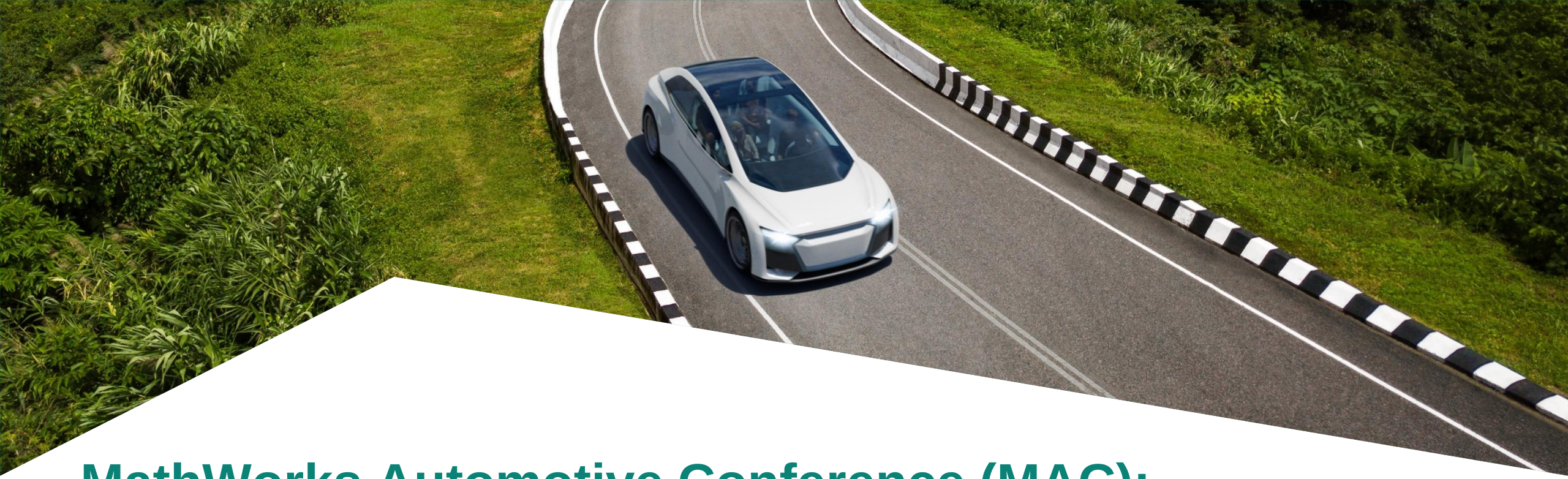


MathWorks Automotive Conference (MAC):

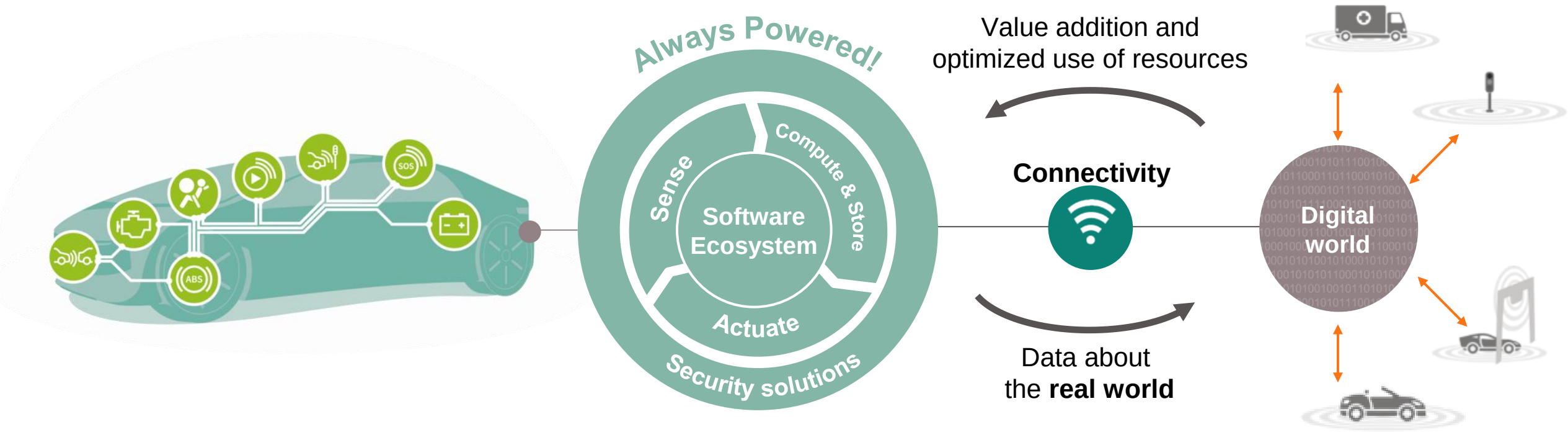
Higher efficiency with scalability in semiconductor and mixed EV architecture

Hans Adlkofer, SVP Automotive System

12th July 2023

The future car is fully connected and always online.
It requires an end-to-end solution and SW-defined architecture

The future car links the real world with the digital world and ensures safer and more efficient roads



