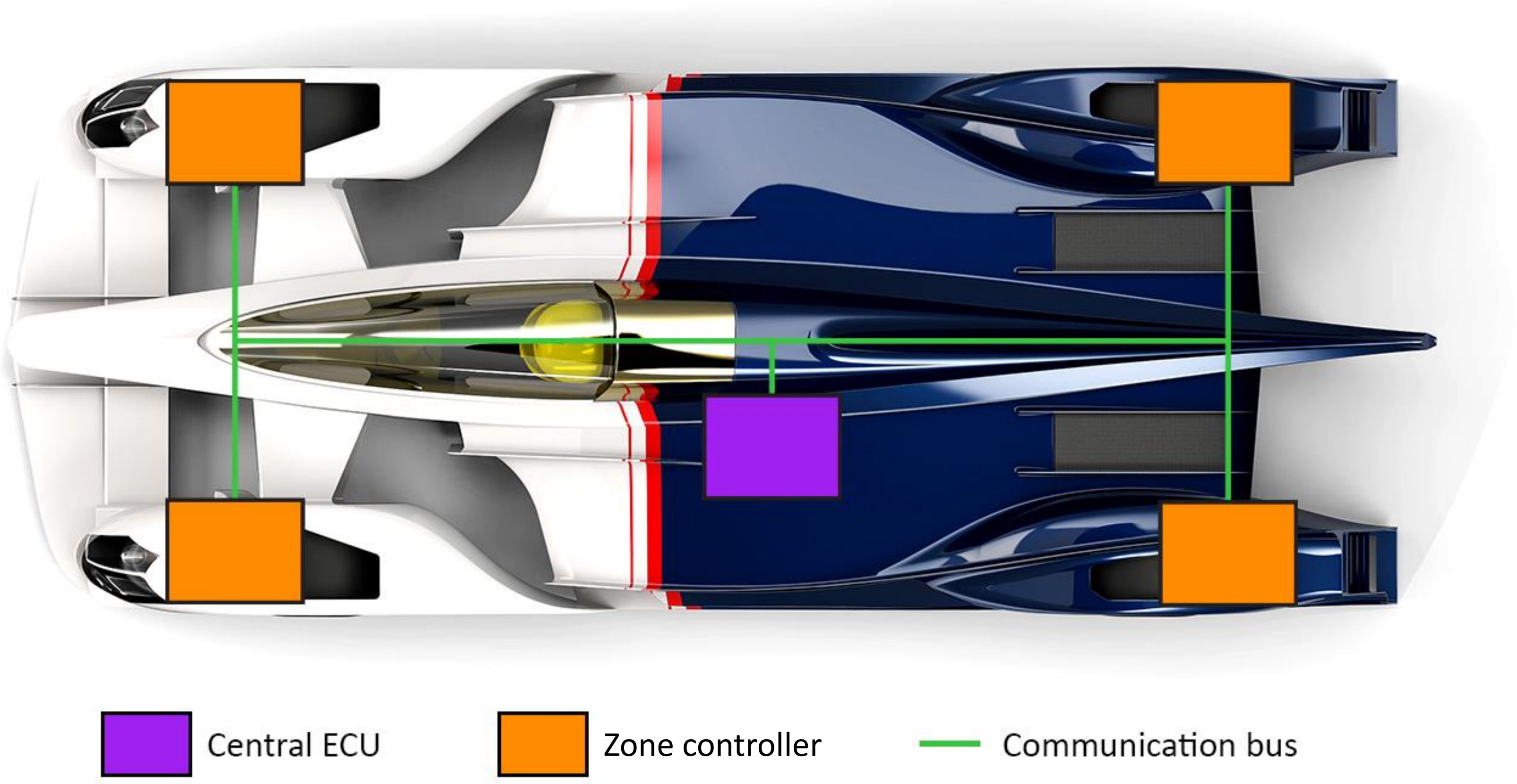
Trends in E-mobility – Software Defined Vehicle

