Trends of Future E/E-Architectures

How new Architectures change the Automotive Industry

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Future Mobility

Electrified, Automated and Connected

costs hybrid e-motor
eBike power electronics

electrified

plug-in eScooter range
fun-to-drive battery
charging infrastructure

legislation driver assistance
emergency braking autopilot

automated

highway-pilot sensors
redundancy electric steering
valet parking

electronic horizon
smartphone integration

connected

eCall cloud
services fleet management
car2car augmented reality

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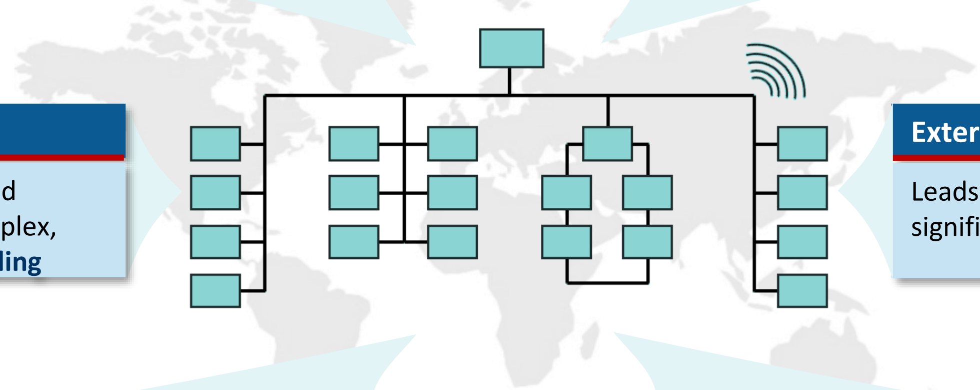
Trends of Future E/E-Architectures
Challenges and Bottlenecks

Functional Complexity
Wide **diversity** of **cross-domain functionalities** need to be handled and distributed

Flexibility
Future E/E systems need to allow swift **introduction of new innovations & SW sharing**

Scalability
Many segments, markets and technologies leading to complex, and expensive **variant handling**



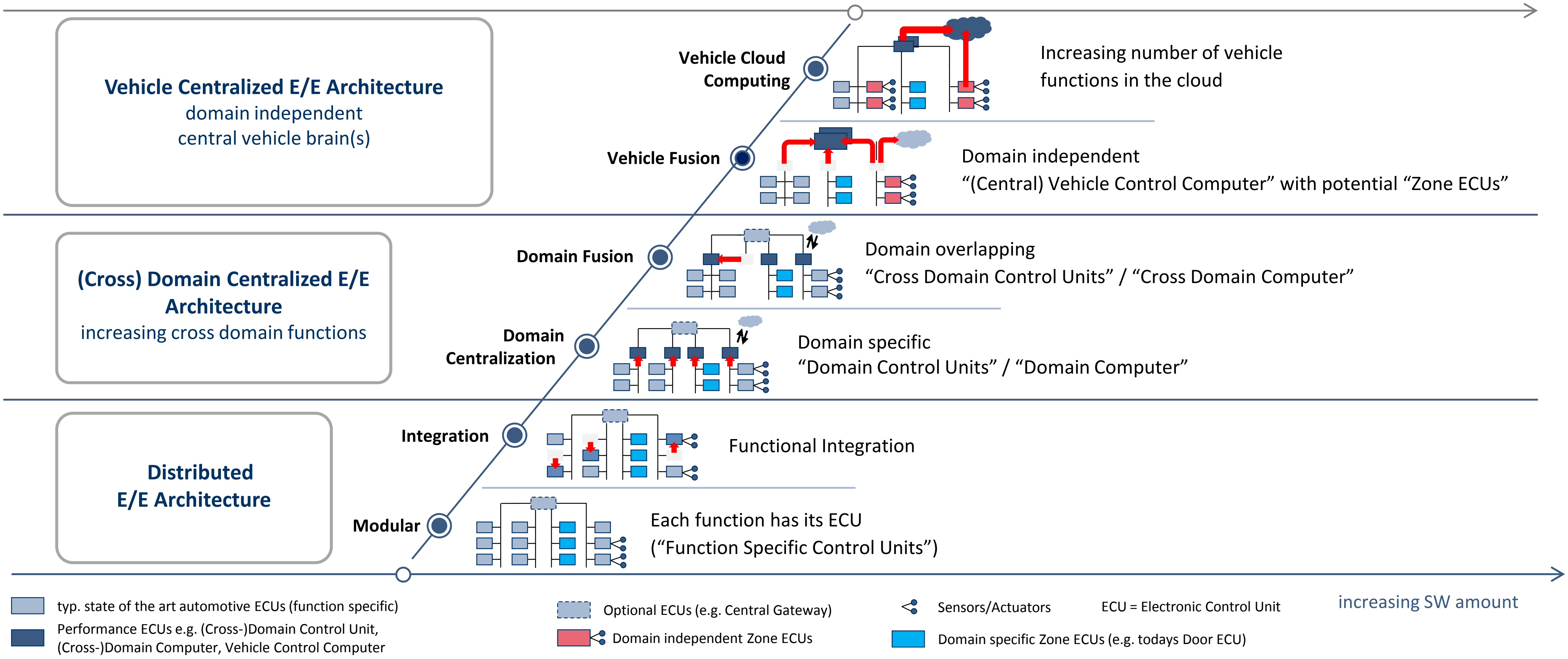
External Communication
Leads to higher data traffic and significant **security risks**