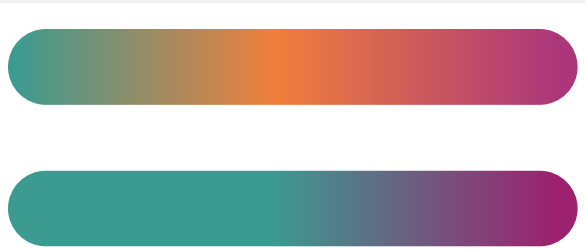
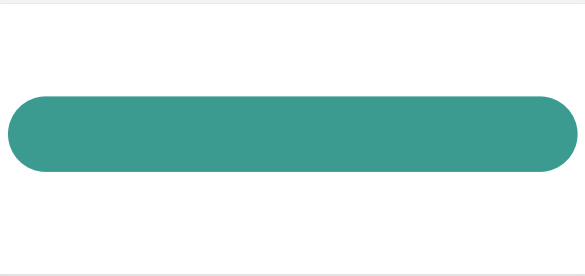
- This transformation requires enormous **computational horsepower, fail operational and security** as well as…
- …a SW ecosystem which allows **reuse, fast T2M, SW update of all important function & units and modern design tools** e.g. Model-Based Design and automatic code generation.

Customer value is the critical ingredient to innovation
EV market will be diverse, efficient use of energy remains a common goal

	Premium Mobility	Common Mobility	Basic Mobility	Mobility Service
Vehicle dynamic				
Range				
Charging time				
Operating hours				
Operating cost				
Cost of purchase				

Energy efficiency improvements are key to extend driving range
Therefore Infineon defined 10 kW/100km as its vision for the future.

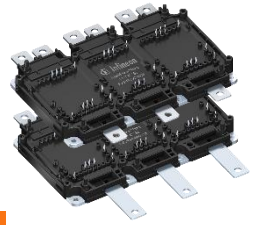
Transition to WBG will vastly differ by application with Si expected to remain technology of choice for many of them

Key automotive applications	2020	2030	Technologies
xEV traction inverter			**SiC** with advantage in **high power** switching performance and **power density**
DCDC HV-HV DCDC HV-LV On-board charger			**GaN** superior switching performance results in **higher efficiency** and **lower system cost**
Power distribution DC motor control Smart Power Switching LED lighting			**Si** is 3-4 times **cheaper than WBG**, will remain competitive in many applications where top performance and form factor are secondary

Si SiC GaN

SiC will be main material for traction inverter, complemented by Si-IGBTs wherever focus on cost is key

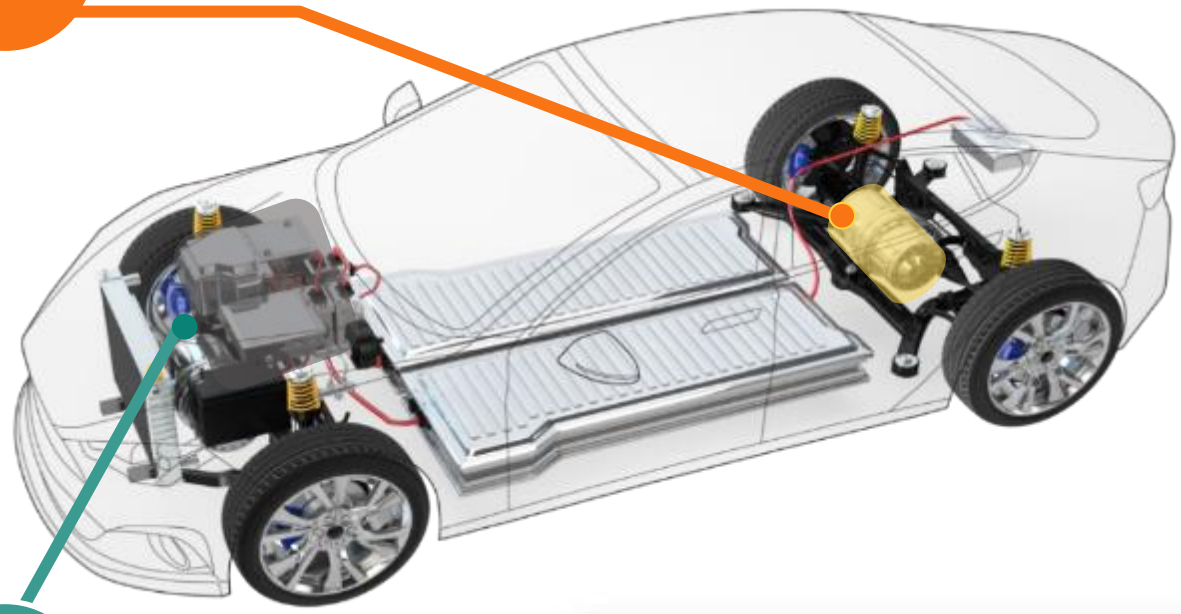
HybridPACK™ CoolSiC™
for primary axle



Focus on

- Range: **SiC**
- Cost
  - Large battery: **SiC**
  - **SiC** mixed with **IGBT**
  - Small battery: **IGBT**

SiC



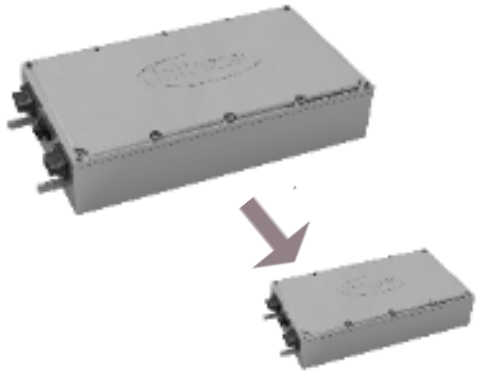
HybridPACK™ IGBT
for secondary axle

Focus on cost : **IGBT**

Si

On-board charger will move from SiC to GaN as high-power
With MDB we provide easy switch from Si to SiC to GaN