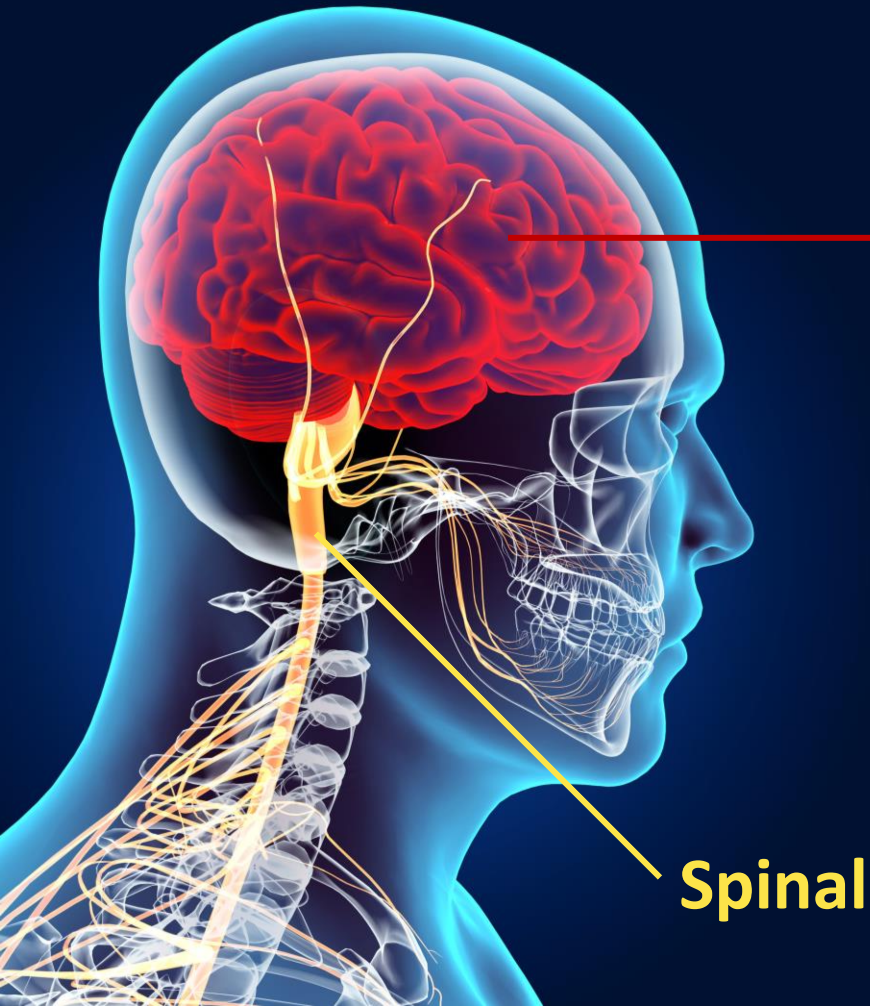
- Cars become Software Defined Vehicles (SDV)
  - Increasing number of functions and applications – As per user demand
  - Faster time to market – More regular software updates
  - Increasing complexity – Hard to manage in traditional development ways

- Cars used to be Hardware Limited Vehicles
  - Increasing number of functions – And therefore Lines of Code
  - Increasing number of ECUs – Adding to weight and costs
  - Increasing amount of wiring – Decreasing robustness

Trends in E-mobility – Integrated E/E Architectures



Trends in E-mobility – Integrated E/E Architectures



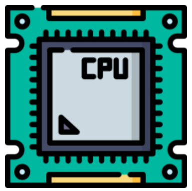
Brain || Awareness || Vehicle control

Spinal cord || Reflexes || Zonal control

Model-based development

- Graphical control model(s) central for the entire development
  - System/control engineers can create SW for mechatronic systems
    - Solves dependency on available people/expertise