Communication Bandwidth
Inter-domain and cross-domain **communication bandwidths** not sufficient for future data traffic

Computing Power
Serial computing in embedded systems is hitting the **technological limits**

Trends of Future E/E-Architectures

BOSCH view on E/E-Roadmap



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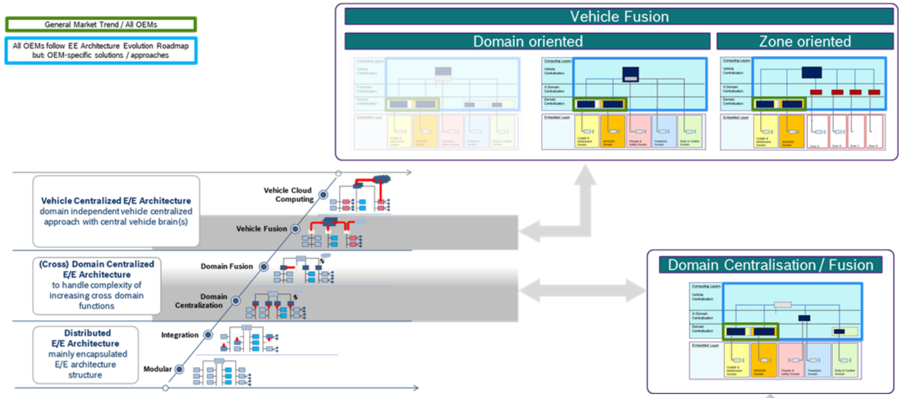
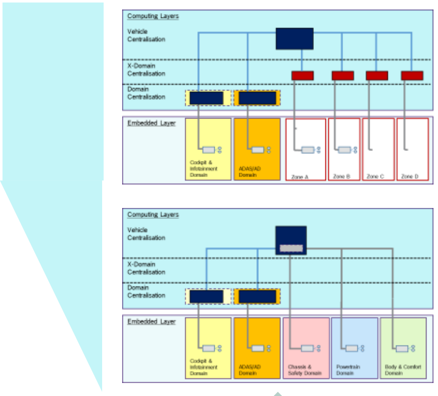
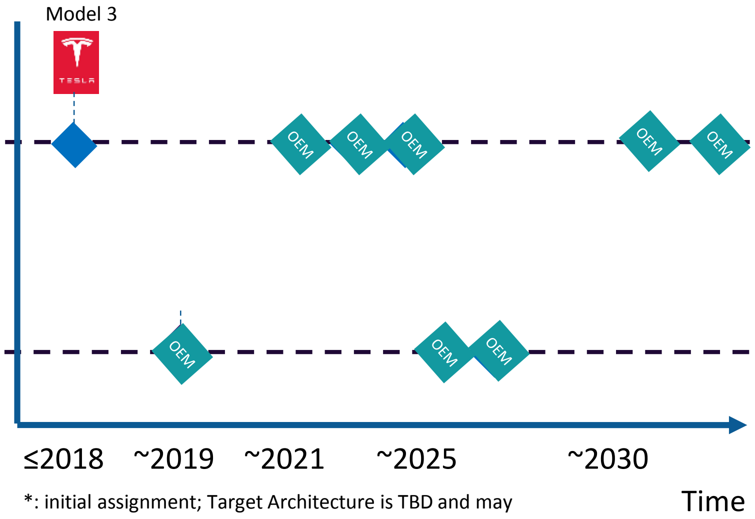
Functional & E/E Architecture - A Change for the Automotive Industry