Today ~ 2kW/l

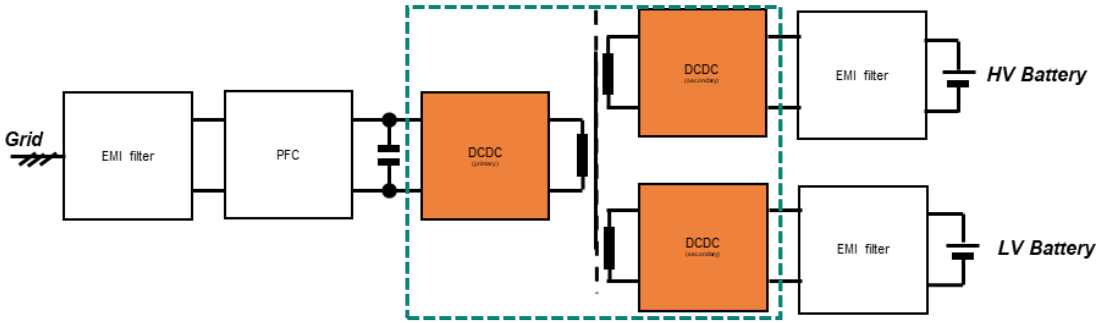


Moving to >10kW/l

in the size of less than 2 milk packs

- Functionality integration
- Topology enhancement
- Model based development

DCDC + OBC + Power distribution

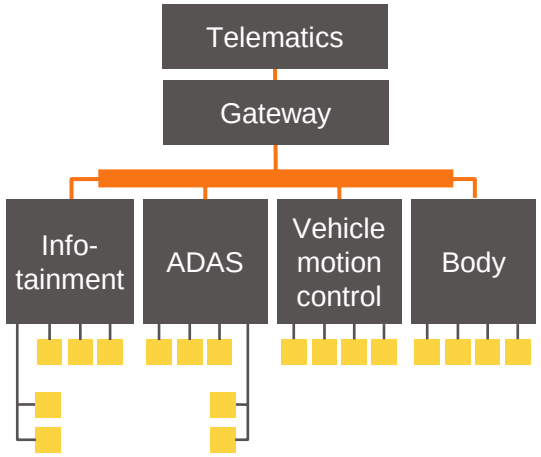


Hybrid Totem pole SiC + Si
650/750/1200V

650/750V based Multi-Level

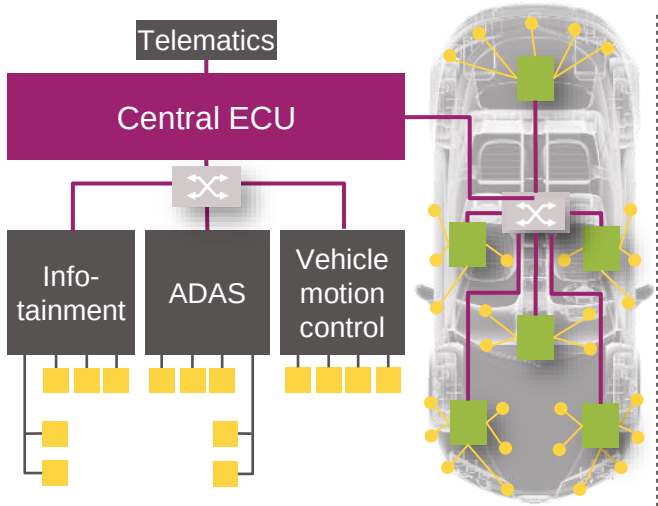
E/E architecture evolution towards SW defined architecture
This architectural transformation and not Revolution!

Domain Architecture

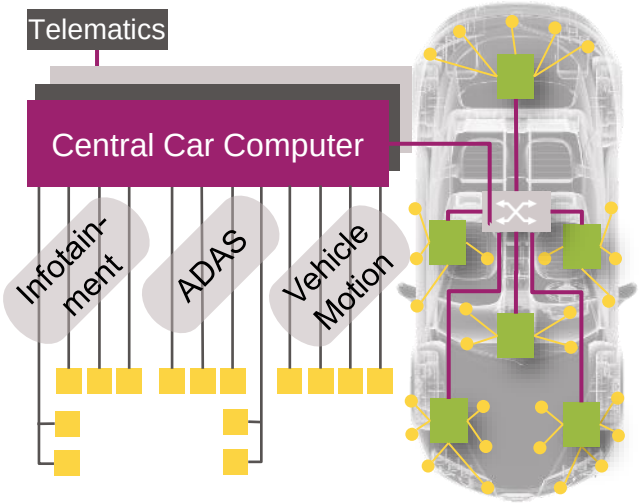


- Central Gateway
- Powerful domain controllers
- Separate function domains

Mixed Domain/Zone Architecture

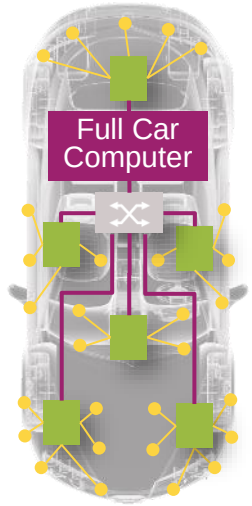


- ADAS, Infotainment, Vehicle motion (powertrain, chassis) remain in own, separated domains
- **One central ECU mainly controls Body-zones**:
  - Direct control of local body loads and their diagnostics
  - In charge of power distribution & management