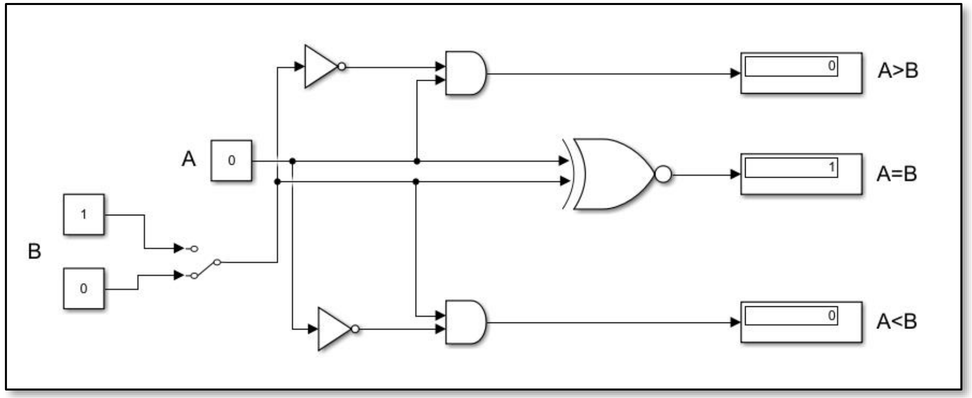
- Simulation of application behavior
  - Test and debug without having the HW already available
    - Solves dependency on available hardware

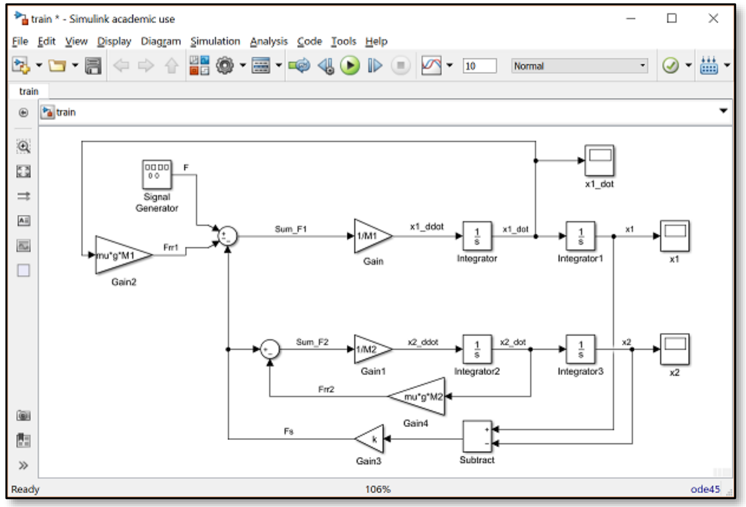


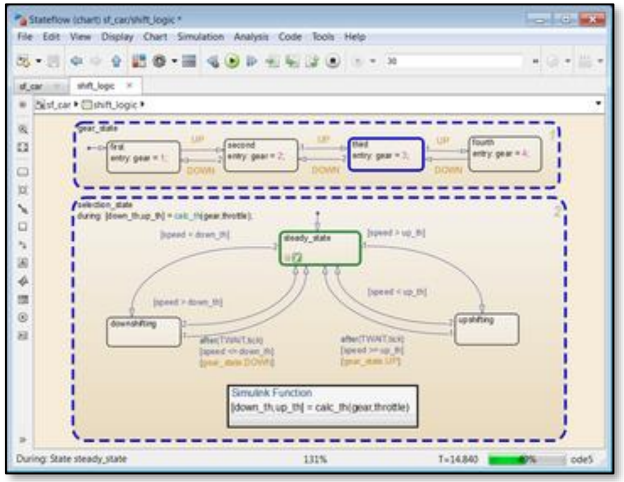
- Managing system complexity
  - Reduction of ECUs and wiring - enabling integrated E/E architectures
    - Increases robustness and reduces time to market