Increasing Market Share of Vehicle Fusion EE Architectures







*: initial assignment; Target Architecture is TBD and may differ from associated picture

OEM -SOP for E/E architectures

- (Cross-) Domain centralized E/E-architectures still considered as mainstream 2021
- Increasing number of major OEMs envisage introduction of vehicle centralized E/E-architectures until ~2025
- Suppliers need to adapt their product portfolio for vehicle fusion architectures (Integration Platform Vehicle Computers, Zone ECUs, Application-SW, MW, ...)

*: initial assignment; Target Architecture is TBD and may differ from associated picture

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Trends of Future E/E-Architectures

High Complexity Meets Automotive Safety And Reliability

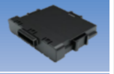
Embedded ECU | Vehicle Computer (*Supporting ARM and x86*) | AI Computer | Cloud Comp.

Integration Platforms (2 – 4) → Performance Platforms (4 – 6)

Mid (3) · High (4)

1 — Embedded ECU

1st SOP: 2019


Body computer

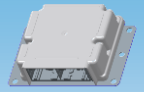
DMIPS: 1.500
RAM: 6 MB

µC

Autosar Classic

2 — Vehicle Computer

1st SOP: 2019


DASy 1.0 base

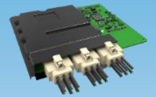
DMIPS: 3.000
RAM: 16 MB

µC

Autosar Classic

3 — Vehicle Computer (Mid)

1st SOP: 2020


MAP ECU


PT ECU

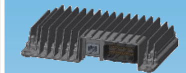
DMIPS: 10.000
RAM*: 16 MB-1GB

µC
µP

Autosar Classic+
Adaptive
Posix OS

4 — Vehicle Computer (High)

1st SOP: 2019


DASy 1.0 enhanced


Head Unit

DMIPS: 14.000-34.000
RAM*: 512 MB-3GB

µC
µP

Autosar Classic+
Adaptive
Posix OS

5 — AI Computer

SOP: 2021


DASy 2.0

DMIPS: 260.000
TOPS: 300
RAM*: 32 GB

µC
µP
HW acceleration

Autosar Adaptive
Posix OS
AI

6 — Cloud Comp.