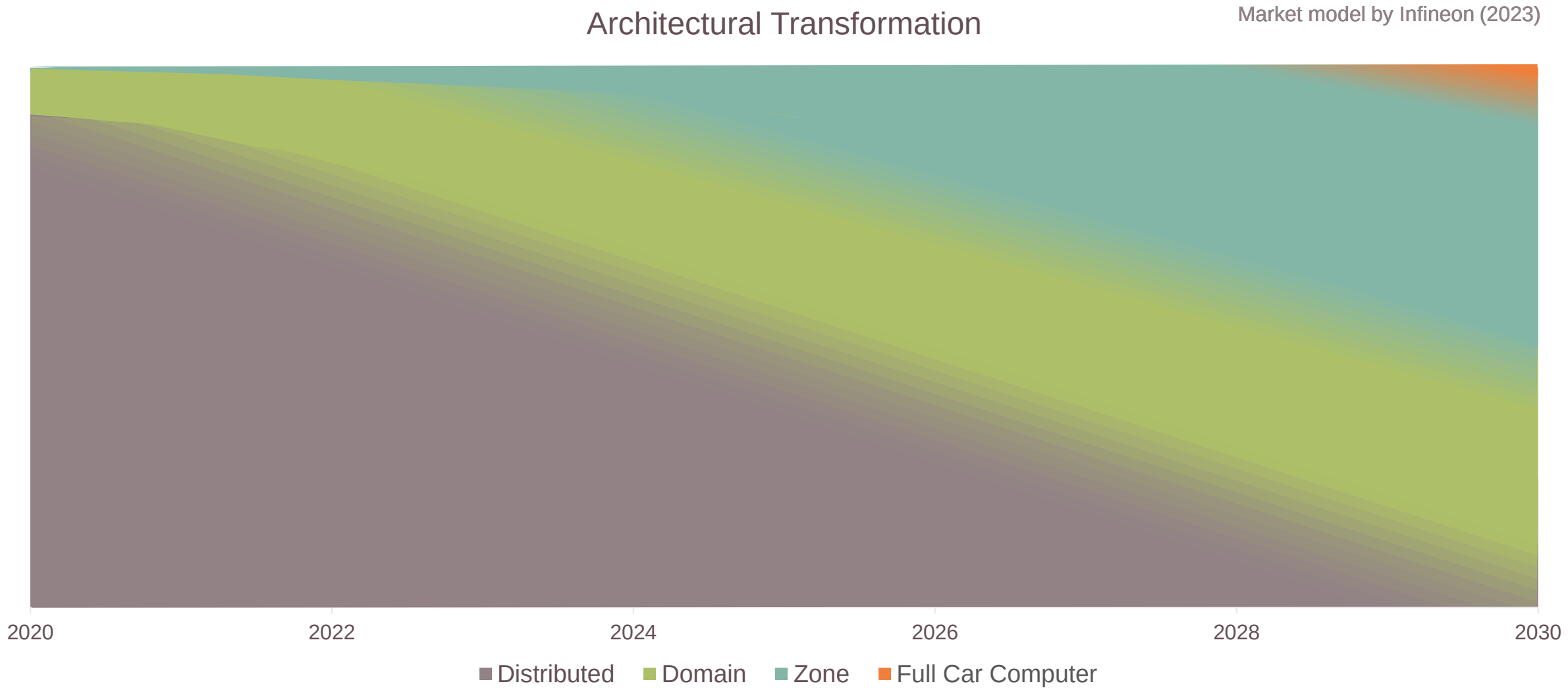
- Former domain controllers **evolve** to mighty **central car computers**
- **More complex zones**
  - Comprising body and comfort
  - Partly vehicle motion functions
  - Partly ADAS functions
  - Sharing of wiring leads to a function agnostic network
  - Increased saving of weight/cost