Model-based development – Matlab/Simulink

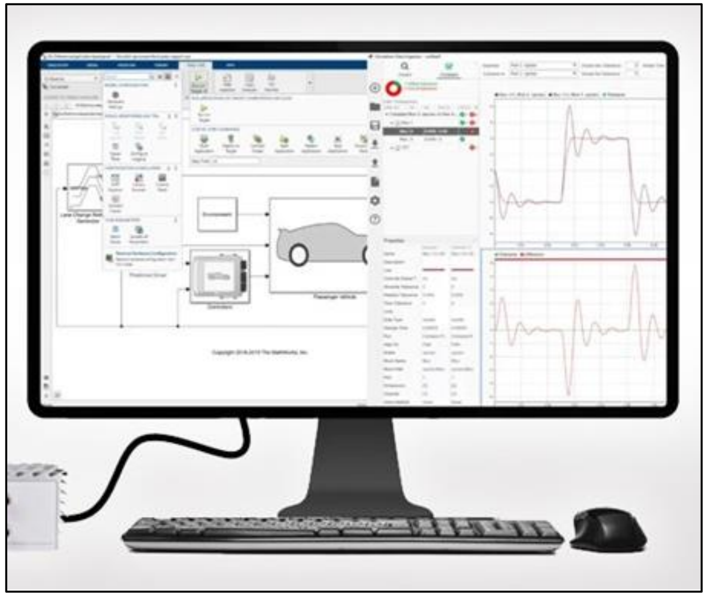
- Industry standard
- Variety of modeling techniques



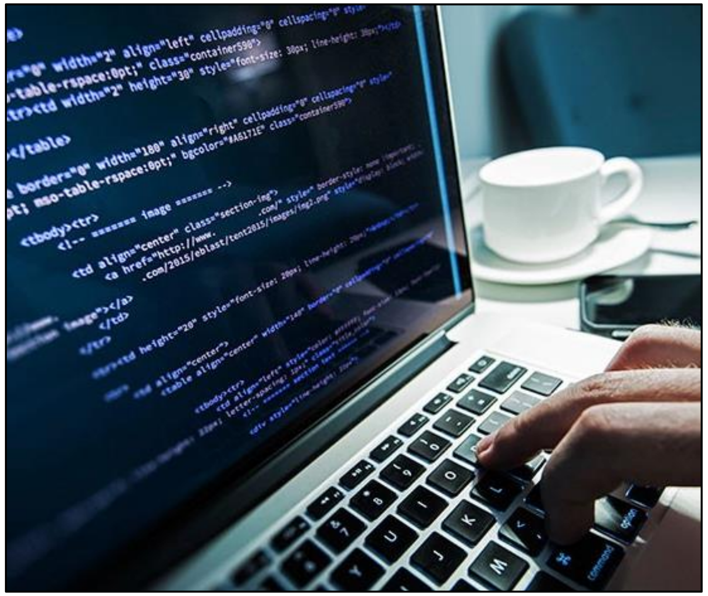




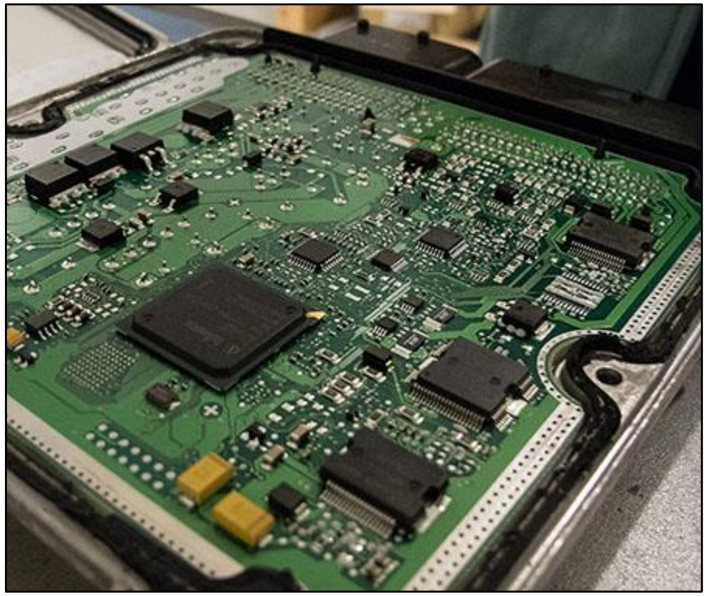
Model-based development – Embedded systems