SOP: 2025

DMIPS: 500.000
TOPS: >300
+ Cloud

µC
µP
HW acceleration

Autosar Adaptive
Posix OS
AI

* ROM: Extension by eMMC possible

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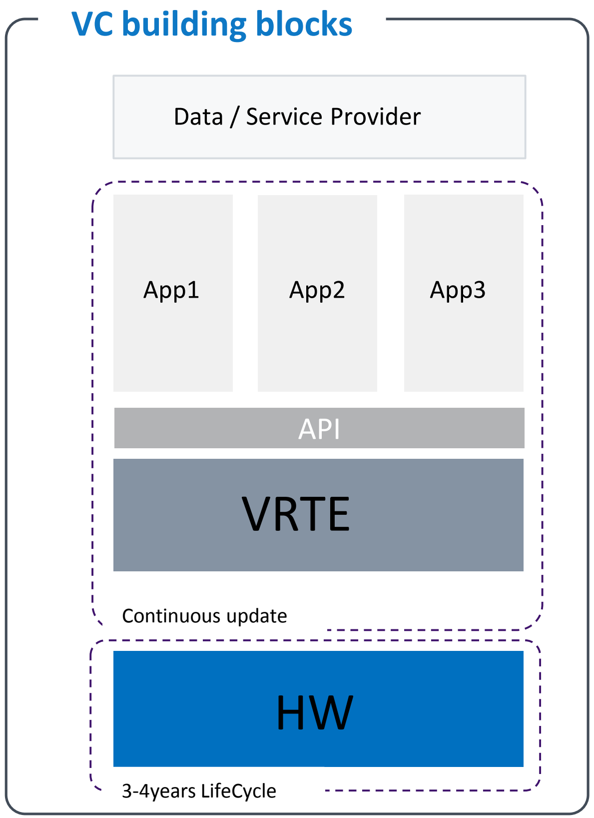
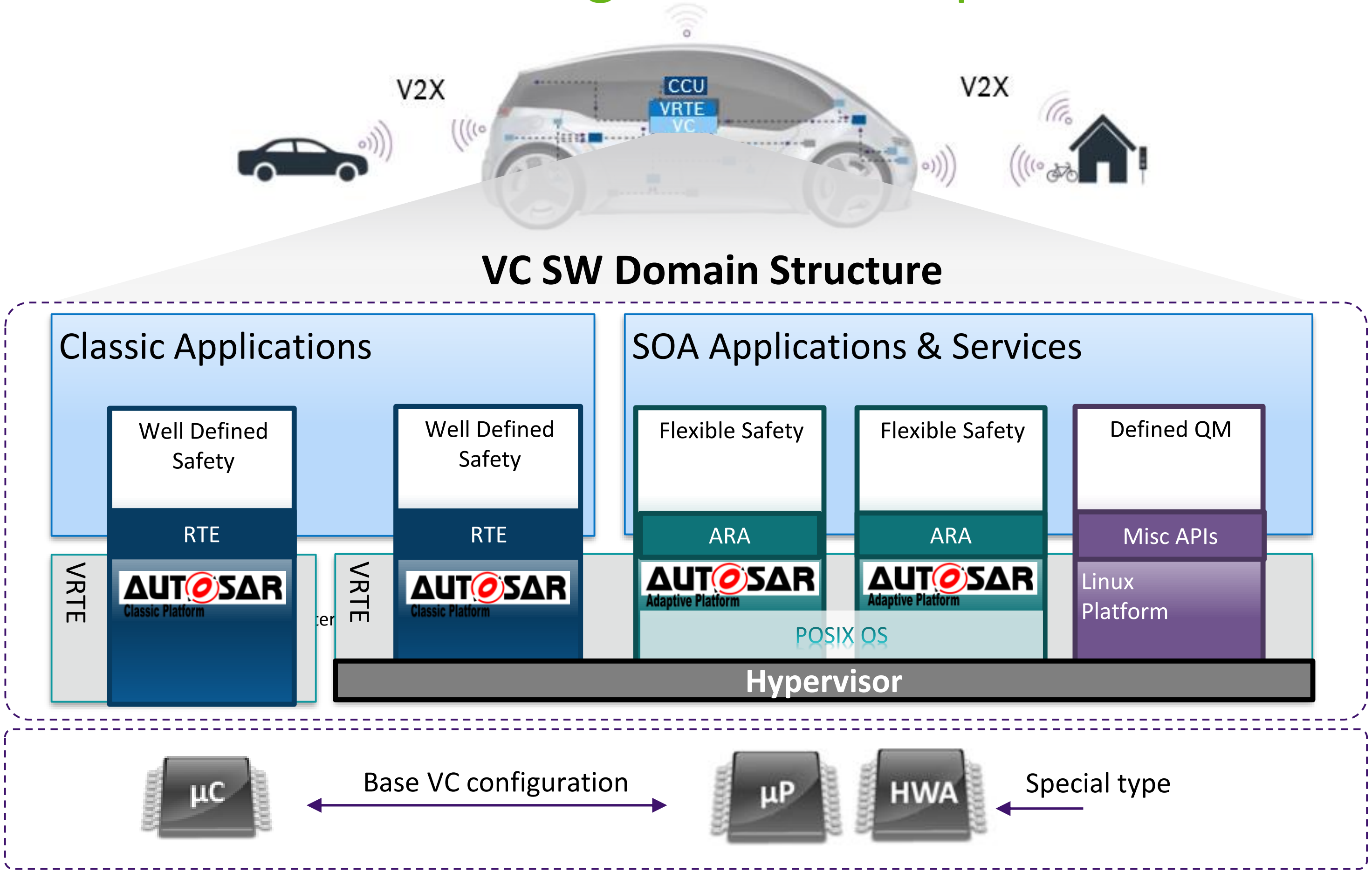
Trends of Future E/E-Architectures