Full Car Computer

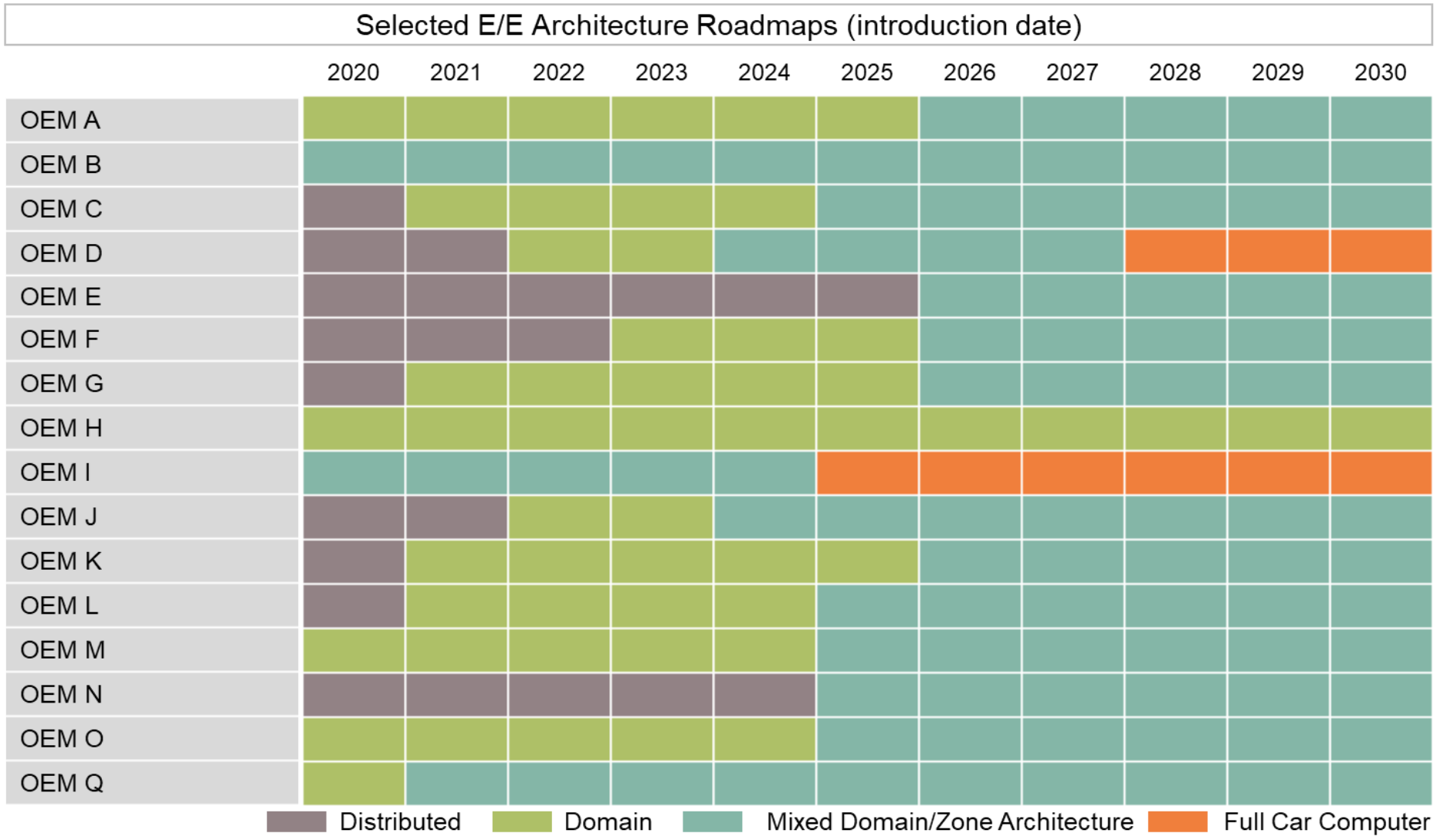


- Single or multiple Central Car computer(s)
- **Most advanced zones**
- Improved sharing of wiring
- full function agnostic network
- Lowest weight and cost of wiring harness

Zonal architectures will replace domain based in the upcoming years. However, a full zonal concept for all functions will take time to come.



Infineon Market Model 2023 - The majority of top16 OEMs will have introduced a mixed domain/zone architecture in 2026



Few OEMs will introduce a full car computer architecture in the second half of the decade

Volume OEMs are assumed to remain longer on a distributed architecture and go directly to a mixed domain/zone architecture

Premium OEMs are going for advanced version of a domain architecture. The introduction of a mixed domain/zone architecture remains to be seen

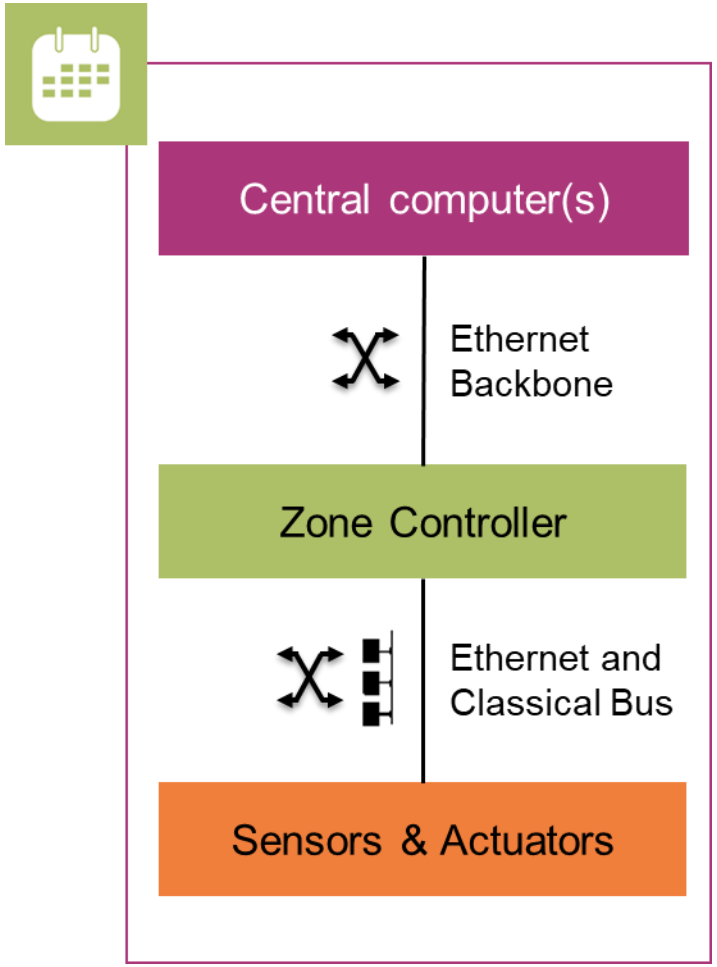
Many Chinese OEMs are introducing a mixed domain/zone architecture earlier than other key OEMs