Simulation



Code Generation



Deployment on target

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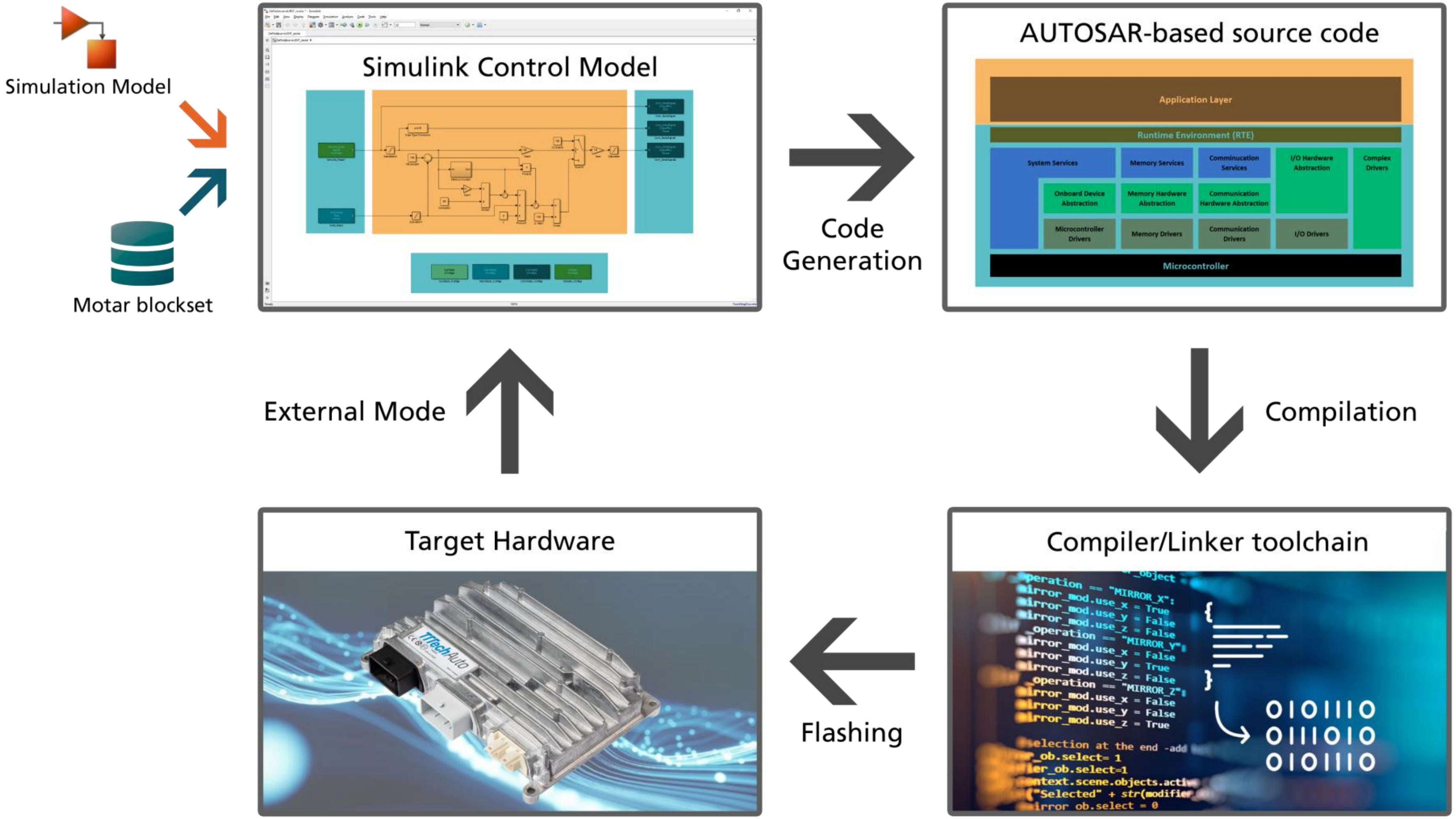
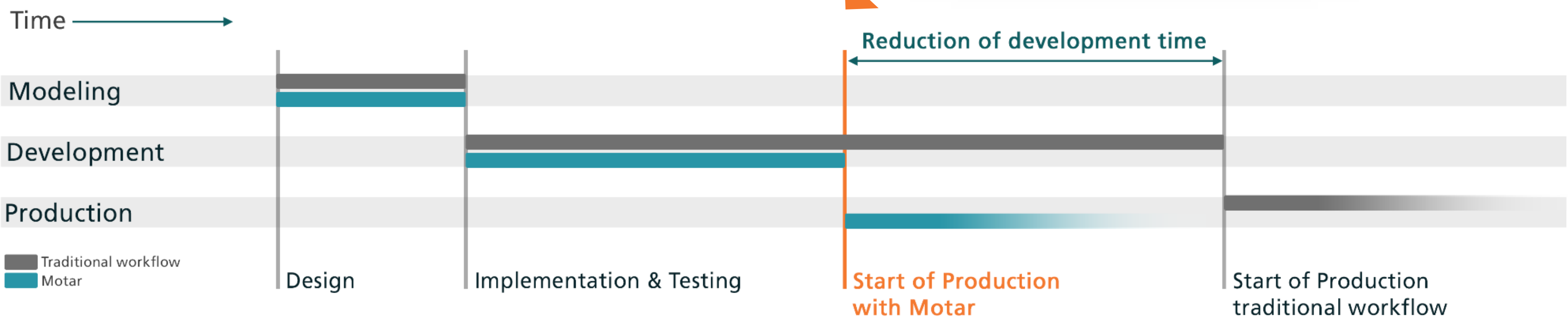
Model-based development – Workflow