Vehicle RunTime Environment: Software enabling Vehicle Computers





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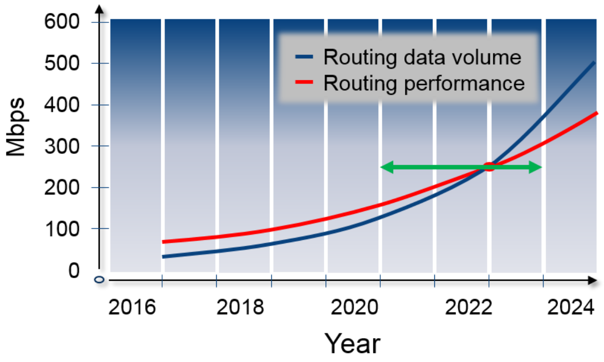
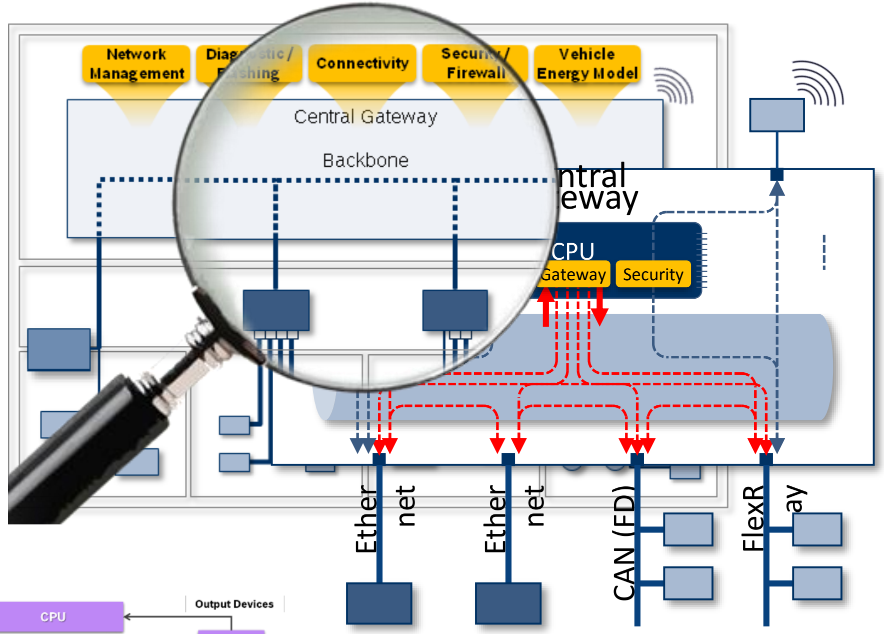
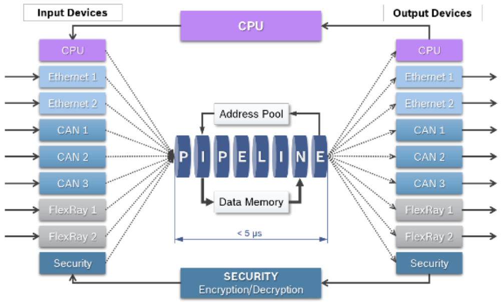
Trends of Future E/E-Architectures
Hardware Acceleration for Central Gateways





ETAS Data Engine

- "Any to any" interface, non-blocking bridging with **low latency (< 2 µs) and low jitter (< 1 µs) , high bandwidth (> 20 Gb/s)**
- Operates on OSI-Layer 2-4 (incl. TCP, UDP, CAN TP, FlexRay TP, 1722)
- **Offloads the CPU** and reduces the interrupt load
- Supports **typical automotive interfaces**: CAN-FD, FlexRay, Ethernet, PCIe
- **Configurable, flexible and extendable** by dedicated software and hardware functionalities