Evolution to the software defined car - Mindset change in the vehicle development process towards models & virtualization

Source:
How To Catch a Moving Target in the Digital World
www.europeanbusinessreview.com

- OEM takes the lead for centralized software
- Functional integration rather than ECU specification
- Security-by-design & Update-by-design
- Decoupling Hardware/Software & virtual development
- Essential reuse of software pieces & strong eco system
- Transformation from HW to Model-Based Design develop
- Standardized actuators and sensors & virtual platforms

Change from hardware defined to a software centric architecture
Hierarchical software concept in a zonal architecture concept



High performance computing cluster

- Service oriented, Application cores in MPUs + companion MCUs
- Virtualization of computing resources
- Application software decoupled from hardware
- Integration of various applications

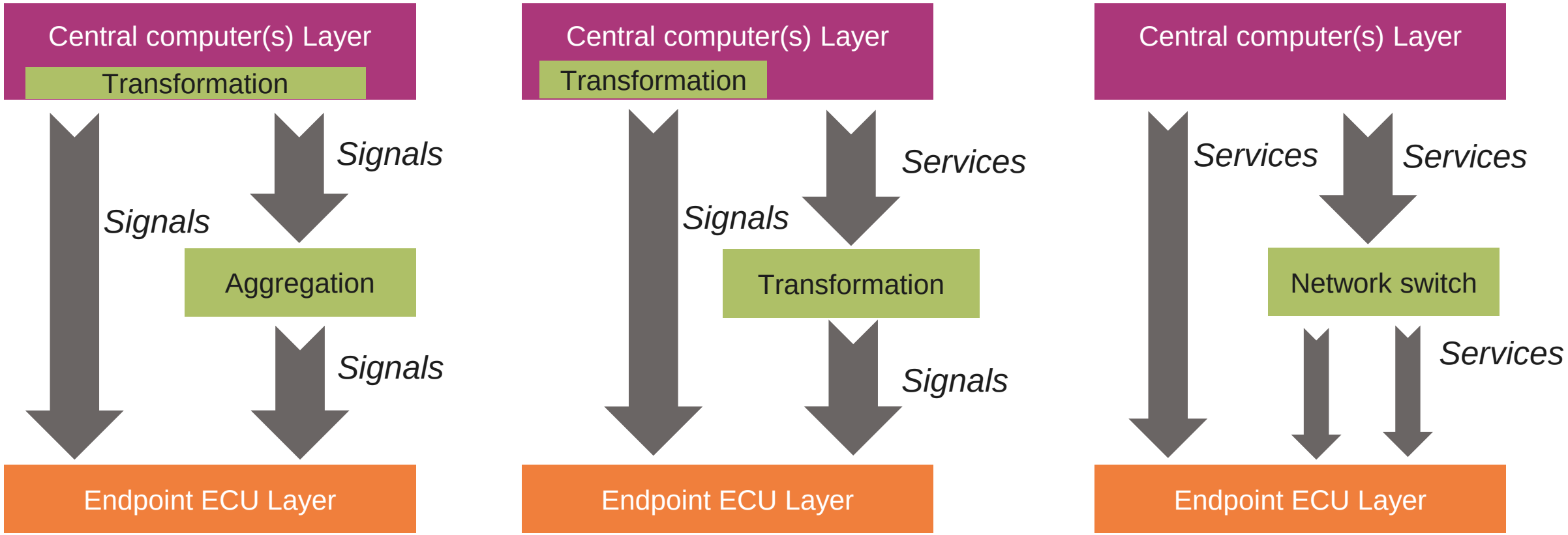
Service to Signal transformation

- Bridge between central computing and real-time satellites
- Converging in-vehicle networking and power distribution
- Enable significant harness reduction
  (power distribution to local sensors & actuator ECUs)

Real-time, signal based

- Bus connection to agnostic network
- Smart mechatronic solutions
- Local legacy ECUs enabling a smooth transformation from given topologies

In reality, OEM architectures will be a mix of these scenarios. There is no standard architecture in the near future nor standard OS