Model-based development – Development time

24h LE MANS®



INMOTION
CHARGING AHEAD

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InMotion

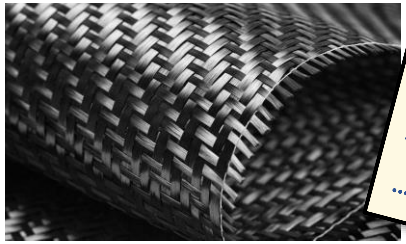
- Proving technology on the racetrack
  - Endurance under harsh conditions – temperature, G-forces, vibrations, oil, EMC, …
  - Fail safe electronic systems – the car should finish in the end

- Innovations originate from racing



Aerodynamics
Air intakes
Anti-lock brake system
Carbon fiber
Disc brakes
Dual overhead camshafts
Kinetic energy recovery system
Paddle shifters
Push-button ignition
Rearview mirrors
Safety
Seat belts
Suspension
Tires
Transmissions
…



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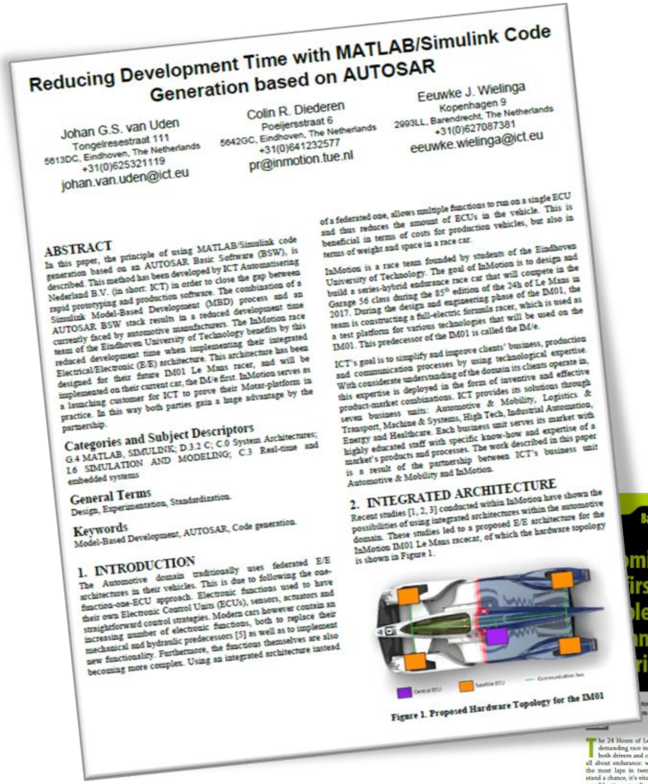
InMotion – A long-lasting partnership