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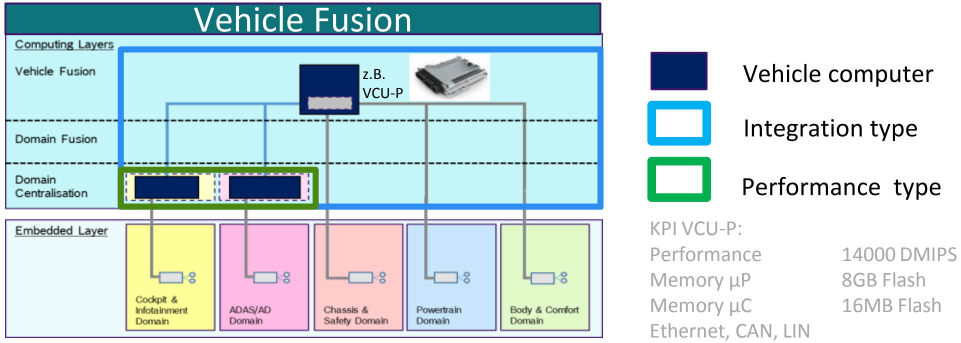
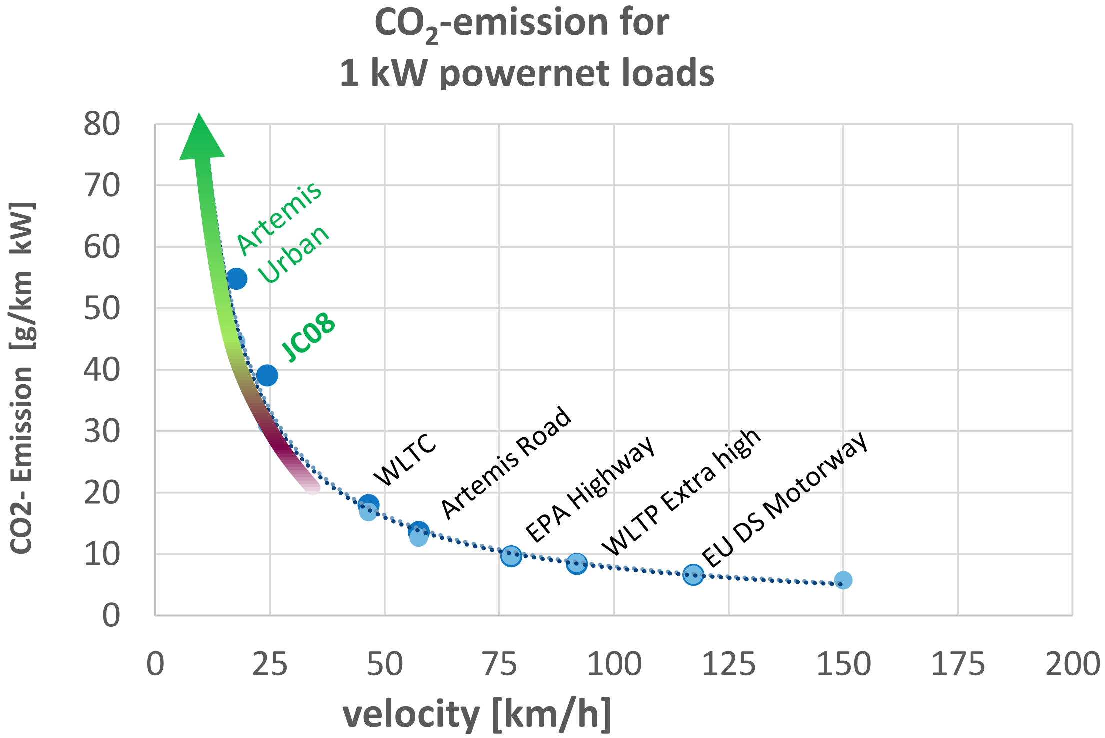
Energy consumption depending on E/E-Architecture



KPI VCU-P:	
Performance	14000 DMIPS
Memory µP	8GB Flash
Memory µC	16MB Flash
Ethernet, CAN, LIN	