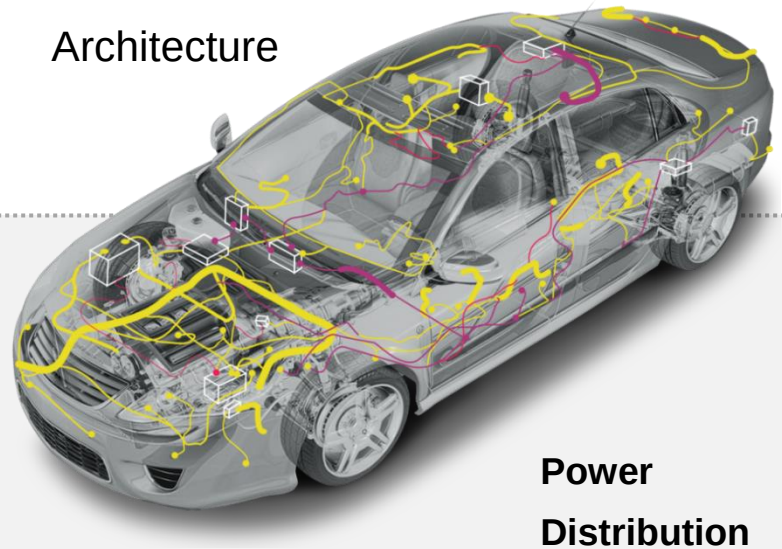


Complexity can be managed only by model based design plus strict virtualization and layer separation
→ **key challenge will be to manage SW complexity, validations and homologation**

The vehicle E/E Architecture includes two main functions: The In Vehicle Network (IVN) and the Power Distribution (PD)

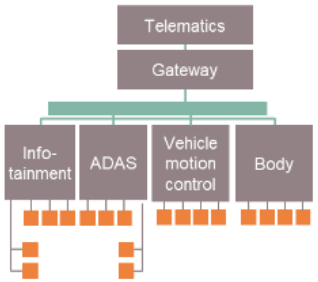
E/E Architecture

Electric and Electronic Architecture

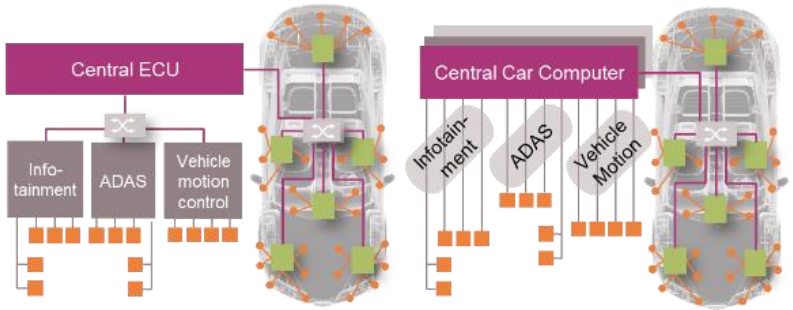


Data / Signal-Distribution & Computing

Domain Architecture



Mixed Domain/Zone Architecture



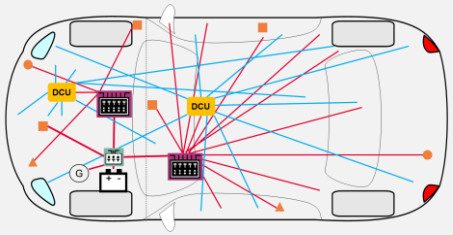
Full Car Computer

centralization

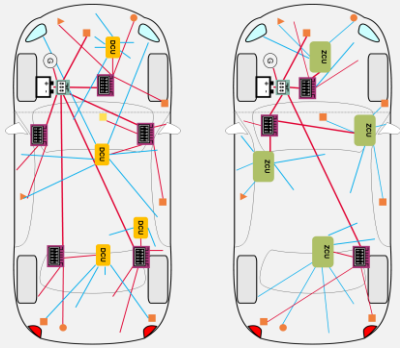
De-centralization

Power Distribution

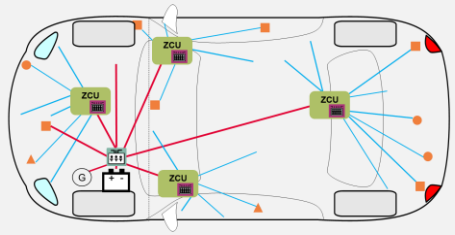
Centralized power distribution
Tree/ star Architecture



Partly decentralized power distribution



Decentralized power distribution
Zone Architecture

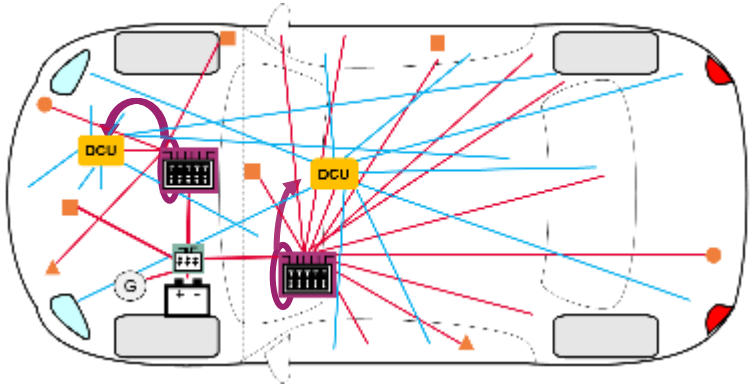


Focus of this Application Roadmap Level II: Power Distribution

Power distribution is a critical aspect of the new software defined E/E architecture, driven by E-Mobility, Automated driving and Connectivity