Reducing Development Time with MATLAB/Simulink Code Generation based on AUTOSAR

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ABSTRACT

Categories and Subject Descriptors

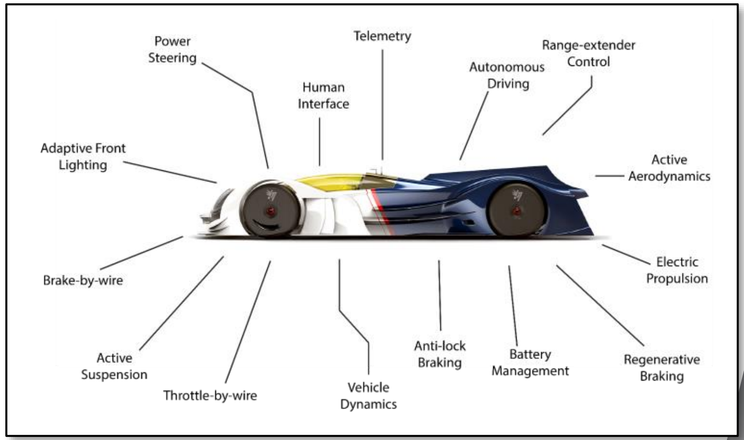
General Terms

Keywords

1. INTRODUCTION

2. INTEGRATED ARCHITECTURE

Figure 1. Proposed Hardware Topology for the IM01



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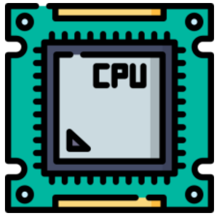
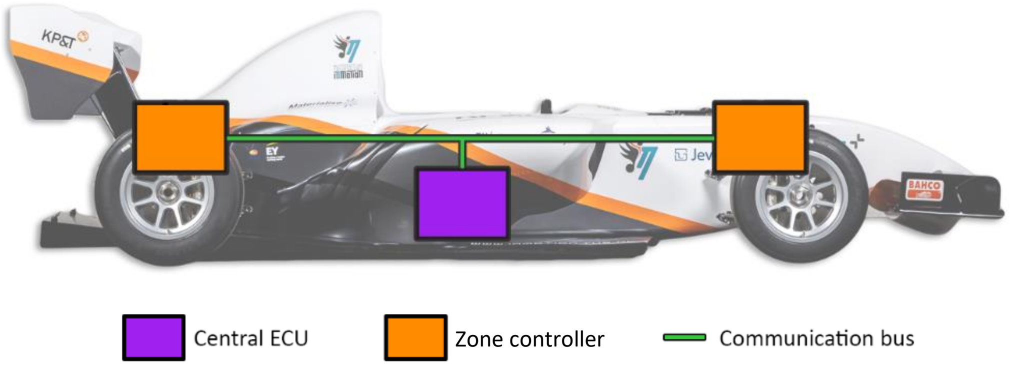
InMotion – Development of the Fusion

- Initial InMotion team during development of the first car mainly mechanical engineering students – limited to no software knowledge

- Managed to develop full functional vehicle SW – even before car was assembled



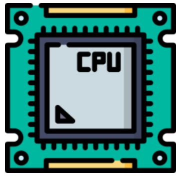


InMotion – Development of the Fusion

- Initial EMC challenges when testing the electronics for the first time on track – Diagnosing would have taken more time with a complex E/E architecture
- On-track adjustments and SW updates – Improving control strategies and application SW and immediately seeing the results on-track

InMotion – The Revolution

- **Focus on Fast-Charging** – sub-4-minutes charging achieved
  - Cooling of the battery is key
  - Testing the refrigerant loop outside of the car – On a test bench



- **SW development of 1 central and 7 zonal controllers** – all model-based
  - Re-use of existing control models

ICT Group – Motar Platform

Stand 7D109 – Visit our InMotion demonstrator!

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https://www.motar-platform.com