- Growing functionality w/ higher computing & communication performance drives the electrical power demand (up to 4 kW)
- Tightening CO_2-emission (ICE) regulations and range requirements (BEV) limit the overall power consumption
- Future E/E-architectures have to become more energy efficient (e.g. HW/SW co-design, local HW-accelerators, …)

In city cycle, 1 kW Powernet-Load increases CO_2-Emission by >30 g/km (cf. Japan. Citycycle JC08)

Assumptions acc. Premises vector 2.0: CompactClass-G5.1, DI/TC 1.0L, 3zyl, 90kW, Efficiency_BRM = 0,85
vehicle weight (Veh+EM+Bat) = 1490 kg, cross section = 2.13 m², cw = 0.248, rolling radius = 306.5 mm, roll friction = 0.008

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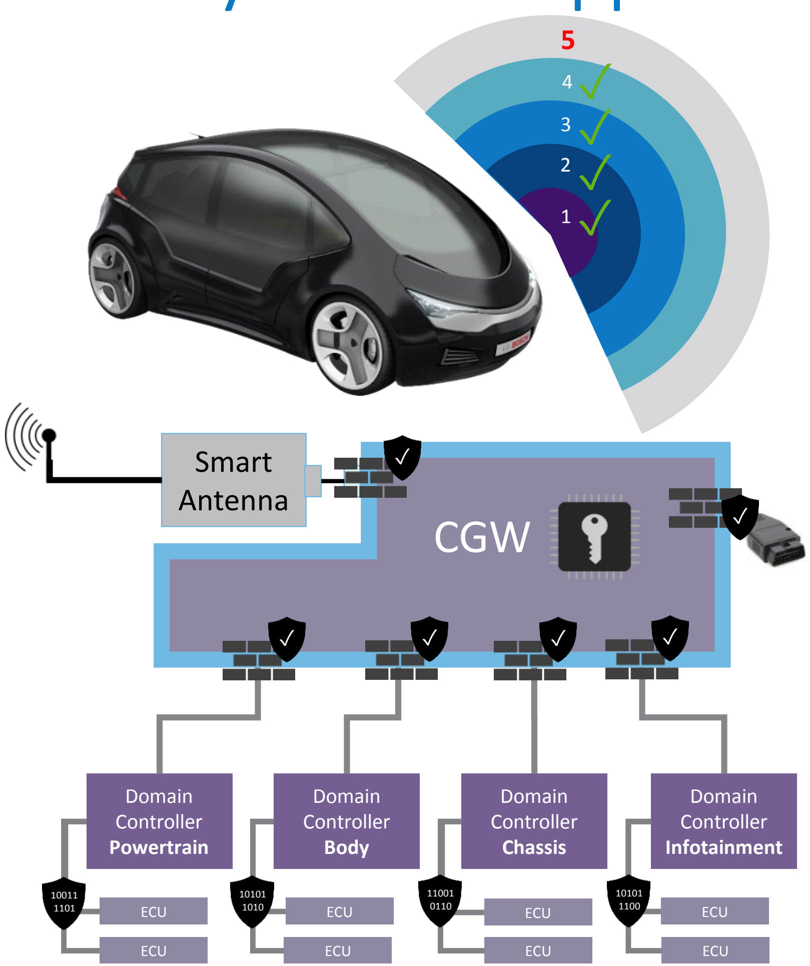
Security: Holistic Approach