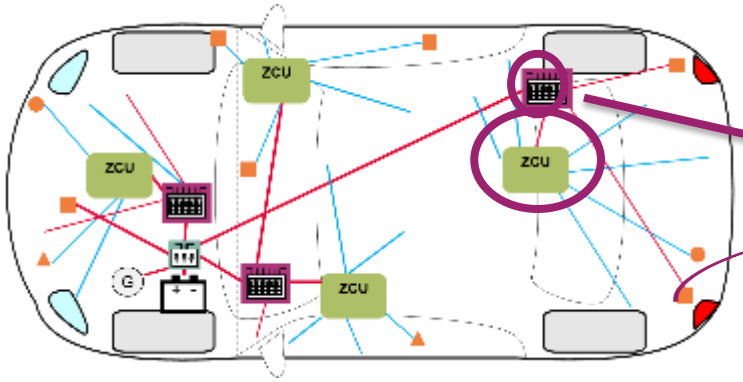
The Power Distribution System is transforming from a centralized to a decentralized zonal architecture

Centralized power distribution



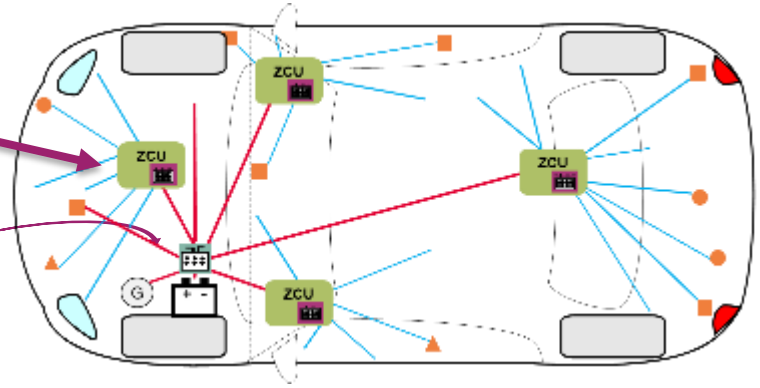
Solution with fuses and electromechanical relays for primary and secondary PDS

Partially decentralized power distribution



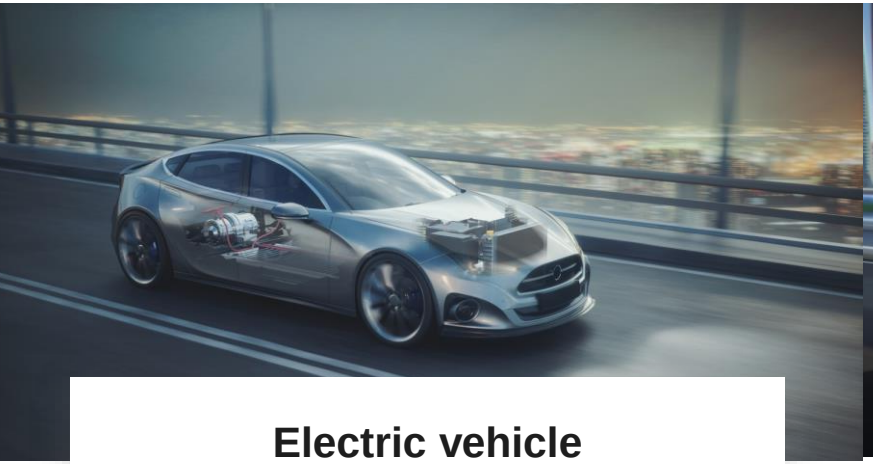
Replace fuses and relays
and create flexibility for decentralization

Decentralized power distribution

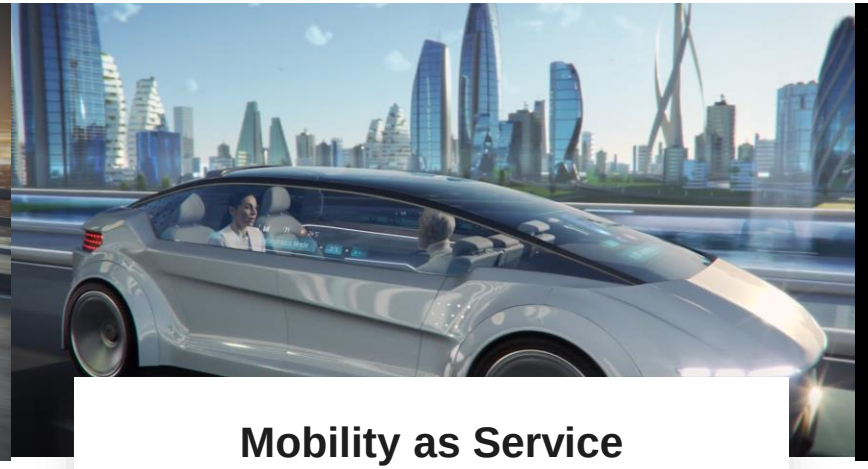


PDS integrated into zone controller

Product to system: How do balance SW with right E/E architecture
We have to virtualize SW & develop HW in model based environment



Electric vehicle



Mobility as Service

Server infrastructure

Microcontroller

Analog/mixed signal chip

Power switch

\+ Software & Algorithms

\+ Development Tools

Integrated ecosystem to achieve T2M and allow Innovation

Think Efficient Systems along the value chain

Transition to **WBG will vastly differ by application** with Si expected to remain technology of choice for many of them.

SW defined E/E architecture requires a new view on SW & HW components and requires more **virtualization and standardization.**

Power distribution becomes a critical aspect of the new E/E architecture and is **part of the SW-defined architecture**.

The KEY to win the game of T2M and innovation plus to manage the complexity of the new E/E Architecture will be **Virtualization & Model Based Design & Automatic Code Generation**

Part of your life. Part of tomorrow.