5 Intrusion Detection System
Monitors data communications and logs abnormal events

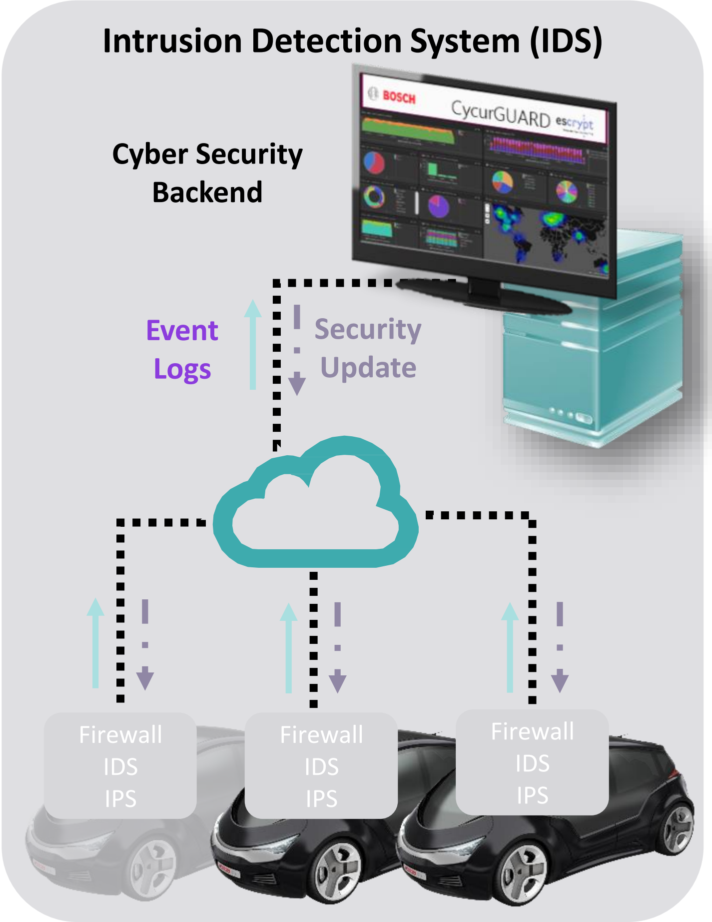
4 Connected Vehicle
Vehicle firewall and security standards for external interfaces

3 EE Architecture
Protected and separated domains by E/E architecture and gateways

2 In-Vehicle Networking
Integrity protection of critical in-vehicle signals and messages

10011
1101

1 Individual ECU
ECU software and data integrity protection



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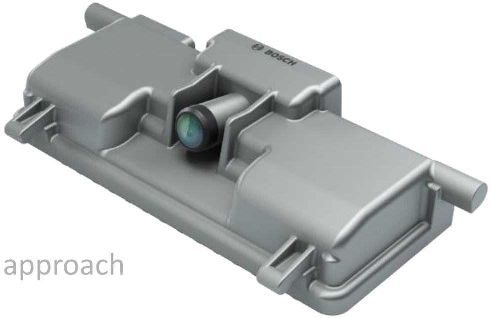
Multi purpose camera



Safe perception through an algorithmic multi-path approach

large field of view
for detection of crossing vulnerable road users

high angular resolution
with increased range at the center

artificial intelligence
for robust perception and behavior prediction

FEATURES

Bosch system-on-chip for ultra-high performance algorithms (flow, classifiers, disparity) with low power consumption and low thermal dissipation

Reliable full scene understanding for increased safety using algorithmic multi-path approach

Semantic segmentation based on deep learning and optical flow for model-free video processing

Optical path optimization for advanced driver assistance systems

Front radar sensor plus

Impresses with improved precision, wider range and opening angles

scalable
construction kit

immune
to adverse weather conditions

high performance
with advanced Bosch chirp sequence modulation scheme

FEATURES

NCAP (AEB City, AEB Inter-Urban, AEB Vulnerable Road Users)

Improved comfort for Adaptive cruise control (ACC) up to 210 km/h

Partially automated driving (supports traffic jam assist / pilot, highway assist)

Multi-object tracking

Handles complex traffic situations

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Trends of Future E/E-Architectures
Summary

- Automated, Connected , Electrified & Shared (ACES) drive …
  - … the tremendous growth of cross domain functions and system characteristics like functional safety, cyber security and energy management and hence system complexity
  - … the functional centralization and introduction of vehicle integration platforms and zone controllers
- In future, vehicle functions can / will be re-allocated to vehicle computers according to changed requirements and constitute the separation of SW from HW
- New architectures require high computational power and communication bandwidth but need simultaneously high power efficiency leading to the use of HWA for selected applications
- Higher AD level (> SAE L3) need large numbers of number of sensors with technological diversity

Vehicles become the internet devices with the most complex software and highest computational power

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Thank you!

The Revolution of
Automotive Architectures
has started

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